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Development of a Tool for Quantifying Need-Supportive Coaching in Technology-Mediated Exercise Classes

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Abstract

Technology-mediated interventions to promote physical activity are growing in popularity and appear to be effective for supporting continued adherence for some people. Some of this efficacy may be related to the cultivation of motivation that is self-determined (i.e., autonomous), which is posited to arise from the satisfaction of three basic psychological needs: competence, relatedness, and autonomy. We developed an observational coding tool for quantifying the frequency of needs-supportive and needs-indifferent coaching during technology-mediated exercise classes. The Peloton Instructor Needs-Supportive Coaching (PINC) tool shows evidence of reliability (average kappa = .91). We also demonstrated the utility of the PINC for characterizing needs-supportive coaching profiles across 4 different types of classes (Beginner, Power Zone, Groove, and High-Intensity Interval Training) and the construct validity of the PINC with respect to examining the relationship of needs-supportive coaching to intrinsic motivation. The PINC offers a useful tool with which future studies could evaluate whether and how instructor coaching impacts self-determined motivation to exercise within a technology-mediated context.

Keywords

technology-mediated; Self-Determination Theory; relatedness; competence; autonomy

Physical activity (PA) confers clear health benefits (Ozemek et al., 2018; US Department of Health and Human Services, 2018; Warburton & Bredin, 2017; Wu et al., 2017) and many adults who are not regularly active intend to increase their activity (Courneya, Plotnikoff, Hotz, & Birkett, 2001; YouGov Plc, 2020) yet roughly half of American adults fail to meet recommended PA guidelines (Centers for Disease Control and Prevention, 2021), and

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Declaration of Interest

None.

48% of those who intend to be active will fail to execute their intentions (Rhodes & de Bruijn, 2013a), suggesting that effective strategies to facilitate the translation of activity intentions into activity behavior could have a major impact on individual and public health. Intention is increasingly recognized as a necessary but insufficient precursor to adoption of regular activity (Rhodes & de Bruijn, 2013b), leading to the development of a number of theories of behavior change that focus specifically on the intention-behavior gap (Rhodes & Yao, 2015). Despite a plethora of studies on the topic, existing research has not yet yielded compelling evidence for the power of any particular behavioral theory to explain intervention-related PA behavior change (Rhodes, Boudreau, Josefsson, & Ivarsson, 2021), but the available research indicates that common barriers to PA adherence include lack of convenience (timing and location of exercise facilities and classes), discomfort with an unfamiliar gym environment, and a lack of peers with whom to exercise (Morgan et al., 2016).

Recent research suggests that technology-mediated interventions hold some promise for closing the intention-behavior gap (Kim, Lee, & Lee, 2021), but published research has not kept pace with the rapid innovation in the consumer-oriented marketplace. Various modalities of technology-mediated home exercise products have been developed to suit consumer preferences, including (but not limited to) stationary bike (e.g., Peloton, SoulCycle At-Home Bike), treadmill (e.g., NordicTrack, Peloton Tread), and resistance training (e.g., Tonal, Tempo Studio) (Moscaritolo, 2021). Common product features include equipment for the home, a screen to stream live or recorded instructor-led classes, performance metrics, and a social component allowing users to connect and compete with other users. These products also have an associated subscription-based application which provides access to workout content and allows new content to become available to the consumer. Purchasing the equipment and subscribing to the associated application is a clear demonstration of an intention to exercise, and the minimization of the barriers related to convenience and social support greatly enhances the probability that individuals who obtain these technology-mediated home exercise products will successfully execute their plans to be physically active. Moreover, with these social and environmental barriers effectively minimized, these products offer a promising platform for evaluating the efficacy of specific behavior change techniques.

It could be argued that these technology-mediated home exercise products have limited generalizability, as the upfront cost of the products ranges from $1,500–3,000 and the monthly subscription fees range from $40–50; an expense that is unaffordable for many people. Yet there is good reason to anticipate that potential savings in healthcare costs make technology-mediated home exercise products a worthwhile investment. An agreement between UnitedHealthcare (a Medicare Advantage organization with a Medicare contract) and Peloton Interactive, Inc provides eligible UnitedHealthcare members free access to the Peloton App (the subscription-based software that offers a library of fitness classes live and on demand) for 1 year (UnitedHealth Group, 2021). The willingness of healthcare insurance companies to offer their members access to technology that promotes PA is commensurate with the evidence that long-term benefits and financial savings gained from regular PA outweigh the short-term cost. Estimated annual per patient disease-related costs are $3,968–6,491 for chronic obstructive pulmonary disease, $29,384–46,194 for cancer,

and $3,212–4,674 for diabetes (Chapel, Ritchey, Zhang, & Wang, 2017), and individuals with hypertension face about $2,000 higher annual healthcare expenditures compared to individuals without hypertension (Kirkland et al., 2018). Physical activity has been shown to reduce the risk and health impact of each of these chronic health conditions (Carbone, Del Buono, Ozemek, & Lavie, 2019; Hirayama, Lee, & Hiramatsu, 2010; National Cancer Institute, 2020; Pescatello et al., 2019), and therefore it is unsurprising that evidence shows that regular PA participation reduces annual healthcare costs. A study of Medicare claims among 21,750 older adults found that those who consistently engaged in PA throughout the lifespan saw an average annualized total healthcare savings ranging from $1,365 to $2,079 per year when compared to inactive individuals (Coughlan, Saint-Maurice, Carlson, Fulton, & Matthews, 2021). Thus, whereas the cost of technology-mediated home exercise products appears high, it is apparent that if they are effective for promoting PA there are likely to be additional opportunities for consumers to gain access to these products through health insurance and/or employer initiatives.

Corporate and government support of access to technology-mediated home exercise products will likely grow commensurate with the evidence for efficacy, and such evidence will be most impactful if it is accompanied by an understanding of why and for whom the products will be effective. The Self-Determination Theory offers a perspective on why these products may be effective. Self-Determination Theory (Ryan & Deci, 2017) posits that individuals will show greater behavioral persistence when their motivation is more self-determined, as opposed to being driven by external incentives, and research confirms that those whose motivation to exercise is self-determined are more likely to engage in regular PA (Teixeira, Carraca, Markland, Silva, & Ryan, 2012). Moreover, a recent meta-analysis of 73 health behavior intervention studies informed by Self-Determination Theory (Ntoumanis et al., 2021) found evidence for positive changes in health behavior that were associated with increases in self-determined motivation. The psychosocial process for strengthening self-determined motivation is described within the Basic Psychological Needs Theory (BPNT), which is considered a mini-theory within Self-Determination Theory (Vansteenkiste, Ryan, & Soenens, 2020), and which holds that increased self-determined motivation will emerge as a function of the satisfaction of the essential needs for autonomy (the experience of volition and willingness), relatedness (the experience of warmth, bonding, and care), and competence (the experience of effectiveness and mastery). Ryan and Deci (2000) posit that individuals are naturally driven to be intrinsically motivated for activities that have the appeal of novelty, challenge, or aesthetic value, and that intrinsic motivation will naturally flourish under conditions that support satisfaction of the basic psychological needs. Moreover, there is empirical evidence that autonomy, competence, and relatedness can be fostered or thwarted by the social interactions between an exerciser and a coach (Rodrigues & Macedo, 2021; Ryan & Deci, 2017).

A large body of research in the sport and physical education (PE) domain demonstrates that autonomy-supportive coaching behaviors positively impact the satisfaction of basic psychological needs among athletes and students (Amorose & Anderson-Butcher, 2007; Kalajas-Tilga, Koka, Hein, Tilga, & Raudsepp, 2020; Li et al., 2019; Vasconcellos et al., 2019). Moreover, autonomy-supportive coaching, in which exercise adherence is encouraged using coaching strategies that target competence, relatedness, and autonomy, has been shown

to increase autonomous motivation for exercise when delivered either in person (Rutten et al., 2014) or through YouTube (McDonough, Helgeson, Liu, & Gao, 2022). It is unknown if the same dynamics will hold with technology-mediated coaching, although a qualitative study with users of a technology-mediated stationary cycling product found that a key component of the user experience lay within the relationship between the rider and the instructor (Richardson, 2020). Extending this work, the present study used a BPNT approach to develop a tool for quantifying the frequency of needs-supportive coaching strategies utilized by instructors during a technology-mediated exercise class.

It should be noted that several observational tools already have been developed to characterize the coaching environment in PE and sports settings; yet these tools are not easily applied to characterizing technology-mediated exercise classes. Created primarily with the intent for being used in a school or exercise club setting, these tools (e.g., Haerens et al., 2013; Quested, Ntoumanis, Stenling, Thogersen-Ntoumani, & Hancox, 2018; Tessier et al., 2013; Webster et al., 2013) assume that instruction is being delivered in real time in a group setting to students or athletes who have the opportunity to interact with their coach before, during, and after the class. To date, we are aware of no published observational tools appropriate for use among adults who are exercising asynchronously with a pre-recorded coach on their own at home. Moreover, until the recent explosion in availability of these platforms, combined with the pandemic-inspired appeal of being able to engage with an exercise instructor from the safety and comfort of home, there was little need for such a tool. Looking ahead, however, the availability of an observational tool that might be deployed in these settings could make possible a range of research that could help close the gap between exercise intentions and exercise behavior among the large proportion of the adult population that stands to derive health benefits from increasing their participation in PA.

The approach adopted in the present study builds on lessons learned from prior work developing observational tools to characterize features of coaching in the PE context. In a review of such tools, Smith et al. (2016) made several recommendations. To optimize the value of research using observational tools, Smith et al. recommended that results should be reported both for individual behavioral strategies as well as for aggregated scores that reflect broader dimensions of the coaching environment. These authors also highlighted the benefits and costs to using a frequency-based rating scale as opposed to a potency-based rating scale. Although the latter has the potential for better characterizing the overall quality of the coaching, frequency-based rating scales were noted to be more objective and have higher reliability. With regards to establishing the validity and reliability of observational tools, Smith et al. drew on prior work (e.g., Brewer & Jones, 2002; Duda, 1998) to recommend a range of approaches including training observers, amending an instrument to be context-specific, establishing face validity, and establishing inter-observer reliability. In the present study, we chose a frequency-based scoring approach to maximize reliability, examined both individual and aggregated scores to facilitate interpretation of the results, and incorporated a range of strategies to establish validity and reliability.

In developing an observational tool for characterizing features of coaching delivered through a technology-mediated exercise platform, several contextual elements are immediately apparent that differentiate this task from similar endeavors undertaken in the context of

live PE classes or sports. Primary among these distinguishing features is the asynchronous nature of the classes and the one-way communication stream. Exercisers are primarily passive recipients of the remotely delivered and pre-recorded video stream. Thus, unlike a live PE or group exercise class, exercisers are cognizant that they are not interacting in real time with the instructor. The absence of an opportunity for the instructor to react in real time to participant behavior makes certain types of behaviors that have been coded in observational tools developed in live settings (e.g., "acknowledging the participants' feelings and responding appropriately"(Quested et al., 2018)) less relevant in an asynchronous technology-mediated context.

In the present study, therefore, we developed an observational tool suitable for characterizing asynchronous technology-mediated exercise sessions. Using Peloton cycling classes as a use case, we created a frequency-based observational coding system to quantify the proportion of time that instructors spent delivering coaching that targeted the three basic psychological needs of autonomy, relatedness, and competence. As evidence for the reliability and potential utility of this tool, we describe the rigorous iterative approach to the tool development, examine the ability of the tool to discriminate between different class types, present data on inter-rater reliability, and provide an example of the tool's construct validity in a study examining the association between needs-supportive coaching and intrinsic motivation. We anticipate that our approach will be useful in future research seeking to evaluate the efficacy of specific behavior change techniques for promoting PA across specific populations or for specific health conditions.

Method

PINC Development

The PINC was developed using an iterative multi-stage process. In Stage One of the PINC development, the first author leveraged familiarity with BPNT (Ryan & Deci, 2017) and the experience gained over 5 months and approximately 100 Peloton Bike rides to create a draft that aligned observed coaching statements with the three basic psychological needs (competence, relatedness, and autonomy). Additional categories of coaching types also were created to capture coaching statements that were needs-indifferent but were frequently observed across classes. Needs indifferent coaching has been described as lacking in "qualities that would support or thwart autonomy, competence, or relatedness (Quested et al., 2018, p. 261)." From a pragmatic perspective, we included these needs-indifferent statements in our coding because they occurred frequently and comprised a large proportion of the instructors' coaching. From a theoretical perspective it has been suggested that needs-indifferent coaching may dilute or undermine the impact of needs-supportive coaching (Rodrigues & Macedo, 2021). Some approaches to testing the BPNT have incorporated assessments of social interactions that actually thwart or impede satisfaction of the basic psychological needs (Reeve & Jang, 2006; Smith et al., 2015), while others have focused only on needs-supportive behaviors (Haerens et al., 2013; Webster et al., 2013). The PINC did not contain categories for needs-thwarting coaching, because this type of coaching was observed to be so infrequent as to be negligible in the observed Peloton classes[1].

In Stage Two of the development of the PINC a data entry template was created which allowed for a coder to document minute-by-minute the presence or absence of an instructor's coaching statement that met the definition for each of the basic psychological needs or needs-indifferent coaching categories. Within each 60-second epoch, coders were instructed to mark a coaching category as present the first time that an instructor delivered a comment that met the coding criterion. Coders also documented word-for-word the comment that was coded, to facilitate later coding comparisons. Only one instance of each coaching category per 60-second epoch was coded. Thus, a single minute of class time might contain multiple categories of coaching, and coders only documented a single instance of each coaching category within that minute. Study data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at the first author's institution (Harris et al., 2019; Harris et al., 2009). REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

In Stage Three of the development of the PINC, the first and second authors each used the REDCap data entry template to code the same 6 Peloton classes, followed by a review and discussion of coding discrepancies, which resulted in formal definitions of each coaching category (see Measures below). Figure 1 shows the REDCap data entry form with the items from the observational scale.

In Stage Four, the PINC was used to train 5 undergraduate research assistants. Training consisted of approximately 3 hours of didactic instruction regarding the theory underlying the PINC and virtual (online) demonstrations of the coding protocol. These research assistants then double-coded 40 Peloton classes across two different class types, which were selected to represent extremes of exercise intensity (Beginner and High-intensity Interval Training [HIIT]). Coders then met virtually in pairs to review their respective codes and identify "missed" codes (i.e., coaching categories overlooked by one coder, which were harmonized in the database) and "unclear" codes (i.e., codes where coders identified different coaching categories for the same comment and actually disagreed). All unclear coding disagreements were then reviewed by the entire research team, which resolved the disagreements by consensus. Based on the group conversations, the PINC coding guide was embellished with examples of coaching statements that did NOT align well with each of the basic psychological needs. For example, the need for competence was not expected to

[1]Confirmation of the general absence of needs-thwarting coaching comments in the Peloton classes comes from an ancillary study in which one of the authors (S.A.) used a modified version of the Need-Relevant Instructor Behavior Scale (NIBS) (Quested et al., 2018) to code the coaching strategies observed in 41 rider-selected Peloton classes (unpublished data). The NIBS observational coding guide includes four coaching strategies that are described as needs-thwarting: 1) Using a language or a tone that is pressurizing or could induce feelings of guilt or shame when communicating commands or goals; 2) criticizing, belittling, devaluing, or dismissing participants; 3) showing disregard or rejection for participants' feelings, preferences, opinions, and feedback; and 4) comparing participants against each other or being overly competitive. Out of the 41 rider-selected Peloton cycling classes coded, none had any instances of criticizing or promoting competition. Comments that showed a disregard of rider's feelings were observed in 12 out of the 41 classes (mean frequency = 0.1) and included comments such as "y'all ready for some spin-ups? It's rhetorical, they're coming anyways". Coaching that could potentially be viewed as pressuring the rider were observed in 26 of the 41 classes (mean frequency = 0.1) and included comments such as "do not stop moving, alright? Whatever you feel, get over it".

be satisfied by the statement “you have made an incredible investment with this bike” (this statement does not refer to exercise behavior on the Peloton bike; it addresses purchasing behavior), the need for relatedness was not expected to be satisfied by the statement “we don’t want you to feel overwhelmed” (this statement draws a distinction between the instructor and the rider, rather than cultivating a sense of shared purpose), and the need for autonomy was not expected to be satisfied by the statement “it’s a lifestyle and you’ve got to adopt it” (this statement does not refer to exercise behavior on the Peloton Bike and is directive, rather than cultivating an internal locus of control).

In Stage Five of the development of the PINC, the research assistants double-coded another 40 Peloton classes representing another two class types (Power Zone and Groove). These additional class types were selected to represent class types that emphasized different aspects of the workout (see Table 1). As before, coders then reviewed their coding in pairs to identify missed codes which were harmonized in the database, and unclear codes, which were resolved through group consensus, thus producing the final approved coded database used in the utility analyses reported in this paper. Although the iterative coding process that we followed likely maximized the validity of the resulting data, it was very time-consuming and could be burdensome to implement in future studies.

Built into the multi-stage process of PINC development were certain procedures intended to maximize content relevance and domain clarity of the tool. The content relevance of the initial draft of the PINC was maximized by basing it on an existing robust theoretical model supported by extensive empirical work (i.e., BPNT), and by drawing heavily on published descriptions of the basic psychological needs in the coding guide (the coding guide is available on Dryad; [Dataset] (Schneider et al., 2022a)). As noted by Fitzpatrick (1983), the recommended procedures for verifying the relevance of an assessment’s content to the intended underlying concepts are largely an exercise in judgment. In the present study, the PINC categories were judged to be relevant to the three basic psychological needs by the first author, who has considerable experience using BPNT in exercise research (Schneider & Kwan, 2013) by the second author, who has more than 4 years of experience implementing exercise interventions, and by the five undergraduate research assistants, who were trained in the tenets of BPNT prior to engaging in the collaborative process of refining the PINC. Domain clarity refers to the clarity with which the content domains of an assessment are defined (Fitzpatrick, 1983). In the present study, we used an approach recommended by Popham (1978), which calls for constructing an assessment tool that provides clarity regarding what is being scored and the rules for scoring as well as test directions and examples of items that are admissible as measures of the target behavior. To ascertain whether the items on the PINC were sufficiently capturing the full universe of coaching strategies, we included a code for “none of the above”. In the earlier phases of tool development coders used this code to identify coaching that did not seem to fit into any of the existing codes. A similar approach was used in development of an observational tool for characterizing coaching behavior within a rugby league to ensure that the tool was capturing salient coaching behaviors (Brewer & Jones, 2002). By the end of stage five of the development process, there were no instances of coders using the “none of the above” code, suggesting that the domains of the PINC had been defined with sufficient clarity.

Test of the Ability of PINC to Discriminate across Class Types

The result of the coding process described above was a database documenting the minute-by-minute presence or absence of needs-supportive and needs-indifferent coaching categories across 80 Peloton cycling classes distributed equally across four class types: Beginner, Power Zone, Groove, and HIIT. Table 1 provides a description for each class type provided by Peloton. Beginner rides are specifically targeted to new riders, Power Zone rides coach riders to align their effort within the class to their own fitness level, Groove rides emphasize music and choreography, and HIIT rides are designed for established riders to get a time-efficient and challenging workout. As a test of how useful the PINC might be for research or clinical applications in which individuals could be matched to rides to maximize impact, we examined the frequency of the different coaching categories across these four class types, each targeting a different rider experience.

Inter-rater Reliability

Following the finalization of the coding guide, the research assistants double coded an additional 30 Peloton classes representing a broad assortment of class types. These classes were self-selected by Peloton riders for a separate study and may be representative of the more popular Peloton cycling class types.

Pilot Study of the Association between Needs-supportive Coaching and Intrinsic Motivation

A pilot study was undertaken to provide evidence of the construct validity of the PINC. In the field of observational measurement of behavior, construct validity refers to “the degree to which a measure produces a pattern of correlations or group difference that are predicted by theory” (Yoder, Symons, & Lloyd, 2018). To evaluate the construct validity of the PINC, we carried out a study to examine the prospective association between the frequency of needs-relevant coaching and self-reported intrinsic motivation for Peloton cycling. We selected intrinsic motivation as the dependent variable as it represents the most autonomous form of motivation defined by the Self Determination Theory and has been shown to be positively associated with exercise participation across a wide range of studies (Kalajas-Tilga et al., 2020; Owen, Smith, Lubans, Ng, & Lonsdale, 2014; Teixeira et al., 2012; Thøgersen-Ntoumani, Shepherd, Ntoumanis, Wagenmakers, & Shaw, 2016). We utilized Facebook to recruit a sample of Peloton bike riders and randomly assigned them to complete a ride that had been previously coded using the PINC. By randomly assigning study participants to complete assigned cycling classes, we intended to minimize the impact of additional contextual factors that might have impacted intrinsic motivation. Assigned rides were characterized as being high or low (relative to median scores from PINC coding) in coaching relevant to autonomy, competence, and relatedness, respectively. Rides representing all possible combinations of high and low coaching content were selected to create 8 possible conditions (e.g., high in all three coaching types, high in relatedness and low in competence and autonomy, etc.). Within each condition riders were provided with three rides to choose from. Riders were instructed to complete an online survey (administered using REDCap) immediately following their assigned ride (henceforth referred to as “post-ride survey”). Riders also provided their Peloton username and agreed

to give the research team access to their online data so that we could verify both the ride completed and the timing of the survey completion in relation to the ride. Survey responses were used to examine the independent and combined contributions of the three types of coaching to self-reported intrinsic motivation in reference to the ride. All data were de-identified. The dataset of 196 valid participants is available on Dryad [Dataset] (Schneider et al., 2022a).

Measures

PINC Coding

Autonomy Coaching.—Autonomy, within the context of BPNT (Ryan & Deci, 2017), has been defined as the experience of volition and willingness. When the need for autonomy is satisfied, there is a sense of integrity "as when one's actions, thoughts, and feelings are self-endorsed and authentic" (Vansteenkiste et al., 2020, p. 3). Examples of instructor statements coded as autonomy included: "If you need a little bit more resistance Peloton, don't wait for me to tell you what to do, control your damn ride" and "Where you sit between those two numbers is totally up to you".

Competence Coaching.—Competence emerges from the experience of effectiveness and mastery, and this need is satisfied "as one capably engages in activities and experiences opportunities for using and extending skills and expertise" (Vansteenkiste et al., 2020, p. 3). For this study, we classified two discrete categories of coaching as targeting the higher-order construct of competence; when the instructor recognized the rider's accomplishment within the class and when the instructor provided encouragement. An example of acknowledging accomplishment was when an instructor told riders to "give yourselves a pat on the back for that awesome ride today", whereas comments of encouragement were typically brief and included such statements as "nice work". An aggregate competence variable was created to quantify the percent of class minutes during which an instructor delivered either encouragement or an acknowledgement of accomplishment.

Relatedness Coaching.—Within the context of BPNT, relatedness involves the experience of warmth, bonding and care, and is satisfied "by connecting to and feeling significant to others" (Vansteenkiste et al., 2020, p. 3). Three discrete categories of coaching were identified as likely to cultivate the higher-order construct of relatedness in that they promoted a feeling of being respected, understood, and cared for by others or engendered a sense of connectedness to the instructor or to the virtual community. First were comments that imparted a sense connection through shared purpose and warmth. Examples of statements of connection included "I am here with you every step of the way" and "we ride together." A second category of coaching aligned with relatedness was when the instructor issued a "shout-out", which is when an instructor called out the username of a rider in the class. Examples of these comments included when the instructor spoke directly to a specific user, saying "congratulations [username] on 500 rides" or "I see you [username], good job." Finally, we identified instances of personal sharing, during which the instructor told a personal story, thus building rapport. For example, an instructor shared that "I used to be a dancer, so for me, the dance floor is the best place to be." An aggregate

relatedness variable was created to quantify the percent of class minutes during which the instructor delivered coaching that met the criteria for any of the three relatedness-supportive coaching categories.

Needs-indifferent Coaching.—Three discrete categories of coaching were identified that occurred frequently during classes and were not expected to impact basic psychological needs: effort, biomechanics, and exhortations. Coaching referring to effort included directions regarding the target speed of pedaling (cadence) and resistance setting (bike tension), both of which are controlled by the rider. Whether the instruction was regarding cadence (e.g., “cadence should be between 80 and 100”) or resistance (e.g., “resistance anything above 40”), these instructions were coded as effort. Another needs-indifferent category of coaching related to how the rider’s body should be positioned and/or how the rider should be using specific muscle groups (biomechanics). For example, an instructor would direct the rider to “sit tall, eyes forward” or “use your legs to pull and push, the whole 360 degrees”. A common type of needs-indifferent coaching was short phrases exhorting the rider to engage with the activity (exhortation). This category of coaching was distinguished from encouragement by a lack of warmth or supportiveness. Examples of exhortations included “go, go, go!”, “don’t stop now”, and “push, push”. These three discrete categories of coaching were aggregated into the higher-order construct of needs-indifferent coaching to quantify the percent of class minutes during which the instructor delivered coaching that met the criteria for any of the three discrete needs-indifferent coaching categories.

Pilot Study of the Association between Needs-supportive Coaching and Intrinsic Motivation

Basic Psychological Needs Satisfaction.—Self-reported satisfaction of the three basic psychological needs (autonomy, competence, and relatedness) was assessed on the baseline screening survey using 12 items (4 for each psychological need) that have been validated across samples drawn from four countries (Chen et al., 2015). The items were scored on a 5-point scale of not at all true to completely true with reference to their life in general and scores for each psychological need were computed as a mean of the four items.

Intrinsic Motivation for Exercise.—On the post-ride survey, respondents were asked to indicate how much they agreed with the statement “I enjoyed this class very much” on a scale of 1 = not at all to 5 = completely. This item is adapted from an item on the Intrinsic Motivation Inventory (McAuley, Duncan, & Tammen, 1989). As specified by Ryan and Deci (2000) in Self-Determination Theory intrinsic motivation is the most autonomous form of motivation.

Instructor Preference.—On the post-ride survey, respondents were asked whether the instructor was one of their favorites (yes/no).

Analyses

The frequency of coaching targeting the basic psychological needs within each class was computed by dividing the number of minutes during which a given category of coaching was present by the total number of minutes in the class. Thus, coaching frequency was expressed

as a percent of class minutes. To explore whether class duration would impact our findings, we compared the coaching frequency of all categories across 20 classes of 20-minutes duration and 20 classes of 30-minutes duration (half Beginner and half HIIT), and we found no statistically significant differences in any coaching frequency by class length (all p's> .05) , so only 30-minute classes (the most abundant class type on the Peloton Bike product) were coded for Groove and Power Zone classes. To examine the utility of the PINC for detecting systematic differences in coaching by class type, we ran One-Way ANOVA tests with post-hoc Tukey's. The dataset and syntax used for this analysis is available on Dryad [Dataset] (Schneider et al., 2022b).

Inter-rater reliability was computed both as percent agreement and using the formula for kappa set forth by Cohen (Cohen, 1960). The former is easy to compute and easily interpreted, but is considered a less rigorous standard for determining inter-rater reliability as compared to Cohen's kappa, which corrects for the expected agreement between raters as a function of chance (McHugh, 2012).

For the pilot study of the association between needs-supportive coaching and intrinsic motivation, a three-way factorial ANOVA was conducted to compare the main and interactive effects of coaching content (high/low relatedness; high/low competence; and high/low autonomy) on intrinsic motivation. Interactions between the three needs-relevant coaching types were explored to acknowledge the complex nature of the expected relationship between coaching messaging and intrinsic motivation. As noted by others in respect to validating a method for coding of teachers' behaviors during physical education (Weaver et al., 2016), coaches may engage in multiple behaviors in an overlapping manner, and the impact of their messaging may be moderated by their own multi-dimensional actions. The analysis controlled for baseline satisfaction of basic psychological needs as well as age and instructor preference, which were significantly correlated with intrinsic motivation, and the frequency of needs-indifferent coaching content within the selected class, which operated as a proxy for the overall quantity of messaging in the class. The dataset and syntax used for the pilot study analysis is available on Dryad [Dataset] (Schneider et al., 2022a).

Results

Descriptive Statistics

Classes Used for PINC Development.—Among the 80 classes analyzed during the development of the PINC, there were 17 different instructors. About two-thirds (67%) of the classes were taught by female instructors, and this proportion was consistent across class type. The average user-rated level of class difficulty (henceforth referred to as "intensity") was obtained from the Peloton dashboard. These ratings are solicited by the product at the end of each ride, and riders have an option to rate the class on a scale of 1 to 10, with 10 being the highest level of difficulty. Class intensity as rated by the Peloton community differed by class type ($F(3, 76) = 37.58$, $p < .001$; $\eta^2 = .59$) and was lowest for the Beginner and Power Zone classes (M(SD) = 6.7(.53) and 7.0(1.0), respectively; no difference between these two means), intermediate for the Groove classes (M(SD) = 7.7), and highest for the HIIT classes (M(SD)=8.5 (.27)).

Frequencies and Correlations of PINC Coaching Categories.—Table 2 shows the mean frequencies of the coaching categories. Combined across all class types, autonomy-supportive coaching occurred at least once per minute during 24% of class time, competence-supportive coaching (whether through acknowledgement or encouragement) occurred at least once per minute during 31% of class time, and relatedness-supportive coaching (personal sharing, shoutouts or statements of connection) occurred at least once per minute during 40% of class time. Needs-indifferent coaching was most frequent and occurred at least once a minute during 89% of class time. At the disaggregated category level, instructors were least likely to support the need for relatedness through personal sharing (4% of the time overall), and most likely to do so through shout-outs (27% of the time overall). Competence-supportive coaching was more likely to take the form of encouragement (22% of the time overall) as compared to acknowledgement of accomplishment (12% of the time overall). Among the needs-indifferent coaching, instructors delivered instructions related to effort most often (74% overall), followed by exhortations (44% overall), and body position (biomechanics) occurred least often (29% overall).

Table 3 shows the correlations between the different categories of coaching delivered by instructors. When the discrete categories were aggregated into their higher-order constructs (relatedness, competence, and needs-indifferent), there were no significant correlations between the frequencies of the coaching statements supporting the three basic needs, but frequency of competence-supportive coaching was positively correlated with frequency of needs-indifferent coaching ($r = .41$, $p < .000$). When examined as disaggregated categories, however, there were significant correlations among the discrete needs-supportive coaching categories. There were no significant correlations among the three coaching categories expected to cultivate satisfaction of the need for relatedness (i.e., personal sharing, shout-outs, and statements of connection between the instructor and the riders). In contrast, the two coaching categories expected to engender satisfaction of the need for competence (encouragement and acknowledgement of accomplishment), were positively correlated, showing that classes that featured frequent statements of encouragement were also likely to contain acknowledgements of accomplishment. Autonomy-supportive coaching correlated positively only with acknowledgments of accomplishment, whereas there were several significant positive associations between the individual coaching categories associated with relatedness-supportive and competence-supportive coaching.

In terms of the needs-indifferent coaching categories, frequency of coaching about effort was positively correlated with exhortations, and each of the needs-indifferent coaching categories were significantly correlated with at least one of the competence-supportive coaching categories. Associations also emerged between the relatedness-supportive coaching and needs-indifferent coaching categories. Shout-outs were positively correlated with exhortations, and negatively correlated with coaching regarding biomechanics. None of the needs-indifferent coaching categories were associated with autonomy-supportive coaching.

Classes Used for Inter-Rater Reliability.—Among the additional 30 classes that were used to demonstrate reliability of the final PINC there were 16 different instructors. The classes were about evenly split between male and female instructors (46% male). The

average class intensity as rated by Peloton riders was 7.5 (SD = 0.49). There were 5 different class types represented among this sample of 30 classes, including the following: Power Zone (N = 6); Intervals (N = 2); Music (N = 15); Theme (N = 6); Live DJ (N =1). Intervals include both HIIT rides and rides that combine high-intensity intervals with arm exercises. Music rides are those that are tagged according to a musical theme, such as Broadway musicals or a particular musician. Theme rides are comprised of a wide variety of rides that may feature a particular musical theme (e.g., mixtape), a particular holiday, or an instructor-specific ride (e.g., Sundays with Love). Live DJ rides feature a live disc jockey in addition to the Peloton instructor.

Participants in the Pilot Study.—A flow chart illustrating the recruitment, screening, random assignment, and study completion of participants for the post-ride survey is provided in Figure 2. In response to posts on Facebook groups with a Peloton theme, 876 baseline screening surveys were completed. After excluding the 235 individuals who were not interested in further participation, we assigned 641 persons to one of the 8 conditions. Recruitment was active until there were at least 20 valid participants in each of the 8 conditions. At the end of data collection, there were 196 valid participants (92% Female, 90% non-Hispanic White, 86% college graduate or above). Respondents varied in age, with 2% in their 20s, 15% in their 30s, 29% in their 40s, 34% in their 50s, and 19% 60 or above.

Pilot Study Survey Responses.—Responses to the baseline screening survey showed that the mean levels of satisfaction of basic psychological needs were similar for competence (M = 4.1, SD = .71, range = 2–5), relatedness (M = 4.1, SD = .80, range = 1.25–5) and autonomy (M = 3.9, SD = .72, range = 1–5). On the post-ride survey, 72% of respondents indicated that the instructor was among their favorites, and intrinsic motivation was generally high (M = 4.13, SD = .92; range = 1–5).

Analysis of the Association of PINC Coaching Categories with Class Type

Table 2 provides the results of the ANOVA analyses, and Figure 3 provides a graphical depiction of the significant differences between specific class types looking at the aggregated variables representing the coaching relevant to the three basic psychological needs. Results of the ANOVAs were significant for coaching targeting all three psychological needs, with effect sizes (η^2) ranging from medium (10% of variance in competence-supportive coaching explained by class type) to large (18% of variance in autonomy-supportive coaching and 19% of variance in relatedness-supportive coaching explained by class type). Moreover, each of the class types manifested a unique profile of coaching, as depicted in Figure 3. Beginner classes featured autonomy-supportive and relatedness-supportive coaching each during about 30% of class time and competence-supportive coaching slightly more frequently (38% of class time). In contrast, Power Zone classes placed more emphasis on relatedness-supportive coaching (36% of the time) and less emphasis on autonomy-supportive and competence-supportive coaching (27% and 24%, respectively). Groove classes were characterized by a low frequency of autonomy-supportive coaching (16%) coupled with relatively frequent competence-supportive and relatedness-supportive coaching (34% and 41%, respectively). Finally, HIIT classes had the highest frequency of relatedness-supportive coaching (54%) in conjunction with

moderately frequent autonomy-supportive and competence-supportive coaching (25% and 30%, respectively).

The ANOVA of the needs-indifferent coaching frequency revealed that the Power Zone classes featured significantly less needs-indifferent coaching as compared to each of the other class types (all p's < .001). At the aggregate level, Power Zone classes featured needs-indifferent coaching during 77% of class minutes, whereas each of the other class types featured needs-indifferent coaching during at least 90% of class time. Examination of the discrete categories revealed that this difference was driven by coaching around effort and biomechanics, both of which were least frequent during Power Zone classes. Exhortations were actually more frequent during Power Zone as compared to other class types.

Analysis of Inter-rater Reliability of PINC Coding

After the first coding pass of the initial 80 classes coded, the percent agreement between paired coders was consistently above 90%, indicating that the two coders agreed more than 90% of the time that a particular coaching category was present or absent during a given 60-second epoch. Averaged across all the coder pairs, the more stringent kappa formula yielded the following respective values for inter-rater reliability: Beginner (k = .71); Power Zone (k = .65); Groove (k = .70); HIIT (k = .73). Once the PINC was finalized and inter-rater reliability was computed for an additional 30 rider-selected Peloton cycling classes, average percent agreement was 97% and the average kappa was .91, which is considered "almost perfect" (McHugh, 2012, p. 279). These robust findings suggest that a single coder could use the PINC guide to code additional classes in future studies.

Analysis of the Association between Needs-supportive Coaching and Intrinsic Motivation

In the ANOVA of the self-reported data from the post-ride surveys, there were no main effects of competence, relatedness and/or autonomy coaching levels on intrinsic motivation, but there was a two-way interaction between autonomy coaching and competence coaching ($F(1, 179) = 4.20$, $p < .05$). Means and standard deviations for intrinsic motivation for each of the conditions in the 2 X 2 X 2 design are shown in Table 4. Marginal means indicated that higher levels of competence coaching were associated with greater intrinsic motivation when there was also a high frequency of autonomy coaching. When autonomy coaching was low, the frequency of competence coaching had no association with intrinsic motivation.

Discussion

We set out to develop an observational tool for characterizing the content of coaching statements delivered by class instructors through a technology-mediated home exercise product. Our systematic approach to coding instructors' coaching demonstrated that psychological needs-supportive coaching frequency could be reliably quantified. In addition, there were differences in coaching content across four different types of classes (Beginner, Power Zone, Groove, and HIIT), suggesting that the PINC holds promise for use as a tool to examine the independent contributions of autonomy-, competence- and relatedness-supportive coaching to exercise participation within the context of a technology-mediated home exercise product. Each class type manifested a distinctive profile in comparison to the

other class types. That the PINC had sufficient sensitivity to be able to distinguish between different class types is encouraging and suggests that this coding system may be useful for testing the efficacy of targeting basic psychological needs to close the intention-behavior gap in exercise behavior adoption and maintenance. In addition, in a test of the construct validity of the PINC, we found some preliminary support for the tool as a means of examining the impact of needs-supportive coaching on intrinsic motivation. In post-ride surveys, there was evidence of an interaction between autonomy-supportive and competence-supportive coaching suggesting that providing riders with frequent coaching encouraging autonomy may be necessary for realizing the potential positive impact of competence coaching on intrinsic motivation.

Some of the differences in coaching frequency between the class types may have been a direct consequence of the class intensity and structure, but there is evidence of a match between behavioral theory and coaching content. The higher frequency during Beginner classes of competence-supportive coaching suggests that these classes are targeting a psychological process that has been found to play an important role in the early phases of exercise adoption. Specifically, exercise self-efficacy has been shown to predict the translation of exercise intentions into exercise adoption (McAuley, 1992). Social Cognitive Theory (Bandura, 2004) posits that a person's belief in their self-efficacy can be most effectively developed through mastery experiences, which is consistent with exercise instructors providing more frequent competence support during Beginner classes. Another finding that resonates with existing theory is the low frequency of autonomy-supportive coaching during Groove classes. These classes are structured to focus the rider's attention on music and choreography, reflecting a strategy of utilizing distraction to motivate riders. Distraction through music is one strategy that can enhance exercisers' enjoyment of exercise (Jones, Karageorghis, & Ekkekakis, 2014), and Groove classes may be particularly effective for individuals who need or prefer distraction as a motivational strategy.

It is worth noting that the three coaching categories that comprised the assessment of relatedness-supportive coaching were not correlated with one another, and that they appeared at different frequencies across the class types. In fact, the higher frequency of relatedness-supportive coaching during Beginner classes was driven by instructors' personal sharing and statements of connection to the rider, whereas shout-outs occurred rarely during Beginner rides. The higher frequency of personal sharing during Beginner rides, as compared to the rest of the class types, may be a function of the lower intensity of these rides, which affords the instructors literally more oxygen to support storytelling. Similarly, the relative paucity of shout-outs during Beginner rides may be an artifact of the small number of Beginner rides offered live on the product and the likelihood that riders on these classes will not be celebrating milestones. It is, however, an empirical question whether personal sharing is as effective for promoting satisfaction of the need for relatedness as shout-outs or statements of connectedness. It is hoped that the PINC will facilitate studies that can address this and related questions about efficacy of needs-supportive coaching for promoting exercise motivation and engagement.

In addition to assessing the frequency of needs-supportive coaching we also quantified the frequency of needs-indifferent coaching, which led to some interesting findings. The

high frequency of needs-indifferent coaching empirically affirms the potential importance of including this category in our observational tool. Similar work that quantified needs-supportive coaching in live cycling classes did not find a high frequency of needs-indifferent coaching (Quested et al., 2018), which may indicate an inherent difference in the way that instructors interact with a live versus a virtual class. Given their high frequency in the technology-mediated classes, future work could evaluate whether replacing these needs-indifferent coaching statements with needs-supportive coaching statements (for example, by replacing exhortations with statements of encouragement) might lead to more self-determined motivation to exercise. It should also be noted that all three of the needs-indifferent coaching categories were independently positively correlated with at least one category of competence-supportive coaching. It is possible that this association is at least in part the result of a natural link between the frequency with which the instructor provides instructions and/or exhortations to the rider and the opportunity to congratulate the rider on an accomplishment. Our findings might be extended by examining the possible interaction between needs-indifferent coaching and needs-supportive coaching in promoting self-determined motivation to exercise.

It merits noting that in our pilot study of the construct validity of the PINC we did not find an association between the frequency of coaching expected to cultivate a sense of relatedness and exercisers' intrinsic motivation. One interpretation of this finding builds on the results of a meta-analysis of Self-Determination Theory in the context of school-based PE (Vasconcellos et al., 2019). In this review of 265 studies, the authors found that students' feelings of relatedness were more likely to be impacted by their peers than by their teachers, whereas teachers and peers alike appeared to have an impact on perceptions of autonomy and competence. Applying this finding to the present study, it may be that Peloton bike riders' sense of relatedness is more likely to be impacted by their interactions with their fellow riders rather than by instructor coaching. These interactions may take place during the class (e.g., through "high fives" between riders or monitoring the leaderboard) or independent of the class through Facebook or other social media platforms, where riders often post photos of themselves or their metrics. The fact that we recruited participants through Facebook may have magnified the role of these social interactions outside of the class, since the survey respondents were self-selected to be individuals who are actively connecting with other Peloton riders on this social media platform.

Our pilot study did provide evidence of a correlation between the scores on the PINC and intrinsic motivation; an association that is predicted by existing theory. This finding speaks to the construct validity of the tool but does not offer evidence of two other types of validity relevant to observational tools: sensitivity to change and criterion validity. To demonstrate sensitivity to change, one would need to intervene with instructors to manipulate their coaching and then apply the PINC to determine whether the expected changes in scores would emerge. Such an undertaking was beyond the scope of this project. To establish criterion validity, it would be necessary to identify a gold standard measure of needs-relevant coaching frequency in asynchronous cycling classes, which does not currently exist. Nevertheless, the data presented here represent the beginnings of an evidence base for the validity of the PINC. Establishing the validity of a tool typically requires multiple sources of evidence (Sullivan, 2011), so it is hoped that future tests of the PINC's construct validity

may add to the evidence base by using the PINC to examine the immediate impact of needs-relevant coaching on intrinsic motivation among a cohort of novice exercisers. Owing to resource constraints, our study recruited a convenience sample of Peloton users who were active on Facebook sites with a Peloton theme, and most of the study participants were long-time riders of the Peloton Bike. As such, their responses to an individual class may have been shaped by their repeated prior exposure to the classes. We also note that others who have developed and validated an observational tool to characterize teaching behavior in physical education classes (Weaver et al., 2016) have noted the potential synergy of multiple class dynamics occurring in the same time frame. It might be illuminating in future research using the PINC for an index indicator to be constructed reflecting the presence of multiple coaching strategies within each epoch.

The development of the PINC represents what we hope will be an initial step toward leveraging technology-mediated home exercise products for research and intervention, but there are additional facets of the experience that should be addressed in future work. The theoretical orientation that informed the development of the PINC was BPNT (Vansteenkiste et al., 2020) which is a mini-theory within the Self-Determination Theory (Ryan & Deci, 2017) and emphasizes a universal drive to satisfy the needs for feeling competent, autonomous, and related to others. Our findings indicate that the instructors' coaching could be reliably coded to quantify coaching relevant to autonomy (through coaching affording the rider leeway in personal choices about how much effort to expend in the class), competence (through coaching providing encouragement and acknowledgement of accomplishments) and relatedness (through shout-outs, statements that highlight the rider's connection to the instructor or community, and personal sharing). Many technology-mediated home exercise products offer additional features beyond the instructor's coaching that have the potential to further impact satisfaction of these three psychological needs. In terms of autonomy, the mere availability of a control knob on stationary bikes, by which the rider determines the resistance on the bike, creates the opportunity for autonomy, especially since most exercisers are exercising in the privacy of their home with no one overseeing and/or judging their effort. A feature that may cultivate a sense of competence is the ability for the exerciser to view an array of metrics reflecting their performance, both within an individual exercise session and over time across multiple sessions. Dashboards give the exerciser the opportunity to observe consistency or improvement in performance and/or adherence to exercise goals, thus reinforcing their perceptions of their own capabilities. Beyond the instructors' coaching, many of these products also operate as a social media node, with exercisers having the ability to interact with others in a variety of ways (e.g., on the Peloton, an optional Leaderboard displays usernames of riders engaged in the same class; during live classes, there is the possibility that an instructor will recognize a rider by username; riders may "high five" one another during a ride; riders can engage in a video chat with friends who they are following through the product). The strategy adopted in this study of quantifying the content of instructors' coaching thus does not capture the full range of channels through which technology-mediated home exercise products could impact the three basic psychological needs. Future research could incorporate exercisers' self-reports of using these additional features and/or derive relevant metrics of engagement from the exercise software.

Besides the coaching quantified in this study, instructors did deliver a range of other content, including detailed forecasting of what to expect in a ride and training tips for the rider to carry with them off the bike, which may have the potential to impact rider motivation. Further, we focused on four specific class types in our evaluation of the utility of the PINC. There are many other class types available through the product, including Low Impact rides (rides that help the rider warm-up, cool down or get their heart rate pumping without stressing their joints), music-themed rides, and Tabata rides (a high-impact style of interval rides) among others. It may be that if we had included additional class types in our analysis, we would have uncovered more differences among the classes. If it were possible to characterize the wide range of class types according to their coaching content, it might provide the opportunity to tailor class recommendations to match riders' psychological needs. Riders with a greater need for feeling related to others during the ride could be directed to classes in which the instructor issues more shout-outs and more statements of connectedness, while those with a greater need for feeling autonomous could be directed toward classes in which the instructor provides the maximum options during the ride. Because the classes remain in the on-demand library, the potential to create customized recommendations exists, and would be worth studying to determine how impactful the coaching truly can be.

The approach taken in this study to quantify needs-supportive coaching differs in some notable ways from strategies used with observational scoring of live exercise classes or one-on-one behavioral coaching. In the Need-Relevant Instructor Behaviors Scale (NIBS) for example, group cycling classes were coded in 20-minute blocks and scores were given for the overall "intensity" of each category of need-supportive coaching (Quested et al., 2018). In an analogous approach, the MMCOS (Smith et al., 2015) was developed to yield overall ratings of the "potency" of needs-supportive coaching in the context of boys' soccer teams. Similarly, the ISPACOT (Rouse, Duda, Ntoumanis, Jolly, & Williams, 2016) offers a tool for assessing needs-supportive actions of a PA promotion advisor in a one-on-one interaction and yields overall scores for the entire interaction. The more global impression approach taken in the NIBS, MMCOS and ISPACOT may more effectively capture the spirit of a given coaching interaction overall, but it is vulnerable to a greater amount of subjectivity as compared to our approach, which breaks the interaction time down into smaller time segments and records presence or absence of each type of needs-supportive coaching. Moreover, our approach yields a number that is easily interpreted, as it represents the percent of time during a class when the coach addresses a given psychological need. Like the NIBS, the MMCOS and the ISPACOT, the PINC was developed using recorded video for coding. Unlike these other measurement tools, however, the PINC is an assessment of the instructors' coaching exactly as it will be delivered to every individual who takes that class. In contrast, the videos used to develop the NIBS, the MMCOS and the ISPACOT were taken of an interaction that occurred once and to which the target of the coaching will not be exposed again. Because technology-mediated classes are recorded and available on demand and because the classes taken by an individual are documented within the product software, it is theoretically possible to use the PINC to code each and every class taken by an individual and use that data to examine how instructor coaching may impact exercise motivation and participation over time.

Among the strengths of the current study is the rigorous coder training and iterative approach, which resulted in a highly reliable tool and a final dataset that may be useful in future intervention research [Dataset] (Schneider et al., 2022b); yet it should be acknowledged that coders engaged in ongoing training and supervised coding over a period of months and dedicated approximately 5 hours per week to the coding tasks. It remains to be seen whether inter-rater reliability will be maintained with naïve coders who have not received this level of ongoing training. When the final PINC was used by trained coders to double code a set of Peloton classes that had been self-selected by riders for another study (as opposed to the 80 classes that we selected to represent certain class categories), the inter-rater reliability was high enough to suggest that future classes could be scored by a single coder with some confidence. Again, however, we note that the coders in this study had by this time gained considerable experience with the task and had engaged in months of regular discussions clarifying the coding criteria. It is recommended, therefore, that newly trained coders should engage in double coding of a small number of classes as a part of the training process before relying on a single coder to characterize additional classes.

Self Determination Theory has guided many studies in the context of PE (Curran & Standage, 2017; Elisavet, Vlachopoulos, & Papaioannou, 2015; Leptokaridou, Vlachopoulos, & Papaioannou, 2016), sports (González, Tomás, Castillo, Duda, & Balaguer, 2017; Trigueros et al., 2019), and interventions (Fortier, Duda, Guerin, & Teixeira, 2012; Ntoumanis et al., 2021). The Self Determination Theory literature, as it relates to needs-supportive coaching, has largely focused on the impact that coaching strategies have on recipients, such as athletes or students, as collected through self-report questionnaires to determine the level of needs satisfaction (Emm-Collison, Standage, & Gillison, 2016; Gunnell, Crocker, Wilson, Mack, & Zumbo, 2013). Tools for assessing the degree to which coaching interactions feature needs-supportive strategies afford the opportunity to discover how best to influence individuals' psychological needs satisfaction. Being able to characterize technology-mediated exercise classes according to their content is a necessary step toward utilizing them to engage in testing the efficacy of specific behavior change techniques The post-ride survey data in our pilot study offer an indication of the kinds of investigations that may be enabled through this approach. As pointed out, however, there are many additional features of these state-of-the-art devices that will need to be similarly quantified to capture the full complexity of the motivational processes that may be at work. Although we controlled for whether the instructor was among the riders' favorites, there are additional facets of the session that were beyond the scope of this study, such as how many other riders were on the leaderboard, whether anyone exchanged "high fives" with the rider, whether the music aligned with the riders' preferences, and whether the type of ride was one favored by the rider.

In addition to its strengths, there are some limitations to this research. Firstly, the PINC does not include codes to assess needs-thwarting behavior. Although needs-thwarting coaching was extremely infrequent across the Peloton classes coded, it was not completely absent. In future applications of the PINC, it can and should be modified to afford assessment of the frequency with which instructors show disregard for riders' feelings and/or pressure riders to engage in a certain behavior. Secondly, we note that our construct validity study did not assess the relationship of each of the PINC subscales with intrinsic motivation. We

initially explored doing so but found that we were unable to identify within our database of coded classes the required array of classes with high versus low coaching frequencies on each of the subscales. Further work is merited to validate the individual codes for coaching behaviors contributing to competence and relatedness. A third limitation of the current study is the focus on a single technology-mediated home exercise product: the Peloton Bike. In addition to other commercially available at-home stationary cycling products, there are also treadmills, rowing machines, and resistance-training equipment that are now available for home use in conjunction with on-demand instructor-led exercise sessions. It remains to be seen whether the PINC could be used or modified for use with these other products. Ultimately, we want to know whether the coaching delivered by coaches in technology-mediated exercise sessions has the potential to bring about increased intrinsic motivation and, if so, whether it will result in sustained participation. The generalizability of the data derived from the post-ride survey is limited by the relatively homogeneous demographics of the participants (i.e.., mostly White college-educated women). Despite these limitations, our study suggests that the PINC could be a useful adjunct to future research elucidating the potential impact and mechanisms of impact of technology-mediated exercise equipment on exercise participation.

Conclusion

The observational tool developed in this study is intended to enable future studies that will extend the current state of the science with respect to understanding how coaching delivered through a technology-mediated intervention can be optimized to promote adoption and maintenance of regular exercise. Using the framework of Self-Determination Theory, this study presents evidence for the reliability and sensitivity of the PINC for quantifying psychological needs-supportive coaching and has generated a publicly available database of 80 coded Peloton classes that could be utilized to test the impact of different coaching approaches on exercise motivation and behavior. Future work building on this study will examine the impact of instructor coaching on exercise behavior in the context of the additional motivational elements delivered through the technology-mediated exercise equipment.

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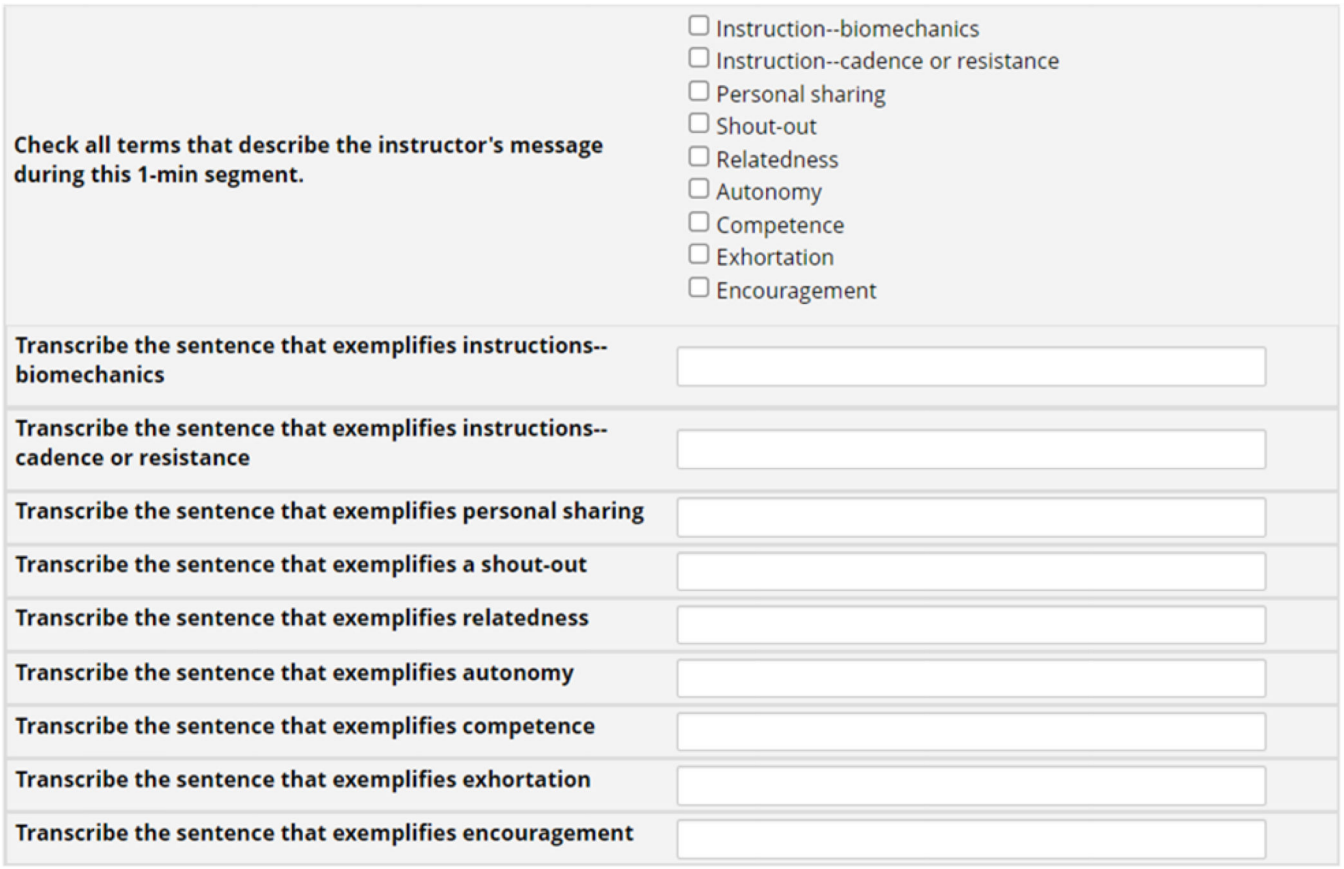

Figure 1.
REDCap Data Entry Form from the PINC
Note: Text boxes appear only for those items that are checked. A new data entry window is used to capture the data for each minute throughout the exercise class.

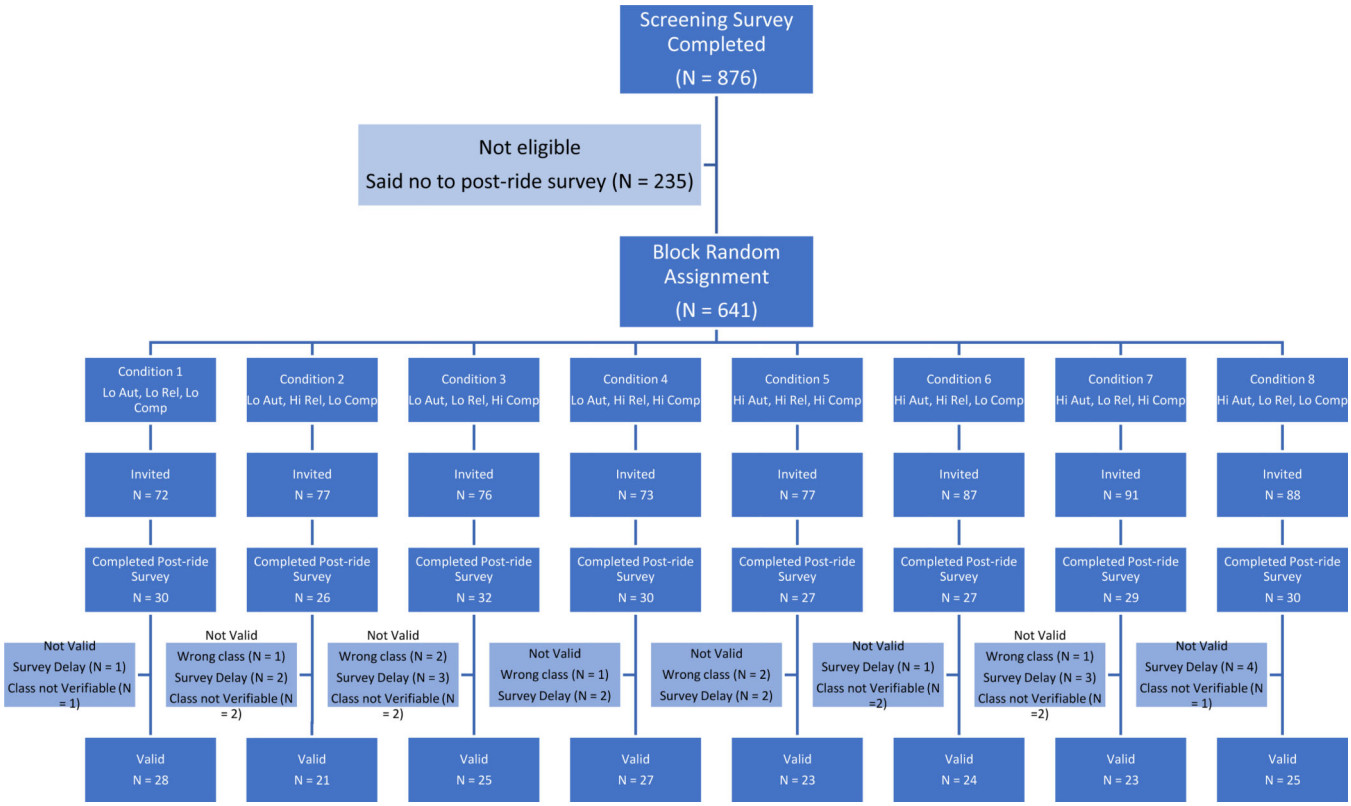

Figure 2.

Recruitment, Screening, Random Assignment, and Completion of Participants for the Post-ride Survey

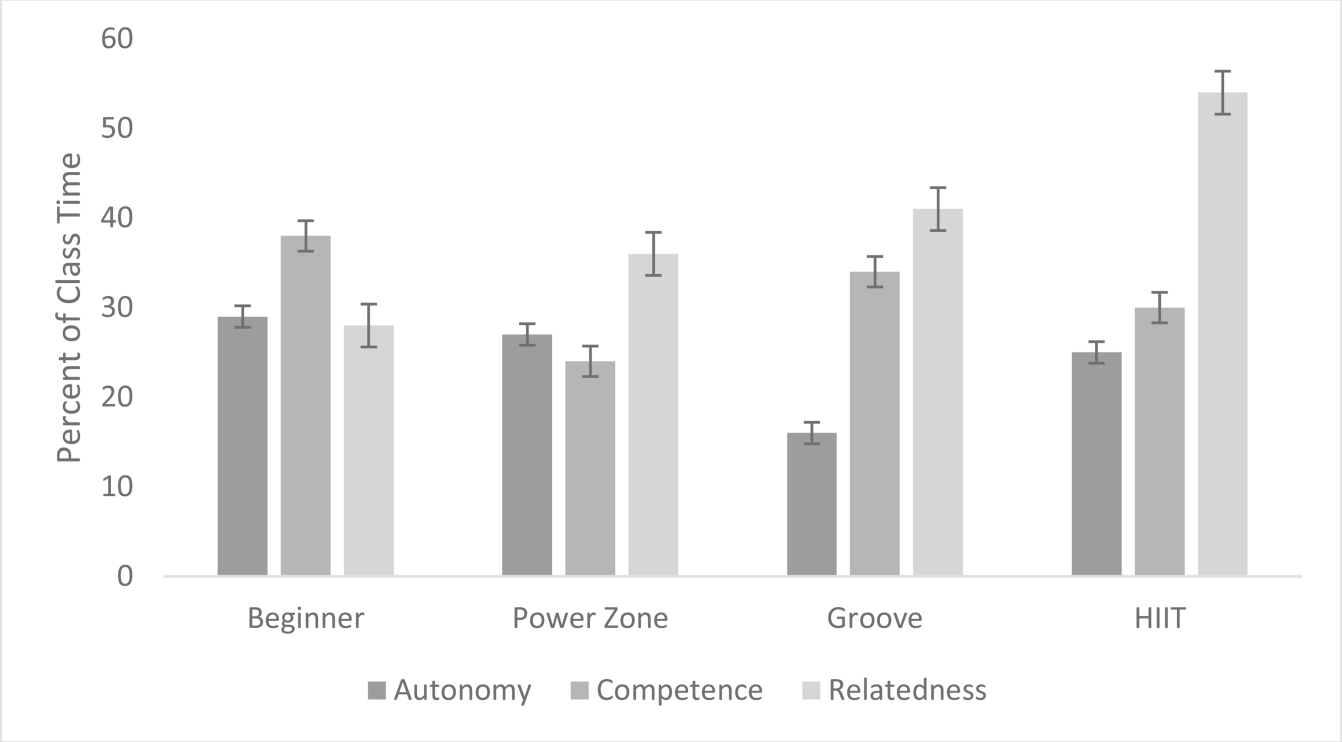

Figure 3.
Needs-Supportive Coaching Profiles by Class Types

Table 1

Class Descriptions Provided by Peloton

Class Type	Peloton Description
Beginner	Intimidation-free rides which introduce proper form and safe, endurance-building techniques.(Peloton Interactive Inc, 2021c)
Power Zone	During this class, your instructor will cue specific Power Zones (1–7), which correspond to personalized output ranges.(Peloton Interactive Inc, 2021c)
Groove	A choreography driven ride. Portions of the rides are executed through movement patterns using the beat of the music.(Peloton Interactive Inc, 2021a)
HIIT	If you’re short on time and looking for a highly efficient workout, HIIT (high intensity interval training) is the way to go.(Peloton Interactive Inc, 2021b)

Table 2

Means and Standard Deviations of Coaching Strategy Frequency by Class Type

	Class Type [a]						
Needs-supportive	**All (N = 80)**	**Beginner (N = 20)**	**Power Zone (N = 20)**	**Groove (N = 20)**	**HIIT (N = 20)**	**F (3, 76)**	**η^2**
Autonomy	24 (11)	29 (12)	27 (9)	16 (10)	25 (9)	5.78***	.18
Competence	31 (16)	38 (17)	24 (16)	34 (15)	30 (13)	2.88*	.10
acknowledgement	12 (9)	16 (11)	7 (4)	11 (8)	12 (8)	3.85**	.13
encouragement	22 (14)	26 (16)	17 (15)	25 (12)	19 (10)	1.92	--
Relatedness	40 (21)	28 (20)	36 (21)	41 (19)	54 (18)	6.11**	,19
sharing	4 (6)	7 (6)	5 (7)	2 (2)	1 (3)	6.50**	.20
shoutout	27 (24)	7 (18)	27 (21)	30 (21)	45 (21)	11.68***	.31
connect	13 (9)	17 (11)	8 (6)	13 (6)	15 (8)	3.69*	.12
Needs-indifferent	89 (9)	90 (6)	77 (11)	94 (4)	93 (5)	20.66***	.44
effort	74 (12)	77 (10)	65 (13)	75 (10)	79 (11)	6.25**	.19
biomechanics	29 (13)	38 (12)	19 (7)	33 (11)	27 (13)	9.77***	.27
exhortation	74 (12)	41 (14)	58 (14)	27 (12)	50 (15)	17.03***	.40

Note. Standard deviations are presented in parentheses. Aggregate variables were a mathematical summation of the relevant individual codes.

[a] Ordered from least-intense to most-intense class type from left to right.

* p< .05.

** p< .01.

*** p< .001.

Table 3

Correlations between Frequency of Discrete Coding Categories across all 80 Peloton Classes

	Needs-Supportive						Needs-Indifferent		
	Relatedness			Competence		Autonomy	Effort	Bio	Exhort
	1	2	3	4	5	6	7	8	9
1. Sharing	--								
2. Shout-outs	−.20	--							
3. Connection	.14	.04	--						
4. Acknowledgment	−.12	.16	.26*	--					
5. Encouragement	.27*	−.05	.23*	.28*	--				
6. Autonomy	.07	−.13	−.14	.25*	.15	--			
7. Effort	−.02	.15	.11	.36**	.37**	.12	--		
8. Biomechanics	−.05	−.28*	.25*	.21	.31**	.11	.21	--	
9. Exhortations	−.20	.27*	.09	.31**	.26*	.02	.47***	.20	--

* p< 05.

** p< 01.

*** p< .001.

Table 4

Marginal Means and Standard Errors for Intrinsic Motivation in the Post-ride Surveys

Relatedness	Autonomy	Competence	Marginal Mean	Standard Error
Low	Low	Low	4.24	.17
		High	3.90	.19
	High	Low	3.92	.19
		High	4.55	.20
High	Low	Low	3.99	.19
		High	4.07	.19
	High	Low	4.13	.23
		High	4.30	.18

Note: Covariates included age, baseline satisfaction of the three psychological needs, instructor preference, and frequency of needs-indifferent coaching in the selected class.