JOURNAL FOR ADVANCING SPORT PSYCHOLOGY IN RESEARCH
2023 Vol. 3, Issue 1, 20-30, https://doi.org/10.55743/000018

Social Comparison in Healthy Adult Peloton Bikers: How Visual Display of Exercise Data Affects Performance

Allison S. Blake, Jean-Charles Lebeau, Lindsey C. Blom, & Kayla Myers

Ball State University

In group exercise settings, individuals compare their performance against others, a process called social comparison. Although social comparison in laboratory-based exercise settings has been investigated, little is known about how exercising with others can boost motivation to perform in a non-laboratory group exercise setting with data display. Peloton bikers (N = 26) completed the same 30-minute cycling session in three conditions: group data display, individual data display, and no data display. Participants' exercise performance (i.e., heart rate, calories burned, and distance cycled) was assessed for each condition. Ego orientation and social comparison were investigated as predictors of performance. Results indicated that in the group data condition, participants had higher heart rates (p = .02), calories burned (p = .03), and longer distance cycled (p < .001) compared to the no data condition. Positive correlations emerged between social comparison and calories burned (r = .52), social comparison and distance (r = .45), and calories burned and distance (r = .75). Additionally, there was a negative correlation between ego orientation and HR (r = -.45), and between task and ego orientations (r = -.47). Ego orientation explained 19% of the variance in HR, and social comparison accounted for 20% and 27% of the variance in distance and calories burned, respectively. These results suggest that social comparison, ego orientation, and visually displayed data can all improve exercise performance. This study is bridging the gap between research and practice by providing further evidence of the application of the motivational effect of visually displayed exercise data in a group exercise setting. Specifically, fitness professionals can utilize the visual presentation of exercise data to increase their participant's engagement, while being cognizant of the risk of over-exertion.

Keywords: exercise motivation, group exercise, exercise data, peloton

Since the rise of the wellness trend in the 1980s, participation in fitness activities such as cycling, aerobics, and running, has continually increased (Karapanos et al., 2016). In exercise settings, individuals commonly refer to peers to compare performance, a process known as social comparison (Festinger, 1954). Social comparison is described as a comparative process of information between the self and others (Wood, 1996). In an exercise setting, social comparison could be described as comparing one's exercise performance (e.g., HR, speed, or level of fatigue) to another person performing the same exercise. Initially, social comparison researchers investigated "with whom" individuals tend to compare themselves, but the interest has morphed into why individuals make social comparisons and how it affects subsequent behaviors (Gerber, 2018).

RECEIVED: June 16, 2022

ACCEPTED: May 05, 2023

CONTACT: Allison Blake, Department of Counseling Psychology, Social Psychology, and Counseling, College of Health, Ball State University, Muncie, IN 47306, E-mail: ablake@bsu.edu

Social Comparison Theory

The social comparison theory, developed by Leon Festinger in 1954, suggests that social comparison arises in times of uncertainty about one's ability and results in pressure for group uniformity (Wood, 1989). Since the original development of the social comparison theory, several factors have been shown to influence social comparison. For example, Aral and Nicolaides (2017) found the influence of same-sex pairs on social comparison was strong, while the influence on mixed-sex pairs was significantly weaker. Self-enhancement is another factor that can influence social comparison

(Wood, 1989). Self-enhancement motives protect self-esteem and primarily occur when an individual experiences a threat or a loss (e.g., an opponent "beat" them). In this case, to protect their self-esteem, individuals compare themselves to others who did worse than them (i.e., downward comparison; Wood, 1989).

Social Comparison and Exercise

Social comparison is also an important factor in the exercise setting. Research among runners in a social network demonstrated that exercise is socially contagious, or impacted by peers (Aral & Nicolaides, 2017). In their study, Aral and Nicolaides (2017) tracked one million runners over five years to assess the influence of social connection and activity levels amongst high- and low-activity runners. Results suggested that high- and low-activity runners had longer run durations and higher calories burned when their peers had run longer distances. Although Aral and Nicolaides (2017) found strong contagion effects, they highlighted the need for more generalizable studies of peer effects on health behaviors in non-laboratory settings rather than laboratory-based settings because individuals may behave differently in a "true" exercise setting.

Few studies have investigated group exercise outside laboratory settings or how exercising with others can boost motivation to perform, that is, providing more effort to increase exercise performance data (e.g., HR, calories; Irwin et al., 2012). Exercising in a group has offered a variety of benefits, including increased enjoyment and enhanced effort, when compared to exercising alone (Mauriello et al., 2014). In a group exercise setting, the Köhler effect can explain the enhanced effort, as it is a process in which a weaker individual working in a more capable group will feel more motivated (Feltz et al., 2011). Irwin and colleagues (2012) examined if the Köhler effect could be used to increase effort and exercise duration when exercising with a virtual partner over a series of sessions in a coactive condition (i.e., exercising side by side but independently), a conjunctive condition (i.e., performance is determined by whichever partner stops exercising first), or a control condition (i.e., cycling alone). They found participants in the coactive condition persisted longer (9.12 minutes) in a cycling task than those who cycled alone. Further, those in the conjunctive condition persisted on average 11.26 minutes longer than individuals in the coactive condition. These results suggest that the Köhler effect is apparent when the outcome of dyad performance relies upon the weaker individual (Irwin et al., 2012). Using isometric plank exercises, Feltz and colleagues (2011) found that participants exercising with a virtual partner, regardless of ability level, had significantly greater persistence than those exercising alone. On average, they observed a 24% (58 seconds) increase in isometric plank duration. This supports the notion that exercising with a virtual partner can serve as motivation to persist longer in exercise, especially when performance of the dyad relies on the weaker individual. However, those studies did not consider the effect of displayed exercise data while exercising.

Exercise Motivation

Motivation is an important factor to consider when investigating performance in general. Motivation to exercise refers to the degree of determination with which an individual is approaching or avoiding exercise situations (Lox et al., 2019). Several theories of motivation have been used in exercise settings, but a theory that is particularly relevant in achievement settings is the achievement goal theory (Elliot & McGregor, 2001). Achievement goal theory differentiates two types of goal orientation in achievement situations: task and ego. Individuals with task orientations judge competency on task mastery, while those with an ego orientation feel competent when they win or outperform others (Ames & Archer, 1988; Dweck, 1986; Nicholls, 1984; Senko et al., 2011). However, Senko and colleagues (2011) suggest that the sole goal of outperforming others can negatively affect attention (Senko et al., 2011). When individuals are other-focused, their attention diverts from the task at hand, causing a decrease in performance (Brophy, 2005; Hoffman, 1993; Senko et al., 2011; Steele-Johnson et al., 2000; Urdan & Mestas, 2006; Vansteenkiste et al., 2007; Van Yperen, 2003). In the physical activity context, Su and colleagues (2015) reported that students endorsing task goal orientations experienced greater enjoyment and less external regulation from peers when being physically active. Conversely, students endorsing ego goal orientations were more likely to engage in physical activity to avoid shame and experienced less enjoyment. Further classification divided goals into categories of valence, indicating whether the goal is focused on approaching positive outcomes or avoiding negative outcomes (Jury et al., 2015).

One area of exploration of achievement goal theory to increase exercise motivation is to focus on task goal orientations and a belief that effort determines success (Ames & Archer, 1988). A task approach climate has impacted exercisers' effort and competence positively (Haggar & Chatzisarantis, 2007), but the effect of individual task orientation on exercise performance is still unclear according to meta-analytic results (Hulleman et al., 2010).

Exercise Motivation and Activity Trackers

Social comparison tendencies have extended into the realm of physical activity with the expanding popularity of activity trackers and virtual exercise environments (Karapanos et al., 2016; NPD, 2013). Activity trackers, such as those used in Peloton bikes, enable exercisers to compare exercise data, leading to increased exercise motivation and awareness (Mauriello et al., 2014). Similarly, immersive virtual exercise environments have been shown to elicit higher motivation and adherence when compared to traditional cycling conditions (Annesi & Mazas, 1997; Liu et al., 2019). According to the Center for Disease Control and Prevention (2020), nearly 80% of adults did not meet the physical activity recommendations in the US for aerobic and muscle-strengthening activity. Activity trackers can help meet those recommendations, as those using a Fitbit have been shown to increase their moderate to vigorous physical activity by 62 minutes per week compared to non-Fitbit users (Cadmus-Bertram et al., 2015).

Wearable technology has also created social contagion amongst fitness communities (Aral & Nicolaides, 2017). Social contagion refers to the extent one's exercise behavior is influenced by their peers' exercise behaviors (Aral & Nicolaides, 2017). Research examining the display of exercise data (e.g., HR) on bike helmets (Walmink et al., 2014), on the back of runners' shirts (Mauriello et al., 2014), and the use of a virtual partner on an exercise bike (Irwin et al., 2012), reported that those exercising with a partner or group tend to persist longer than those exercising alone. Having access to others' exercise data appears to increase effort in terms of persistence and HR. Aral and Nicolaides (2017) highlighted this peer effect that catalyzes behavior and related this effect to the concepts of motivation and social comparison.

Many activity trackers and virtual exercise technologies compare exercise data and instill competition with others (Karapanos et al., 2016), which may increase exercise adherence, effort, and longevity of tracker use. Many activity trackers integrate exercise motivation strategies such as reinforcements (e.g., badges and rewards) and self-monitoring (data summaries) to increase exercise behavior (Karapanos et al., 2016). Both reinforcement and self-monitoring are often shared amongst peers, increasing competition in the exercise environment. Activity trackers promote autonomy, offer new social experiences, boost self-esteem, and provide social support in an online community (Karapanos et al., 2016). As such, it comes as no surprise that the virtual exercise market is growing exponentially from $15.65 billion in early 2022 to $21.82 billion in early 2023 (The Business Research Company, 2023). Because of the growing popularity of virtual exercise, more research needs to be done on how it can be leveraged for improving exercise performance.

The Present Study

The effect of exercise trackers on exercise performance has been investigated via the display of individual data or others' data in separate studies, but those two modes of data display have not been compared directly in the same study. Additionally, important motivational variables such as goal orientation and social comparison tendencies have not been investigated in combination with activity trackers. The purpose of this study was to address this gap by assessing whether group or individual display of exercise data while exercising impacts exercise performance (i.e., HR, calories burned, and distance) among Peloton users. The Peloton system allows the participants to exercise outside of the laboratory while providing the opportunity to display individual data, group data, or no data. It was hypothesized that group exercise data display would lead to higher HR, calories burned, and distance cycled compared to the individual data or no data display conditions. A secondary goal was to investigate to what extent goal orientation and social comparison tendencies can predict exercise performance. Based on goal achievement theory and social comparison theory, researchers posited that individuals who reported higher social comparison combined with a task orientation would have higher HR, calories burned, and distance cycled. To investigate this cause-effect relationship, the present study utilized an experimental design to test the impact of group, individual, and control (no data) conditions of data display on exercise performance measures.

Method

Participants

A power analysis using G*Power 3 (Faul et al., 2007) was employed to determine the number of participants required for the study. With α level set at .05 and power at .80, with a moderate effect (f = .27), the power analysis using a within-subject Repeated Measures (RM) ANOVA revealed a required sample size of 24. A sample of 26 Peloton bike users (23 females and 3 males, M_{age} = 34.81, SD_{age} = 8.7) self-selected themselves to participate in this study via a flyer posted on social media. This sample was purposeful because the bike has the appropriate instruments and system currently in place to monitor HR, calories burned, and distance, which is displayed to the participant. To be eligible for the study, participants must have attended at least four Peloton cycling sessions in the last month to ensure familiarity with the technology (i.e., monitoring systems and data display) of the bike. Participants were excluded if they were taking medication for blood pressure that may affect their HR data during exercise. Data collection occurred in Spring 2020.

Instruments

Demographic Questionnaire

Demographic information collected from participants included age, gender, use of blood pressure medication, perceived fitness level, amount of Peloton bike use, and number of sessions attended in the past month.

Iowa-Netherlands Comparison Orientation Measure (INCOM; Gibbons & Buunk, 1999)

The INCOM assesses social comparison orientation and contains 11 items that are rated on a Likert scale from 1 (*I disagree strongly*) to 5 (*I agree strongly*). The INCOM is comprised of two subscales: comparison of performance (ability) and comparison of thoughts/emotions (opinion). Tested with an American adult sample, the INCOM has been reported to have an internal consistency ranging from .78 to .85 (Gibbons & Buunk, 1999). For this study, the purpose of the INCOM scale was to assess general social comparison orientation and the Cronbach's alpha for the scores analyzed was .80.

Goal Orientation in Exercise Measure (GOEM; Petherick & Markland, 2008)

The GOEM was developed to measure ego and task orientation in exercise settings. The 10 items of the GOEM are scored on a Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The GOEM is scored by calculating the means for the task and ego subscales. The GOEM has been reported to have internal consistencies of .78 and .88 for task and ego scales, respectively (Petherick & Markland, 2008). In the current study, Cronbach's alphas were .80 for the task scale and .75 for the ego scale. The GOEM was used in this study to assess task and ego orientations to control for goal orientation in the performance of participants.

Heart Rate Technology (Peloton HR Monitor)

The Peloton HR system is composed of a HR monitor worn around the upper abdomen and is connected to a system that transforms the HR data into various exercise data. For the purpose of this study, the exercise data used included HR, calories burned, and distance cycled.

Manipulation Checks

Likert-style questions were asked upon completion of the intervention condition (i.e., visual display of group data) to assess the extent to which individuals compared themselves to others, and to what extent they viewed the exercise data on the screen. Two items were developed: "I was comparing myself to other exercisers during the exercise session" and "I looked at the exercise data on the screen during the exercise session." Those items were measured on a scale from 1 (*never*) to 6 (*always*).

Visual Display

The Peloton bike employs a large screen located between the handles of the bike and was used for this study. This system recorded the individuals' exercise data and displayed them on the monitor. The monitor had the capability to display the participants' own data as well as the others participating in the same exercise class.

Intervention

Participants completed the following three conditions in a counterbalanced order: HR monitor + group data, HR monitor + individual data-only, or control (i.e., no visual display). In the HR monitor + group data condition, participants wore a HR monitor that displayed group exercise data (i.e., HR, calories burned, and distance cycled) on the Peloton bike screen and allowed other participants to access their data during the class. Each member of the group had their data displayed below their name. In the individual data-only condition, participants wore their HR monitor, but others' data were hidden from the screen so that only their data was visible for the duration of the session. In the control condition, participants wore their HR monitor, but the data display was turned off for the duration of the session.

Procedure

Upon Institutional Review Board (IRB) approval, participants were recruited via social media. Potential participants were asked to fill out a brief survey to gauge their eligibility for the study. After eligibility and consent were finalized, participants were instructed to fill out the INCOM and the GOEM and given instructions to complete each of the three exercise sessions, in the order given to them via a randomization spreadsheet. This order was concealed from them until after they completed the questionnaires. The first author generated the assignment sequence, enrolled participants, and assigned them to conditions. Only the first author was aware of the condition assignment. Participants were instructed to select a 30-minute cycling session on their own Peloton bike at home and completed the same session for each of the three conditions and stopped the exercise session at 30 minutes. Following each session, participants submitted their exercise data to the principal investigator via email. Each participant participated in the three exercise sessions with at least 24 hours but no more than 7 days in between sessions. Following the third exercise session, participants completed the two manipulation check questions.

Design and Analysis

This research study employs an experimental, within-subject design. Differences in exercise data (i.e., HR, calories burned, distance cycled) among conditions were analyzed via repeated measures ANOVA. When the omnibus test was significant, post-hoc analyses were performed to identify the differences among the conditions. Then, the relationship among the outcome variables was explored via correlation analysis. Finally, a regression analysis was performed with goal orientation and social comparison as predictors and exercise performance (i.e., HR, calories burned, distance cycled) as the outcome. The alpha level was set at .05 for all analyses. Outliers were defined as absolute values with a z-score greater than 3. The normality of the data was checked via the Shapiro-Wilk test.

Results

No outlier or missing data emerged. All outcome variables were normally distributed ($p > .05$), and all participants completed the three exercise conditions. Table 1 presents participant characteristics.

Manipulation Check and Descriptive Results

The two manipulation check items revealed that participants viewed the exercise data displayed on the bike very frequently ($M = 4.69/6$, $SD = .74$) and compared themselves to others during the exercise session occasionally to frequently ($M = 4.27/6$, $SD = 1.08$).

Table 2 presents the main exercise performance variables in all three conditions.

Analyses Related to Participants Characteristics

To investigate a potential effect of participants' characteristics on outcome variables, we grouped class participation in the past month into two categories: 12 classes or less ($n = 10$) and more than 12 classes ($n = 16$). In the survey, participants had four response choices to report their class participation in the past month (0-3, 4-8, 8-12, and 12+), and the first three response choices (0-3, 4-8, and 8-12) were lumped together to create a large enough group that could be compared to the 12+. Perceived fitness levels were grouped into slightly to moderately fit ($n = 19$) and very to extremely fit ($n = 7$). Using HR, calories, and distance for all three conditions as outcome variables, a MANOVA revealed a non-significant effect of class participation in the past month, Wilks' $\lambda = .44$, $F(9, 16) = 2.23$, $p = .08$, $\eta p^2 = .56$. Similarly, no difference emerged between perceived fitness levels across all outcome variables, Wilks' $\lambda = .53$, $F(9, 16) = 1.55$, $p = .21$, $\eta p^2 = .47$.

Table 1. Characteristics of Participants

Variable	Number	Percentage
Gender		
Male	3	11.5
Female	23	88.5
Class participation in the past month		
4-8	7	27
8-12	3	11.5
12+	16	61.5
Perceived fitness level		
Slightly fit	5	19.2
Moderately fit	14	53.8
Very fit	6	23.1
Extremely fit	1	3.8

Table 2. Participant Means and Standard Deviations for Heart Rate, Calories Burned, and Distance Cycled in Each of the Three Exercise Conditions

	Control (no data) Mean (*SD*)	**Individual data only** Mean (*SD*)	**Group data** Mean (*SD*)
HR (bpm)	147.81 (15.17)	151.54 (15.71)	154.96 (12.88)
Calories (Kcal)	310.23 (85.52)	337.69 (105.28)	362.42 (125.70)
Distance (miles)	8.69 (1.15)	8.89 (1.12)	9.05 (1.13)

Note. HR = heart rate, Kcal = calories burned, distance = distance cycled.

Analyses Related to The Effect of Exercise Condition on Exercise Performance

Heart Rate

The analysis revealed a significant effect of condition on HR, Wilks' λ = .72, $F(2, 24) = 4.63$, $p = .02$, $\eta p^2 = .28$. Post-hoc analyses revealed that HR was higher when participants were seeing others' data than when they were not seeing any data ($p = .02$, $d = 0.51$). No HR difference emerged between the individual data and no data conditions ($p = .20$), or between the individual data and group data condition ($p = .43$).

Distance Cycled

Analyses revealed a significant effect of condition on distance cycled, Wilks' λ = .39, $F(2, 24) = 18.56$, $p < .001$, $\eta p^2 = .61$. Post-hoc analyses revealed significant differences among all conditions. Participants cycled the longest distance when they were able to see the group data, which was significantly higher than when they only saw their own data ($p < .001$, $d = 0.14$) or when they were unable to see any data ($p < .001$, $d = 0.32$). The distance covered in the individual data condition was also significantly higher than the no data condition ($p < .001$, d = 0.16).

Calories Burned

Analyses revealed a significant effect of condition on calories burned, Wilks' λ = .77, $F(2, 24) = 3.67$, $p = .04$, $\eta p^2 = .23$. Post-hoc analyses revealed calories burned were higher when participants were able to see the group data compared to when they were unable to see any exercise data ($p = .03$, $d = 0.49$). No calories burned difference emerged between the individual data and no data conditions ($p = .20$), nor between the individual data and group data conditions ($p = .16$).

Correlation and Regression Analyses

Correlations among exercise performance variables, goal orientation, and social comparison disposition are presented in Table 3.

The analysis revealed a strong positive correlation between social comparison disposition and calories burned, and a moderate to strong positive correlation

Table 3. Pearson's *r* Correlations Among Exercise Performance Variables, Goal Orientation, and Social Comparison Disposition

Variable	**1**	**2**	**3**	**4**	**5**	**6**
1. HR						
2. Calories	.20					
3. Distance	.00	.75**				
4. Ego orientation	-.45*	-.10	-.05			
5. Task orientation	.14	.16	.20	-.47*		
6. Social comparison	-.05	.52**	.45*	.02	.06	

Note. *$p < .05$, **$p < .01$.

between social comparison disposition and distance cycled. A moderate to strong negative correlation emerged between ego orientation and HR, and between task and ego orientations. Finally, calories burned were strongly correlated with distance cycled, but HR was not significantly correlated with either calories burned or distance cycled.

Linear regression analyses were performed to determine if social comparison tendencies and ego orientation predicted exercise performance (i.e., HR, calories burned, and distance). Those analyses were performed for the group data condition only.

Social Comparison Orientation

Regression analysis results are presented in Table 4.

Social comparison orientation was a significant predictor of distance cycled, $F(1, 24) = 5.99$, $p = .02$, $R = .45$, $R^2 = .20$. Social comparison scores accounted for 20% of the variance in distance cycled. The β coefficients revealed that the higher the social comparison orientation, the longer the distance cycled, $\beta = .45$, $t = 2.45$, $p = .02$.

Social comparison orientation was also a significant predictor of calories burned, $F(1, 24) = 8.94$, $p = .006$, $R = .52$, $R^2 = .27$. Specifically, social comparison accounted for 27% of the variance in calories burned. Inspection of the β coefficient revealed that the higher the social comparison, the more calories were burned, $\beta = 0.52$, $t = 2.99$, $p = .006$.

Ego Orientation

Regression analysis are presented in Table 5.

Ego orientation was a significant predictor of HR, $F(1,24) = 5.60$, $p = .03$, $R = .44$, $R^2 = .19$, with ego orientation accounting for 19% of the variance in HR in the group condition. Inspection of the β coefficients revealed that the higher the ego orientation, the higher the average HR, $\beta = -6.20$, $t = -2.37$, $p = .03$.

Discussion

The current study explored exercise performance amongst Peloton bike riders when exposed to varying exercise data displays. Participants exhibited a higher average HR and cycled for a longer distance in the group data display condition compared to the individual data or no data display condition. These results suggest that individuals who exercised with the ability to see other participants' exercise data during their session performed at a higher level than when seeing their data only or without any data display. This is consistent with previous research indicating that when exercisers have access to others' exercise data, whether that is a partner or group, individuals tend to increase effort (i.e., calories burned) and persist longer (i.e., run duration; Aral & Nicolaides, 2017; Irwin et al., 2012; Walmink et al., 2014). This study extends the literature by presenting evidence of the motivational benefits of group data display while exercising, without the physical presence of other exercisers.

Table 4. Regression Coefficients of Social Comparison on Exercise Performance

Variable	*B*	*SE*	*p*	R^2
HR	-2.01	8.35	.80	.00
Calories Burned	208.27	69.66	.006	.27**
Distance	1.61	.66	.02	.20*

Note. *$p < .05$. **$p < .01$.

Table 5. Regression Coefficients of Ego Orientation on Exercise Performance

Variable	*B*	*SE*	*p*	R^2
HR	-6.20	2.62	.03	.19*
Calories Burned	-13.28	28.26	.64	.009
Distance	-.06	.26	.82	.002

Note. *$p < .05$.

To gain a better understanding of the variables involved in this motivational benefit, we ran regression analyses with social comparison and ego orientation as potential predictors of exercise performance. Social comparison significantly predicted 20% of distance cycled and 27% of calories burned, indicating that those with a higher tendency of comparing to others had a higher exercise performance when group data was available for comparison. The amount of variance in performance explained by social comparison is substantial and provides group exercise leaders with a strategy to increase participants' engagement. By incorporating tracking technology in exercise, specifically when in group settings, exercise leaders can more intentionally create opportunities for social comparison of performance. Visually presenting data from the group, even virtually, increases participants' effort and benefits from the exercise session. Those results are consistent with Aral and Nicolaides (2017), who reported that cyclists with higher social comparison tendencies perform at a higher intensity when they can access others' exercise data. Specifically, the authors found that when cyclists were able to compare themselves with others, they cycled longer and burned more calories than those who did not have access to others' data.

While social comparison orientation significantly predicted calories burned and distance cycled, it did not predict HR. Social comparison was also not significantly correlated with HR. It is possible participants have been motivated to observe and compare to others while not trying to outperform them. Researchers using a virtual reality exercise similarly found no increase in HR across sessions (Chapman-Lopez et al., 2020), which was explained by a lack of competitive on-screen elements and a need for enhanced display. This may apply to Peloton screens as only a list of participants is available but no videos or pictures of participants exercising are displayed. Additionally, participating in the same cycling class for each condition, participants already had a high HR ($M_{control}$ = 147.8, M_{ind} = 151.5, M_{group} = 154.9) and had little room for improvement across conditions. The HR means were at the high end of the target HR range (93-157bpm) for maximum exercise benefits, which is considered high intensity (CDC, 2020) for the average participant's age in this study (M_{age} = 34.8, which lead to a theoretical HR max of 185).

Ego orientation was a significant predictor of HR in the group data condition, explaining 19% of the variance in HR. Previous research assessing task and goal orientation mostly focused on sport contexts and has shown mixed results in predicting performance. For example, Abdullah and colleagues (2016) found ego orientation significantly predicted sport performance across a range of athletes, whereas in a study with martial artists, ego orientation was not a significant predictor of sport performance (King & Williams, 1997). The current study addresses the limited research related to the inclusion of ego orientation in exercise settings, and the present results suggest that 19% of the variance in HR during exercise is explained by ego orientation. These results echo previous exercise research, which demonstrated that ego orientation significantly predicted exercise effort (Easton, 2018). Exercise trackers and display systems in a group setting facilitate comparison among participants and potential competition. Ego orientation is concerned with comparing to and outperforming others (Gråstén & Watt, 2016). Social comparison and ego orientation can be integrated in a two-step process: first, social comparison is used to collect information (i.e., the performance of others compared to your own), then ego orientation uses this information as a criterion to outperform others. It is unclear, however, why ego orientation was a significant predictor of HR but not calories burned and distance. Nevertheless, this study suggests that ego orientation can be a motivating factor to increase intensity in a virtual exercise setting.

Limitations

Potential limitations of this study on Peloton riders must be considered. First, the present results apply to virtual exercise settings, and the generalization to in-person exercise should be tested in future studies. Second, exercise sessions were completed individually within the home of each participant rather than in a lab setting, potentially impacting control and standardization. Specifically, the calibration of the bikes for HR, calories, and distance was not checked. Participants also "scheduled" the exercise sessions around their lifestyle and individual schedules, meaning variability of fatigue or energy levels and their respective impact on performance may need to be taken into consideration. Participants were also not instructed to forgo other exercises while participating in the study or to avoid caffeine, two factors that may have impacted participant performance. Next, most participants identified as female which may not accurately depict performance across all genders. Finally, it is important to understand there is considerable financial privilege for those able to afford a Peloton system, which further limits generalizability. Despite these potential limitations, the study findings are in line with current research findings and extend the literature on the effect of visual exercise data, social comparison, and goal orientation on exercise performance.

Future Research and Implications

Future research should aim to control for the above limitations to further validify the present study's findings regarding the positive effects of exercise data display on exercise performance in a group setting. Future research should examine in-person group exercise sessions to better control and standardize the exercise sessions and equipment. Additionally, to provide a more holistic view of factors influencing exercise performance, self-determination theory, and the exercise climate—the environment created in the gym or by the leader/coach of the exercise session—should also be considered. For example, high extrinsic motivation and a climate favoring social comparison or competition might also lead to participants exerting too strenuously and increase the risk of injury. Finally, future research should include Body Mass Index, race/ethnicity, and household income to get a more inclusive demographic picture of the participants, along with a qualitative follow-up to complement objective data.

While exercise performed in a home setting could be perceived as a limitation, the future of the health and fitness industry has become increasingly virtual, a shift that was potentially expedited by the Coronavirus pandemic. As home-workout technology revolutionizes and new pieces of equipment are developed, it is necessary to research the impact of social comparison across multiple modalities of exercise and various forms of technology. For instance, FightCamp Gym (shadowboxing) and Tempo Studio (resistance training) are two at-home exercise machines with live classes and virtual trainers who the user follows and uses as a guide during workouts. Other companies, such as NordicTrack, sell multiple pieces of equipment, such as treadmills, bikes, ellipticals, and the Vault (interactive strength training), allowing users to participate in live classes at home. Similar to Peloton, live classes on the aforementioned devices allow participants to utilize leaderboards and stats to compare their performance to others taking classes.

Exercising with others can boost motivation to perform, increase enjoyment, and enhance effort or intensity (Irwin et al., 2012; Mauriello et al., 2014). Past social comparison in exercise research focused on using virtual partners when comparing exercise performance and group fitness has received limited attention (Feltz et al., 2011). Further, previous studies have focused on subjective experience in exercise and social comparison (Tholander & Nylander, 2015), whereas this study included both subjective and objective measures. As activity trackers have become a popular way to engage with others during exercise, they have granted the ability to explore factors affecting exercise performance. This study suggests that when an individual has access to group exercise data, their exercise performance increases (i.e., average HR, calories burned, and distance cycled). For fitness facility owners and group exercise leaders, this study provides support for visually presenting data from the group, even virtually, to increase participants' effort and engagement, ultimately increasing the benefits from the exercise session. For those who are not sufficiently active, seeing their data can allow them to monitor their progress. Then, as participants exercise more regularly, the presentation of group data of people with similar fitness levels can help them increase their engagement during exercise.

ORCiD

Allison S. Blake
https://orcid.org/0000-0001-9687-8122
Jean-Charles Lebeau
https://orcid.org/0000-0001-6550-6676
Lindsey C. Blom
https://orcid.org/0000-0002-7870-6623
Kayla Myers
https://orcid.org/0000-0002-7354-4303

References

Abdullah, M. R., Musawi Maliki, A. B. H., Musa, R. M., Kosni, N. A., Juahir, H., & Haque, M. (2016). Multi-hierarchical pattern recognition of athlete's relative performance as a criterion for predicting potential athletes. *Journal of Young Pharmacists, 8*(4), 463-470. https://doi.org/10.5530/jyp.2016.4.24

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*(3), 260-267. https://doi.org/10.1037/0022-0663.80.3.260

Annesi, J. J., & Mazas, J. (1997). Effects of virtual reality-enhanced exercise equipment on adherence and exercise-induced feeling states. *Perceptual and Motor Skills, 85*(3), 835-844. https://doi.org/10.2466/pms.1997.85.3.835

Aral, S., & Nicolaides, C. (2017). Exercise contagion in a global social network. *Nature Communications, 8*(1), 1-8. https://doi.org/10.1038/ncomms14753

Brophy, J. (2005). Goal theorists should move on from performance goals. *Educational Psychologist, 40*(3), 167-176. https://doi.org/10.1207/s15326985ep4003_3

Cadmus-Bertram, L. A., Marcus, B. H., Patterson, R. E., Parker, B. A., & Morey, B. L. (2015). Randomized trial of a Fitbit-based physical activity intervention for women. *American Journal of Preventive Medicine, 49*(3), 414-418. https://doi.org/10.1016/j.amepre.2015.01.020

Centers for Disease Control and Prevention (2020, September 17). *Measuring physical activity intensity.* https://www.cdc.gov/physicalactivity/basics/measuring/

Chapman-Lopez, T., Kelling, N. J., Arecemant, D. J., Amonette, W. E., & English, K. L. (2020). Effects of virtual reality during rowing ergometry on metabolic and performance parameters. *Proceedings of the TACSMI Conference, 2*(1), Article 96. https://digitalcommons.wku.edu/ijesab/vol2/iss12/96

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist, 41*(10), 1040-1048. https://doi.org/10.1037/0003-066X.41.10.1040

Easton, L. E. (2018). *The relationship of exercisers' reasons for using physical activity trackers, goal orientations, effort, and enjoyment* (Publication No. 27551) [Doctoral dissertation, University of Kansas]. KU ScholarWorks.

Elliot, A. J., & McGregor, H. A. (2001). A 2 × 2 achievement goal framework. *Journal of Personality and Social Psychology, 80*(3), 501-519. https://doi.org/10.1037/0022-3514.80.3.501

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175-191. https://doi.org/10.3758/bf03193146

Feltz, D. L., Kerr, N. L., & Irwin, B. C. (2011). Buddy up: The Köhler effect applied to health games. *Journal of Sport and Exercise Psychology, 33*(4), 506-526. https://doi.org/10.1123/jsep.33.4.506

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7*(2), 117-140. https://doi.org/10.1177/001872675400700202

Gerber, J. P. (2018). Social comparison theory. In V. Zeigler-Hill & T. Shackelford (Eds). *Encyclopedia of Personality and Individual Differences* (1st ed, pp. 4005-4011). Springer.

Gibbons, F.X., & Buunk, B.P. (1999). Individual differences in social comparison: The development of a scale of social comparison orientation. *Journal of Personality and Social Psychology, 76*(1), 129-142. https://doi.org/10.1037/0022-3514.76.1.129

Grasten, A., & Watt, A. (2016). Perceptions of motivational climate, goal orientations, and light-to-vigorous-intensity physical activity engagement of a sample of Finnish grade 5 to 9 students. *International Journal of Exercise Science, 9*(3), 291-305.

Hagger, M., & Chatzisarantis, N. (2007). Self-determination theory and the psychology of exercise. *International Review of Sport and Exercise Psychology, 1*(1), 79-103. https://doi.org/10.1080/17509840701827437

Hulleman, C. S., Schrager, S. M., Bodmann, S. M., & Harackiewicz, J. M. (2010). A meta-analytic review of achievement goal measures: Different labels for the same constructs or different constructs with similar labels? *Psychological Bulletin, 136*(3), 422-449. https://doi.org/10.1037/a0018947

Irwin, B. C., Scorniaenchi, J., Kerr, N. L., Eisenmann, J. C., & Feltz, D. L. (2012). Aerobic exercise is promoted when individual performance affects the group: A test of the Kohler motivation gain effect. *Annals of Behavioral Medicine, 44*(2), 151-159. https://doi.org/10.1007/s12160-012-9367-4

Jury, M., Smeding, A., & Darnon, C. (2015). Competing with oneself or with others: Achievement goal endorsement in amateur golf competition. *International Journal of Sport Psychology, 46*, 258-273. https://hal.science/hal-01859658

Karapanos, E., Gouveia, R., Hassenzahl, M., & Forlizzi, J. (2016). Wellbeing in the making: Peoples' experiences with wearable activity trackers. *Psychology of Well-Being, 6*(1), 1-17. https://doi.org/10.1186/s13612-016-0042-6

King, L. A., & Williams, T. A. (1997). Goal orientation and performance in martial arts. *Journal of Sport Behavior, 20*(4), 397-411.

Liu, W., Zeng, N., Pope, Z. C., McDonough, D. J., & Gao, Z. (2019). Acute effects of immersive virtual reality exercise on young adults' situational motivation. *Journal of Clinical Medicine, 8*(11), Article 1947. https://doi.org/10.3390/jcm8111947

Lox, C. L., Ginis, K. A. M., Gainforth, H. L., & Petruzzello, S. J. (2019). *The psychology of exercise: Integrating theory and practice*. Routledge.

Mauriello, M., Gubbels, M., & Froehlich, J. E. (2014, April). Social fabric fitness: the design and evaluation of wearable E-textile displays to support group running. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI, 14*, 2833-2842. https://doi.org/10.1145/2556288.2557299

Nicholls, J. G. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91*(3), 328-346. https://doi.org/10.1037/0033-295X.91.3.328

NPD (2013). Digital fitness and wearable technology, NPD group's consumer technology report. Retrieved May 21, 2019 from: Wearable Tech Device Awareness Surpasses 50 Percent Among US Consumers, According to NPD (prnewswire.com)

Petherick, C. M., & Markland, D. (2008). The development of a goal orientation in exercise measure (GOEM). *Measurement in Physical Education and Exercise Science, 12*(2), 55-71. https://doi.org/10.1080/10913670801903902

Senko, C., Hulleman, C. S., & Harackiewicz, J. M. (2011). Achievement goal theory at the crossroads: Old controversies, current challenges, and new directions. *Educational Psychologist, 46*(1), 26-47. https://doi.org/10.1080/00461520.2011.538646

Steele-Johnson, D., Beauregard, R. S., Hoover, P. B., & Schmidt, A. M. (2000). Goal orientation and task demand effects on motivation, affect, and performance. *Journal of Applied Psychology, 85*(5), 724-738. https://doi.org/10.1037/0021-9010.85.5.724

Su, X., McBride, R. E., & Xiang, P. (2015). College students' achievement goal orientation and motivational regulations in physical activity classes: A test of gender invariance. *Journal of Teaching in Physical Education, 34*(1), 2-17. https://doi.org/10.1123/jtpe.2013-0151

The Business Research Company (2023, January). Online or virtual fitness global market report 2023. https://www.thebusinessresearchcompany.com/report/online-virtual-fitness-global-market-report

Tholander, J., Nylander, S. S., & Sweat, P. (2015). Snot, sweat, pain, mud, and snow: Performance and experience in the use of sports watches. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, CHI, 15*, 2913–2922. https://doi.org/10.1145/2702123.2702482

Turner, A. (2017). How does intrinsic and extrinsic motivation drive performance culture in organizations? *Cogent Education, 4*(1), Article 1337543. https://doi.org/10.1080/2331186x.2017.1337543

Urdan, T., & Mestas, M. (2006). The goals behind performance goals. *Journal of Educational Psychology, 98*(2), 354-365. https://psycnet.apa.org/doi/10.1037/0022-0663.98.2.354

Van Yperen, N. W. (2003). Task interest and actual performance: The moderating effects of assigned and adopted purpose goals. *Journal of Personality and Social Psychology, 85*(6), 1006-1015. https://doi.org/10.1037/0022-3514.85.6.1006

Vansteenkiste, M., Neyrinck, B., Niemiec, C. P., Soenens, B., De Witte, H., & Van den Broeck, A. (2007). On the relations among work value orientations, psychological need satisfaction and job outcomes: A self-determination theory approach. *Journal of Occupational and Organizational Psychology, 80*(2), 251-277. https://doi.org/10.1348/096317906X111024

Walmink, W., Wilde, D., & Mueller, F. F. (2014, February). Displaying heart rate data on a bicycle helmet to support social exertion experiences. In *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction* (pp. 97-104).

Wood, J. V. (1989). Theory and research concerning social comparisons of personal attributes. *Psychological Bulletin, 106*(2), 231-248. https://doi.org/10.1037/0033-2909.106.2.231

Wood, J. V. (1996). What is social comparison and how should we study it? *Personality and Social Psychology Bulletin, 22*(5), 520-537. https://doi.org/10.1177/0146167296225009