PARTNER WEIGHT AS A MODERATOR OF EXERCISE MOTIVATION IN AN OBESE SAMPLE

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The authors declare no conflict of interest.

ABSTRACT

OBJECTIVE—Köhler motivation gain principles were utilized (based on the group dynamics principles of upward social comparison and indispensability) to explore increasing exercise duration in an obese community sample (mean BMI = 38 $kg \cdot m^{-2}$) with a lighter versus same weight virtually-presented interactive exergame partner.

METHODS—Community adults (N = 48; age = 45.3 ± 15.86 years) completed the first block of three isometric abdominal exercises alone. After resting, participants completed the second block either alone (Control), with a lighter weight (LW), or with a same weight partner (SW). Partners were actually confederates recorded earlier and presented virtually as live, from another lab. Exercise persistence, self-efficacy beliefs, enjoyment, perceived exertion, perceptions of one's own and relative partner ability, and body image were collected.

RESULTS—Mean persistence was greater for participants in the LW (23.2 sec) condition than for those in the Control condition (-12.44 sec; 95% CI: 11.57, 59.3, $p < 0.002$). Mean persistence was also greater for participants in the SW (21 sec) condition than for those in the Control condition (-12.44 sec; 95% CI: 8.74, 58.14, $p < 0.006$). Despite persisting longer than Controls, SW participants rated their own ability lower than Controls ($p = 0.027$). Body image assessment choice correlated with BMI ($r = .69$), but was not significantly related to persistence.

CONCLUSIONS—The Köhler motivation effect increased persistence with abdominal isometric exercises in obese adults and was not moderated by the relative weight of one's partner.

Keywords—conjunctive; exergame; motivation; obesity; social comparison

1.0 INTRODUCTION

The majority of Americans do not meet recommended standards of physical activity to maintain or improve health, with those adults in the highest obesity class reported to have the lowest levels (Tucker, Welk, & Beyler, 2011). Measured with accelerometry, 5.1% of adults with a body mass index (BMI) of 30-34.9 $kg \cdot m^{-2}$ met the guidelines of 150 minutes per week of moderate-to-vigorous physical activity and only 3.5% of those with a BMI of higher than 35 $kg \cdot m^{-2}$ met the guidelines (Tucker, Welk, & Beyler, 2011). In an analysis of the National Health and Nutrition Examination Survey (NHANES) 2003-2005 data, researchers examined the relationship between obesity and accelerometer-derived moderate-to-vigorous physical activity and noted a consistent inverse association, regardless of sedentary behavior (Maher, Mire, Harrington, Staiano, & Katzmarzyk, 2013).

Increasing the amount of time spent in moderate-to-vigorous physical activity has been a key intervention strategy to reduce obesity and associated health risk. However, motivation also has been a key issue related to these intervention strategies, especially at higher exercise intensities (Pearson, 2012; Gourlan, Trouilloud, & Sarrazin, 2011; Dishman, 2001). For instance, high-intensity, intermittent exercise has been shown to be effective when body weight reduction is a goal (Trapp, Chisholm, Freund, & Boutcher, 2008), and weight training has been shown to prevent increases in body fat percentage in middle-aged women (Schmitz, Jensen, Kugler, Jeffery, & Leon, 2003), but exercise duration is harder to maintain as intensity increases (Boutcher, 2011). Thus, finding ways to motivate people who are at risk for obesity to exercise longer at higher intensities is needed to help them realize associated health benefits.

One line of research has explored a successful method to increase the duration of exercise by providing a tailored exercise partner and framing the exercise performance task (e.g., performing abdominal exercises as a team) to operationalize specific group dynamics processes of motivation (Feltz, Kerr, & Irwin, 2011; Feltz, Irwin, & Kerr, 2012; Irwin, Scorniaenchi, Kerr, Eisenmann, & Feltz, 2012). This research has employed the group-motivation dynamic known as the *Köhler effect* with virtually-presented partners in exergames. The Köhler effect was named after a German industrial psychologist, Otto Köhler (Hertel, Kerr, & Messé, 2000), who found that the less capable member of a dyad performed longer at a simple but physically-exerting task (standing biceps curls) when paired with someone moderately better than when performing alone. This effect occurred in *conjunctive* task conditions, where the pair could persist no longer than its weaker partner (i.e., when the weaker partner quit, the stronger partner was not allowed to continue). Conjunctive task conditions are team-oriented, involve upward social comparison, and stress the indispensability of people's efforts when they see their efforts as being highly instrumental in achieving team success (i.e., the weaker partner's motivation to perform well is enhanced). The conjunctive task environment avoids common team performance losses, such as partner performance variability and perceived team dispensability (i.e., free-riding or social loafing) (Karau & Williams, 1993). Therefore, the Köhler effect, with its social comparison, sense of indispensability, and conjunctive-task environment, has shown promise for improving effort and motivation

in exercise (Feltz, Kerr, & Irwin, 2011; Feltz, Irwin, & Kerr, 2012; Irwin, Scorniaenchi, Kerr, Eisenmann, & Feltz, 2012).

Using virtually-presented partners in exergames, Feltz and her colleagues demonstrated significant increases in physical activity persistence ranging from 15% to 48% with abdominal isometric exercises (i.e., planks) and wall-sit exercises and increases of 125% utilizing an aerobic cycling task (Feltz, Kerr, & Irwin, 2011; Feltz, Irwin, & Kerr, 2012; Irwin, Scorniaenchi, Kerr, Eisenmann, & Feltz, 2012; Forlenza, Kerr, Irwin, & Feltz, 2012; Kerr, Forlenza, Irwin, & Feltz, 2013). These types of exercises were used because they required considerable effort but did not require much skill/coordination, thus making them ideal for testing physical effort. Feltz et al. (2011) argued that for this paradigm, virtually-presented partners were more practical than finding an ideally-matched, live exercise partner (i.e., someone who is moderately more capable with similar exercise goals), trying to coordinate a time to exercise with another person, and having possible social physique anxiety (i.e., anxiety about one's body shape being evaluated). Additionally, potential moderators of the Köhler effect could be investigated more efficiently using a virtual-partner paradigm.

There are recognized moderators that may regulate the Köhler effect, potentially interfering with the key conjunctive mechanisms, and affecting whether the exerciser responds to the partner and manipulated condition (Forlenza, Kerr, Irwin, & Feltz, 2012; Kerr & Seok, 2010; Kerr & Hertel, 2011). One potential moderator is the discrepancy in ability between partners. Feltz et al. (2012) tested whether there is an optimal level of ability discrepancy between an exergame player and a virtually-presented partner. The authors found that the Köhler effect was smaller when one's virtually-presented partner was either only slightly more capable or extremely more capable than the participant. This Köhler "discrepancy effect" can weaken performance gains by undermining the motivation in partner comparison processes. A moderate discrepancy in ability seems to encourage comparison, but not so if the partner discrepancy is slight or very discrepant (Feltz, Irwin, & Kerr, 2012).

Another potential moderator is the weight of the partner relative to weight of the person exercising. In terms of partner weight, it is plausible that exercising with a lighter weight partner, versus a similar weight partner, might instill unfavorable comparison responses, which could attenuate any motivation gains from the Köhler effect (Schwartz, Vartanian, Nosek, & Brownell, 2006). For example, because obese individuals may perceive lighter weight people as being more capable at the exercise task, they may view them as an incomparable partner and reject the team goal as unrealistic. Yet, little is known about the influence of an exercise partner's weight as a potential moderator of Köhler motivation gain effect. Further, no studies have explored this moderator in an obese sample, considering both the weight of the partner and participant.

Engaging in a physical activity task with a heavier weight, virtually-presented (i.e., video projection) partner did not attenuate persistence gains in a non-obese college student sample (Forlenza, Kerr, Irwin, & Feltz, 2012). The results showed that conjunctive team participants persisted longer, relative to individual exercisers, regardless of their virtually-presented

partner's weight. However, other studies on the Köhler effect in exercise, as with this prior study, have employed only lighter weight, college-aged participants. Whether or not partner weight characteristics moderate the Köhler effect with adult obese participants has not been explored. The answer to this question is important because obese individuals have reported feelings of being too overweight, feeling self-conscious, and experiencing high levels of distress when exercising among others (i.e., social physique anxiety) (Napolitano, Papandonatos, Borradaile, Whiteley, & Marcus, 2011; Smits, Tart, Presnell, Rosenfield, & Otto, 2010) and thus, the use of virtually-presented partners with optimal partner characteristics could potentially add powerful sources of motivation to exergame design to increase exercise intensity and duration for obese populations. Using an obese (≥ 30 BMI) community sample, we examined the motivation to persist at an exergame task when exercising with a lighter or same weight virtually-presented partner. In addition, obese participants' weight perceptions (own and partner) and ability perceptions (own and partner) were explored in relation to performance outcomes.

2.0 METHOD

2.1 Participants

Forty-eight adult community members in Michigan, USA (M = 45.3 ± 15.86 years) were randomly assigned to three experimental same-sex conditions: Lighter Weight partner (LW), Same Weight partner (SW), or no partner Control (CON). The experiment was powered on the repeated measures ANOVA used to evaluate the primary dependent variable of persistence to detect a medium effect size. The sample consisted of 41 females and 7 males (6 African-American, 42 Caucasian) meeting the inclusion criteria of a BMI ≥ 30. Obese was defined by the National Heart, Lung, and Blood Institute's weight categories (US, 1998): obesity equal or greater than 30.0 BMI (Grade 1 obesity as a BMI of 30-34.9, Grade 2 obesity as a BMI of 35-39.9, and Grade 3 obesity as a BMI of 40 or greater). Participants were compensated with a Tanita BC-418 body composition analyzer assessment (e.g., BMI, percent body fat, fat free mass, estimate of total body water) and an opportunity to win one of the three $50 gift cards.

2.2 Procedure

Participants were recruited through a variety of online and posted advertisements, as well as in collaboration with a local weight management clinic. All experimental sessions were held in a laboratory at a university or in a private room at the weight management clinic. The authors' Institutional Review Board provided ethical approval.

Upon arrival at either lab space, all participants completed the informed consent process, a demographics questionnaire, and the Physical Activity Readiness Questionnaire (PAR-Q), and they subsequently viewed an instructional video that explained and demonstrated a series of three abdominal isometric exercises: a front plank, right side plank, and left side plank. Afterward, participants performed the three plank exercises by holding each of them for as long as possible (Block 1). Using the EyeToy: Kinetic™ exergame for the PlayStation2 (Sony, Tokyo, Japan), a webcam captured their live performance and projected it onto a screen alongside the exergame's virtual trainer (who demonstrated each exercise). After completing Block 1 individually, and following a 10-minute rest period, each

participant was randomly assigned to complete the second block of exercises (Block 2) alone (CON), with an LW partner, or with an SW partner. Partners were pre-recorded confederates who were presented as live in another lab by manipulating video recordings and looped images.

Prior to Block 2 (which was the same as Block 1, i.e., holding the same set of three plank exercises for as long as possible), experimental condition participants met their pre-recorded partner via a mock Skype internet introduction. During these introductions, participants and their partners exchanged four pieces of personal information: name, age, what they do for a living, and their favorite television programs. Participants were then provided truthful feedback on their own Block 1 performance (i.e., the average length of time the exercises were held) and false feedback on their partner's prior performance (always calculated as 40% longer to establish a moderate discrepancy in ability). Partnered participants were also told that the team score would be determined by the teammate who quit holding the abdominal plank exercise first, and that once one partner quits, the other partner must also quit.

Just as with Block 1, participants' live performance was projected onto a screen using the exergame, but those in the experimental conditions were also able to view their partner's 'live' performance on another screen. The partner video was pre-recorded and synchronized so that the partner always outperformed the participant by holding the exercises longer (i.e., until participants quit holding the exercise). The CON condition participants simply repeated the three exercises individually, without a partner.

Köhler conjunctive partner conditions were established by providing participants comparative feedback for a moderately superior partner's first block performance and 'live', simultaneous Block 2 exercise performance. Additional conjunctive conditions were created with team indispensability cues (e.g., dyad score based upon performance of weakest member). In addition to performing the plank exercises, participants completed questionnaires during and after the experiment (described subsequently). Following completion of the study, participants were debriefed and thanked for their participation.

2.3 Measures

Persistence. Because it is difficult to measure motivation (a cognitive process) directly, motivation gain was inferred from effort at the persistence task as is typical in the Köhler effect paradigm. Persistence was defined as the total number of seconds that the exercise position was held. Block scores were calculated by taking the summed total of the three exercise position times within each trial.

Body image assessment. Following completion of all exercises and other measures, participants rated their body image utilizing the Body Image Assessment for Obesity (BIA-O) silhouette cards (Williamson et al., 2000), which were shuffled and displayed in front of participants. These 18 cards each had a silhouette image of a person on their front, each with a different body size. Numbers on the back of each card (1 = thinnest, 18 = heaviest) were recorded when a participant chose the silhouette. Participants from partnered conditions were told to select the image that "most accurately depicts your partner's body size as you perceive it to be." Participants were then told to "select the

silhouette that most accurately depicts your body size as you perceive it to be." These images have been validated in individuals up to a BMI of 50 in Caucasian and African-American male and female adults (Williamson et al., 2000).

Perceptions of fitness and partner's ability. Prior to beginning the experiment, ratings of personal fitness were collected (1 = poor, 2 = below average, 3 = average, 4 = good, 5 = excellent) for all participants. As a manipulation check for invoking a conjunctive task demand, after the second block of exercises, participants estimated their partner's relative competence by responding how their partner compared to them in ability (1 = "much less capable", 9 = "much more capable"). Participants should have perceived their partner as more competent relative to their own ability, if the manipulation check held true.

Self-efficacy beliefs. Participants recorded how many seconds they believed they could hold each exercise at three different time points as a measure of self-efficacy beliefs (SE). Participants estimated the number of seconds they were completely confident they could hold each exercise before Block 1, before Block 2 (after meeting the partner and receiving comparative feedback), and after all exercises were completed. For each rating, a sum of the three estimated times was calculated as the total SE score.

Enjoyment. The Physical Activity Enjoyment Scale (PACES; Raedeke, 2007) was used to assess perceptions of physical activity enjoyment with an 8-item, 7-point bipolar scale (1 = I loved it, 7 = I hated it) after completion of Block 2.

Perceived exertion. Immediately after quitting each plank exercise, participants were prompted to verbally report ratings of overall perceived exertion for that exercise using the Borg Rating of Perceived Exertion scale (RPE; Borg, 1998). The scale ranges from 6 to 20, with 6 being "no exertion at all" and 20 being "maximal exertion." An explanation, including anchoring, and poster of the scale was provided.

3.0 RESULTS

Condition	***N***	***Mean (SD)***
Control	16	40.33 (5.84)
Lighter Weight	16	36.92 (5.85)
Same Weight	16	36.83 (5.32)
Total	48	38.03 (5.79)
Gender	***N***	***Mean (SD)***
Male	7	40.26 (6.78)
Female	41	37.64 (5.61)
Total	48	38.03 (5.79)

Table 1. Participant Body Mass Index (BMI)

3.1 Participant characteristics

Mean BMI was higher in the LW and SW groups than CON but was not significantly different, F(2,45) = 1.98, p = .15 (see Table 1). Participants self-reported having "below average" fitness (M = 2.50, ± .799) with no significant differences among conditions, F(2,45) = 1.18, p = .32.

3.2 Persistence effects

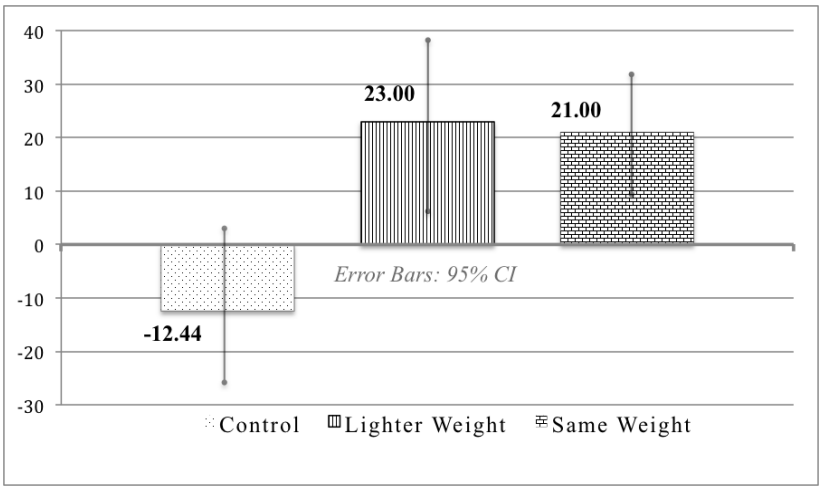

Figure 1. Persistence: Block2 – Block1 (Mean seconds & 95% CI)

The overall mean for persistence time in Block 1 was 86.7 sec. (± 54.15). A sum of the participant's three plank persistence times was used to calculate a difference score between Block 2 and Block 1, which permitted a control for individual differences in strength (estimated by Block 1 performance). There were significant differences in Mean persistence times between the partnered conditions and the control condition F(2,43) = 8.05, p < 0.001 (Figure 1). Mean persistence difference times were significantly greater for participants in the LW partnered condition (M = 23.2 ± 29.71 sec.) than for those in the CON condition (M = -12.44 ± 30.82 sec), 95% CI: 11.5, 59.3, *d* = 1.17. Mean persistence difference times were also significantly greater for participants in the SW partner condition (M = 21.00 ± 21.05 sec.) than for those in the CON condition (M = -12.44 ± 30.82 sec) 95% CI: 8.74, 58.14, *d* = 1.29. For the persistence difference times, there was not a significant difference between the three group's variances (Levene's F(2,43) = 1.082 p=0.348).

There was no significant difference in persistence times for gender (41 female and 7 male), F(1,44) = 0.029 p = 0.87 or race (Caucasian 42, African-American 6), F(1,44) = 0.69 p = 0.41. Male and female data were combined for each condition for all other analyses.

3.3 Body image assessment

For the BIA-O silhouette choices, the mean in the LW condition for the participant selection of own body size (OwnSize) was 9.75 (± 2.77) compared to 5.44 (± 2.58) for partner's body size (PartSize). In the SW

condition, the OwnSize mean was 9.80 (± 1.98) versus a mean for PartSize of 9.56 (± 1.55). There was a significant difference in participant perceptions of body size relative to their partner in the LW condition, while no such difference was perceived in the SW condition, suggesting the partner-weight conditions were valid.

A Pearson correlation was run to assess the relationship between body image assessment and other variables of interest. OwnSize perceptions were positively related to BMI ($r = .69$ $N = 31$ $p < .001$). OwnSize perceptions for the partnered conditions were not correlated to plank block difference times ($r = .01$, $N = 29$ $p = .96$) nor did there appear to be a relationship between OwnSize perceptions and the experimental condition each of the partnered participants were randomly assigned to ($r_s = -.077$, $N = 31$ $p = .68$). OwnSize did not appear to be tied to measures of self-efficacy or exertion, yet there was a negative relationship between OwnSize and enjoyment ($r = -.44$ $N = 31$ $p = .03$).

3.4 Perceived partner ability

As a manipulation check for the conjunctive task demand, at the end of the exercises, participants provided a best estimate of how their partner compared to them in ability, "much less capable = 1" to "much more capable = 9." Both SW and LW groups perceived Partner Ability (SW: 7.13 ± 2.42; LW: 5.94 ± 3.13) as higher than their own and there was not a significant difference between the two conditions, $F(1,30) = 1.44$, $p = .24$).

3.5 Self-efficacy beliefs

Participants' estimates (in seconds) of confidence in holding each plank exercise were summed to obtain an SE score for each measurement point. There were no significant differences in SE between conditions at each time point. SE was positively correlated with persistence at each plank block of exercises (Block 1: $r = 0.49$, $N = 47$, $p < 0.001$; Block 2: $r = .79$, $N = 46$, $p < 0.001$).

3.6 Enjoyment

Physical activity enjoyment was measured using an 8-item, 7-point bipolar scale (1 = I loved it, 7 = I hated it) after completion of the Block 2 exercises. There were no differences among conditions in overall ratings of enjoyment, $F(2,45) = 1.02$, $p = .37$. Persisting longer did not impact perceptions of enjoyment in the partnered conditions.

3.7 Perceived exertion

Self-reported ratings of perceived exertion (RPE) were collected after each plank was completed and averaged for each block to obtain block exertion scores. Overall mean ratings at Block 1 (M= 14.15, ±1.82) and Block 2 (M = 14.5, ± 1.81) fell between the scale's verbal anchors of "somewhat hard" (13) and "hard" (15). Exertion ratings did not differ across conditions, Block 1: $F(2,43) = .32$, $p = .73$; Block 2: $F(2,43) = .390$, $p = .68$), regardless of increased persistence in the partnered groups.

4.0 DISCUSSION

This study explored partner's weight as a potential moderator of the Köhler motivation gain effect in an adult sample with grade 2 obesity (a mean BMI of 38). We showed that obese adults persisted significantly longer in an exergame based on abdominal strength exercises when partnered with either a same weight or lighter weight partner, under conjunctive-

task conditions, compared to no partner. Persistence averages for the combined partnered conditions (22 sec) versus the no-partner condition (-12.44 sec) demonstrated a 36% performance gain. The Köhler effect continues to be effective in motivating exercise persistence in an exergame setting, despite weight as a potential moderator.

For the obese individuals in our study, similarity/dissimilarity in appearance may not have been the most salient partner characteristic. Participants may have been more motivated by wanting to make a good impression (not be the weak link) on their partner regardless of his/her size (Ede, Forlenza, & Feltz, in press). Even though there are multiple weight-related social psychological mechanisms (e.g., anti-fat bias, social physique anxiety, stereotyping, and internalization of weight stigma) that may be powerful enough to interfere with the desired upward social comparison and team indispensability, discrepant weight and perceptions of ability (own and partner) did not seem to trigger social cues or other mechanisms that might have otherwise inhibited the Köhler effect in this sample.

Our findings may be clinically important to obese and overweight adults who want to increase short but intense bouts of physical activity, weight or circuit-type training (Schmitz, Jensen, Kugler, Jeffery, & Leon, 2003) and/or control their diabetes (Dunstan et al., 1998) by incorporating Köhler motivation gain principles into the design of future exergames and other healthy lifestyle software applications. Further, the use of a virtually-presented partner has the practical advantages for this population of overcoming the challenges of finding an ideally-matched exercise partner who can be available at any given time and location, and can help with possible social physique anxiety. For instance, web-based applications could be developed to optimally match exercise/training partners (similar to online dating services) (Irwin & Feltz, in press). However, a virtually-presented partner is still a real person, just pre-recorded and adjusted in relation to the target participant's ability level. It also involves providing false feedback of partner ability, which may be impractical in exercise settings or games (Feltz, Forlenza, Winn, & Kerr, 2014). The ideal solution would be to create computer-generated partners whose appearances, movements, and ability discrepancies could be manipulated.

The motivation gains achieved with a more capable partner, regardless of lighter weight or same weight, did not come at the expense of aversion to the task. No differences were observed in self-efficacy, enjoyment, or perceived exertion among the groups, which mirrors previous research (Feltz, Kerr, & Irwin, 2011; Feltz, Forlenza, Kerr, Irwin, & Feltz, 2012; Forlenza, Winn, & Kerr, 2014). Participants did not perceive they were working any harder, enjoy the exercise less, or have lower self-efficacy about the task than controls. These findings are encouraging as they show it may be plausible to extend exercise duration without leading to adverse consequences.

The limitations of this study are that we used a single type of isometric strength task in a one-time exercise session. Future research should examine other types of moderate-to-vigorous exercise (e.g., interval-based aerobic exercise, other types of resistance training) and examine the Köhler effect over multiple sessions. Although race and gender did not significantly differ in our sample's analysis, a larger sample size may reveal meaningful differences. Considering the relatively high mean BMI of this sample (M = 38.03, SD = 5.79), only lighter and same weight partners were utilized to compare

against controls. Ideally, a greater weight condition would have also been useful to more fully explore weight as a moderator on the Köhler motivation gain effect in the obese sample. However, including greater weight male and female partners would require significantly heavier confederates to ensure the successful manipulation of the participant's perception of a greater weight partner. As mentioned, non-obese college students did demonstrate persistence gains when engaging in an abdominal plank exercise task with a heavier weight, virtually-presented partner similar to those with a same weight partner (Forlenza, Kerr, Irwin, & Feltz, 2012). Finally, considering the popularity of video games and virtual reality software, application of this line of research to computer-generated partners promises to present additional opportunities to manipulate relevant characteristics and conditions toward eliciting exercise performance gains.

5.0 Conclusion

Our results support the Köhler motivation effect with obese adults in an exergame task. We showed that obese adults will persist significantly longer in an exergame based on abdominal strength exercises when partnered with either a same weight or lighter weight partner, under conjunctive task conditions, compared to no partner. The Köhler effect was not moderated by the relative weight of one's partner. These findings may also be incorporated into the design of future exergames and other healthy lifestyle software applications to motivate those who prefer this growing segment of electronic personal devices.

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