Enhancing Aerobic Exercise with a Novel Virtual Exercise Buddy Based on the Köhler Effect

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Abstract

Objective: Research on active videogames (AVGs) has demonstrated the motivation-boosting power of the Köhler effect (a motivating force for “weak links” in groups based on group principles of upward social comparison and indispensability) with software-generated partners (SGPs), but the effect has yet to be examined over time. We tested the viability of the Köhler effect in an AVG with an SGP over 12 exercise sessions using a cycle ergometer and whether a fatiguing partner (FP) could further boost the effect.

Materials and Methods: A repeated-measures design was used to assess mean changes in exercise persistence over time. Participants were randomly assigned to one of three game conditions: AVG alone (individual-control [IC]), AVG with a consistently superior partner (CSP), or AVG with a superior partner who showed signs of fatigue (FP). Assessments were conducted on 82 participants (42 college students and 40 adults from the community) in a laboratory over 12 experimental sessions. The main outcome measure was exercise persistence (minutes of gameplay cycling at 75% HR_{max}).

Results: Data yielded significant improvements in exercise duration for men in the FP condition when compared with men in the IC condition ($M_{\text{diff}} = 12:32$ minutes, $SE_{\text{diff}} = 4:54$). Women showed no change in exercise persistence over time and no condition differences.

Conclusion: Exercising in an AVG with a superior SGP, who shows signs of fatigue over time, improved exercise persistence for men but not for women under present experimental conditions.

Introduction

PHYSICAL INACTIVITY is the key contributing cause for a number of health problems plaguing U.S. citizens, responsible for an estimated 5.1 million deaths per year worldwide.¹ Despite an abundance of evidence for the health benefits of physical activity (PA) and established guidelines to achieve them, only a small fraction of Americans meet or exceed recommended PA levels.² The Centers for Disease Control and Prevention (CDC) states that 150 minutes of moderate-to-vigorous physical activity per week (MVPA) can elicit substantial health benefits, yet this guideline is met by very few Americans. Motivation has been identified as a key factor limiting participation in PA.³ Nearly half of all persons who begin a structured exercise program quit within 6 months, and those who persist may still fail to meet the prescribed levels of exercise intensity or volume.⁴

Social psychological factors such as support from valued others (e.g., family, friends, and physician) have been identified as potential contributors to increased PA.⁵ Other group

dynamics may also contribute to or detract from exercise motivation (e.g., social loafing and social facilitation). One key group dynamic that shows promise for motivating people in exercise contexts is the Köhler effect, where the weaker member of the group tends to be more motivated when working together with a moderately more capable partner than working individually.⁶ The effect is observed most readily when the task is conjunctive (i.e., the outcome is reliant upon the weaker group member).⁷

However, employing the Köhler group dynamic effect in practical exercise settings poses some problems. Finding a superior exercise partner who has just right amount of superiority (i.e., discrepancy should be moderate) and consistently utilizing such a partner in the real world are difficult and offer little benefit in terms of motivational effort for the superior partner.⁶ The utilization of a software-generated partner (SGP) in an active videogame (AVG) that employs the Köhler effect design has been proposed as a solution to scheduling problems with a real partner, finding the ideal superior partner, and adjusting for the player's improvements in relation to the

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partner's improvements.⁸ An SGP's abilities can be adjusted automatically over time to perform at a level that is always the most motivating to the player, thereby keeping the player engaged and active. Furthermore, there is research that suggests humans will establish significant social relationships (e.g., keep promises and perceive virtual characters as teammates) with SGPs.⁹ Though AVGs are a promising alternative to traditional exercise modalities, none of them that have been marketed for consumers (e.g., Wii Fit™, XaviX® J-Mat, PlayStation® Move, Xbox® Kinect) have utilized an SGP to harness the dynamics of Köhler effect.

Recent research has provided strong support for the motivation-boosting potential of the Köhler effect in AVGs.^{10–12} Feltz et al.'s early studies examined the effect with an ostensibly real (but virtually present) superior partner. More recent research has utilized an SGP and found support for the Köhler effect, but has used only single exercise bouts employing an isometric abdominal planking task.^{8,13} One study to date has examined the Köhler effect in an aerobic exercise task over repeated sessions, but it was with a virtually present partner rather than an SGP.¹⁴ Support was found for the Köhler effect for exercise persistence with a female-only college age sample over six separate sessions.

One concern with using a task design that employs the Köhler effect (i.e., exerciser is the weak link and the outcome depends on her/him) over time is the demotivating potential of perpetually being the weaker partner. For long-term exercise, exercisers may begin to feel helpless if, when comparing themselves invidiously, they see no progress and their superior partner appears indefatigable: forced upward social comparisons, like those employed in conjunctive tasks necessary to elicit the Köhler effect, can depress self-evaluations.¹⁵ Accordingly, an examination of the motivation-boosting potential of an SGP over a greater number of aerobic exercise sessions with both sexes, an age-diverse sample, and a varying degree of athletic superiority is warranted.

Hypotheses

Hypothesis 1: Compared with exercising alone, participants will exercise longer when working together under conjunctive task demands with a moderately superior SGP who is either consistently superior or who is perceived to fatigue over time.

Hypothesis 2: Compared with exercising with an SGP who shows consistent superiority, participants will exercise longer when working with an SGP who shows signs of fatigue over time (yet remains ultimately superior).

Methods

Design and participants

This study employed a 3 (condition: individual-control [IC], consistently superior software-generated partner [CSP], superior SGP who showed signs of fatigue [FP]) $\times$ 2 (sex) $\times$ 2 (sample: college students, community-based adults) $\times$ 12 (exercise sessions) design examining mean exercise persistence changes. After obtaining IRB approval, participants were recruited based on their interest in exercise and were told they would play a stationary cycle AVG three times per week for 4 weeks and complete a survey about their experience (Fig. 1 for participant flow). The final total sample consisted of 82 participants (36 males): 42 college students (M age = 19.36, SD = 1.17) and 40 nonstudent adults (M age = 36.22, SD = 6.10). See Table 1 for fitness details.

Exercise task

The task for this study was an AVG designed for the Monark LC4 cycle ergometer and was used in conjunction with a PC, monitor, and numeric keypad. Participants pedaled the cycle ergometer at a fixed wattage eliciting $\sim 75\%$ of the HR_{max} (qualifying as MVPA) while viewing their gameplay through the computer monitor.

FIG. 1. Participant flow.

TABLE 1. PARTICIPANT FITNESS DETAILS

	<i>Condition</i>					
	<i>IC</i>		<i>CSP</i>		<i>FP</i>	
	<i>Male, M (SD)</i>	<i>Female, M (SD)</i>	<i>Male, M (SD)</i>	<i>Female, M (SD)</i>	<i>Male, M (SD)</i>	<i>Female, M (SD)</i>
BMI	25.98 (6.31)	27.32 (6.97)	25.58 (3.85)	26.29 (6.63)	24.98 (5.81)	26.33 (5.60)
HR _{max}	194.00 (9.29)	192.75 (10.15)	195.08 (6.88)	189.80 (10.15)	192.09 (9.71)	191.40 (10.71)
VO _{2max}	38.06 (9.07)	42.31 (18.68)	36.88 (11.32)	48.04 (20.56)	38.77 (11.89)	42.19 (17.49)

VO_{2max} is age adjusted and presented in mL_{O2}/kg_{bodyweight}/min.

CSP, consistently superior partner; FP, fatiguing partner; IC, individual-control; PWE, partner-without-encouragement.

Procedures

Procedures followed were in accordance with the ethical standards of Michigan State University's Human Research Protection Program. Before their first experimental session, participants completed an informed consent form and Physical Activity Readiness-Questionnaire (PAR-Q). The PAR-Q was used to screen participants who had any condition that may increase their risk of participation (three people were screened out of the study based on an affirmative answer to one or more of the PAR-Q questions, per ACSM recommendations). Each participant was fitted with a Polar HR monitor and a blood pressure cuff for baseline cardiovascular measurements. The experimenter administered the Åstrand-Ryhming submaximal test to estimate aerobic fitness and the watts required to elicit 75% of participant's HR_{max}. After completion of the submaximal test, the experimenter scheduled the participant's next sessions (3 per week for 4 weeks with a minimum of 24 hours and a maximum of 4 days between sessions).

Before the first experimental session (day 1), each participant was randomly assigned to one of three conditions: IC, CSP, or superior fatiguing partner (FP). On day 1, each participant experienced the same protocol regardless of condition. Participants arrived at the laboratory, were instructed to remove any timepieces, and were fitted with a HR monitor strap. Participants completed a pre-exercise questionnaire and then mounted the cycle ergometer, where each participant was introduced to a software-generated trainer (SGT) who told her/him that she/he would be riding the cycle ergometer for as long as possible without risking injury, pressing quit when ready to terminate the session. The SGT explained the perceived exertion scale, and participants were instructed to record their rating when randomly prompted by the game (measures were actually obtained every 5 minutes). Participants then chose an avatar that would represent them for the rest of the exercise sessions. After a 5-minute warm-up at 50% of their prescribed workload, participants began gameplay. An experimenter monitored the participant's HR continuously to ensure it fell within 10% of the target (75% HR_{max}) and recorded it every 3 minutes until the participant completed the session (there were no instances of HR falling outside of the target range). After terminating gameplay by selecting the "Quit" option or timing-out of the game at 50 minutes (which meets CDC guidelines of 3 × 50 minutes per week), participants completed a brief questionnaire and were then dismissed.

The manipulation began at the second experimental session. Participants in the IC condition experienced the same

protocol as before, but participants in the CSP and FP conditions were also told they would be cycling with an SGP who was programmed to be somewhat more fit for the rest of their exercise sessions. The nature of the conjunctive task was explained by the SGT (i.e., the participant and the SGP would be working toward a "team score" that was determined by whoever quit first), and then the participant met his/her same-sex SGP on screen through a guided dialogue-tree interface, which allowed participants to respond to questions posed by their SGP by selecting from several preprogrammed responses on screen.

Visual feedback and experimental protocol were identical for both partnered conditions: participants saw their avatar riding alongside the SGP on a virtual trail throughout gameplay (Fig. 2). The factor that distinguished FP from CSP was the presence of verbal feedback from the SGP at the end of each experimental session in the FP condition. For days 2–7, the feedback was neutral (e.g., "See ya next time!" or "That was a good workout today!" etc.). Starting on day 7, the SGP's verbal feedback began to betray his/her fatigability (e.g., Wow, this is getting tough!" or "Whew, I'm totally beat! I almost quit first this time!"). At the end of day 12, all participants were debriefed, reimbursed with either \$30 and course credit if they were from the student sample or \$80 if they were from the community sample, and thanked for their participation.

FIG. 2. Image of gameplay. Image of partnered gameplay. IC condition was visually identical except for the absence of a partner in the dark shirt.

Measures

Exercise persistence. Persistence was the primary measure of motivation in this study, measured in seconds from the beginning of the workout portion of the experimental session (i.e., postwarmup) to the termination of gameplay (i.e., when the participant pressed “Quit” or timed-out the game).

Ratings of perceived exertion. Participants’ subjective evaluation of effort levels throughout exercise, using the 15-point version of the Borg RPE scale (minimal effort=6; maximum effort=20), was averaged for each experimental session. We assessed ratings of perceived exertion (RPE) because perceptions of exertion also may influence one’s motivation to persist at an exerting task.¹⁶

Enjoyment. Enjoyment was assessed with a 5-item version of the PAES.¹⁷ Each item was rated on a 7-point bipolar scale beginning with the stem “Please rate how you feel at the moment about the physical activity you have been doing according to the following scales” (e.g., 1=“*I enjoy it*”; 7=“*I hate it*”). Responses on the PAES were averaged for an overall enjoyment score.

Team perceptions. At the end of the experiment, participants in the partnered conditions completed a 5-item questionnaire that assessed their perceptions of the working relationship with their partner.^{9,11} The questionnaire asked participants to rate a series of statements from *Strongly Disagree* to *Strongly Agree* (e.g., I felt I was part of a team).

Perceived ability discrepancy. At the end of the experiment, participants in the partnered conditions responded to a single item assessing their perceived ability discrepancy: “Concerning gameplay, how do you feel you compared to your partner? (1=*Much less capable than my partner*, 7=*Much more capable than my partner*).

Results

Primary analyses

Persistence was measured as the duration of gameplay for each of the 12 experimental sessions. Cycling time in minutes ranged from 10:27 to 50:00 ($M=29:48$, $SD=10:40$). Only two participants consistently “timed out” of the game (i.e., cycled the full 50 minutes until the game self-terminated): one from each partnered condition.

The primary analyses were divided into two parts. In Part 1, we assessed exercise persistence on days 2–7 (i.e., exercise sessions before the change in language for the FP condition, which occurred postexercise on day 7). In Part 2, we assessed exercise persistence on days 8–12 (i.e., postlanguage change).

Part 1. First, persistence measures were grouped to form three persistence block scores (i.e., mean scores for days 2 and 3, days 3 and 4, and days 6 and 7) to reduce the day-to-day variability in persistence but still allow for the detection of any trends across days. A repeated measures Analysis of Covariance (ANCOVA) with 3 (condition) $\times$ 2 (sex) $\times$ 2 (sample) $\times$ 3 (persistence blocks), with day 1 persistence baseline as covariate revealed only one significant between-subject effect; the younger college sample persisted significantly

longer than the noncollege sample, $F(1, 69)=10.86$, $P<0.05$. Within-subject analyses revealed no main or interaction effects for performance block, condition, sex, or sample for the first half of the study, $P_s>0.10$ (i.e., there were no systematic differences in between-session trends for any of our primary categorical variables and there was no change in performance over time). Because there was no systematic variation associated with sample, the sample was excluded from subsequent analyses.

Part 2. Next, persistence measures for the remaining days (i.e., after the language change) were grouped to form two persistence blocks (i.e., mean scores of days 8 and 9, and days 10, 11, and 12). Two blocks were formed to reduce the day-to-day variability in persistence. A repeated measures ANCOVA with 3 (condition) $\times$ 2 (sex) $\times$ 2 (persistence blocks), with day 1 persistence baseline as covariate, revealed significant within-subject effect for persistence block, $F(1, 75)=7.30$, $P=0.009$, and a significant persistence condition $\times$ sex $\times$ block interaction, $F(2, 75)=4.96$, $P=0.009$. A reanalysis of each sex individually revealed no significant main or interaction within-subject effects for women, $P_s>0.2$, but yielded a significant condition $\times$ block interaction for men, $F(2, 32)=5.18$, $P=0.011$ (Fig. 3). Pairwise comparisons of men in each condition revealed a significant condition $\times$ persistence block interaction only between the IC and FP conditions, $F(1, 21)=8.95$, $P=0.007$, where men in the FP condition persisted longer than men in the IC conditions. A t -test on persistence in the final persistence block (days 10, 11, and 12) showed that FP participants persisted significantly longer than IC participants in cycling time ($M_{\text{diff}}=12:32$ minutes, $SE_{\text{diff}}=4:54$, $P=0.018$, $d=1.09$). These findings suggest that the overall condition $\times$ sex $\times$ block interaction effect was due to men in the IC and FP conditions.

Ancillary analyses

RPE and enjoyment were each grouped into blocks in the same pattern used for persistence. RPE was examined with a 3 (condition) $\times$ 2 (sex) $\times$ 5 (RPE blocks) RM ANCOVA with RM on the final factor and day 1 baseline RPE as a covariate, which yielded only one significant main within-subjects effect. Participants showed a significant decline in RPE over time, $F(4, 240)=14.95$, $P<0.001$. No significant changes or notable trends were observed for enjoyment ($P_s>0.05$). In addition, no significant condition differences were observed on measures of team perception.

One of the two key mechanisms of the Köhler effect is upward social comparison. A 2 (partner conditions) $\times$ 2 (sex) analysis revealed a significant main effect for sex, $F(1, 47)=8.37$, $P=0.006$, where women reported a greater discrepancy than men. Women were significantly lower than the scale midpoint ($M=2.93$, $SD=1.46$; $t(27)=-3.87$, $P=0.001$) and men were not different from the scale midpoint ($M=4.17$, $SD=1.64$, $P>0.6$). These findings suggest that women viewed their partner as significantly more capable than themselves when compared with men.

Furthermore, there was no significant main effect for condition and no interaction between condition and sex ($P_s>0.16$), but the CSP condition was significantly lower than the scale midpoint ($M=3.19$, $SD=1.58$; $t(25)=-2.61$, $P=0.015$), whereas the FP condition was not different from the scale

FIG. 3. Subexperiment 2. Repeated measures ANCOVAs on condition $\times$ performance block, split by sex. Covariates appearing in the model are evaluated at the following values: Persistence 1=0:27:24.

midpoint ($M=3.80$, $SD=1.71$; $P>0.5$). These findings suggest that only participants in the CSP condition perceived their partner more capable than themselves, and that the verbal statements in the FP condition successfully attenuated perceived superiority.

Discussion

In this study, we examined the motivation-boosting potential of the Köhler effect with an SGP in aerobic exercise over 12 exercise sessions. The analysis of exercise persistence was divided into two parts to assess any changes attributable to time and a fatiguing SGP. For Part 1 of our analyses, contrary to our expectations (and unlike any previous research on the Köhler effect), we observed no differences by condition. Participants exercising alone failed to exhibit the expected fatigue/boredom effects and those working with an SGP gained no motivation boost.

Part 2 of the primary analysis revealed partial support for both our first and second hypotheses. Men who exercised with an SGP demonstrated motivation gains in tandem with reductions in SGP superiority: gains only began to emerge after signs of SGP fatigue and persisted (and increased) throughout the duration of the study, as the participants could plausibly perceive that they were starting to “catch up” to their SGP. By the end of the study, men exercising with an SGP who showed signs of fatigue persisted for an average of 12.5 minutes longer per session than those exercising alone. This difference, if it were to be sustained over time, sums to 37.5 additional minutes per week of MVPA, accounting for one-fourth of the CDC recommendation for weekly PA.¹⁸ Women were seemingly insensitive to our manipulation; exercising with an SGP provided no reliable motivation gain when compared with exercising alone. However, women also showed no fatigue or boredom effects (i.e., they did not decline in performance) and no decline in enjoyment, suggesting that the women were sustained by gameplay regardless of condition.

The absence of the Köhler effect in the first half of the study may have been an artifact of the game design; this was

the first study on the Köhler effect with an SGP where participants were represented with an avatar instead of a mirror image of themselves or no image at all. Instead of a virtual representation of one’s current self, the avatar used may have been viewed as either a virtual model of one’s “better self” or been a distraction from the activity. Some research has suggested that being represented by an avatar perceived as fitter than oneself may enhance motivation in AVGs.¹⁹ If one’s own avatar were perceived in such a way, the result would be a more conservative control condition, thereby reducing the size of potential condition differences. The behavior of the avatar may have also provided performance feedback inconsistent with the intended ability discrepancy; the avatar’s cycling cadence and speed were consistent (because it was linked to watts and not rpm). Participants may have not understood that their exercise intensity and cycling speed were programmed to be consistent regardless of how fast they pedaled, and that their avatar’s behavior was linked to watts, not rpm. Avatars showed no traditional signs of fatigue (slowed rpm, sweating, etc.) and only slowed when the participant stopped pedaling or quit, potentially modeling resilience for the participant.

One explanation for the interaction between condition and sex may be differences in competitiveness. Only men showed a motivation gain when exercising with a superior FP. Although we did not measure competitiveness in our sample, some extant research suggests that men may be more competitive in performance contexts.^{20–23} Men may have been especially discouraged by an indefatigable SGP and conversely encouraged by their SGP’s first signs of “weakness.” For women, companionship (or absence thereof) may have been a greater priority in this context. Recent research suggests that women are typically closer with their real-world exercise partners when compared with men, but the SGP in our game was minimally engaging.²⁴ Thus, differing responses to the SGPs used in our study may depend, in part, on whether someone approaches their workouts competitively or instead seeks a relational connection.

Relatedly, in AVGs, engagement may be influenced by other components of the game’s design. For example, our

game utilized a third-person perspective of their avatar cycling through virtual terrain. Though we did not examine immersion directly in our game, recent research has highlighted the first-person perspective as a potential for boosting immersion in game contexts.²⁵ In addition, participants in our study exercised either alone watching their own avatar on screen or along with a computer-controlled SGP. Perhaps women were as motivated watching their avatar cycling as they were with an SGP. In other gaming contexts, playing against a human-controlled opponent improved game enjoyment and immersion.²⁶ Future research on AVGs may examine the effect of exercising with an SGP that is human controlled.

This study employed a randomized between-subjects design that also examined within-subject changes in persistence. Another future direction of research is to use a randomized crossover design to examine within-subject differences across conditions.

In conclusion, this study provides support for the Köhler effect *for men*, when exercising with an SGP who shows signs of fatigue. Women were seemingly indifferent to exercising with an SGP. In that same vein, AVG developers may consider incorporating realism in SGPs, such as fatigability, to improve motivation in men. Researchers should also explore the effects of competitiveness and avatar use on motivation within the Köhler paradigm.

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References

- Wen CP, Wu X. Stressing harms of physical inactivity to promote exercise. *Lancet* 2012; 380:192–193.
- Troiano RP, Berrigan D, Dodd KW, et al. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc* 2008; 40:181–188.
- Dishman RK. The problem of exercise adherence: Fighting sloth in nations with market economies. *Quest* 2001; 53:279–294.
- Dishman RK, Heath GW, Lee I-M. *Physical Activity Epidemiology* (2nd ed.), Champaign, IL: Human Kinetics; 2013.
- Burke SM, Carron AV, Eys MA, et al. Group versus individual approach? A meta-analysis of the effectiveness of interventions to promote physical activity. *Sport and Exercise Psychology Review* 2006; 2:1–39.
- Kerr NL, Hertel G. The Köhler group motivation gain: How to motivate the “weak links” in a group. *Soc Personal Psychol Compass* 2011; 5:43–55.
- Kerr N, Lembke J, Psychology O. Social indispensability or social comparison: The why and when of motivation gains of inferior group members. *J Appl Soc Psychol* 2008; 38: 1329–1363.
- Feltz DL, Forlenza ST, Winn B, Kerr NL. Cyber buddy is better than no buddy: A test of the Köhler motivation effect in exergames. *Games Health J* 2014; 3:98–105.
- Reeves B, Nass C. How people treat computers, television, and new media like real people and places. In: *The Media Equation* Cambridge, UK: CSLI Publications and Cambridge University Press; 1996:19–36.
- Kerr NL, Feltz DL, Irwin BC. To pay or not to pay? Do extrinsic incentives alter the Köhler group motivation gain? *Gr Process Intergr Relations* 2012; 16:257–268.
- Feltz DL, Kerr NL, Irwin BC. Buddy up: The Köhler effect applied to health games. *J Sport Exerc Psychol* 2011; 33: 506–526.
- Irwin BC, Feltz DL, Kerr NL. Silence is golden: Effect of encouragement in motivating the weak link in an online exercise video game. *J Med Internet Res* 2013; 15:e104.
- Samendinger S, Max EJ, Winn B, et al. Interactive dialogue is important in software-generated workout partners. *J Sport Exerc Psychol* 2015; 37:S143.
- Irwin BC, Scorniaenchi J, Kerr NL, et al. Aerobic exercise is promoted when individual performance affects the group: A test of the Köhler motivation gain effect. *Ann Behav Med* 2012; 44:151–159.
- Collins RL. For better or worse: The impact of upward social comparison on self-evaluations. *Psychol Bull* 1996; 119:51–69.
- Borg GAV. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 1982; 14:377–381.
- Raedeke TD, Amorose AJ. A psychometric evaluation of a short exercise enjoyment measure. *J Sport Exerc Psychol* 2013; 35:S110.
- United States Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans: Contents. *hhs.gov*. 2008. www.health.gov/PAGuidelines/guidelines/default.aspx
- Li BJ, Lwin MO, Jung Y. Wii, myself, and size: The influence of proteus effect and stereotype threat on overweight children's exercise motivation and behavior in exergames. *Games Health J* 2014; 3:40–48.
- Buunk AP, Massar K. Intrasexual competition among males: Competitive towards men, prosocial towards women. *Pers Individ Dif* 2012; 52:818–821.
- Cashdan E. Are men more competitive than women? *Br J Soc Psychol* 1998; 37:213–229.
- Bornstein G, Gneezy U, Nagel R. The effect of intergroup competition on group coordination: An experimental study. *Games Econ Behav* 2002; 41:1–25.
- Niederle M, Vesterlund L. Gender and Competition. *Annu Rev Econ* 2011; 3:601–630.
- Max EJ, Wittenbaum GM, Feltz DL. Characterizing exercise relationships: Communication, closeness, and performance. *J Sport Exerc Psychol* (in press 2016S).
- Jennett C, Cox AL, Cairns P, et al. Measuring and defining the experience of immersion in games. *Int J Hum Comput Stud* 2008; 66:641–661.
- Weibel D, Wissmath B, Habegger S, et al. Playing online games against computer- vs. human-controlled opponents: Effects on presence, flow, and enjoyment. *Comput Human Behav* 2008; 24:2274–2291.

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