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The Effects of Competitive Orientation on Performance in Competition

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ABSTRACT

The competitive environment is reported to influence greater exercise intensity in most persons, thus enhancing practice and training. This effect may be mediated by individual characteristics and the nature of the competitive environment. In particular, persons with non-competitive traits may find live one-on-one physical competition discouraging to full engagement and high effort, but there is little research to support this belief. The purpose of this experiment, thus, was to evaluate the influence of live competition versus no competition (i.e., solo) in persons classified as competitive versus less competitive, or athletes versus non-athlete. After informed consent, 91 subjects were scored on competitive trait using the SOQ tool and grouped into three competitive trait groups (Low, Mid, High). Subjects were also classified as a collegiate varsity athlete or non-varsity athlete. Subjects engaged in maximal vertical jump trials and maximal 40 yard sprint trials under solo conditions and in the presence of another competitor. Maximal single trial performance in the solo condition was compared to the best competition performance and the average competition performance. Repeated measures ANOVA results indicated no significant differences from the solo best trial to the average competition trial in vertical jump height or sprint times. However, the subjects' single best competition sprint trial was significantly faster than the best solo sprint trial, but the best competition vertical jump was not significantly higher than the solo jump. Persons grouped as having a higher competitive trait, and those classified as varsity athletes, had faster sprints and higher jumps, but all groups performed similarly in response to competition. In conclusion, competition produced similar results in all groups, indicating that even less competitive persons and non-varsity athletes respond competitively when in certain circumstances.

Key words: Competition, competitive behavior, SOQ, sprint, vertical jump, athlete

INTRODUCTION

It is well recognized that to maximize the effects of physical training or practice that one needs to exert maximal effort throughout the training and practice cycles. For instance, Nash, Sproule and Horton (24) reported that elite coaches repeatedly made use of highly intense, effortful, and stressful practices. These characteristics create challenging practice and training environments to enable both psychological and physiological adaptations to take place. Maintaining repeated or sustained high effort is a motivational challenge and the inability to maintain motivation and effort is as a barrier to attaining expert performance (7). To maintain high motivation toward physical effort, a number of strategies have been employed by coaches and athletes, such as rewards and punishments. Another strategy is within-team competitions that are used to mimic competitive game play for better transfer of performance, and in doing so enhance motivation and effort toward higher exercise intensity (30).

Competition is generally defined as a situation in which two or more rivals vie against one other to gain a desired goal or object, generally resulting in a victor and a loser. Competition has been long recognized to motivate individuals to better performance in many activities, including sports (22, 35). Competitions result in greater exercise intensity than practices or training (3, 29), and thus a competitive aspect added to practice can both simulate game play and increase exercise effort. For instance, small-sided games (30) and simulated matches (5) are used to develop game experience and tactical skills, while simultaneously promoting greater physical effort (12). However, even simulated game play may not fully mimic the intensity of actual competition (3, 23), perhaps due to an enhanced anticipatory effect athletes take on prior to actual competitions (6).

A competitive environment is also used by recreational exercisers to improve motivation, adherence, and training intensity. Evaluation of exercise intensity in live head-to-head competition in recreational exercisers is scant, though there is a growing database on virtual reality and exergaming competition against real or simulated rivals. Competition during exergaming may increase motivation, adherence, and exercise intensity (for brief reviews, see 19, 21, 37). For instance, Snyder, Anderson-Hanley and Arciero (32) showed that cycling exer-gamers exercised with greater intensity when competing against a live opponent or a virtual opponent versus riding solo.

It is not the case, however, that competition invariably increases motivation and effort; other factors such as characteristics of the activity and characteristics of the individual influence the competitive environment (1, 27). In cyclists, for example, factors such as the number of competitors, quality of competitors, and the importance of the activity influences race pacing and the timing of maximal efforts (15, 17, 18). The task goal, such as task mastery versus winning, during a competitive physical task can also influence physical performance (15, 28). Finally, the nature of the individual may influence how strongly the competitive environment influences them. One's competitive orientation, defined as the desire to strive for success in competitions (11), may influence the amount of effort one puts into competition. Persons identified as having a more competitive behavioral orientation are particularly influenced to give more effort versus a live competitor than a virtual reality opponent such as seen in exergaming (1, 32). In contrast, non-athletes or individuals without a strong competitive orientation may be reluctant to engage in rigorous physical competition, particularly if the competition appears too challenging (25). Additionally, non-competitive persons, even if they perform well, may find less enjoyment in the exercise experience (33).

An individual's competitive orientation may interact with the nature of the competitive environment. Research using competitive exergaming activities has demonstrated that social networks and the Köhler effect influence motivation, adherence, and enjoyment (21). The Köhler effect, where a weaker member of a collaborative group strives to make a meaningful contribution to their team, has been shown to be stronger when the team or partner is real rather than a computer simulated avatar (8). The social network effect is often framed according to social facilitation theory (4), or achievement goal theory (28), and generally shows that peer influences and other social interactions can enhance exercise performance. Social facilitation researchers have noted that even the perception of being evaluated by others, including coaches and researchers, may motivate some toward better performance (14, 20). Studies with children (2, 31) and adults (4, 13) confirm that exercise with peer groups, friends, and partners, collectively referred to as coactors, inherently include collaboration or competition and may increase exercise motivation and exercise intensity.

The impact of one's competitive orientation on performance against live competitors has not been investigated thoroughly, particularly in persons not classified as athletes. Further, the nature of the competitive environment in regards to being simultaneous or sequential has not been investigated. It was the purpose of this project to examine if the competitive orientation of individuals – athletes and non-athletes alike – influenced their physical performance in solo (non-competitive) and head to head competitive environments. It was hypothesized that performance would be better in competitive situations, and this better performance would be more marked in those persons with more competitive traits.

METHODS

The methods were designed to evaluate rigorous physical performance under conditions of perceived competition (competition) and no competition (solo). The tasks considered were a 40-yard sprint and a vertical jump because both are sensitive to the level of physical effort and these tasks are familiar to most people, including those not regularly engaged in athletics. In addition, the tasks provided two different forms of head-to-head competition, simultaneous (40 yard sprint) and non-simultaneous (sequential: vertical jump). Also considered was trait competitiveness of the participants, athletic experience, and sex.

Participants

A sample size estimation was conducted to determine the number of subjects necessary to detect differences in the dependent variables, namely differences in 40 yard sprint speed and vertical jump in solo and competitive environments, considering three competitive orientation groups (low, mid, high). G*Power (v. 3.1) software was used to evaluate sample size for a three group (between) x two condition (within) ANOVA, using a =.05, b = .95, a small effect size of f = .10, and a repeated measures test-retest correlation of .90 that was based on pilot data. From these data, a sample size of 68 subjects was determined. Following institutional review board approval, informed consent was gathered from 91 participants. There were 33 NCAA Division III collegiate varsity athletes (Athlete Group: n = 12 males, 21 females) and 58 college-aged participants without collegiate varsity experience (Non-Athlete Group: n = 23 males, 35 females), all from the same institution. This non-athlete group included recreational exercisers, non-exercisers, and club and intramural sport participants. Table 1 provides demographic data based on competitive trait grouping and sex.

Table 1. Subject height and weight (M ± SD) broken down by SOQ Group and Sex.

SOQ Group	Sex	Height (cm)	Weight (kg)
Low (*n* = 30)	Female (*n* = 24)	166.5 ± 6.9	63.7 ± 8.3
	Male (*n* = 6)	177.2 ± 4.2	76.3 ± 8.3
Mid (*n* = 27)	Female (*n* = 13)	161.5 ± 12.8	61.7 ± 7.8
	Male (*n* = 14)	179.7 ± 7.6	80.3 ± 9.8
High (*n* = 34)	Female (*n* = 19)	168.2 ± 6.6	65.8 ± 9.1
	Male (*n* = 15)	176.7 ± 4.8	76.0 ± 9.4

All participants completed the Physical Activity Readiness Questionnaire (PAR-Q) to screen for potential issues that could compromise their safety and limit their ability to produce full effort. Subjects were further asked if they had any injuries or complications that could hamper their ability to do maximal effort sprints and vertical jumps. Potential subjects were excluded if they answered affirmative to any question on the PAR-Q or identified any injuries or complications. All athletes had been medically cleared to participate without restriction in their sport.

Procedures

Subjects were tested over a two-day period, separated by 48 hours. On day 1 each subject completed the informed consent, were instructed on the test procedures, and were measured for height and weight. Each subject then completed the Sport Orientation Questionnaire (SOQ: 8) to evaluate competitive traits, and a sport questionnaire to record their exercise and sport experience. Data from the sport questionnaire were used to categorize the participants as a varsity collegiate athlete or non-athlete. Following the questionnaires, each subject completed a warm-up routine consisting of one lap around a 200 m indoor running track at a light to moderate intensity. After the lap, participants performed high knee kicks for 15 seconds, elbow-knee touches for 15 seconds, and carioca for 30 seconds.

After the warm up each subject completed three trials of maximal vertical jump height trials and three maximal 40 yard sprints, all done solo with only the researchers present (solo condition). Vertical jumps always preceded the sprints to avoid any fatigue caused by repeated sprints. Sprint data were then used to help match participants for competition trials on day 2. Participants were first matched on sex and secondarily, on 40-yard sprint speed. Sprint speed matching was done to match coactors within 1 s of each other's time. There was no attempt to match times precisely, only to ensure a competitive race. Coactors were the same for sprints and jumps. Participants were not told of their coactors' race times or vertical jump heights.

Day 2 of testing was separated by 48 hours from day 1, and followed the same day 1 warm-up procedures. Following warm-up, the subjects engaged in three vertical jump trials with their matched coactor watching (competition condition). For each vertical jump trial the subjects alternated who went first, enabling each participant to watch their coactor and then perform their own jump. In this "sequential competition" there was no encouragement from the researchers to actually compete against the other person. The aim was to enable each participant to perceive and create their own competitive atmosphere with the hypothesis that persons with a more competitive orientation would perceive this task as a competition to jump higher. Following the vertical jumps, the same coactors began the sprint trials in head to head sprinting. The first sprint trial, however, was run solo with no coactor, and with only the researchers in direct view of performance. Following the solo trial, subjects ran side by side for three competition trials.

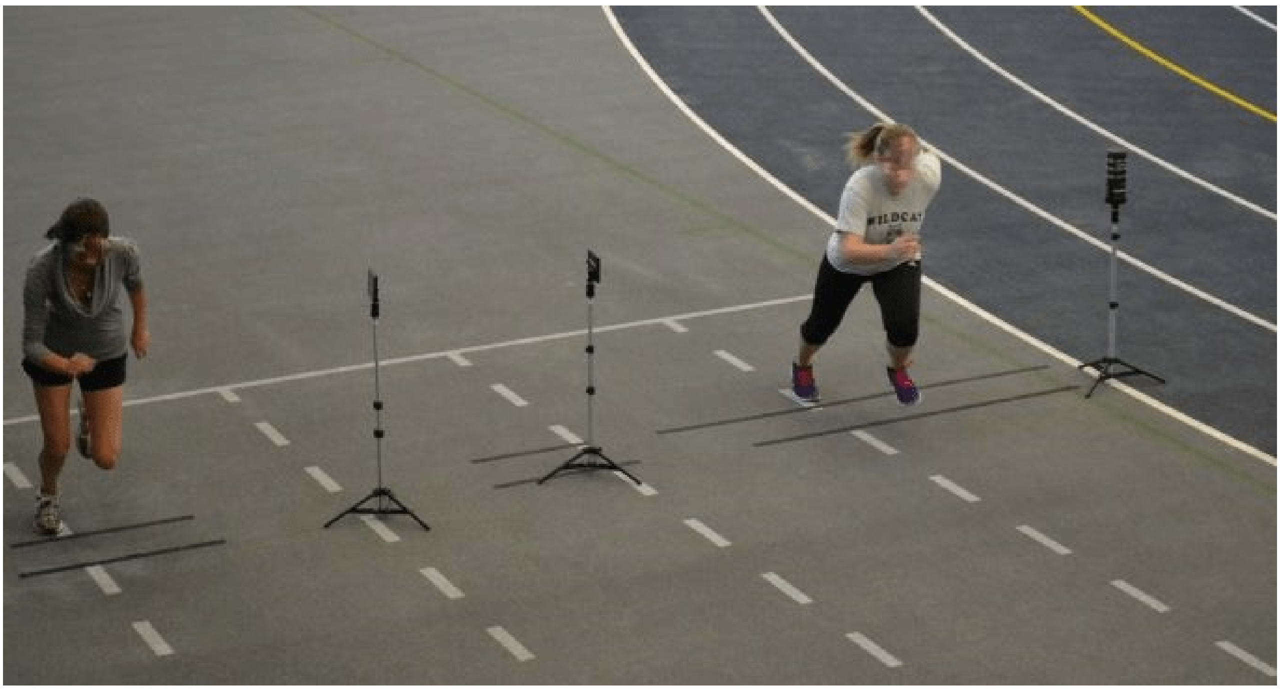
Test Protocols and Measurements

The SOQ (9) is a 25-question instrument with three subscales; competitiveness, goal orientation, and win orientation. For the current study only the total SOQ score was used for analysis, as it provided the best overall view of competitive orientation and desire to compete, regardless of the motivation. Further, a large sample of the data (n = 78) revealed correlations of .98 between the total SOQ score and the competitiveness subscale, and a correlation of .92 between the total SOQ score and the win orientation subscale which provided good evidence that the total SOQ score was measuring the traits of interest. Total SOQ scores range from 25 (minimally competitive) to 125 (maximally competitive). This scale has been found to have strong internal consistency across subscales, and good test-re-test reliability and a valid determinant of competitive orientation and striving to win or meet goals (9).

Straight-line sprints of 40 yards (36.6 m) were done on an indoor track with a photocell timing system (Smartspeed; Fusion Sport; Brisbane, Australia). The timing system initiated the sprint by an external reaction light (Figure 1). The photocell timing gates were placed at the start and end of the 40-yard sprint course. Subjects were placed 12” (0.3 m) behind the start gate in a sprint-ready standing position, and responded to a light stimulus that began the timer and signaled the subject to run. Subjects were instructed to react to the light as fast as possible and run the course as fast as possible. The start line photocell gate was set at a height to be triggered by the subject’s trunk and was purposed to gather reaction time and initial movement response time. The time period was labeled sprint response time (RpT). Time from photogate to photogate was labeled sprint time (SPRINT) and total time (RpT + SPRINT) was labeled 40TOTAL.

In each condition (solo, competition) the subjects completed each sprint with two minutes rest in between. In solo sprints there were no coactors present and no feedback was provided on performance. Competition trials were done side by side with the coactor, but no explicit instructions were provided that the sprint was a race to be won. It was hypothesized that persons with a more competitive orientation would more likely perceive the task as a race to be won. For measurement purposes, and to gather the most conservative estimate of the effects of competition, the single best sprint time from the solo condition was compared against the average or the best of the three trials of the competitive condition.

Figure 1. 40 yard sprint competition condition. Subjects ran side by side in response to a stimulus light. One black line is the starting line consistent with the timing lights and the other black line is 30 cm behind, and is the starting position of the subject.



Vertical jump (VJ) height was measured using a jump timing contact mat (Just Jump, Probotics, Huntsville, AL), but a Vertec jump device (JumpUSA, Sunnyvale, CA) was used as an external target providing performance feedback to the jumpers. All jumps were countermovement jumps with full arm swing. In solo jumps the subjects made three maximal effort vertical jumps, each trial separated by one minute. Subjects were instructed to swat at the Vertec's vanes, and the vanes were not reset after each trial, thus serving as performance feedback and providing an external target focus. In competition trials the subjects alternated jumping and were encouraged to watch one another, though there were no explicit instructions regarding competition against one another. The vanes were reset after each jump in the competition condition. As with the sprints, to provide the most frugal comparison of the effects of competition, the single best vertical jump done solo was compared to the average or maximum of the competition jumps.

Data Analyses

Subjects were scored on level of total trait competitiveness based on the total score from the SOQ document (25-125 score range), time to complete the entire 40 yard sprint from reaction light to crossing the finish line (40TOTAL), time to respond to the sprint stimulus light (RpT), time to run just the 40 yards (SPRINT), and maximal vertical jump height (VJ). Competitive trait grouping using the total SOQ scores were based on tertiles of low, medium, and high competitiveness scores to group the subjects. Subjects were grouped into least (n = 30, M_{SOQ} = 85.1, range = 63-97), mid (n = 27, M_{SOQ} = 106.5, range = 98-112) and most competitive (n = 34, M_{SOQ} = 117.5, range = 113-125). Uneven group numbers were due to tie scores.

A 3 (SOQ group) x 2 (sex) x 2 (competitive environment) repeated measures analysis of variance was used to examine performance differences between the solo and competitive environments while factoring in SOQ scores (low, mid, high), and sex (male, female). A separate analysis using athlete status (athlete, non-athlete) in place of the SOQ status was also conducted. A p-value set at .05 for all analyses. Sphericity violations were adjusted using the Greenhouse-Geisser method. All statistics were calculated using SPSS v. 25.

RESULTS

Group Composition, Data Reliability, and Data Reduction

Groups based on SOQ scores resulted in an uneven distribution of varsity athletes and male and female participants, with more females and non-athletes in the lowest SOQ group. These data are consistent with findings that females and non-athletes have a lower competitiveness rating (10), and could have confounded the results. Initial analyses used the full factorial model using a 3 (SOQ Group) x 2 (Sex) x 2 (Athlete Status) x 2 (Competitive Environment) repeated measures ANOVA on each of the dependent variables. These analyses revealed that males and varsity athletes significantly jumped higher, ran faster, and responded faster than females and non-athletes. However, there were no meaningful interactions of sex and athlete status with the primary independent variables of interest (SOQ group, Competitive Environment) and so the data were collapsed over sex and athlete status, resulting in a final analysis model of a 3 (SOQ Group) x 2 (Competitive Environment) repeated measures ANOVA.

Day 1 solo performance was analyzed for trial to trial reliability with intra-class correlations (ICC) and repeated measures ANOVA. The three trials of VJ had an ICC of .96 and were not significantly different from one another (p = .239). The 40TOTAL (ICC = .97), the SPRINT time (ICC = .97) and RpT time (ICC = .77) showed moderate to high ICCs. The 40TOTAL significantly (p = .01) differed from trial to trial, slowing over the three trials on day 1 and then improving on the day 2 solo sprint. Overall, the mean sprinting performance during competition was significantly faster than the mean performance done solo, but given the trial-to-trial differences in the solo performance; it was decided to provide the most frugal evaluation of competition effects. For this reason, the single best solo performance, regardless if on day 1 or day 2, was compared to either the mean competition performance or the best competition performance.

SOQ Group and Competition Environment Effects: Average Competitive Performance

Table 2 displays means and standard deviations for all variables broken down by SOQ Group and Competition Environment. These results compared the best solo performance versus the average competition performance across the three competition trials. There were no significant interactions of the SOQ group with the Competition Environment. Results from the 3 (SOQ Group) x 2 (Competition Environment) repeated measures ANOVA indicated that there were no significant competition environment effects in any of the variables. Only 40TOTAL (p = .074; partial η^2 = 0.036) approached significance.

Results from the ANOVA showed SOQ Group effects for all variables. Specifically, VJ (p = .003; partial $\eta 2$ = .122), SPRINT (p < .001; partial $\eta 2$ = .211), RpT (p =. 022; partial $\eta 2$ = .083), and 40TOTAL (p < .001; partial $\eta 2$ = .218) time were significantly better in the two higher SOQ groups compared to the low SOQ group. Bonferroni post hoc tests revealed that for all variables the lowest SOQ group significantly differed from the mid and high SOQ groups, and there were no differences between the mid and high SOQ groups.

Table 2. Results ($M \pm SD$) of the sprint and vertical jump performance for SOQ competition groups and competition environment. Solo Max is the single best trial among the solo conditions, Competition Avg is the mean of the three competition trials, and Competition Max is the single best trial from the competition trials. See text for statistical differences.

SOQ Group	Competition Environment	VJ (cm)	SPRINT (s)	RpT (s)	40TOTAL (s)

Low (*n* = 30)	Solo Max	45.34 ± 9.12	6.17 ± 0.70	0.715 ± 0.11	6.95 ± 0.73
	Competition Avg	44.68 ± 8.76	6.17 ± 0.60	0.714 ± 0.08	6.88 ± 0.65
	Competition Max	46.18 ± 9.40	6.09 ± 0.60	0.652 ± 0.08	6.80 ± 0.63
Mild (*n* = 27)	Solo Max	53.29 ± 12.27	5.57 ± 0.62	0.646 ± 0.12	6.27 ± 0.67
	Competition Avg	52.24 ± 11.48	5.57 ± 0.59	0.667 ± 0.10	6.24 ± 0.63
	Competition Max	54.05 ± 11.81	5.50 ± 0.57	0.606 ± 0.11	6.16 ± 0.60
High (*n* =34)	Solo Max	53.70 ± 10.80	5.55 ± 0.46	0.642 ± 0.13	6.25 ± 0.49
	Competition Avg	53.26 ± 11.66	5.55 ± 0.50	0.675 ± 0.07	6.22 ± 0.52
	Competition Max	54.89 ± 11.99	5.47 ± 0.47	0.623 ± 0.07	6.14 ± 0.50

SOQ Group and Competition Environment Effects: Maximal Competitive Performance

Table 2 displays means and standard deviations for all variables broken down by SOQ group and competition environment. In these comparisons, the single best solo performance was compared to the single best competition performance. There were no significant interactions of SOQ Group with Competitive Environment. Results from the repeated measures ANOVA for Competition Environment effects indicated that the SPRINT ($p < .001$; partial $\eta 2 = .145$), RpT ($p < .001$; partial $\eta 2 = .115$), and 40TOTAL ($p < .001$; partial $\eta 2 = .278$) time were significantly faster in the competitive environment. Vertical jump was not statistically different between Competition Environment conditions ($p = .086$; partial $\eta 2 = .033$).

Results from the repeated measures ANOVA for SOQ Group indicated that VJ ($p = .003$; partial $\eta 2 = .121$), SPRINT ($p < .001$; partial $\eta 2 = .213$), RpT ($p =.025$; partial $\eta 2 = .080$), and 40TOTAL ($p < .001$; partial $\eta 2 = .224$) were significantly better in the higher SOQ Groups. Further analysis of the SOQ groups revealed that the mid and high SOQ groups were not significantly different from one another, and both were significantly different from the low group.

DISCUSSION

The purpose of this study was to compare rigorous physical performance under conditions of perceived competition with a coactor versus solo with no competition, and considering the effects of subject competitive trait. It was hypothesized that performance with a coactor present would produce better performance, and this better performance would be particularly strong among subjects with a high competitive trait. The hypothesis was only partly supported, as the competitive environment with a coactor produced similar results regardless of one's competitive orientation.

In order to provide the most conservative effects of competition, the single best solo performance was used to compare against performance with competition. When the best solo performance was compared to the average competition performance, there were no significant differences in any of the measures. These data imply that the average competition effect produces results consistent with the best solo performance. On the other hand, when the best solo trial was compared to the best competition trial, the competitive environment resulted in statistically faster sprints, faster response times, but not significantly higher jumps (p = .086). These sprint and response time improvements only ranged from 1.2% to 4%, but given the difficulty in improving sprint performance, these changes are relevant. These findings are consistent with data from a variety of physical performance settings showing that a competitive situation may result in better performance or more strenuous physiological processes (3, 29).

There are a number of reasons proposed why competition may produce better performance or more effort, with increased motivation to put forth effort being the most common. Recent data may offer an additional insight regarding the competition itself. Competition may increase the psychophysiological stress response that may or may not influence subsequent performance. Chuang et al. (5), for instance, noted that match-simulated taekwondo kicking sequences produced a similar exercise intensity (heart rate and perceived exertion) as simulated competitions, but the simulated competitions produced a number of elevated blood biomarkers showing increased stress and inflammatory responses.

The significant competition effects seen in sprinting were not found in the vertical jump. Though it could be a statistical anomaly (p = .086), the competitive environment only produced increases in vertical jump ranging from 0.75-1.1 cm. The nature of the competitive environment could explain the differences between the vertical jump and sprint tasks. Subjects were not explicitly told to win against their coactor in either the sprint or the jump, but the nature of the two different events could easily have influenced how the subjects perceived the competitive nature of the event. The 40-yard sprint was a simultaneous head-to-head task with an obvious understanding that the task was a competitive race. Conversely, the sequential performance of the vertical jump was not as obvious as to whether it was a competition, and thus the competitive environment was largely determined by each performers him or herself.

Individuals grouped into the mid and high competitive groups ran faster, responded faster, and jumped higher than the low competitive group. Given that these higher SOQ groups had more males and more athletes, this is not surprising. However, in contrast to our hypothesis, all SOQ groups were affected similarly under competitive situations. Our results are also in contrast to authors reporting that persons that are more competitive perform particularly well in the competitive environment (32). It could be argued that our low competitive trait group was not very low on the SOQ scale (M_{SOQ} = 85 on a 25-125 scale), but there are other explanations. Recently Parton and Neumann (26) found that the competitive trait of individuals did not influence race performance against a virtual reality competitor in a rowing ergometer task, however the level of challenge did matter. Parton and Neumann's findings have been explained in terms of outcome goals, that is, whether the outcome goal was winning or mastery (26, 28). In direct head-to-head competition, non-competitive individuals may simply respond to the implied task demands (10), which in the current study's 40 yard sprint was strongly implied a race to be won. Thus, even a non-competitive person may have complied with the task requirements to compete in a race, even if their experience was less enjoyable (33). It would be difficult not see the sprint task goal as winning, given the direct, instantaneous, and ongoing feedback of competition performance.

The vertical jump was a different task as the sequential nature of the competitive situation could have been easily interpreted differently by different subjects, or "colored and construed" by performers to frame their responses (28). It was hypothesized that the vertical jump task would be more likely to be interpreted as a competition by the higher competitive trait group, and thus this group would display greater improvements in performance compared to the low competitive trait group. This hypothesis was not supported. Two explanations are offered for this. First, performance during solo trials could have been effectively maximal from which little or no improvement could be realized. Maximal performance could have been an outcome of not resetting the vanes on the jump device during the solo trials, permitting both performance feedback and an external focus of attention, both of which could improve performance (16, 36). Moreover, not resetting the vanes on the jump device during the solo trials may have created a task mastery environment (28). Second, regardless of if any of the subjects considered the jumping as a task to be won, the simple presence of a coactor could have been enough to create a social facilitation and evaluative atmosphere that could have equally influenced all participants, regardless of their competitive trait (14, 33, 34).

Though the current study and that of others (26) have found that competitive trait may sometimes not differentially influence performance outcome during competitive events, it may influence underlying physiological processes. Parton and Neumann (26) and found changes in respiratory gas measures in more competitive individuals compared to less competitive individuals when faced with competition. These findings are consistent with Snyder et al. (32) who found cycling effort, as indicated by power output, to be greater in more competitive exer-gamers. This apparent paradox is strengthened by Chuang et al. (5) who found that underlying physiological processes may differ during competition even when effort is similar to that of a non-competitive situation. In other words, data from these researchers show that overt performance outcome may not change even as the underlying physiological indices may change. The current study was not designed to address this issue, but this appears to hold promise for future research.

CONCLUSIONS

The simultaneous, head-to-head environment of the sprint task led to faster sprinting, but the sequential competitive environment of the vertical jumping did not lead to significantly higher jumps. These findings suggest that a definitive competitive environment can lead to improved physical performance, or at least consistent maximal performance, compared to a more ambiguous competitive environment. This enhanced training environment was likely an outcome of a more motivating environment that contributed to stronger mental and physical effort. Most notably, this effect was found in all subject groups, even those not considered to have strong competitive traits. These results were also consistent in athletes, non-athletes, males, and females, and have implications for athlete training and recreational exercisers.

APPLICATIONS IN SPORT

Head to head competition during high effort physical activity like sprint running may motivate both athletes and non-athletes and competitive and non-competitive persons to exercise with more effort. However, if the competitive environment is not obvious, these effects may not be realized. For some individuals in a typically non-competitive exercise setting, periodic competitive situations may bring about higher performance and thus raise the exerciser's own standards for exercise effort, that is, a new "normal" of intensity or performance. To receive these benefits the nature of the exercise setting or instructions should be obvious toward competition. However, previous research findings would also suggest that the setting could similarly be devised to take advantage of social facilitation and mastery goal setting.

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REFERENCES

1. Anderson-Hanley, C., Snyder, A. L., Nimon, J. P., & Arciero, P. J. (2011). Social facilitation in virtual reality-enhanced exercise: Competitiveness moderates exercise effort of older adults. *Clinical Interventions in Aging*, 6, 275-280.
2. Barkley, J. E., Salvy, S. J., Sanders, G. J., Dey, S., Von Carlowitz, K. P., & Williamson, M. L. (2014). Peer influence and physical activity behavior in young children; an experimental study. *Journal of Physical Activity and Health,* 11, 404-409.
3. Bridge, C. A., McNaughton, L. R., Close, G. L., & Drust, B. (2003). Taekwondo exercise protocols do not recreate the physiological responses of championship combat. *International Journal of Sports Medicine,* 34(7), 573-581.

4. Carnes, A. J., Petersen, J. L., & Barkley, J. E. (2016). Effect of peer influence on exercise behavior and enjoyment in recreational runners. *Journal of Strength and Conditioning Research*, 30(2), 497-503.
5. Chuang, S.-J., Sung, Y.-C., Chen, C.-Y., Liao, Y.-H., & Chou, C.-C. (2019). Can match-mimicking intermittent practice be used as a simulatory training mode of competition using Olympic time frame in elite taekwondo athletes? *Frontiers in Physiology*, 10, 1-12.
6. Coswig, V. S., Hideyoshi Fukuda, D., de Paula Ramos, S., & Boscolo Del Vecchio, F. (2016). Biochemical differences between official and simulated mixed martial arts (MMA) matches. *Asian Journal of Sports Medicine*, *7*(2), 1–6.
7. Ericsson, K. A., Krampe, R. T., & Tesch-Roemer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100(3), 363-406.
8. Feltz, D. L., Forlenza, S. T., Winn, B., & Kerr, N. L. (2014). Cyber buddy is better than no buddy: A test of the Köhler motivation effect in exergames. *Games for Health Journal*, 3(2), 98-105.
9. Gill, D. L., & Deeter, T. E. (1988). Development of the Sport Orientation Questionnaire. *Research Quarterly for Exercise & Sport*, 59(3), 191-202.
10. Gill, D. L., & Dzewaltowski, D. A. (1988).Competitive orientations among intercollegiate athletes: Is winning the only thing? *Sport Psychologist,* 2(3), 212-221.
11. Gill, D. L., Kelley, B. C., Martin, J. J., & Caruso, C. M. (1991). A comparison of competitive-orientation measures. *Journal of Sport & Exercise Psychology, 13*(3), 266-280.
12. Giménez, J. V., & Gomez, M. A. (2019). Relationships among circuit training, small-sided and mini goal games, and competition in professional soccer players: A comparison of on-field integrated training routines. *Journal of Strength and Conditioning Research*, 33(7), 1887-1896.
13. Grindrod, D., Paton, C. D., Knez, W. L., & O'Brien, B. J. (2006). Six minute walk distance is greater when performed in a group than alone*. British Journal of Sports Medicine,* 40, 876-877.
14. Harkins, S. G. (2006). Mere effort as the mediator of the evaluation-performance relationship. *Journal of Personality and Social Psychology, 91*(3), 436-455.
15. Hibbert, A. W., Billaut, F., Varley, M. C., & Polman, R. C. J. (2018). Goal orientation and the presence of competitors influence cycling performance. *Frontiers in Psychology*, *9*, 1212. https://doi-org.ezproxy.ithaca.edu/10.3389/fpsyg.2018.01212
16. Keller, M., Lauber, B., Gottschalk, M., & Taube, W. (2015). Enhanced jump performance when providing augmented feedback compared to an external or internal focus of attention. *Journal of Sports Sciences*, *33*(10), 1067–1075.
17. Konings, M. J., & Hettinga, F. J. (2018a). The impact of different competitive environments on pacing and performance. *International Journal of Sports Physiology and Performance*, *13*(6), 701–708.
18. Konings, M. J., & Hettinga, F. J. (2018b). Pacing decision making in sport and the effects of interpersonal competition: A critical review. *Sports Medicine*, 48(8), 1829-1843.

19. Marker, A. M., & Staiano, A. E. (2015). Better together: Outcomes of cooperation versus competition in social exergaming. *Games for Health Journal*, 4(1), 25-30.
20. McFall, S. R., Jamieson, J. P., & Harkins, S. G. (2009). Testing the mere effort account of the evaluation-performance relationship. *Journal of Personality and Social Psychology, 96*(1), 135-154.
21. Moss T., Feltz D. L., Kerr N. L, Smith A. L., Winn B., & Spencer B. D. (2018). Intergroup competition in exergames: Further tests of the Köhler effect. *Games for Health Journal*, 7(4), 240-245.
22. Murayama, K., & Elliot, A. J. (2012). The competition-performance relation: A metaanalytic review and test of the opposing processes model of competition and performance. *Psychological Bulletin*, 138, 1035-1070.
23. Murphy, A. P., Duffield, R., Kellett, A., & Reid, M. (2016). A comparison of the perceptual and technical demands of tennis training, simulated match play, and competitive tournaments. *International Journal of Sports Physiology & Performance*, *11*(1), 40–47.
24. Nash, C. S., Sproule, J., & Horton, P. (2011). Excellence in coaching: The art and skill of elite practitioners. *Research Quarterly for Exercise and Sport*, 82(2), 229–238.
25. Park, T., Yoo, C., Choe, S. P., Park, B., & Song, J. (2012). Transforming solitary exercises into social exergames. Proceedings of the ACM CSCW 2012ACM (2012), 863-866. doi:http://dx.doi.org/10.1145/2145204.2145332.
26. Parton, B. J., & Neumann, D. L. (2019). The effects of competitiveness and challenge level on virtual reality rowing performance. *Psychology of Sport & Exercise*, 41, 191–199.
27. Reeve, J., & Deci, E. L. (1996). Elements of the competitive situation that affect intrinsic motivation. *Personality and Social Psychology Bulletin*, 22, 24-33.
28. Reinboth, M., & Duda, J. L. (2016). Effects of competitive environment and outcome on achievement behaviors and well-being while engaged in a physical task. *Sport, Exercise, and Performance Psychology,* 5(4), 324-336.
29. Rhea, M. R., Landers, D. M., Alvar, B. A., & Arent, S. M. (2003). The effects of competition and the presence of an audience on weight lifting performance. *Journal of Strength and Conditioning Research,* 17, 303-306.
30. Ric, A., Hristovski, R., Gonçalves, B., Torres, L., Sampaio, J., & Torrents, C. (2016). Timescales for exploratory tactical behaviour in football small-sided games. *Journal of Sports Sciences*, 34(18), 1723-1730.
31. Salvy, S. J., Bowker, J. W., & Roemmich, J. N. (2008). Peer influence on children's physical activity: An experience sampling study. *Journal of Pediatric Psychology,* 33, 39-49.
32. Snyder, A. L., Anderson-Hanley, C., & Arciero, P. J. (2012). Virtual and live social facilitation while exergaming: Competitiveness moderates exercise intensity. *Journal of Sport & Exercise Psychology,* 34(3),252-259.
33. Song, H., Kim, J., Tenzek, K. E., & Lee, K. M. (2013) The effects of competition and competitiveness upon intrinsic motivation in exergames. *Computers in Human Behavior, 29*(4), 1702-1708. http://dx.doi.org/10.1016/j.chb.2013.01.042

34. Szymanski, K., Garczynski, J., & Harkins, S. (2000). The contribution of the potential for evaluation to coaction effects. *Group Processes & Intergroup Relations, 3*(3), 269-283.
35. Triplett, N. (1898). The dynamogenic factors in pacemaking and competition. *The American Journal of Psychology, 9*(4), 507-533.
36. Wulf, G., Dufek, J. S., Lozano, L., & Pettigrew, C. (2010).Increased jump height and reduced EMG activity with an external focus. *Human Movement Science, 29,* 440–448.
37. Zhang, T., Moore, W., Gu, X., Chu, T.L., & Gao, Z. (2016). Promoting children's physical activity in physical education: The role of active video gaming. *Journal of Teaching, Research, and Media in Kinesiolo*gy, 1, 1-13.