Altered Psychological Responses to Different Magnitudes of Deception during Cycling

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ABSTRACT

WILLIAMS, E. L., H. S. JONES, S. A. SPARKS, A. W. MIDGLEY, D. C. MARCHANT, C. A. BRIDGE, and L. R. MCNAUGHTON. Altered Psychological Responses to Different Magnitudes of Deception during Cycling. *Med. Sci. Sports Exerc.*, Vol. 47, No. 11, pp. 2423–2430, 2015. **Purpose**: Deceptive manipulations of performance intensity have previously been investigated in cycling time trials (TT) but used different magnitudes, methods, and task durations. This study examines previously used magnitudes of deception during 16.1-km TT and explores yet unexamined psychological responses. **Methods**: Twelve trained cyclists completed five TT, performing two baseline trials alone, one against a simulated dynamic avatar representing 102% of fastest baseline trial ($TT_{102\%}$), one against a 105% avatar ($TT_{105\%}$), and one against both avatars ($TT_{102\%,105\%}$). **Results**: Deceptive use of competitors to disguise intensity manipulation enabled accomplishment of performance improvements greater than their perceived maximal (1.3%–1.7%). Despite a similar improvement in performance, during $TT_{102\%,105\%}$, there was significantly lower affect and self-efficacy to continue pace than those during $TT_{105\%}$ ($P < 0.05$), significantly lower self-efficacy to compete than that during $TT_{102\%}$ ($P = 0.004$), and greater RPE than that during TT_{FBL} ($P < 0.001$). **Conclusions**: Because the interpretation of performance information and perceptions depends on the manner in which it is presented, i.e., "framing effect," it could be suggested that the summative effect of two opponents could have evoked negative perceptions despite eliciting a similar performance. Magnitudes of deception produce similar performance enhancement yet elicit diverse psychological responses mediated by the external competitive environment the participants were performing in. **Key Words:** PACING STRATEGY, POWER OUTPUT, PERCEIVED EXERTION, AFFECT, SELF-EFFICACY

The teleoanticipatory setting of a pacing strategy for an athletic event is based on expected task demands (34). A confounding issue, however, is that the tactics, pacing strategies, and abilities of opponents are relatively unknown and somewhat surreptitious before competition. Consequently, during a task, anticipatory pacing strategies require continual adjustment in an attempt to match goal-driven targets and in reaction to competitors' performances (18,35,39). Competition enforces decision making through the calculation of potential benefit and perceptions of risk, relating to a change in pace during the event (29). The associated actions and affective responses of these decisions then motivate behavioral choices and steer the amount of effort one is willing to exert (35,42). Little is currently known about the decision making processes that influence pacing or the underlying psychological mechanisms involved, despite evidence suggesting that the presence of competitors, who are striving to achieve the same outcome, interferes with athletes' psychological dispositions (6,23,26,30). In particular, affect and goal achievement are pertinent to the selection of a pacing strategy (31). It is therefore important to gain further understanding of the effect of direct competition on these constructs, the physiological and psychological influences, and the resultant changes in behavior and performance.

Visually simulated competitors have been used in the laboratory setting to investigate the influence of direct competitor presence on cycling performance (7,25,36,43,44). This simulation of competitor behavior improves the illusion of real-time feedback within a virtual environment (42) and enables instantaneous exploration of direct competition influences during performance (34). In addition, the provision of false information regarding an opponent's ability has manipulated task expectancy, further examining the influence of competitor presence on performance outcomes (7,43). Participants were informed that they were competing against opponents with ability similar to theirs, but in reality, they were competing against their previous best performance. In contrast, Stone et al. (36) deceived participants into believing that an onscreen avatar represented their fastest previous performance, but it actually represented performance corresponding to 2% greater power output. These manipulations of the expectant task demands and the use of simulated competitors

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resulted in observed behavioral changes and performance improvements associated with changes in motivation (7,43), attentional focus (43), and pacing strategies (36). A false manipulation of feedback of 5% greater speed than actual performance however has been shown to modulate pacing strategy but had negligible effect on performance (24). The magnitude of the deception was seemingly too large to be maintained when attempted in a subsequent trial performed with accurate feedback, as this would have been equivalent to 14.5% power (14). In addition, Micklewright et al. (24) did not include a competitor in their deception, where the additional influences associated with the presence of competition (7,43) may have resulted in improved performances. Moreover, studies have manipulated previous performances using magnitudes of deception applied to a whole-trial average, i.e., 102% of average trial power output (36). This provides an unrealistic performance to compete against or be used as a training tool, as a fixed pace for the task duration is both unrepresentative of the previous performance being simulated and a true competitor's behavior. If they are to capture the temporal aspects of pacing decision making, researchers should consider using more sensitive manipulations that better replicate the dynamic pacing profile of the previous trial. Avatars can provide accurate visual representations of previously performed pacing variations while concealing any deceptive manipulation applied to subsequent trials.

Research into the magnitude of deception that elicits performance improvements is in its infancy (36). Furthermore, deceptions of 102% (36) and 105% (24) manipulations of a performance have been performed using different methods (with and without competitive simulations), different performance variables (power output and speed), and different distances (4 and 20 km). This issue is notable because the effect of different magnitudes of deception may be dependent on the duration of the task with respect to whether the deception remains undetected and whether successfully competing against the simulated competitor seems achievable. Consequently, the different distances used by previous deception studies confound the interpretation of findings with respect to the influence of the deception magnitude on performance outcomes. Further research into the influence of different magnitudes of deception during the same distance events are therefore warranted, in which adopting a distance commonly performed during time trials (TT) would increase ecological validity.

The main aim of the present study was to investigate the effects of two magnitudes of deception (102% and 105% speed manipulations), alone and simultaneously, on 16.1-km self-paced cycling TT performance. To address the limitations of existing research, this study compares the two magnitudes across the same commonly performed distance and enhances ecological validity using a true competitor's pacing profile rather than an even-pace representation. Further inclusion of a novel condition allowed exploration into the influence of the multiple-competitor presence on performance. A secondary aim was to explore the influence of psychological constructs, of affect and self-efficacy, on decision making and performance outcomes.

METHODS

Participants. Twelve trained competitive male cyclists (age 35.2 ± 5.0 yr body mass, 84.3 ± 11.0 kg; height, 179.4 ± 6.5 cm; peak oxygen uptake ($\dot{V}O_{2peak}$), 58.7 ± 6.7 $mL \cdot kg^{-1} \cdot min^{-1}$) participated in this study. Each had over 8 yr of competitive cycling experience, race experience in 16.1-km TT, and typical training volumes equating to >8 $h \cdot wk^{-1}$. $\dot{V}O_{2peak}$ values obtained on the first visit categorized the participant's performance level as "trained cyclists" (10). The institutional ethics committee approved the study, and all participants gave an informed consent and completed health screening before participation. Prospective power analysis showed that a sample size of 12 participants achieves 86% power with 5% significance level and minimum worthwhile effect of 2.2% between conditions, equating to a standardized effect size of 1.1 (17).

Experimental design. A repeated-measures, counterbalanced design was implemented, and participants visited the laboratory on six occasions performing a maximal oxygen uptake procedure and five 16.1-km TT. The trials were performed at the same time of the day (±2 h) to minimize circadian variation and were separated by 3–7 d to limit training adaptations. Participants were asked to maintain normal activity and sleep pattern throughout the testing period and to replicate the same diet for the 24 h preceding each testing session. Participants refrained from any strenuous exercise, excessive caffeine, or alcohol consumption for the previous 24 h. They consumed 500 mL of water and refrained from food consumption in the 2 h before each visit. Hydration state was assessed before trial commencement using a portable refractometry device (Osmocheck; Vitech Scientific, West Sussex, United Kingdom). Participants were informed that the study was examining the influence of visual feedback during the TT and were fully debriefed regarding the true nature of the study upon completion of all trials (20). All participation in the study was kept anonymous; in addition, participants were asked to refrain from any potential discussion with other participants until study completion. To prevent any premeditated influence on preparation or preexercise state, the specific feedback presented was only revealed immediately before each trial. No verbal encouragement was given to the participants during any trial to prevent inconsistencies in the provision of this feedback. Participants were instructed to complete each TT in the fastest time possible and to prepare for each session as if it were a genuine competitive event.

$\dot{V}O_{2peak}$. During their initial visit, participants performed an incremental maximal exercise test on a cycle ergometer (Excalibur Sport; Lode, Groningen, Netherlands), established as having coefficients of variation (CV) of agreement with the Computrainer for both $\dot{V}O_{2peak}$ and HR as 8% and 4.4%, respectively (11). After a 5-min warm-up at 100 W, participants began the protocol at a prescribed resistance in accordance with accepted guidelines (4), and 20-W increments were

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applied until participants reached volitional exhaustion to determine $\dot{V}O_{2peak}$. Continuous respiratory gas analysis (Oxycon Pro; Jaeger, GmbH Hoechburg, Germany) and HR (Polar Electro OY, Kempele, Finland) were measured throughout.

TT. During five further visits, participants performed a 16.1-km cycling TT on their own bike, mounted on a cycle ergometer (Computrainer Pro; Racermate ONE, Seattle, WA). This ergometer has previously been reported to provide a reliable measure of power output (8) and produced a low CV (0.6%) for time between two 16.1-km trials from our laboratory. The ergometer was interfaced with the Computrainer's three-dimensional visual software and projected onto a 230-cm screen positioned 130 cm away from the cyclists' front wheel and calibrated according to manufacturer's instructions.

Before each TT, participants completed a 10-min warm-up at 70% HR_{max}, determined from the maximal test, followed by 2 min of rest. The first TT familiarized participants with the equipment and procedures, during which participants performed with a virtual visual display of an outdoor environment and total distance covered throughout, as if performing on a flat, road-based 16.1-km course. Participants were not informed that the initial visit was a familiarization session, but that it was one of the five experimental trials, to avoid a change in performance. The second visit replicated the familiarization trial, and paired *t*-tests were performed to analyze the presence of any systematic bias between the two baseline trials (BL). The two BL showed no significant differences in power output ($P = 0.60$), HR ($P = 0.35$), RPE ($P = 0.88$), affect ($P = 0.15$), or self-efficacy ($P = 0.58$). Only the faster of the two BL (TT_{FBL}) was included in the inferential analysis. Six participants performed their fastest baseline in their first baseline trial, and the six, in their second baseline, illustrating no evidence of a learning effect.

During three further visits, participants were informed that they would be competing against simulated avatars projected onto the screen and that the avatar represented performances produced by cyclists of a similar ability. Each competitive TT had different simulated avatars as opponents, the order of which was randomized and counterbalanced. One was performed with an avatar actually representing a performance 2% greater in speed than their fastest baseline ($TT_{102\%}$), one representing 5% greater speed manipulation ($TT_{105\%}$), and one performed with simultaneous 2% and 5% avatars ($TT_{102\%,105\%}$). Distance covered and distance of the lead avatar(s) were displayed throughout. Participants were blinded to all other data (speed, power output, HR) during each experimental TT.

Experimental measures. Power output, speed, and elapsed time were blinded during all trials and stored at a rate of 34 Hz. Each was subsequently downloaded after performance for analysis. Percentage of mean speed across each quartile was also expressed to demonstrate pacing profiles. HR was also blinded and recorded continuously using polar team system sampled at 5-s frequencies. These were then averaged as quartile data points for analysis. During each TT, breath-by-breath respiratory gases were measured for the duration of a kilometer at every 4 km, subsequently averaged, and expressed in 5-s intervals. This intermittent collection of respiratory data was adopted to allow for data collection while providing minimal interference on performance and permit fluid intake (500 ± 20 mL) during the TT. Before each trial, willingness to invest physical and mental effort were individually assessed on a visual analog scale ranging from 0 (not willing) to 10 (willing). Pretask self-efficacy and affect were also recorded, together with measurements every 4 km during the trial. These pretrial equivalence measures were used to determine consistency of pretrial states across the conditions and identified no significant differences between all trials across resting values of willingness to invest physical effort ($P = 0.11$), willingness to invest mental effort ($P = 0.75$), hydration status ($P = 0.17$), affect ($P = 0.78$), and self-efficacy ($P = 0.73$).

At each 4 km of the trial, participants were asked to rate their perceived exertion (RPE) on a 6–20 Borg scale (3) and their affective feeling states as to whether the exercise felt pleasant or unpleasant, measured using an 11-point Likert scale ranging from −5 to +5 with verbal anchors at all odd integers and zero (+5, very good; +3, good; +1, fairly good; 0, neutral; −1, fairly bad; −3, bad; −5, very bad). In addition, at every 4 km, self-efficacy to continue at the current pace (SE_{pace}) and their self-efficacy to compete with the competitor(s) for the remaining distance of the trial during the competitor trials (SE_{comp}) were recorded on a 0%–100% scale divided into 5% integer intervals. The self-efficacy scales were adopted from guidelines previously developed and recently constructed (41). Posttrial interviews were completed and qualitatively analyzed using the QSR NVivo 10 software (NVivo 10; QSR International Ltd., Cheshire, United Kingdom). Information was collected using semistructured interviews pertaining to how participants felt, their thoughts toward their pace, their thoughts toward the competitor, and their strategy during each 4 km of the trial. Data were collated into a thematic analysis followed by a process of descriptive frequencies.

Statistical analysis. The effects of condition (TT_{FBL}, $TT_{102\%}$, $TT_{105\%}$, and $TT_{102\%,105\%}$) and distance quartile (0–4, 4–8, 8–12, and 12–16.1 km) were analyzed for completion time, speed, HR, RPE, and affect and self-efficacy variables using the mixed procedure for repeated measures (28). Various plausible covariance structures were assumed for each dependant variable, and the one that minimized the Hurvich and Tsai criterion (AICC) value was chosen as the best fitting and was used for the final model. A quadratic term for distance quartile was entered into the model where appropriate and removed where no significance value was observed. *Post hoc* pairwise comparisons with Sidak-adjusted P values were conducted where a significant F ratio was observed. In addition, bivariate relations between pacing and psychological responses were analyzed using Pearson product moment correlations. Statistical significance was accepted as $P < 0.05$ (IBM Statistics 22.0; SPSS, Inc., Chicago, IL). The smallest worthwhile change in performance was calculated and expressed as a percentage change relative to TT_{FBL} in addition to increase applicability and practicality to athletes and coaches (19).

RESULTS

Performance. There was no significant main effect for condition ($F = 1.2$, $P = 0.34$) observed for TT time (Table 1). The competitive trials, however, were performed faster than TT_{FBL}; $TT_{102,105\%}$ (mean difference (MD), −0.46 min; 95% confidence limit (CL), −1.33 to 0.42; $P = 0.61$), $TT_{102\%}$ (MD, −0.39 min; 95% CL, −1.05 to 0.27; $P = 0.43$), and $TT_{105\%}$ (MD, −0.36 min; 95% CL, −1.11 to 0.38; $P = 0.67$). Each of the competitor conditions elicited TT time improvements greater than the previously reported smallest worthwhile improvement (0.6%) (28) and greater than the present study's baseline trial CV (CV, 0.6%). $TT_{102\%}$ improved by 1.4%, $TT_{105\%}$ improved by 1.3%, and $TT_{102\%,105\%}$ improved performance by 1.7%. There was no significant main effect for condition observed for speed ($F = 0.7$, $P = 0.58$); however, there was a significant decrease in speed across distance quartiles ($F = 7.6$, $P = 0.001$). There was no significant condition–distance quartile interaction ($F = 0.054$, $P = 1.00$); however, during $TT_{102\%,105\%}$, participants did perform a greater starting strategy (Fig. 1), of which a greater mean speed in the initial quarter of the trial was significantly correlated with a lower mean speed in the third quarter ($r = -0.848$, $P < 0.001$).

Physiological measurements. No significant main effects for condition ($F = 2.3$, $P = 0.11$) or an interaction between condition and distance quartile ($F = 0.1$, $P = 0.99$) were identified for HR. However, a main effect for distance quartile was observed, with HR significantly increasing over time ($F = 24.5$, $P < 0.001$). There was no main effect for condition for $\dot{V}O_2$ ($F = 1.1$, $P = 0.95$), but a significant main effect was evident for distance quartile ($F = 6.2$, $P < 0.001$), with $\dot{V}O_2$ in the final quartile significantly higher than in the second (MD, 1.7 $mL \cdot kg^{-1} \cdot min^{-1}$; 95% CL, 0.1–3.34; $P = 0.04$) and third quartiles (MD, 2.0 $mL \cdot kg^{-1} \cdot min^{-1}$, 95% CL, 0.7–3.2; $P < 0.001$). There was however, no condition–distance quartile interaction ($F = 0.2$, $P = 0.99$). No significant condition effect was observed for RER ($F = 1.3$, $P = 0.27$), but a main effect for distance quartile was seen ($F = 8.2$, $P < 0.001$). The RER was significantly higher in the first quartile than those in the second (MD, 0.03; 95% CL, 0.01–0.05; $P = 0.006$) and the third (MD, 0.04; 95% CL, 0.02–0.06; $P < 0.001$). In addition, that in the fourth quartile was significantly greater than that in the third (MD, 0.03; 95% CL, 0.004–0.05; $P = 0.013$). There was no interaction ($F = 0.3$, $P = 0.97$).

TABLE 1. Mean (SD) completion time and whole TT average power output, speed, and HR for the experimental conditions.

Condition	Completion Time (min)	Power Output (W)	Speed ($km \cdot h^{-1}$)	HR (bpm)
TT_{FBL}	27.2 (2.1)	252 (45)	35.8 (2.6)	159 (14)
$TT_{102\%}$	26.8 (1.6)	259 (38)	36.2 (2.0)	162 (11)
$TT_{105\%}$	26.8 (1.6)	258 (37)	36.2 (2.8)	159 (11)
$TT_{102\%,105\%}$	26.7 (1.9)	260 (44)	36.3 (2.4)	159 (12)

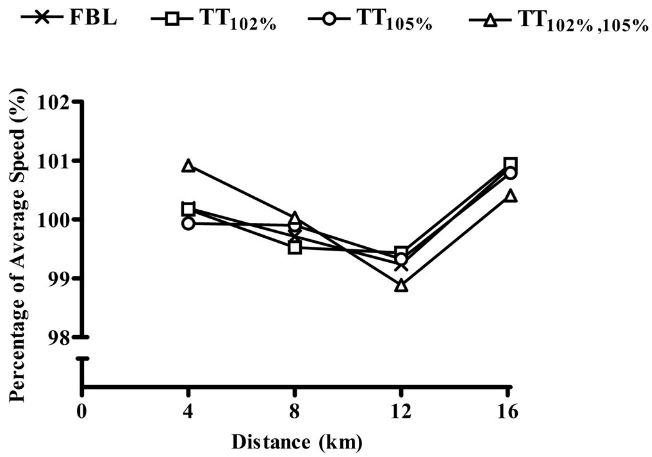

FIGURE 1—Percentage of mean speed during each TT. Error bars are omitted for clarity.

Psychological variables. RPE had a significant main effect for condition ($F = 13.4$, $P < 0.001$), in which RPE was significantly higher in $TT_{102\%}$ than that in TT_{FBL} (MD, 0.8; 95% CL, 0.3–1.4; $P < 0.001$) and that in $TT_{102\%,105\%}$ was significantly higher than that in TT_{FBL} (MD, 0.9; 95% CL, 0.4–1.3; $P < 0.001$). RPE also significantly increased across distance quartiles ($F = 25.0$, $P < 0.001$), but there was no condition–distance quartile interaction effect ($F = 0.4$, $P = 0.92$) (Fig. 2A). There was a significant main effect for condition observed for affect ($F = 3.0$, $P = 0.03$), with significantly higher values reported during $TT_{105\%}$ than those reported during $TT_{102\%,105\%}$ (MD, −0.9; 95% CL, −1.8 to −0.1; $P = 0.03$). Affect also significantly decreased across distance quartiles ($F = 9.0$, $P < 0.001$). There was no condition–distance quartile interaction ($F = 0.2$, $P = 0.99$) (Fig. 2B). In addition, during the first quartile of $TT_{102\%,105\%}$, significant positive correlations were observed between the percentage of mean speed performed and RPE ($r = 0.70$, $P = 0.02$) and a strong negative correlation with affect ($r = -0.6$, $P = 0.052$).

There was a significant main effect for condition for SE_{pace} ($F = 3.6$, $P = 0.03$) but no significant distance quartile effect ($F = 0.9$, $P = 0.45$) or interaction ($F = 0.5$, $P = 0.87$). Significantly greater SE_{pace} (Fig. 2C) was found during $TT_{105\%}$ than that during $TT_{102\%,105\%}$ (MD, 11.6%; 95% CL, −0.02 to 23.1; $P = 0.05$). There was a significant main effect across the three competitor trials for SE_{comp} ($F = 4.6$, $P = 0.02$) but no significant main effect for distance quartile ($F = 2.7$, $P = 0.07$) and no interaction ($F = 0.4$, $P = 0.91$). *Post hoc* analysis found significantly higher SE_{comp} (Fig. 2D) during $TT_{102\%}$ when compared with those during $TT_{105\%}$ (MD, 15.8%; 95% CL, 5.3–26.3; $P = 0.001$) and $TT_{102\%,105\%}$ (MD, 14.3%; 95% CL, 3.7–24.8; $P = 0.004$).

Qualitative responses. Frequency data recorded from the posttrial questions found that the most common strategy participants adopted during $TT_{102\%}$ was to "stay ahead" of the competitor (41.7%). During $TT_{105\%}$, they adopted to "go at own pace" (58.3%), and during $TT_{102\%,105\%}$, they chose to "ignore the fastest competitor" (33.3%). The participants' thoughts toward the competitor during $TT_{102\%}$

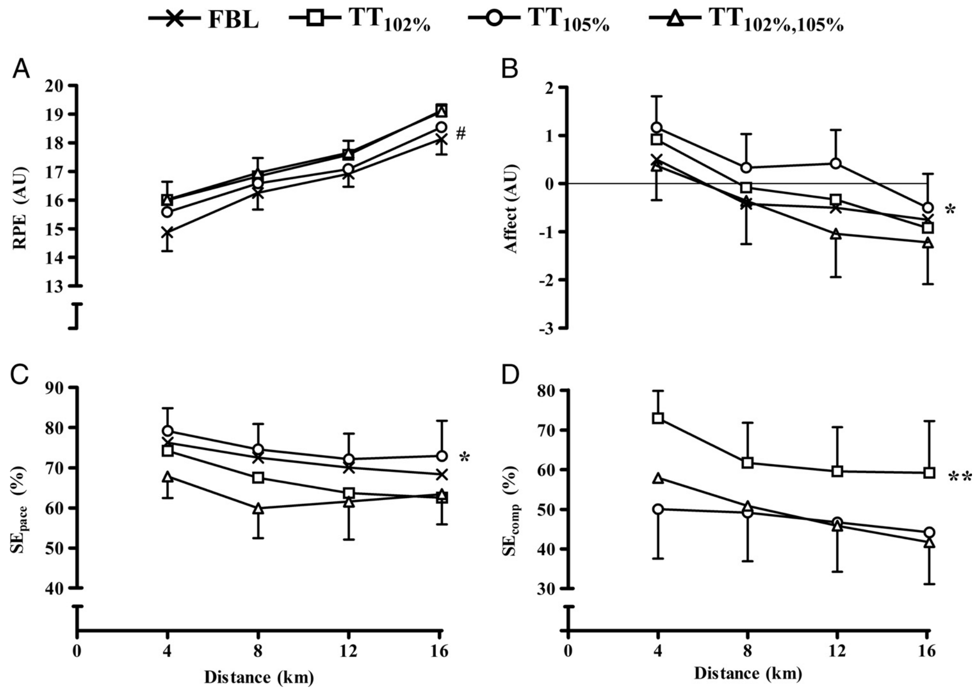

FIGURE 2—Psychological responses to the TT conditions. A. RPE. B. Affect. C. SE_{pace}. D. SE_{comp}. *Error bars* illustrate SEM. # Denotes main effect for condition; TT_{FBL} is significantly different from $TT_{102\%}$ (P < 0.001) and $TT_{102\%,105\%}$ (P < 0.001). * Denotes main effect for condition; $TT_{105\%}$ is significantly different from $TT_{102\%,105\%}$ ($P \leq 0.05$). ** Denotes main effect for condition; $TT_{102\%}$ is significantly different from $TT_{105\%}$ (P = 0.001) and $TT_{102\%,105\%}$ (P = 0.004).

were to "ignore" (25%), as were the thoughts during $TT_{105\%}$ (50%), as well as perceiving the competitor to be "too fast" (50%), whereas during $TT_{102\%,105\%}$, thoughts were to "concentrate on the closer competitor" (41.7%). The most frequent thoughts toward pace during $TT_{102\%}$ were that it was "manageable" (41.7%) and, during $TT_{105\%}$ and $TT_{102\%,105\%}$, that the participant "could not sustain" (50% each).

DISCUSSION

The primary aim of this study was to examine the influence of different magnitudes of deception (102%, 105%) elicited through dynamic pacing avatars on 16.1-km self-paced cycling TT performance. This study is the first to investigate both of these magnitudes of deception under the same task duration and further investigated such influences within a novel competitive environment performing in the presence of two competitors. The main findings demonstrate that each method of deception, irrespective of its magnitude, elicited comparable improvements in 16.1-km TT performance (1.3%–1.7%) compared with performing alone. This equates to a "real-world" competitive advantage in the region of 21.6–27.0 s and highlights the ergogenic potential of increasing perceived maximal performances by deceptively altering performance feedback or stimulating a competitive environment. A secondary aim of our study was to explore the influence of different magnitudes of deception on psychological constructs during such performances. We demonstrate for the first time that although each magnitude of deception and competitive environment produced comparable performance improvements, they produced disparate psychological responses.

Performing against a single competitor, comparing different magnitudes of deceptively hidden performance intensity ($TT_{102\%}$ and $TT_{105\%}$), elicited similar improvements in performance times of 1.4% (23.4 s) and 1.3% (21.6 s), respectively, compared with those when performing alone. These improvements are at least two times greater than the previously reported minimal worthwhile change in performance of 0.6% (representative of 10 s in the present study) (27). In support of previous research, despite different methodological approaches, the presence of simulated competitors improved TT performances greater than the athletes' previous best performance (TT_{FBL}) (7,36,43). This includes improvements when misleading feedback is presented as a competitor representing a performance 2% greater than the athlete's previous best performance (36). Although the present study supports such findings, it must be noted that the 2% increase in power output manipulation in the previous study will represent a 0.7% increase in speed during comparisons with the present investigation (14).

Important to note, however, is that while the findings of facilitation even when against a 2% increase in performance correspond with previous research, the present study informed the participants differently as to the nature of their competitor. During the present study, participants were informed that their visual opponent was a cyclist of a similar ability to themselves. In contrast, during the research of Stone et al. (36), participants were informed that the avatar represented their own previous performance. Caution must

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be sought when directly comparing such results because performing against one's self or an opponent will alter the intrinsic and extrinsic nature of competitive motivation and could influence the behavioral strategy one chooses during competition (40). Nevertheless, the present methodology enabled a true comparison of manipulation magnitudes among 100%, 102%, and 105% of the same performance variable, and a novel finding is that performance also improved when misleading feedback is presented as a competitor representing a performance 5% greater in speed than the athlete's previous best performance.

Simultaneous with similar improvements in performance times across the conditions, there were also no significant differences in the physiological or psychological responses between $TT_{102\%}$ and $TT_{105\%}$. There was no significant difference between trials for RPE, affect, and athlete's self-efficacy to continue at the chosen pace. Participants, however, did report significantly greater during-task self-efficacy to compete with their opponent during $TT_{102\%}$ compared with that during $TT_{105\%}$, and interestingly, both trials resulted in more positive affect than TT_{FBL} despite an increase in exercise intensity. The findings during $TT_{102\%}$ support the proposal that greater affective valence is observed despite increase in pace when the subject successfully stays in contact with a competitor (29). Alternatively, it has previously been proposed that athletes who realize that they are failing to achieve meaningful goals during competition, represented in the present study as lower self-efficacy to compete with the simulated competitor, experience a negative affective state labeled "competitive suffering" (5,13). If the subject cannot stay in contact with the competitor, a reduced affect and increased RPE might be expected. This, however, was not evident during $TT_{105\%}$ despite participants indicating an inability to stay with their opponent through their reduced self-efficacy responses and posttrial interviews, in which half of the participants expressed that they could not sustain the pace. There was significantly lower self-efficacy to compete during $TT_{105\%}$ than that during $TT_{102\%}$, yet they expressed an affect similar to that during $TT_{102\%}$, which was more positive than that during TT_{FBL}. Notably, during posttrial feedback, half the participants reported that they abandoned competing with the avatar and continued to ride the trial for time, rather than as a competition, during $TT_{105\%}$. This supports that people with low task- or self-efficacy may avoid such goal attempts (33) and that if an athlete is not in close proximity to their competitors, pacing is better focused on producing an optimal individual performance (32). However, the temporal aspects of such decision making require further consideration. Although the two magnitudes of deceptive manipulations produced similar improvements in performance time when competing against as a single competitor, their differential influence on perceptions of self-efficacy is noteworthy.

The summative effect of competing against two avatars during the same trial has not previously been investigated. Although the presence of competitors during each condition ($TT_{102\%}$, $TT_{105\%}$, and $TT_{102\%,105\%}$) elicited similar improvements in performance time (1.4%, 1.3%, and 1.7%, respectively), the collective influence of the two competitors ($TT_{102\%,105\%}$), creating a different competitive environment (albeit representative of the same pacing profiles experienced within the single competitor conditions), produced different psychological responses. A significantly greater RPE than that during $TT_{FBL}$was observed during $TT_{102\%,105\%}$ and $TT_{102\%}$. However, RPE during $TT_{105\%}$ was not significantly greater than that during TT_{FBL}. The contrasting responses could be explained by the decision in $TT_{105\%}$ to change the performance goal away from competing with the avatar, as expressed by the participant's posttrial responses. Thus, the perceptions of exertion are significantly increased when competing with opponents compared with that when striving to reach personal goals, such as during alone conditions and $TT_{105\%}$ (30). Notably, research has recently documented performance improvements in the absence of elevated RPE when competing with an avatar, which was ascribed to the greater external attentional focus during the task (43). However, this former study used an avatar representing 100% of previous performance, whereas the present study used greater intensity magnitudes of 102% and 105%. Such increased work rate may negate any processing of external information through greater salience of physiological feedback. As such, competing against opponents who are superior to an athlete's previous fastest performance elevates RPE (36).

There was also significantly lower affect during $TT_{102\%,105\%}$ than that during $TT_{105\%.}$ Competing against two opponents evoked meaningful performance improvements despite participants experiencing higher RPE and lower affect. An explanation for the more negative affective responses and heightened perceived exertion during $TT_{102\%,105\%}$ could be the "framing effect" of the feedback provided (29). Emotional responses and the interpretation of afferent physiological sensations are dependent on the circumstances in which information is presented to the individual (9,30). Therefore, performing against two competitors could have been perceived as more stressful than performing against a single competitor or performing alone, encouraging more negative perceptions. In addition, affective and psychological responses could have been influenced by self-efficacy appraisals. There is a proposition that variations in self-efficacy are antecedents of variability in affective responses (12) and that sensations of fatigue are interpreted differently according to one's degree of self-efficacy (22). During $TT_{102\%,105\%}$, participants reported significantly lower self-efficacy to compete than that during $TT_{102\%}$. One's perceived progress toward goal achievement is important in the generation of affect responses (15). Therefore, the lower self-efficacy during $TT_{102\%,105\%}$, possibly generated according to a perceived greater risk toward the achievement of their overall goal when competing against two opponents, may have resulted in reduced affective valence. The self-efficacy question was not separate for each avatar during $TT_{102\%,105\%}$, prohibiting investigations as to which opponent they were anchoring their appraisal of self-efficacy. The values were, however, similar to those reported during $TT_{105\%}$, and both ($TT_{105\%}$ and $TT_{102\%,105\%}$) had significantly lower self-efficacy than that during $TT_{102\%}$. In addition, it could be assumed that during $TT_{102\%,105\%}$, the influence of the 102% avatar, in closer proximity, motivated the choice to continue competing despite worse affective and efficacy responses. This as 41.7% of the participants specified that they chose to concentrate on the closer competitor. As previous findings have elucidated (38), similar deception methods allow for association of negative affect with successful performances through enhanced motivation to withstand a workload otherwise considered unsustainable.

A further explanation for the similar improvement in performance despite worse affective and efficacy responses during $TT_{102\%,105\%}$ could be the influence of two competitors during the initial 4 km. While the cyclists' speed profiles across all trials were illustrative of the commonly reported parabolic pacing strategy (1), during $TT_{102\%,105\%}$, there was a greater percentage of mean speed displayed in the initial quarter of the trial (Fig. 1). This suggests that participants did not select their initial pace from their perceived optimal strategy but adjusted their speed to that imposed by the competition (39). Extending the findings of previous research, individuals are likely to select work rates on the basis of the behavior of competitors and be less influenced by afferent information relating to their personal status (29). In which, during $TT_{102\%,105\%}$, a faster start was found to be significantly associated with greater RPE and reduced affect. The presence of competition, particularly two competitors, may have induced greater motivation (2), encouraging acceptance of a high level of unpleasant sensations in an attempt to achieve a goal of beating the opponents.

The selection of an unsustainable power output at the start of $TT_{102\%,105\%}$ possibly led to the necessity to slow down during the third quarter (16). Consciously reducing pace during the third quarter (37), in response to a greater initial 4-km pace, is further evidence supporting a psychophysiological pacing decision as an active step to maintain overall pacing strategy and prevent a physiological catastrophe (39). This was also demonstrated in previous research using 105% speed manipulation (24). Furthermore, the pacing profile for $TT_{102\%,105\%}$ illustrated that athletes were still able to increase pace in the final quartile, which is indicative of the presence of a reserve. The motivational influence of competition (7,43) could be considered an incentive that in spite of unpleasant experiences (increased RPE and reduced affect) during $TT_{102\%,105\%}$, performance was not debilitated. This provides further support for previous findings of a significant negative association between affect and power output during 16.1-km TT (21), and between affect and increased task performance (38).

CONCLUSIONS

In conclusion, data from the current study confirms the beneficial effect of the surreptitiously augmented feedback of a previous performance. Deceptive employment of dynamic competitors to disguise the intensity manipulation enabled cyclists to accomplish performance improvements, even with a magnitude increase of 2% and 5% greater speed than that in the previous performance. Although supporting previous findings that deception magnitudes of 105% speed were too large to be sustained for the whole task, when this magnitude is presented as direct competition, participants may change their performance goal to prevent reduced performance and negative emotions. Notably, participants' willingness to achieve their competitive goal when against two opponents increased persistence of performance by counteracting negative psychological responses of greater RPE and permitted the acceptance of reduced affect. Finally, the magnitude to which the feedback is augmented and the way in which it is presented to athletes stimulate different psychological influences. When implementing this strategy into practice or training, consideration must therefore be given to the implications associated with different magnitudes of deception and the use of competitive environments upon previously unexamined psychological constructs.

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APPLIED SCIENCES

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