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ORIGINAL RESEARCH

The Effects of Overt Head Movements on Physical Performance After Positive Versus Negative Self-Talk

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Research on self-talk has found that what athletes say to themselves influences their performance in sport settings. This experiment analyzed the relationship between positive and negative self-talk and physical performance in light of another variable: overt head movements. Participants were randomly assigned to first generate and then listen to either positive or negative self-statements. They were then randomly assigned to nod (up and down) or to shake (side to side) their heads while being exposed to the self-statements they had previously generated. Finally, physical performance was assessed using a vertical-jump task, a squat test, and a deadlift task. As expected, positive self-statements led to better performance than negative self-statements in 2 out of 3 physical tasks. Most relevant, the main effect of self-talk was significantly qualified by head movements. Consistent with the authors' hypothesis, athletes' self-statements were significantly more impactful on physical performance in the head-nodding condition than in the head-shaking condition

***Keywords**:* embodiment, performance, self-persuasion, self-talk, validation

Athletes' self-talk involves talking to themselves either out loud or internally during a sport task and occurs "as verbalizations or self-statements addressed to the self" (Hardy, 2006, p. 84). Van Raalte, Vincent, and Brewer (2016, p. 141) have proposed a definition that emphasizes the linguistic features of self-talk, defining this phenomenon as "the syntactically recognizable articulation of an internal position that can be expressed either internally or out loud, where the sender of the message is also the intended receiver." Described differently, this definition considers self-talk as an act of communication in which the sender of the message and the receiver of that message are the same person. Most relevant for the present research, these authors distinguish between verbal self-statements (i.e., self-talk) from nonverbal self-statements made by gestures (e.g., head movements; see also Van Raalte & Vincent, 2017). Thus, according to prior theory and research, self-talk may be viewed as a type of self-delivered verbal persuasion (more specifically, self-persuasion; e.g., Briñol, McCaslin, & Petty, 2012; Maio & Thomas, 2007) that occurs under specific circumstances (e.g., Wood, Perunovic, & Lee, 2009) such as when the goal of athletes' self-talk is to increase their perceived self-efficacy in performing a sport-related behavior (e.g., Bandura, 1997; Hardy, 2006; Theodorakis, Hatzigeorgiadis, & Zourbanos, 2012; Tod, Hardy, & Oliver, 2011).

Prior research has found that what athletes say to themselves through self-talk influences their performance in sports settings. For example, self-talk has been shown to affect the learning of sport skills, the performance of sport accuracy tasks, the performance of tasks that involve strength and power, the performance in endurance sports, and so on (e.g., see Hatzigeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011; Tod et al., 2011; Van Raalte & Vincent, 2017 for a review). In a meta-analysis of research on self-talk in sports, it was found that self-talk had a moderate positive effect on sport-task performance, including physical performance (Hatzigeorgiadis et al., 2011; see Tod, Edwards, McGuigan, & Lovell, 2015 for an additional review). This is an important finding, given that physical performance (e.g., maximal strength, endurance, or power) is a key factor of most sports (e.g., see Baechle & Earle, 2008; McGuigan, Wright, & Fleck, 2012; Suchomel, Nimphius, Bellon, & Stone, 2018).

One of the most important dimensions of self-talk is the valence (Hardy, 2006; Theodorakis et al., 2012; Tod et al., 2011). Valence refers to the content of self-talk in terms of "the emotional tone of a self-talk statement" such as whether the talk is positive or negative (Van Raalte & Vincent, 2017). Positive self-talk consists of statements that people say to themselves that are encouraging or self-assuring in tone (e.g., "I can do it"). Negative self-talk refers to statements that are discouraging or self-deprecating in tone (e.g., "I can't do it"; see Van Raalte et al., 1995). In a systematic review of self-talk research, Tod et al. (2011) found that whereas positive self-talk had a significantly beneficial effect on performance (see also Tod et al., 2015), the relationship between negative self-talk and performance was nonsignificant.

Contemporary self-talk research goes beyond by examining whether self-talk influences performance by asking "second-generation questions" such as when, how, and why the effects of self-talk on performance occurs (e.g., Hardy, Oliver, & Tod, 2009; Tod et al., 2011). Research now tends to focus on identifying the moderators and mediators underlying the effects of self-talk on performance. Given the theoretical and applied value of this approach, the present research analyzed a new moderating variable of the relationship between positive (vs. negative) self-talk and performance: overt head movements.

Overt Head Movements and Persuasion Research

Mind and body are interconnected. In fact, bodily responses and overt behavior can affect thoughts, feelings, and judgments (e.g., see

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Briñol, Petty, & Hinsenkamp, 2018 for a review in sport settings). Supporting this idea, early research on overt head movements found that vertically moving one's head up and down (nodding) produced more positive attitudes (evaluations) toward a persuasive message than horizontally moving one's head from side to side (shaking; e.g., Wells & Petty, 1980). Among other possibilities, this persuasive effect of head movements can occur either because head nodding (vs. shaking) biases thinking in a favorable direction or because head nodding (vs. shaking) serves as a relatively simple affective association or contributes to a simple heuristic (e.g., "I am nodding so I must agree with this message"; Tom, Pettersen, Lau, Burton, & Cook, 1991; see Briñol & Petty, 2008 for a review). Beyond influencing the thoughts that come to mind, recent research has shown that bodily responses such as head nodding can also validate a person's thoughts. This metacognitive process of embodied validation involves thinking about one's thoughts to assess the extent to which they are perceived to be correct and whether they feel good (see Petty, Briñol, Teeny, & Horcajo, 2018 for a review).

In an early illustration of embodied validation, Briñol and Petty (2003) induced participants to nod or shake their heads while listening to a persuasive message as part of a study ostensibly designed to test the quality of a set of headphones. Participants were randomly assigned to one of two different versions of a message consisting of either strong or weak arguments. As expected, for participants in the head-nodding condition, those who were assigned to listen to the strong message were significantly more persuaded than those who were assigned to listen to the weak message. By contrast, for participants in the head-shaking condition, the difference between those who were assigned to listen to the strong message and those who were assigned to listen to the weak message was not significant. Viewed differently, this interaction revealed that when people listened to strong arguments (and as a consequence generated positive thoughts), vertical head movements led to more favorable attitudes than horizontal head movements. This is precisely what would be expected if vertical movements relatively increased the perceived validity of one's favorable thoughts. However, when people listened to weak arguments (and as a consequence generated negative thoughts), vertical head movements led to less favorable attitudes than horizontal head movements, as would be expected if vertical movements increased the perceived validity of one's unfavorable thoughts. As we will describe in the hypotheses of the current experiment, the results of previous research revealed that head movements moderated the effects of positive and negative thoughts on subsequent attitudes (see Briñol & Petty, 2008; Briñol, Petty, & Wagner, 2012 for reviews of embodiment and persuasion). Importantly, these results were obtained in conditions that required motivation and ability to think, and when head movements were performed during or following the generation of thoughts (for additional examples, see Briñol, DeMarree, & Petty, 2015; Wichman et al., 2010).

The findings from Briñol and Petty (2003) are consistent with the self-validation hypothesis which holds that people's thoughts about their own thoughts are an important determinant of whether those thoughts are used or not (Briñol & Petty, 2009; Petty, Briñol, & Tormala, 2002). In this instance, overt head movements can signal general approval (nodding) or disapproval (shaking) of one's own thoughts. According to self-validation, generating thoughts is not sufficient for the thoughts to have an impact on judgment. One must also perceive validity in one's thoughts (see also e.g., Horcajo, Petty, & Briñol, 2010). Just as vertical (vs. horizontal) head movements from others would enhance (vs. undermine) the perceived validity of one's externally expressed thoughts (i.e., what we are saying to others), one's own vertical (vs. horizontal) head movements might enhance (vs. undermine) the perceived validity of one's internally expressed thoughts (i.e., what we are thinking and saying to ourselves; see Cian, 2017). Therefore, vertical (vs. horizontal) head movements can polarize (vs. undermine) the impact of thoughts on judgment (Briñol & Petty, 2003).

Following this logic, the present experiment examined to what extent a self-validation framework can be applied to understanding the effects of self-talk on physical performance when overt head movements (nodding vs. shaking) are experimentally induced. As noted previously, athletes' use of positive or negative self-statements (self-talk) can be viewed as a form of persuasion. In addition, given that self-statements can be differentiated from bodily responses, but both can occur during physical performance, one might wonder how these variables relate to each other. We addressed this question by specifically analyzing whether nodding (vs. shaking) could validate athlete's positive (vs. negative) self-statements, thus yield a significantly greater impact on physical performance in the head-nodding condition than in the head-shaking condition.

First, participants were randomly assigned to generate and write either positive or negative self-statements, then recorded audio files with their self-statements using a smartphone. Next, participants listened to their self-statements using headphones. While listening to their previously recorded self-statements, participants were randomly assigned to either nod or shake their heads to test the sound quality and comfort of the headphones. Finally, performance was assessed on three physical tasks.[1]

Consistent with the prior research on the effects of self-talk, we expected that the valence (positive vs. negative) of self-talk would predict physical performance. Thus, we hypothesized the following:

> **H1**: Positive self-statements would lead to better physical performance than negative self-statements.

According to the prior research on embodied validation reviewed, we expected that the main effect of self-talk would be qualified by head movements. Specifically, we hypothesized the following:

> **H2**: The valenced (positive vs. negative) self-statements would influence physical performance to a greater extent for individuals nodding rather than shaking their heads. For participants in the head-nodding condition, those who were assigned to first generate and then listen to positive self-statements would be expected to perform significantly better than those who were assigned to first generate and then listen to negative self-statements. By contrast, for participants in the head-shaking condition, the difference between those who were assigned to generate and listen to positive self-statements and those who were assigned to generate and listen to negative self-statements would be expected to be significantly smaller or even nonexistent. In addition, participants in the positive self-statements condition would be expected to show better physical performance when nodding rather than shaking their heads. However, for those in the negative self-statements condition, performance would be expected to be greater when shaking their heads compared with nodding.

Another way to examine the influence of self-talk is to explore the correlation between self-statements and physical performance. The more the people are relying on their self-statements, the larger the correlation should be between valenced self-statements and physical performance. Therefore, we hypothesized the following:

> **H3**: The relationship between the favorability of self-statements generated by participants and their subsequent physical performance would be greater in the validation (nodding) rather than invalidation (shaking) conditions.

Method

Participants and Design

Participants were 150 CrossFit practitioners from various gymnasiums located in a metropolitan area of Madrid (32% women, $M_{age} = 32.76$ years, $SD = 7.36$, range: 18–52), who voluntarily participated as part of a training session.[2] Participants were randomly assigned to a 2 (self-talk: positive vs. negative self-statements) × 2 (head movements: nodding vs. shaking) between-participants factorial design.

Procedure and Materials

Permission to conduct the study was provided by the ethics committee of the Autonomous University of Madrid before the study began. We also ensured that all participants read and signed an informed consent form indicating that their participation was voluntary and could be terminated at any time without any explanation or consequences, and their data would remain anonymous.

Participants were led to believe that the study's aim was to test their opinions about the use of headphones at the gym and their impact on performance. First, all participants were randomly assigned to list either three positive or three negative self-statements about their physical fitness. Next, participants were provided with a smartphone on which they privately recorded audio files using the self-statements they had listed. Each self-statement was recorded three times.[3] Once they finished recording their self-statements, participants were provided with headphones. They were told that the researchers were interested in testing the headphones' sound quality, comfort, and so on, while athletes engaged in various movements.[4] Participants were then instructed to listen to their self-statements using the headphones. Half of the participants were told that they should move their heads up and down (nodding condition) while listening to their self-statements, whereas the other half of the participants were told to move their heads from side to side (shaking condition), about once per second to test the headphones. Assignment to nodding and shaking conditions was randomly made. The words *nodding* and *shaking* were not mentioned explicitly to prevent semantic priming.[5] After listening to their own self-statements while moving their heads, participants' performance was assessed in three different tasks. (A vertical jump task in which jump height was computed, a squat test in which pulse rate [PR] was measured, and a deadlift task in which amount of weight in one-repetition maximum [1RM] was estimated.) Participants were given the choice to use the headphones during the performance tasks. By giving them the chance to move to the next task according to their preferences, we made the task easier and reduced the perception of any potential link between the inductions and performance. All participants refused their use.[6] After they finished the performance tasks, participants were debriefed, thanked, and dismissed.[7] Participants were also told that they could obtain a copy of the results on request and provided with the researcher's contact information.

Independent Variables

Self-Talk. Participants were randomly assigned to the *positive self-statements* or *negative self-statements* conditions. This manipulation was adapted from prior research on self-talk (e.g., Hamilton, Scott, & MacDougall, 2007; Son, Jackson, Grove, & Feltz, 2011; Van Raalte et al., 1995). The valence of self-talk was manipulated by asking each participant to make self-statements that were either encouraging ("I can do it") or discouraging ("I can't do it") to himself/herself. Participants assigned to the *positive self-statements* condition were asked to think and write three self-statements reflecting that "at the moment, you are *capable* of showing a good physical fitness in the performance tasks you will take later." By contrast, participants in the *negative self-statements* condition were asked to think and write three self-statements reflecting that "at the moment, you are *incapable* of showing a good physical fitness in the performance tasks you will take later." Participants were told not to worry about grammar or spelling, and an example of either a positive or a negative self-statement (according to their condition) was provided. Self-statements were personally generated by each participant, and thus, their verbalizations were "personalized" or meaningful (clear and relevant) to them (Magnusson & van Roon, 2013). Some examples of positive self-statements were as follows: "I have trained very hard every day," "I have increased my resistance," and "I'm in really good physical condition." Some examples of negative self-statements were as follows: "I've been missing some workouts lately," "I feel more tired than usual," and "I get injured way too often."[8] As noted previously, participants recorded and listened to their self-statements using a smartphone and headphones provided by the experimenter.[9]

Head Movements. As previously noted, overt head movements were experimentally manipulated in accord with prior research (Briñol & Petty, 2003; Wells & Petty, 1980). Participants received instructions either to move their heads up and down (*nodding*) or from side to side (*shaking*). Participants were told that the movements should not be too vigorous or exaggerated. Before beginning this task, the experimenter instructed them to move their heads until they achieved a standard movement and rate. The rate of movement was about one time per second.[10]

Dependent Variables

Vertical Jump. Following Balsalobre-Fernández, Glaister, and Lockey (2015), the MyJump2 app was used to measure participants' countermovement jump performance. Each participant performed a single countermovement jump with hands on their hips, starting from a static standing position, and with their legs straight during the flight phase of the jump (Haekkinen & Komi, 1985). The landing was performed simultaneously with both feet maintaining ankle dorsiflexion. Participants were instructed to jump as high as possible. Scores were computed by the MyJump2 app. Higher scores on this dependent measure represented a higher vertical jump in centimeters.

Squat Test. The Ruffier–Dickson test is a 45-s squat test that has been proposed as a suitable protocol to assess cardiorespiratory fitness (e.g., Sartor et al., 2016). The test consisted of three parts: First, we measured the participants' PR while they were in a relaxed sitting position ($P_0 = \text{PR}$ for 15 s multiplied by 4).[11] Second, participants performed 30 squats in 45 s following the tempo set by a metronome used to help ensure a constant rhythm for each participant (1 squad per 1.5 s). The squatting movement consisted of flexion of the knees to 90°, while keeping their back straight and arms extended frontally. Complete squatting was avoided to make this test feasible to a large range of people. At the end of the 45 s, PR was immediately measured as in part one (P_1). Finally, participants were asked to assume a relaxed position for 1 min, after which we again assessed their PR (P_2). The Ruffier–Dickson index (RDI) scores were calculated using the following formula: $RDI = [(P_1 - 70) + (P_2 - P_0)]/10$. Lower scores on this index represented higher cardiorespiratory performance.

Deadlift. The deadlift is a movement that requires lifting a weighted barbell from the floor until the body reaches a completely upright position, and the weight is positioned at waist height. To minimize the likelihood of injury while lifting the heaviest amount of weight possible for one repetition, the Powerlift app (Balsalobre-Fernández, Marchante, Muñoz-López, & Jiménez, 2017) was used. This application estimates the heaviest load a person is capable of lifting through the speed at which lighter loads are lifted. To make this estimation, each participant lifted four different weights while the experimenter recorded the movements. Participants were free to choose four weights in ascending order (from lighter to heavier). Taking each weight and the speed at which each weight was lifted into consideration, the app then calculated the heaviest load each participant could lift in a 1RM. Higher scores on this dependent measure represented a higher deadlift performance in kilograms.

Results

Each dependent measure (vertical jump, squat test, and deadlift) was individually submitted to a 2 (self-talk: positive vs. negative self-statements) × 2 (head movements: nodding vs. shaking) factorial analysis of variance (ANOVA).[12]

Vertical Jump

As expected, a significant main effect of self-talk on vertical jump measures was found such that participants who were assigned to the positive self-statements condition performed better on the vertical jump ($M = 31.09$, $SD = 7.51$) than participants assigned to the negative self-statements condition ($M = 27.70$, $SD = 6.92$), $F(1, 146) = 8.65$, $p = .004$, $\eta_p^2 = .056$. There was no effect of head movements on vertical jump ($F < 1$, $p = .62$).

In addition, a significant interaction also emerged, $F(1, 146) = 9.94$, $p = .002$, $\eta_p^2 = .064$. As hypothesized, for participants in the head-nodding condition, those who were assigned to first generate and then listen to positive self-statements performed significantly better on the vertical jump ($M = 33.15$, $SD = 7.32$) than those who were assigned to first generate and then listen to negative self-statements ($M = 26.15$, $SD = 6.16$), $F(1, 146) = 18.55$, $p < .001$, $\eta_p^2 = .113$. However, as expected, for participants in the head-shaking condition, no significant difference emerged between those who were assigned to generate and listen to positive ($M = 28.96$, $SD = 7.19$) versus negative ($M = 29.21$, $SD = 7.35$) self-statements, $F(1, 146) = 0.02$, $p = .881$, $\eta_p^2 = .000$ (see Figure 1).[13]

Squat Test

No main effect of self-talk, $F(1, 146) = 1.33$, $p = .250$, $\eta_p^2 = .009$, or of head movement ($F < 1$, $p = .685$) emerged on the RDI. As predicted, a significant interaction emerged, $F(1, 146) = 7.06$, $p = .009$, $\eta_p^2 = .046$. That is, for participants in the head-nodding condition, those who were assigned to generate and listen to positive self-statements performed significantly better ($M = 4.64$, $SD = 1.55$) than those who were assigned to generate and listen to negative self-statements ($M = 5.75$, $SD = 1.78$), $F(1, 146) = 7.26$, $p = .008$, $\eta_p^2 = .047$. However, for participants in the head-shaking condition, no difference in RDI was found between those who were assigned to generate and listen to positive ($M = 5.53$, $SD = 2.10$) versus negative ($M = 5.10$, $SD = 1.67$) self-statements, $F(1, 146) = 1.13$, $p = .289$, $\eta_p^2 = .008$ (see Figure 2).[14]

Deadlift

Results indicated a significant main effect of self-talk, such that participants assigned to generate and listen to positive self-statements performed a significantly better estimated 1RM deadlift

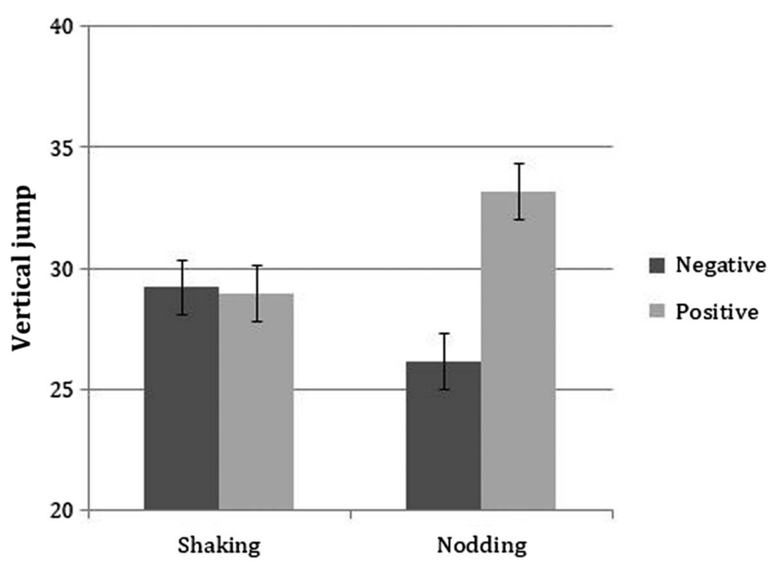

Figure 1 — Vertical jump (in centimeters) as a function of self-talk and head movements. Error bars represent the standard error associated with each mean.

($M = 159.86$, $SD = 54.52$) than those who were assigned to generate and listen to negative self-statements ($M = 133.12$, $SD = 43.99$), $F(1, 146) = 11.50$, $p = .001$, $\eta_p^2 = .073$. There was no effect of head movements on 1RM deadlift ($F < 1$, $p = .534$).

As hypothesized, a significant interaction emerged, $F(1, 146) = 11.13$, $p = .001$, $\eta_p^2 = .071$. As Figure 3 illustrates, for participants in the head-nodding condition, those who were assigned to generate and listen to positive self-statements performed a significantly better 1RM deadlift ($M = 175.23$, $SD = 55.08$) than those who were assigned to generate and listen to negative self-statements ($M = 122.31$, $SD = 39.32$), $F(1, 146) = 22.62$, $p < .001$, $\eta_p^2 = .134$. However, for participants in the head-shaking condition, no difference was found between those who were assigned to generate and listen to positive ($M = 144.08$, $SD = 49.85$) versus negative ($M = 143.65$, $SD = 46.22$) self-statements, $F(1, 146) = 0.00$, $p = .969$, $\eta_p^2 = .000$.[15]

Self-Talk and Physical-Performance Linkage

Finally, we predicted that participants in the head-nodding condition would rely more on their self-statements in guiding their physical performance than participants in the head-shaking condition. Regressing physical performance onto the favorability index of self-talk (centered), head movements (effect coded: −1 = head shaking and 1 = head nodding), and their interaction term, we obtained a significant two-way interaction between the favorability index of self-talk and the head movements. This interaction was significant for all dependent measures of physical performance, namely, vertical jump, $B = 3.64$, $t(146) = 3.08$, $p = .002$, confidence interval (CI) [1.3083, 5.9805]; RDI, $B = -0.76$, $t(146) = -2.54$, $p = .012$, CI [−1.3533, −0.1705]; and 1RM deadlift, $B = 27.68$, $t(146) = 3.44$, $p < .001$, CI [11.7959, 43.5680]. Consistent with the embodied validation prediction, these interactions revealed that

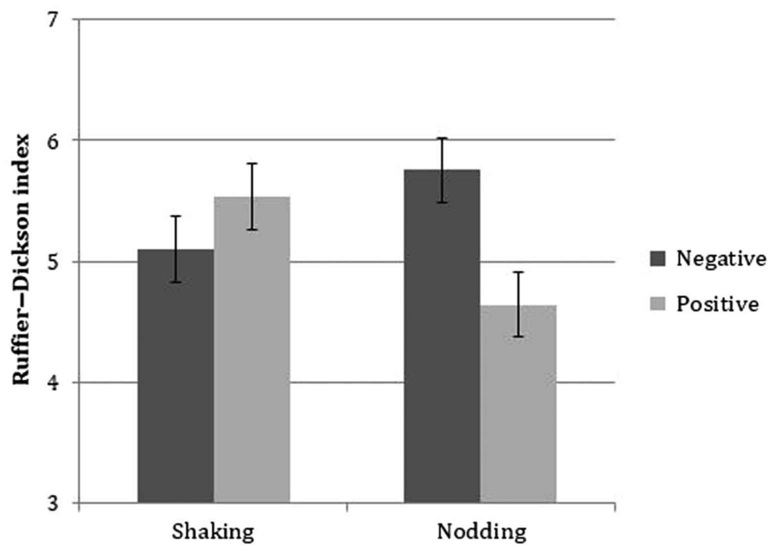

Figure 2 — The Ruffier–Dickson index as a function of self-talk and head movements.

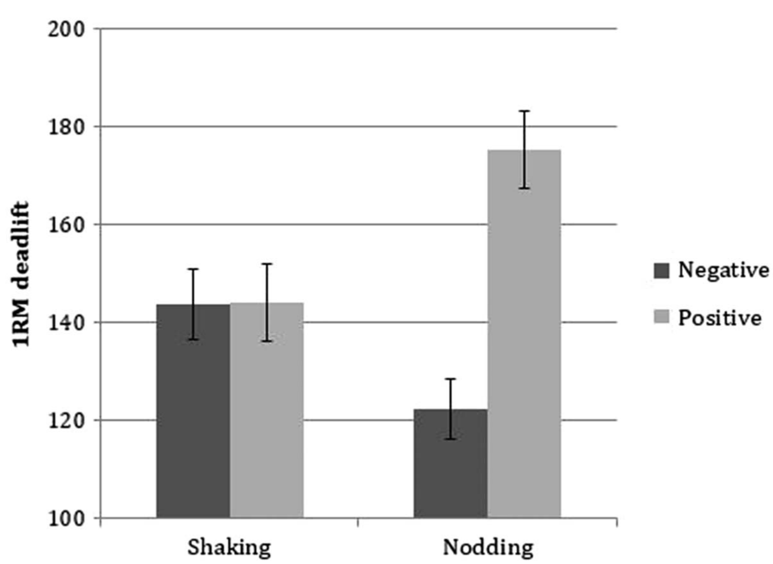

Figure 3 — Deadlift (1RM in kilograms) as a function of self-talk and head movements. 1RM = one-repetition maximum.

participants' self-statements were more closely associated with physical performance when participants were in a head-nodding condition (vertical jump, $B = 3.37$, $t(146) = 4.03$, $p < .001$, CI [1.7199, 50311]; RDI, $B = -0.53$, $t(146) = -2.54$, $p = .012$, CI [−0.9579, −0.1197]; 1RM deadlift, $B = 26.88$, $t(146) = 4.71$, $p < .001$, CI [15.6272, 38.1442]) than when they were in a head-shaking condition (vertical jump, $B = -0.27$, $t(146) = -0.32$, $p = .746$, CI [−1.9170, 1.3793]; RDI, $B = 0.22$, $t(146) = 1.05$, $p = .292$, CI [−0.1941, 0.6403]; 1RM deadlift, $B = -0.79$, $t(146) = -0.14$, $p = .888$, CI [−12.0040, 10.4115]).[16]

Discussion

The present experiment demonstrated that the self-generated statements that athletes generate, write, record, and then listen to can influence their physical performance. In two out of three different performance tasks, positive self-statements led to better physical performance compared with negative self-statements. These results replicate prior research on self-talk (e.g., see Hardy et al., 2009; Hatzigeorgiadis et al., 2011; Theodorakis et al., 2012; Tod et al., 2011; Van Raalte et al., 2016 for a review) and more importantly, also extends those findings by specifying a novel moderating condition (head movements) under which self-talk effects are more likely to occur.

In addition to contributing to the self-talk literature, these results are also consistent with the concept of *embodied validation* (Briñol et al., 2012) such that a person's own bodily responses can impact his/her judgments and his/her subsequent behaviors by affecting thought usage. Thus, the effects of positive and negative self-statements on physical performance were significantly greater when participants were led to nod rather than shake their heads. Described differently, the results revealed that listening to positive self-statements while nodding increased physical performance relative to listening to positive self-statements while shaking. However, listening to negative self-statements reversed this pattern. When listening to negative self-statements, participants tended to perform better if they engaged in a behavior associated with low validity (shaking) rather than a behavior associated with high validity (nodding). This is a unique implication of the self-validation logic according to which bodily movements can magnify or attenuate the effect of anything that is currently available in people's minds including self-talk as demonstrated in the present study.

In summary, the present study advances the domain of self-talk by showing how a new variable (head movements) can magnify or attenuate the impact of what people say to themselves. Moreover, this study also contributes to the research on self-validation by demonstrating for the first time that physical performance can vary as a function of what people think about their thoughts.

In spite of the contributions of the present study, it also has several limitations. First, variables such as elaboration and timing are likely to moderate the results obtained. The accumulated research on embodied validation suggests that for validation processes to matter, people need to have some thoughts (in this case, induced through self-talk) to validate and some motivation to think about those thoughts (in this case, by telling participants that physical performance was very important and was going to be assessed). Therefore, future research can benefit from including measures and manipulations of elaboration (e.g., see Horcajo & de la Vega, 2014; Horcajo & Luttrell, 2016). Regarding timing, the influence of bodily responses on performance through a thought validation is more likely when bodily movements (in this case, head movements) are salient *following* (as in the present study) or at least, during thought generation rather than prior to thought generation (Briñol & Petty, 2003). This is why we had participants first generating their self-statements and then moving their heads while listening to them. If head movements occurred prior to generating self-statements, then other processes would be more likely to occur (e.g., head movements biasing the self-statements coming to mind; see Briñol et al., 2012).

A second limitation has to do with the role of intentionality in the present findings. Given that the cover story used in our study (testing the use of headphones at the gym) aimed to hide the connection between head movements and subsequent physical performance, an important matter to consider for future research is the question of whether head movements could also be used *intentionally* in producing changes in the athletes' performance. Indeed, people use not only their self-talk to intentionally improve their own performance but also use their nonverbal behavior to deliberately influence their own performance or the performance of others (e.g., when an audience smiles, applauds, or stands up when cheering for their team). However, it is not clear whether people could also use their own nodding and shaking head movements to deliberately improve their performance. Thus, future research should examine to what extent the present findings can be generalized to intentional head movements (performed with the explicit goal of improving performance) and incidental inductions of self-talk (e.g., to test the quality of the recorder rather than influence performance). Furthermore, subsequent studies need to include other populations (e.g., professional athletes, injured athletes); other contexts (e.g., actual competitions); other sports (e.g., football, basketball); other more prototypical inductions of self-talk used in prior research (e.g., exclusively verbalizing self-statements); other kinds of self-talk (e.g., instructional); other types of performance measures and tasks (e.g., accuracy tasks) or even other types of performance (e.g., academic performance, artistic performance); and other behaviors related to high and low validity (e.g., smiling vs. frowning, pulling chest out vs. curving the back).

A third limitation has to do with the absence of measures relevant to testing some of our assumptions. We chose body movements that had very clear meanings attached to them but did not include measures of those associations. Nodding is often associated with high validity meanings (agreement, truth, approval; Cian, 2017), whereas shaking tends to be associated with low validity (disagreement, negation, disapproval). If the meaning associated with these head movements was different than assumed, the effect of those bodily movements on subsequent performance could also change (Briñol, Petty, Santos, & Mello, 2018; Gascó, Briñol, Santos, Petty, & Horcajo, 2018). In addition, we did not assess the association between head movements and perceived validity, as it was done in previous research (Briñol & Petty, 2003). Instead of measuring thought validity, we tested this assumption indirectly by examining the relationship between self-talk and performance across the head movement conditions and found the predicted pattern. Thus, we expected (hypothesis 3) and found a significantly larger correlation between self-statements and performance for nodding (vs. shaking).

Fourth, some scholars might wonder whether the effects obtained in this research were due mostly to the manner in which either head nodding or head shaking (or a combination of both) affected self-statements reliance or to how positive and negative self-talk separately influenced the extent to which people used their self-statements to perform the physical tasks. Having control groups without head movements or without self-talk would contribute to making more precise conclusions, but ultimately, this is not critical for our conceptual contribution. Whether nodding or shaking (or whether positive or negative self-talk) would always have greater impact over a neutral no-treatment group would likely depend on many factors such as, for example, how confident or pleasant people are feeling prior to the movement induction, how positive they are to begin with, and so on. Most important, identifying what movement is relatively more likely to be responsible for the validation effects is not conceptually as critical as showing that different head movements interact with self-talk producing opposite effects and, as revealed by the present study for the first time, affecting physical performance. This finding is in line with the recommendations by Tod et al. (2011, p. 680) “in moving self-talk research’s focus from first- to second-generation questions.” Future research should replicate and extend our findings by including a more complete experimental design with no-treatment groups, and baseline measures to analyze also within-participants differences (pre- vs. posttreatment) because their potential applied value. Moreover, future research should extend our results to cases in which athletes merely verbalize their self-talk rather than generate, write, record, and then listen to it, as in the present study. Furthermore, subsequent studies could compare the effect of physical movements on self-talks provided by others rather than generated by the self (Gascó, Briñol, & Horcajo, 2010; Gascó et al., 2018).

Understanding how athletes’ own bodily behaviors can influence their cognition (e.g., their self-statements) is an essential element in the domain of sports. Research has found that cognitive strategies and interventions can be effective in improving athletes’ performance (see e.g., Tod et al., 2015). The present findings suggest that psychological processes involving metacognition (e.g., embodied validation) can be also useful. For example, coaches should take our research into account when advising athletes to engage in any form of self-talk. As this experiment has shown, in addition to the performance benefits of athletes’ self-talk, what athletes do with their body, and the meaning associated with those physical movements, can also have an important impact on their performance. Furthermore, coaches and researchers should not only observe what athletes tell themselves during their physical performances but also attend to their bodily responses such as head movements. Based on the results of our study, either self-talk alone or head movements do not always lead to the best performance on their own, and coaches can benefit from knowing how body and mind interact with each other (rather than producing additive effects in all cases; see Guyer, Briñol, Horcajo, & Petty, in press for a review on the effects of head movements in others rather than in the self). Future research should explore these and many other possibilities for practical applications. For example, if a coach sees that an athlete is engaged in repetitive, overt negative self-talk, instead of trying to change those negative statements or counterargue them with positive statements, the results of our experiment suggest that the coach could incidentally lead the athlete to engage in invalidating body movements (such as head shaking) that could reduce the perceived validity of those negative thoughts. Moreover, a coach could incidentally lead athletes to engage in validating body movements (such as head nodding) to increase the beneficial impact of their positive self-statements. As noted, these recommendations should be taken with caution, given that self-validation processes depend on a number of factors described before such as the amount of thinking present in the situation, the timing in which head movements are included, the incidental (vs. intentional) nature of the inductions, the meaning of nodding (vs. shaking), and whether statements are self-generated or externally provided.

Notes

1. By randomly assigning participants to different experimental conditions and subsequently assessing the differences in their performance as a function of the treatment received, one can infer relative performance changes between groups. We relied on the relative differences (i.e., which group shows more performance) allowed by a between-participants experimental design (rather than dealing with the potential problems associated with within-participants designs).

2. Sample size was determined based on the number of participants who could be collected at each gymnasium during a season. Thus, we had little control over the final sample size, but we anticipated that there would be at least 30 participants per condition. This was achieved resulting in an average of 37 per condition. Post hoc power analysis indicated that the sample had a power of 0.89 for vertical jump, 0.76 for the squat test, and 0.91 for the deadlift to detect the three obtained interaction effect sizes.

3. Three self-statements were expected to be an easy number to generate (e.g., Tormala, Petty, & Briñol, 2002). Likewise, listening to the generated self-statements three times was not considered tedious or boring (Petty, Jarvis, & Evans, 1996). In addition, there were no particular instructions regarding the emotional tone (beyond the valence) in which participants had to record their self-statements.

4. The volume of the headphones was set at the same level for all participants (10 out of 16). The brand and model of headphones was Q6 Sennheiser HD 250 II (Sennheiser electronic GmBH & Co. KG; Wedemark, Germany), and the smartphone used was an iPhone 6 (Apple; Cupertino, CA)

5. As a test of the successful random assignment of participants to conditions, we submitted the demographic variables of participants to two different analyses. For age, a 2 × 2 ANOVA that was run with self-talk and head movements as the independent variables and age as the dependent variable showed no significant effects ($ps > .09$). For gender, given that it is a dichotomous variable (1 = male, 2 = female), a logistic binary regression was run with self-talk and head movements as the predictors and gender as the dependent variable. Once again, results showed no significant effects ($ps > .20$), suggesting that participants were indeed randomly assigned to the experimental conditions.

6. In previous studies using head movements (e.g., Briñol & Petty, 2003), participants were not given this particular choice and instead were directly asked to remove the headphones after the experimental inductions. Giving participants this choice was a unique adaptation of the present study and did not make any difference in the obtained pattern of results.

7. In addition, participants were asked to fill out other ancillary measures related to the cover story and suspicions questions. On the one hand, attitudes toward headphones were assessed using seven 9-point semantic-differential scales (e.g., *like* vs. *dislike*) that were combined to create one attitude index ($\alpha = .91$). As expected, a 2 × 2 ANOVA did not show any significant effect on this measure ($Fs < 1$, $ps > .44$). Likewise, participants were also asked to assess the extent to which they thought that the head movements were difficult to perform (Briñol & Petty, 2003). Responses to this question were made on a 9-point scale, and there were no significant effects on this measure either ($F < 1$, $p = .44$). On the other hand, participants were asked two questions at the very end of the study designed to assess whether participants became aware of the actual purpose of the study. Specifically, the questions were as follows: “To what extent did you suspect what the real purpose of the study was?” Responses were provided on a scale ranging from 1 (*I did not suspect*) to 9 (*I suspected very much*) and “To what extent do you think you had figured out the true purpose of the study?” Responses were provided on a scale ranging from 1 (*I had not figured it out at all*) to 9 (*I had totally figured it out*). We submitted the

responses to these two measures to two 2 × 2 ANOVAs with self-talk and head movements as the independent variables and each measure as the dependent variable. Results showed no significant main effect or interaction in either analysis, Fs < 1.19, ps > .277, confirming that no differential perception of having figured out/suspected the purpose of the study emerged as a function of the condition to which participants were randomly assigned. Furthermore, to test whether those who believed to know the true purpose of the study were more or less likely to show the expected pattern of results, these two items were included as moderators of the original two-way interaction between self-talk and head movements. Neither item significantly moderated the two-way interaction, ps > .19.

8. Although participants complied with the instructions to write three positive or three negative statements, two independent judges, unaware of the experimental conditions, coded the participants' self-statements as positive, negative, or neutral (Briñol & Petty, 2003). Judges agreed on 99% of the self-statements, and disagreements were resolved by discussion. An index of the favorability of self-statements was created for each participant by subtracting the total number of negative self-statements generated from the number of positive self-statements that the participant had listed. To control for verbal skill, this difference score was then divided by the total number of self-statements (Cacioppo & Petty, 1981). This measure served as a self-talk manipulation check. As expected, a 2 × 2 ANOVA showed a significant main effect of self-talk, $F(1, 146) = 2144.25$, $p < .001$, $\eta_p^2 = .936$. That is, participants' self-statements were more positive when they were asked to generate positive self-statements ($M = 0.98$, $SD = 0.15$) than when they were asked to generate negative self-statements ($M = -0.91$, $SD = 0.32$). Therefore, the manipulation of self-talk was effective. In addition, consistent with our predictions, there were no significant effects of head movements or a two-way interaction ($ps > .14$).

9. Writing, recording, and then listening back to self-generated statements are not the most prototypical protocol used in self-talk research. It is indeed neither the most "pure" nor the most frequent induction of self-talk, but nonetheless useful for our purposes (see also, Hamilton et al., 2007; Son et al., 2011).

10. The research assistant administering the treatment was blind to the self-talk manipulation conditions, but that assistant was not blind to the head movement manipulation conditions. This difference was necessary because the research assistant had to instruct participants to properly move their heads (nodding vs. shaking). Importantly, the research assistant was not aware of the interactive implications of the self-validation hypothesis. Without knowing the nature of the self-talk, it would be impossible for knowledge of the head-movement conditions alone to enable the assistant to produce the predicted interaction obtained.

11. Heart frequency was captured by registering PR manually in the radial artery. This approach followed the recommendations of past research that highlights the benefits of using this particularly nonintrusive, easy-to-use approach (e.g., see Katch, McArdle, & Katch, 2015; Meri, 2005). Even though we know this approach can be less reliable to assess heart frequency than other more sophisticated instruments, it has the advantage of serving as easy-to-use, ecologically valid for crossfit practitioners.

12. In addition, all dependent variables were submitted to a single 2 (self-talk: positive vs. negative self-statements) × 2 (head movements: nodding vs. shaking) factorial multivariate analysis of variance with vertical jump, squat test, and deadlift as the dependent variables. All 3 two-way interactions remained significant, vertical jump, $F(1, 146) = 9.94$, $p = .002$, $\eta_p^2 = .064$; squat test, $F(1, 146) = 7.06$, $p = .009$, $\eta_p^2 = .046$; deadlift, $F(1, 146) = 11.13$, $p = .001$, $\eta_p^2 = .071$, and all of the main and simple effects.

13. Described differently, for participants in the positive self-statements condition, those who were assigned to the head-nodding condition performed significantly better at vertical jump ($M = 33.15$, $SD = 7.32$) than those who were assigned to the head-shaking condition ($M = 28.96$, $SD = 7.19$), $F(1, 146) = 6.82$, $p = .010$, $\eta_p^2 = .045$. However, for participants in the negative self-statements condition, those who were assigned to the head shaking performed marginally better ($M = 29.21$, $SD = 7.35$) than those who were assigned to the head nodding ($M = 26.15$, $SD = 6.16$), $F(1, 146) = 3.45$, $p = .065$, $\eta_p^2 = .023$.

14. Viewed differently, for participants in the positive self-statements condition, those who were assigned to the head nodding had a significantly better performance ($M = 4.64$, $SD = 1.55$) than those who were assigned to the head shaking ($M = 5.53$, $SD = 2.10$), $F(1, 146) = 4.82$, $p = .030$, $\eta_p^2 = .032$. By contrast, for participants in the negative self-statements condition, those who were assigned to the head shaking performed better ($M = 5.09$, $SD = 1.67$) than those who were assigned to the head nodding ($M = 5.75$, $SD = 1.78$), but this difference did not reached statistical significance, $F(1, 146) = 2.47$, $p = .118$, $\eta_p^2 = .017$.

15. For participants in the positive self-statements condition, those who were assigned to the head nodding performed a significantly better 1RM deadlift ($M = 175.23$, $SD = 55.08$) than those who were assigned to the head shaking ($M = 144.08$, $SD = 49.85$), $F(1, 146) = 8.06$, $p = .005$, $\eta_p^2 = .052$. However, for participants in the negative self-statements condition, those who were assigned to the head shaking performed marginally better ($M = 143.65$, $SD = 46.22$) than those who were assigned to the head nodding ($M = 122.31$, $SD = 39.32$), $F(1, 146) = 3.58$, $p = .060$, $\eta_p^2 = .024$.

16. An additional ANOVA was run including self-talk, head movements as between-participants factors and the three physical performance dependent variables as one within-participants factor. Results yielded a significant main effect of self-talk, $F(1, 146) = 12.17$, $p = .001$. Importantly, this main effect was not qualified by the within-participants factor, $F(2, 146) = 1.74$, $p = .177$, revealing that the main effect of self-talk on physical performance did not differ significantly across dependent measures. The predicted two-way interaction between self-talk and head movements also emerged, $F(1, 146) = 18.37$, $p < .001$. No other effects reached significance, Fs < 0.51, ps > .477.

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