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Athletes Intending to Use Sports Supplements Are More Likely to Respond to a Placebo

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Abstract

Purpose: We investigated associations between athletes' use of sport supplements and their responsiveness to placebo and nocebo interventions. **Methods:** Participants (n=627) reported their intention to use, and actual use of, sport supplements. They then completed a 5x20m repeat sprint protocol in the baseline condition, prior to being randomized to one of three treatments. Participants in the positive-belief treatment were administered an inert capsule described as a potent supplement which would improve sprint performance. Participants in the negative-belief treatment were administered an inert capsule described as a potent supplement which would negatively affect sprint performance. Participants in the control treatment received neither instruction nor capsule. 20 minutes following baseline trials, all participants completed the same repeat sprint protocol in the experimental condition. **Results:** Compared to controls, no mean differences in performance were observed between baseline and experimental conditions for the positive-belief treatment (-0.07 ± 0.27%, d=0.02), but mean differences were observed for the negative-belief treatment (-0.92 ± 0.31%, d=0.32), suggesting a moderate nocebo effect. In the positive-belief treatment however, a relationship between intention to use supplements and performance was observed. Performance worsened by -1.10% ± 0.30% compared to baseline for participants not intending to use supplements, worsened by -0.64 ± 0.43% among those undecided about supplement use, but improved by 0.19 ± 0.24% among those participants intending to use supplements. **Conclusion:** Information about a harmful supplement worsened repeat sprint performance (a mean nocebo effect), whereas information about a beneficial supplement did not improve performance (no mean placebo effect was observed). However, participants' intention to use sport supplements influenced the direction and magnitude of subsequent placebo responses, with participants intending to use supplements more likely to respond to the positive intervention.

Key words: Nocebo, responders, beliefs, ergogenic aids

Introduction

A placebo effect is a positive psychobiological response to a purported beneficial treatment (11). Placebo effects have been extensively studied in sport (3, 4, 7, 8, 12, 15, 21, 31, 32, 34, 35, 39), with a systematic review (6) reporting that placebo treatments can exert a significant effect on sport performance. For example, Ross et al. (34) reported a 1.2% improvement in 3-km running time-trial performance when participants self-administered saline injections believing it to be a performance enhancing substance. Likewise, Saunders et al. (35) reported that mean power output improved by 3.7% among cyclists deceptively administered a placebo when they believed they had ingested caffeine.

While there is empirical support for the potential role of the placebo effect in sports performance, there is less evidence for the nocebo effect; that is, a negative psychobiological response to a purported harmful treatment. Arguably the first study of the nocebo effect in sport was conducted by Beedie et al. in 2007 (5). These authors reported that n=21 participants who believed they had ingested a placebo, that is a capsule described as a beneficial sport supplement, ran progressively faster compared to baseline. Likewise, n=21 participants who believed they had ingested a nocebo, that is a capsule described as a supplement likely to be detrimental to performance, ran progressively slower compared to baseline. Findings highlighted the potentially significant impact of positive and negative expectations on sports performance.

However, the study in question (5) lacked a no-treatment control. It is therefore problematic to estimate the true relative magnitude of the placebo and nocebo effects reported; changes in performance could be attributed to statistical or methodological artefacts such as regression to the mean or spontaneous improvements/decrements in performance (25). Further, it is problematic from this uncontrolled study to discern whether actual effects were all positive, all negative, or whether both placebo and nocebo effects occurred. As a result, the reported magnitude of either the nocebo or placebo effect might have been overestimated. Further, while the n=42 reported was relatively large for an intervention study in sport, it was however too small to facilitate the reliable identification of any psychosocial variables that might have been associated with the placebo and nocebo responses observed.

In most studies of the placebo/nocebo effect in sport, the standard deviation of the dependent measure is greater in experimental conditions than at baseline (6). This suggests that, even if a mean placebo effect is observed, there is considerable inter-individual variability in response to the treatment. Few studies have attempted to identify the variables related to placebo responses, and those that have are perhaps methodologically unsatisfactory. For example, Beedie et al. (7) identified a possible link between placebo responding and personality factors, but the sample size was too small for their findings to be considered reliable. In fact, the small sample sizes of nearly all studies of the placebo effect in sport has precluded the reliable investigation of any factor that might be associated with placebo responding. If our knowledge and understanding of the placebo and nocebo effects is to progress beyond simple description, we need to better understand the relevant antecedents and mechanisms.

We aimed to extend Beedie et al.'s study (5) via two specific criteria, each allowing us to test two novel hypotheses. First, by using a no-treatment control we were able to estimate the relative magnitude of placebo and nocebo effects in response to treatments. In this context we hypothesised that compared to controls, positive effects on performance would be associated with a positive belief (placebo) treatment, while negative effects on performance would be associated with a negative belief (nocebo) treatment. Second, by using a sufficiently large sample, we were able to reliably identify factors that might be associated with observed placebo and/or nocebo responses. Given the range of such factors is potentially large, we were presented with a number of possible hypotheses. Recent data from both medicine and psychology suggest that prior use of a treatment can influence the response of a patient to a subsequent placebo treatment (10). We hypothesised that athletes with prior experience of sport supplements would be more likely to respond to a placebo sport supplement than those who do not use sport supplements. Furthermore, prior use of a supplement is suggested to be influenced via a person's intention to use that substance (33). We therefore further hypothesised that those intending to use supplements would also be more likely to respond to a placebo intervention.

The idea that greater understanding of the placebo effect among athletes and coaches might reduce doping has been proposed (6, 26, 31, 32). Given the gateway hypothesis (26), which posits that supplement use can lead to doping, it is reasonable to suggest that, over and above enhancing our understanding of placebo and nocebo effects in sport, this study could also enhance our understanding of factors that underpin doping.

Methods

Design

The placebo and nocebo interventions used in this study required the deceptive administration of an inert capsule delivered to members of teams in their usual team environment. We therefore used a cluster randomized controlled trial design to minimize cross-contamination between experimental and control treatments. Participants completed a pre-experimental questionnaire relating to sport supplementation, before performing 5 × 20-m repeat sprint with 30s recovery at baseline. Following Beedie et al.'s original design (5), participants in the positive-belief treatment (n = 288) were deceptively administered an inert capsule described as a potent supplement which would improve sprint performance. Also following the original design, participants in the negative-belief treatment (n = 232) were deceptively administered an inert capsule described as a potent supplement which would negatively affect sprint performance. However, extending the original study, no-treatment control participants (n = 192) received neither instruction nor placebo. Twenty minutes following the administration of the capsules, participants completed the experimental condition, which was a repeat of the 5 × 20-m sprints.

Participants

We used convenience sampling, and invited athletes from a range of sports to participate in the study. Seven hundred and twelve competitive athletes from 43 different teams (number of athletes in each team: median = 14; range = 8 to 40) were initially recruited to the study. Participant demographics are presented in Table 1. All participants were aware that their involvement in the study was voluntary and that all data collected would be treated as confidential. Ethical approval was granted by the Institutional Research Ethics Committee. Participants gave written informed consent once they had read the participant information sheet.

Measures

Pre-experimental questionnaire

All participants were asked to complete a pre-experimental questionnaire detailing sex, age, sport played and competitive level (club, county, regional or national). They were asked to indicate whether they used sports supplements (yes or no), the total number of supplements used, and the frequency of use (daily, weekly, monthly or never). They were also asked to indicate their agreement with a statement of their intention to use sport supplements in the next three months on a 6 point Likert-type scale anchored at strongly disagree (1), through to strongly agree (6). Those scoring 1 and 2 were grouped as ‘not intending’, 3 and 4 as ‘undecided’, 5 and 6 as ‘intending’.

Repeat sprint performance

Whereas Beedie et al. (5) used a 3 × 30-m repeat sprint protocol, Schimpchen, Skorski, Nopp and Meyer (36) reported that four or more sprints should be used to decrease the typical error and improve the precision of estimating true changes in performance. Furthermore, the majority of sprinting in team sports events occurs over relatively short distances (i.e. <30-m; (14)) and short durations (i.e. <4 seconds; (37)). For these reasons, participants were asked to complete five 20-m maximal intensity repeat sprints with 30 seconds of recovery between each sprint. Sprint time was measured using an automated, single-beam photocell, light gate system (Smartspeed Pro™, Fusion Sport Inc., Australia). Single-beam light gate systems are the most common method for measuring sprint performance and have been shown to have good reliability (20).

Belief Manipulation

During the 20-minute recovery period between baseline and experimental conditions, participants in the positive- and negative-belief treatments were given a capsule described as a potent sport supplement, ‘inorganic nitrate.’ Similar to Beedie et al. (5), the positive-belief treatment participants were given two red and white, size 1 (20-mm), gelatine capsules containing 200-mg of cornflour (Sainsbury’s, London UK) and informed that inorganic nitrate would improve both endurance and repeat sprint performance. Negative-belief treatment participants were given two red and black, size 1 (20-mm), gelatine capsules containing 200-mg of cornflour and informed that inorganic nitrate would improve endurance but have a negative effect on sprint speed. The effectiveness of the belief manipulation was assessed during a debrief immediately following the experimental trials, at which point the true nature of the study was revealed. Participants were asked to respond on a 10 point Likert-type scale, how much they believed the treatment influenced their performance (1 = no influence to 10 = high influence).

Procedure

Testing was performed at the 43 different training facilities habitually used by the teams recruited to the study. All data per each participant were collected on one day to minimize meteorological and biological variation. Teams were randomised to the three treatments (i.e. positive, negative and control) using a computer generated cluster programme (allocation ratio 1:1:1), which was performed by the lead author who was also involved in delivering the intervention. To reduce potential confounding, only one team per club were permitted to take part in the study. All treatments were conducted on separate days and at separate sites to maintain the experimental blind.

Participants completed the sprints in footwear and clothing suitable for high intensity exercise, and were encouraged to perform their standard warm-up. They began each sprint in a stationary position, ~50-cm behind the first light gate. They were instructed not to rock back and forth prior to the sprint, but were permitted to start the sprint in any position (e.g. split-stance or crouch start), which was replicated for each sprint. Each sprint was started by a green LED, which would flash up on the photocell. Participants were encouraged to sprint as fast as possible for the full 20-m, with times recorded to the nearest $1/100^{th}$ of a second. Participants were given thirty seconds to jog back to the start position and begin the next sprint. This process was continued until each participant had completed five sprints.

After the baseline condition, participants in the positive- and negative-belief treatments received the capsules and the belief manipulation. All participants then completed a 20-minute recovery consisting of light exercise to minimize the search for physiological symptoms associated with the intervention (16), before commencing the experimental condition in the same manner as the first. The total duration of the repeat sprint protocol, including recovery, was less than 30-minutes per participant. On completion, participants were debriefed about the true nature of the study in line with American Psychological Association guidelines for deceptive research (1).

Statistical analysis

Data were inputted into SPSS version 23.0 (IBM, Armonk, NY, USA) and tested for homogeneity of variance, normal distribution and anomalies. Inspection of the data indicated that 55 participants (8%) did not complete the experimental condition (positive-belief treatment n = 20; negative-belief treatment n = 16; control n = 19). In addition, data values that exceeded 2.5 times the standard deviation were identified as extreme outliers (30). Thirty participants (4%) were identified as extreme outliers (positive-belief treatment n = 7; negative-belief treatment n = 7; control n = 16) and were subsequently removed from further analysis (27). Data for the remaining sample of 627 participants (positive-belief treatment n = 261; negative-belief treatment n = 209; control n = 157) were entered into subsequent statistical analyses.

One-way Analysis of Variance (ANOVA) and chi-square (χ^2) tests were used to compare continuous (years training, hours per week training and number of supplement used) and categorical (sex, age, sport, ability, supplement use, frequency of supplement use and intention to use supplements) variables between treatments, respectively.

Sprint times for each condition (i.e. baseline and experimental) and treatment (i.e. positive, negative and control) were inputted into Hopkins' (22) reliability spreadsheet. Data were log transformed to reduce non-uniform errors and the intra-class correlation (ICC) provided estimates of reliability. The precision of ICC was interpreted as extremely high = 0.99; very high = 0.90; high = 0.75; moderate = 0.50; low = 0.20 (22).

Hopkins, Hawley and Burke (24) suggest that research investigating athletic performance should report outcome as a percentage change from baseline. Sprint times were therefore converted to the proportion of the first sprint speed, expressed as a percentage. Differences between participant's average performance for each condition (i.e. performance average for baseline [sprints 1 to 5] and experimental conditions [sprints 6 to 10]), and the difference in the fastest sprint trial in each condition (i.e. fastest individual sprint at baseline minus fastest individual sprint at experimental) were calculated.

Repeated measures ANOVA identified differences in sprint performance between each condition, with treatment included as a between-subject factor. Greenhouse-Geisser epsilon was reported where sphericity was violated, and post-hoc LSD tests were conducted where a significant interaction was observed. Point-Biserial correlations (r_{pb}) were used to assess the relationship between performance and categorical variables (i.e. sex, age, ability, sport supplement use, frequency of sport supplement use, intention to use sport supplements, belief manipulation scores). Data of the variables that correlated significantly with performances were further analysed using repeated measures ANOVA and Multivariate ANOVA (MANOVA). Given the possibility that differences between treatments may reflect the large sample size and sampling variability (38), Cohen's d (d) effect sizes were calculated. Differences between 0.2 and <0.5 were interpreted as a small effect, between 0.5 and <0.8 as moderate, and ≥0.8 as large (13). Data are presented as mean ± standard error of the mean (SEM), with statistical significance accepted at $P \leq 0.05$.

Results

Participant demographics

No significant differences were observed between treatments for number of years training ($F_{(2,573)} = 2.072$, $P = 0.127$), hours per week training ($F_{(2,580)} = 0.403$ $P = 0.669$), sex ($\chi^2 = 5.28$, $P = 0.071$), supplement use ($\chi^2 = 2.32$, $P = 0.312$), frequency of supplement use ($\chi^2 = 6.50$, $P = 0.370$) and intention to use supplements ($\chi^2 = 4.65$, $P = 0.098$). Differences between treatments were observed for age ($\chi^2 = 21.99$, $P = 0.001$), ability ($\chi^2 = 21.69$, $P = 0.001$) and sport played ($\chi^2 = 225.76$, $P < 0.001$). Covariate analysis, adjusting for the differences in categorical variables, revealed no effect on the outcome of the performance sprint data (P >0.05). The results of the subsequent analyses are therefore reported with unadjusted covariate data.

Reliability of sprint trials

Baseline sprints (i.e. trials 1 – 5) were associated with very high reliability in the positive-belief treatment (ICC = 0.94), negative-belief treatment (ICC = 0.96) and control treatment (ICC = 0.90). Similar reliability coefficients were also observed for experimental sprints (i.e. trials 6 – 10) in the positive-belief treatment (ICC = 0.94), negative-belief treatment (TE = 0.94) and control treatment (ICC = 0.94).

We also investigated the possibility that greater reliability was associated with fewer than 5 sprint trials. If for example, reliability between sprint trials 1 – 4 or 1 – 3 are more reliable than 1 – 5, this could reduce the error and improve the chances of finding a true effect of the intervention on sprint performance. ICC’s were however, similar for trials 1 – 4 (ICC range = 0.92 to 0.96) and 1 – 3 (ICC range = 0.93 to 0.96). Therefore, sprint trials 1 – 5 are reported in the subsequent analysis.

Differences in baseline and experimental performance between treatments

No between-treatment differences were observed at baseline ($F_{(2,624)}$ = 0.149, P = 0.861). However, between-treatment differences were observed in experimental trials ($F_{(2,624)}$ = 5.879, P = 0.001). In the negative-belief treatment, performance was worse than at baseline (-1.42 ± 0.15%, P <0.001, d = 0.56), and also worse than performance in the positive-belief treatment (-1.04 ± 0.28%, P <0.001, d = 0.34) and in the control treatment (-0.92 ± 0.31%, P <0.001, d = 0.32). No differences were observed between the positive-belief and control treatments (-0.07 ± 0.27%, P = 0.696, d = 0.02). Figure 1 illustrates the differences in performance for each condition between treatments.

Correlations between performance and categorical variables

Point-Biseral correlations revealed a significant relationship between participant's intention to use supplements and performance (average performance in each condition: r_{pb} = 0.106, P = 0.012; fastest performance difference between conditions: r_{pb} = 0.101, P = 0.016). No other significant relationships were observed between other categorical variables for average performance in each condition (sex r_{pb} = -0.009, P = 0.819; age r_{pb} = 0.006, P = 0.891; ability r_{pb} = -0.039, P = 0.353; use of supplements r_{pb} = 0.071, P = 0.078; frequency of supplements r_{pb} = 0.075, P = 0.074; belief manipulation scores r_{pb} = -0.035, P = 0.563) or fastest performance between conditions (sex r_{pb} = -0.014, P = 0.723; age r_{pb} = 0.005, P = 0.906; ability r_{pb} = -0.042, P = 0.318; use of supplements r_{pb} = 0.075, P = 0.071; frequency of supplements r_{pb} = -0.062, P = 0.135; belief manipulation scores: r_{pb} = 0.025, P = 0.677; fastest performance: r_{pb} = 0.025, P = 0.677).

Differences in baseline and experimental performance between supplement intention

Further analysis using repeated measures ANOVA identified differences in participant's repeat sprint performance in each treatment by intention to use sport supplements (i.e. not intending; n = 174; undecided; n = 112; and intending; n = 284). No differences between baseline and experimental conditions were observed for participants in the positive-belief treatment intending to use supplements (0.28 ± 0.14%, P = 0.886, d = 0.01). However, sprint performance worsened for participants in the positive-belief treatment who were undecided about supplement use (-0.67 ± 0.36%, P = 0.039; d = 0.22), and not intending to use sport supplements (-0.64% ± 0.25, P = 0.036; d = 0.23; figure 2A). No differences in sprint performance by intention to use supplements were observed in the negative-belief (figure 2B) and control (figure 2C) treatments (P >0.05).

Between-treatment differences in fastest performance by intention

Differences in fastest sprint performance and intention to use supplements were analysed using MANOVA. The performance of participants intending to use supplements in the positive-belief treatment was more positive compared to that of participants in the negative-belief treatment (1.29 ± 0.37%, P = 0.001, d = 0.51) and control treatment (0.90 ± 0.41%, P = 0.029, d = 0.33). Performance for participants not intending to use supplements in the negative-belief treatment was worse compared than controls (negative-belief vs. controls = -1.34 ± 0.48%, P = 0.005, d = 0.52). This trend was similar between the positive-belief and control treatment (-0.91 ± 0.45%, P = 0.060; d = 0.38). No differences were observed for participant's undecided about supplement use between all three treatments (P > 0.05; figure 3).

Within-treatment differences in fastest performance by intention

Differences in fastest sprint performance by intention to use supplements were observed in the positive-belief treatment ($F_{(2,239)}$ = 4.952, P = 0.008) but not in negative-belief treatment ($F_{(2,197)}$ = 1.247, P = 0.290) or control treatment ($F_{(2,131)}$ = 0.637, P = 0.530). In the positive-belief treatment, fastest sprint performance in experimental compared to baseline for participants not intending to use supplements worsened by -1.10% ± 0.30%, performance of those undecided about supplement use worsened by -0.64% ± 0.43%, while performance of those intending to use supplements improved by 0.19% ± 0.24% (figure 3). In the positive-belief treatment, change in performance from baseline and experimental also differed significantly between those participants intending to use supplements and those not intending to use supplements (1.29% ± 0.38%, P = 0.003, d = 0.49). No other within-treatment differences in fastest sprint performance between baseline and experimental were observed when classified by intention to use supplements (P >0.05; figure 3).

Discussion

We aimed to replicate a previous study of placebo and nocebo effects in repeat sprint performance (5), albeit with the inclusion of a no-treatment control and a larger sample. We observed a mean nocebo effect in repeat sprint performance across the sample, but no mean placebo effect when compared to a no-treatment control. This suggests that, while receiving a purported harmful supplement significantly impaired performance, receiving a purported beneficial supplement did not enhance it. This finding differs to those of Beedie et al. (5) who reported significant placebo and nocebo effects in repeated sprinting.

Although no mean placebo effect was observed, data from the positive-belief treatment did suggest that the performance of participants intending to use supplements improved to a greater degree in the experimental conditions than the performance of participants not intending to use supplements (d = 0.49, figure 3). These improvements were also greater than those observed among participants of equivalent intention in the negative-belief treatment (d = 0.51) and control treatment (d = 0.33). Given that effect sizes >0.2 are considered potentially beneficial for sport performance (23), these improvements in repeat sprint performance are likely meaningful for athletes. Furthermore, given that this relationship was observed only in the positive-belief treatment is of particular importance, as it supports our hypothesis that intention to use sports supplements might relate to placebo responding.

While intention to use supplements influenced the placebo response, this relationship was not shown for prior supplement use (r_{pb} = 0.071, P = 0.078). We did however examine the effect on performance of intention to use supplements and its interaction with prior supplement use. Intention to use supplements was strongly associated with prior supplement use (r_{pb} = 0.666; P <0.001). This suggests that intention to use supplements is associated with prior supplement use and may moderate an athlete's responsiveness to a placebo intervention. Although the design of this research precluded a robust test of this relationship, it is an intriguing research question that should be addressed in future research.

In consideration of the above, placebo responding is arguably a learned phenomenon. Research has shown that placebo effects can be initiated via verbal instructions (creating an expectation of a drug; (28)) and/or via repeat exposure to a drug with a subsequent placebo intervention mirroring the action of that drug (9). Previous experiences of a drug are therefore remembered, creating a memory of effective and ineffective treatments (29). This learning process is manifest in specific brain regions, with expectations and conditioning cues mediating and maintaining the turnover of, for example dopamine (19), and creating rewarding stimuli. On this basis, for a placebo responsive athlete, a placebo induced improvement in performance is the result of verbal information about the treatment (e.g. the suggestion that a supplement can improve performance) and/or cued or contextual conditioning (e.g. repeated exposure to a real treatment that results in treatment-like effects even when the treatment is replaced by a placebo). The athlete then recalls previous experiences and information about the effectiveness or ineffectiveness of the treatment, which shapes their subsequent intention to use it. This is perhaps a reason why athletes intending to use supplements are more likely to use these substances (17) and are arguably more likely to use other forms of performance enhancements (26).

The finding that intention may influence the placebo effect has particular relevance to sports practitioners aiming to improve an athlete's performance. Specifically, if improvements in performance following administration of a treatment (e.g. caffeine, sodium bicarbonate, β-alanine) are the result of both pharmacological and placebo effects (3), but the athlete does not have a prior intention to use that treatment, it may not elicit a placebo response and the athlete may not fully benefit from the treatment. Ultimately, a treatment may be more effective when an athlete intends to use it than when they do not. Sport practitioners should therefore be aware of an athlete's intentions towards a treatment prior to its administration, to ensure the effectiveness of the treatment. This is also important in research, in which intentions towards a treatment could likewise influence outcomes.

Any reference to the results of our study should take into account potential limitations. First, we did not control for the presence of others or social support (e.g. cheering from teammates) during the sprint trials, and this may have affected performance. Second, while participants were asked to report on a Likert-type scale from 1 to 10 the degree to which they believed the treatment influenced their performance, they were not specifically asked if they believed the information they were given. We are therefore unable to assess the credibility of the belief-manipulation. Finally, the use of self-reported sport supplement use may not be reliable, as there may be differences between what athletes' report and what they actually think and/or do.

Given that previous studies have used expensive and complex techniques such as positron emission tomography (2) and genotyping (18) to identify placebo responders/non-responders, a self-report measure could provide a cost-effective and practical alternative. Future research should aim to further explore the impact of intention on the effects of legitimate sports supplements, and how this could influence an athlete's decision to use other forms of performance enhancements (e.g. doping). This understanding could enhance treatments, and inform athlete education and anti-doping strategy (26).

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Table 1. Demographics of participants between treatments

		Positive	Negative	Control	Overall
n =		288	232	192	712
Gender (%)	Male	83.1	76.9	71.0	78.0
	Female	16.9	23.1	29.0	22.0
Age (%)	18 to 24	66.7	65.0	79.0	69.4
	25 to 34	29.6	30.0	18.8	26.8
	35 to 44	3.7	5.1	2.3	3.8
Sport (%)	Rugby Union	46.2	42.7	22.3	39.0
	Soccer	42.9	36.9	44.1	41.3
	Field Hockey	5.3	8.9	2.8	5.8
	Other	5.6	11.6	30.7	13.9
Ability (%)	Club	25.5	35.4	21.1	27.5
	County	39.9	38.8	30.4	37.0
	Regional	25.9	19.6	32.7	25.7
	National	8.7	6.2	15.8	9.8
Intention to use sport supplements (%)	Not intending	23.9	33.5	35.6	30.0
	Undecided	21.6	18.9	18.1	19.8
	Intending	54.5	47.6	46.3	50.2
Use of Supplements (%)	Yes	51.1	50.9	52.7	51.5
	No	48.9	49.1	47.4	48.5
Frequency of supplement use (%)	Daily	24.1	26.6	26.2	25.5
	Weekly	22.6	21.0	24.4	22.5
	Monthly	4.4	3.3	1.8	3.4
	Never	48.9	49.1	47.6	48.6
Mean ± SEM	Years training	10.77 ± 0.38	10.94 ± 0.59	9.68 ± 0.45	10.68 ± 0.24
	Hours per week training	6.13 ± 0.25	5.93 ± 0.25	5.84 ± 0.30	5.9 ± 0.15
	Amount of supplements used	1.14 ± 0.10	1.11 ± 0.10	1.20 ± 0.13	1.09 ± 0.06

SEM, standard error of the mean

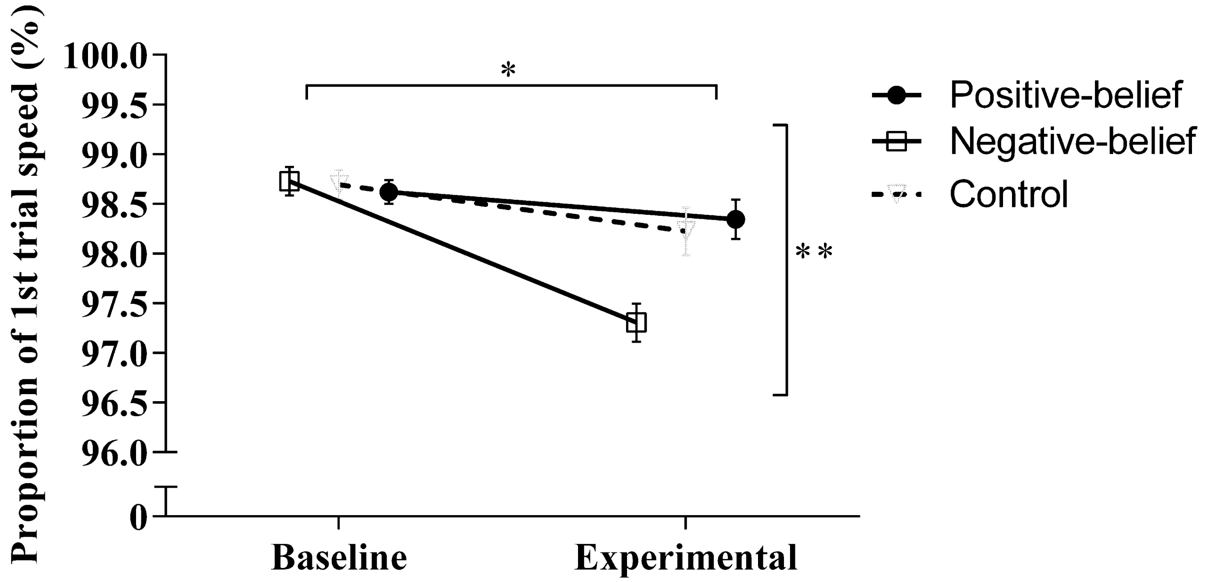
Figure captions

Figure 1. Average performance in each condition between treatments. Note: *baseline vs. experimental for negative-belief = P <0.05; **positive-belief and control vs. negative-belief = P <0.05.

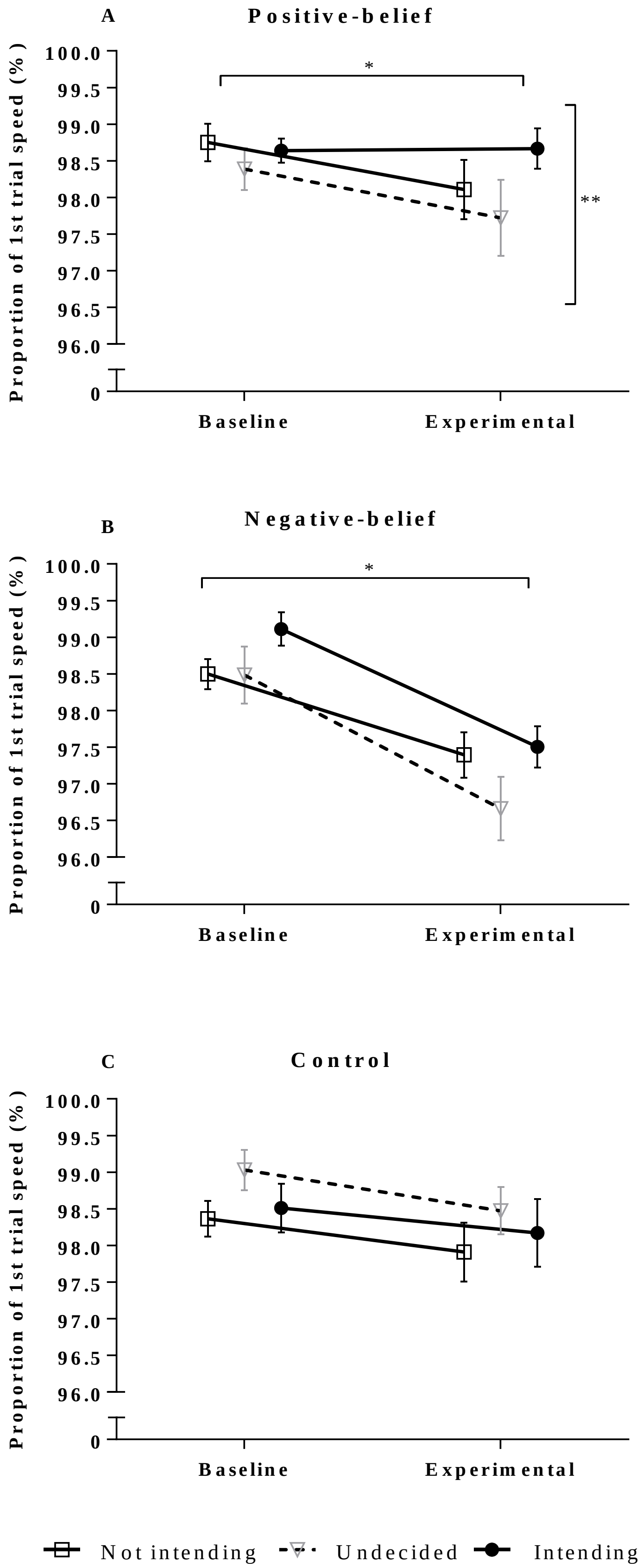
Figure 2. Average performance in condition by each treatment separated by participants' intention to use sport supplements in the next three months. **A.** Positive-belief treatment. Note: *Baseline vs. Experimental for those not intending to use supplements = P <0.05; **intending to use supplements vs. not intending to use supplements = P <0.05. **B.** Negative-belief treatment. Note: *baseline vs. experimental for those not intending, undecided and intending to use supplements = P <0.05. **C.** No-treatment control.

Figure 3. Differences in fastest performance between conditions, grouped by intention to use sport supplements. Note: *control vs. positive-belief and negative-belief = P <0.05, **positive-belief vs. negative-belief = P <0.05, †positive-belief intention vs. positive-belief no intention = P <0.05

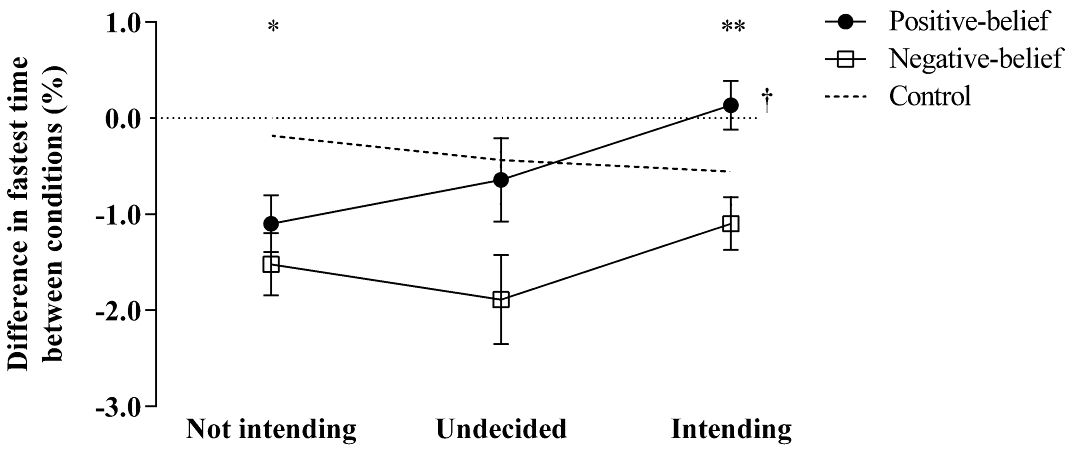
478 **Figure 1**


Proportion of 1st trial speed (%)
100.0
99.5
99.0
98.5
98.0
97.5
97.0
96.5
96.0
0
Baseline
Experimental
*
**
Positive-belief
Negative-belief
Control

479 Figure 2


A
Positive-belief
Proportion of 1st trial speed (%)
100.0
99.5
99.0
98.5
98.0
97.5
97.0
96.5
96.0
0
*
**
Baseline
Experimental
B
Negative-belief
Proportion of 1st trial speed (%)
100.0
99.5
99.0
98.5
98.0
97.5
97.0
96.5
96.0
0
*
Baseline
Experimental
C
Control
Proportion of 1st trial speed (%)
100.0
99.5
99.0
98.5
98.0
97.5
97.0
96.5
96.0
0
Baseline
Experimental
Not intending
Undecided
Intending

480 **Figure 3.**



Difference in fastest time between conditions (%)
1.0
0.0
-1.0
-2.0
-3.0
*
**
†
Not intending
Undecided
Intending
Positive-belief
Negative-belief
Control