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Article

The effects of knowledge, lack of knowledge, and deception on rate of perceived exertion and performance during workouts

Jamir Howard, Jason Scott
The Neighborhood Academy, Pittsburgh, Pennsylvania

SUMMARY

The purpose of this study is to examine how knowledge, lack of knowledge, and deception affect the rate of perceived exertion (RPE) and actual performance of moderately trained teenagers engaged in sprint training. This study has two hypotheses. The first hypothesis is that athletes who do not know their sprint duration will have a lower reported RPE and actual performance, compared to athletes who are aware of their sprint duration. Our second hypothesis is that athletes deceived with a lower sprint duration will report a higher RPE and performance compared to when they have knowledge of their duration. The order of the experimental conditions was knowledge, deception, and then lack of knowledge. Participants started from the midfield line of an indoor soccer field and ran to the end of the field and back to midfield ten times for all conditions. While on their way back, they reported their RPE to an assigned assistant who was timing them. We found that participants ran the slowest and reported the lowest RPE throughout the ten sprints in the lack of knowledge condition. We also found that the knowledge condition had a slower average sprint time than the sprints during deception, but the knowledge condition yielded the fastest and most consistent speeds. Coaches should strongly consider telling their athletes the truth about workout duration since our study along with many others suggests that it is the best way to maximize performance and RPE.

INTRODUCTION

The information provided to an athlete about the duration of a workout may have an effect how their effort and performance. In this study, we investigate how knowledge, lack of knowledge, and deception affect the rate of perceived exertion (RPE) and performance of moderately trained high school athletes engaged in sprint training. This is important because most studies have well-trained adult participants while this study includes moderately-trained teenagers. According to the NCAA, there are over eight million student athletes across the United States that play every year (1). Since RPE has been proven to be a reliable way to measure exhaustion, athletes can be trained more effectively once we determine whether the best method to maximize RPE is using knowledge, lack of knowledge, or deception (2, 3).

The rating of perceived exertion (RPE) is usually used during exercises to measure the perceived intensity of the person working out. The measure of the participants' perceived exertion is recorded by using the Borg scale. The scale ranges from 6-20, with 6 being extremely light perceived exertion and 20 being extremely difficult (2). Studies have demonstrated that RPE is a reliable way to measure the actual physical exertion of people (3). The brain adjusts RPE and one's actual performance, based on the amount of energy that remains from the beginning of the exercise (2). RPE is a reliable and accurate way to measure workout intensity; prior research suggests that regardless of the length of exercise and desired intensity, the subject's RPE and actual workout intensity showed no difference (4).

The proposed relationship between knowledge of endpoint and RPE is that the degree of knowledge that someone has about the length of their exercise affects how hard they believe they are working. Studies have found that knowing the duration of the workout increased ratings of perceived exertion, therefore suggesting that knowledge improves the actual intensity of the participant (5, 6). Another study considered if the brain makes a perceived exertion strategy not only in the expected duration of the workout but in how much someone believes in the workout length they were told. The results of the study supported the idea that knowledge of the exercise's endpoint proved to result in a more aggressive pacing strategy that produced superior performance (7).

Previous studies have also investigated the role of deception of endpoint or duration on rating the participants' perceived exertion. One study found that when deceived, a runner's RPE increased significantly compared to the first control trial of a known distance (8). Studies have also investigated the influence of prior knowledge of the length of an exercise on pacing strategies during game-based activities. Twelve men competed in a game under three different conditions (deception, control, unknown). In the deception and unknown groups, the intensity was found to be higher than in the control group. Players alter their pacing strategies during games based on their anticipated endpoint (9).

While there have been many studies on RPE, no other study using the three conditions (known, unknown, deception) has also measured performance and used sprint training as opposed to running/cycling. Also, instead of using well-

trained adults like in other studies, this study will examine high school children who exercise moderately. We hypothesize that lack of knowledge of sprint duration will have a lower reported RPE and lower actual performance, compared to the control condition. This agrees with previous research, which found that lack of knowledge leads to a more conservative pacing strategy and lower RPE (5, 6, 7). We also predict that deception of sprint duration will have a higher RPE compared to control, in agreement with prior sources (8, 9, 10). Lastly, we hypothesize that deception of sprint duration will increase the overall performance because the participants will believe that the amount of work they are told to do is not that much, and they will work harder, despite the possible lack of motivation when it's revealed that they must exercise longer.

RESULTS

This study's purpose was to examine how the knowledge, lack of knowledge, and deception of exercise duration affect the rate of perceived exertion (RPE) and performance of moderately trained high school athletes engaged in sprint training. Eleven students participated in ten sprints for each trial day over the course of four weeks. After every other sprint, the participant's RPE was reported along with their sprint time. The order of the conditions was knowledge, deception, and then lack of knowledge. In the deception condition, athletes were told to run five sprints, but at the end of the fifth sprint were told to run five additional. In all conditions, the reported RPE of the participants saw a gradual increase throughout the workout, but the lack of knowledge condition had the lowest reported numbers overall (**Figure 1**). The participant's actual performance was generally slower in the lack of knowledge condition compared to the knowledge and deception conditions (**Figure 2**). The average reported RPE in the deception condition was highest initially but slowed down drastically after participants realized they had to run more. The average reported RPE in the knowledge group was the fastest of all conditions but still decreased as the number of sprints increased, due to the duration of the exercise.

Next, differences in RPE and performance across the three conditions for each of the five sprints were measured for each sprint (**Table 1**). There were three significant

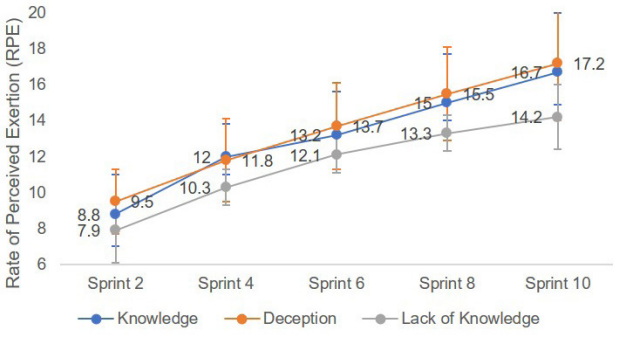

Figure 1: Sprint number vs. rate of perceived exertion. The average RPE for each sprint and each condition is displayed above. The error bars represent standard deviations.

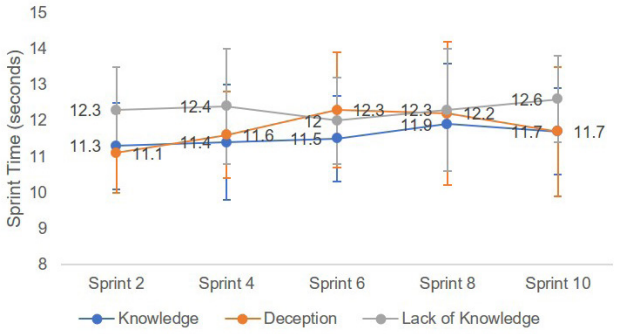

Figure 2: Sprint number vs. performance. The average sprint time for each condition is displayed above. Participants were told of the deception regarding workout length at the end of sprint 5.

differences. During sprint 4, the lack of knowledge condition (12.4 ± 1.0) was slower than the knowledge condition (11.4 ± 1.6, $p < 0.05$; **Figure 2**). In sprints eight and ten, there were differences in RPE (**Figure 1**). In sprints 8 and 10, runners in the lack of knowledge condition reported a lower RPE (13.3 ± 3.0), compared to the knowledge (15.0 ± 2.7) and deception (15.5 ± 2.5, $p < 0.05$) conditions. Overall, our results show that the lack of knowledge group did not think they were working hard but the data show that their performance was actually not significantly different from the other two conditions (**Table 1**).

In order to identify if the moment of deception (sprint five), affected the athletes' performance, we also investigated differences in performance and RPE between sprint four and sprint six. We found that there was a significant difference in the participant's actual performance in the deception group ($p = 0.019$) unlike in the knowledge and lack of knowledge groups. In the deception group, the average time from sprint 4 to sprint 6 went from 11.6 ± 1.2 seconds to 12.3 ± 1.5 seconds.

In all three conditions, there was a significant increase in RPE. In the knowledge condition, RPE increased by 1.2 points ($p = 0.007$), 1.9 points in the deception condition ($p = 0.03$) and 1.8 points in the lack of knowledge ($p = 0.0003$). The deception condition had the largest average increase. There were no overall differences in performance between the three conditions across all ten sprints. ($p = 0.10$). However, there was a clear trend between the conditions with the average increasing from the fastest condition (knowledge, 11.6 ± 1.2), to deception (11.8 ± 1.1), to the slowest condition (lack of knowledge, 12.3 ± 0.9).

DISCUSSION

We hypothesized that a lack of knowledge of sprint duration will result in a lower RPE and actual performance, compared to the control condition. The results of the study showed that the participants ran the slowest and reported the lowest RPE throughout the ten sprints in the lack of knowledge condition (**Figures 1 & 2**). Therefore, the first hypothesis was partially supported, since lack of knowledge had the slowest overall sprint time and reported RPE, although only some of

	Performance				
	Sprint 2	Sprint 4	Sprint 6	Sprint 8	Sprint 10
Knowledge	11.3 (1.2)	11.4 (1.6)	11.5 (1.2)	11.9 (1.7)	11.7 (1.2)
Deception	11.1 (1.1)	11.6 (1.2)	12.3 (1.5)	12.2 (2)	11.7 (1.3)
Lack of Knowledge	12.3 (1.8)	12.4 (1)	12 (1)	12.3 (1)	12.6 (1.3)
p-value	0.09	0.02	0.25	0.8	0.09
	Rate of perceived exertion (RPE)				
	RPE 2	RPE 4	RPE 6	RPE 8	RPE 10
Knowledge	8.8 (2.2)	12 (1.8)	13.2 (2.4)	15 (2.7)	16.7 (3.3)
Deception	9.5 (1.9)	11.8 (2.3)	13.7 (2.4)	15.5 (2.5)	17.2 (3.2)
Lack of Knowledge	7.9 (1.8)	10.3 (2.5)	12.1 (3)	13.3 (3)	14.2 (3.3)
p-value	0.18	0.07	0.09	0.007	0.00023

Table 1: Averages of RPE and performance through all sprints and across all conditions. The mean performance (in seconds) and mean RPE (6-20 on the Borg scale) for each sprint and condition are listed above with standard deviations in parentheses.

the sprint speeds had significant differences (**Table 1**).

We also predicted that deception of sprint duration will increase RPE and performance, compared to the control. The control group (knowledge condition), had a faster average sprint time compared to deception due to the significant drop in performance when it was revealed that they had been lied to (**Table 2**). Their speed at the beginning of the deception trial averaged with the decrease in speed after the lie, revealed their overall time to be not significantly different to the control group. At the moment of deception, there was a significant increase in RPE, but it was not larger than the increase in RPE in the control condition (**Table 2**). However, overall, the RPE was higher during the four of the five sprint measurements, but not significantly (**Figure 1**). Therefore, the second hypothesis was not supported because although there was a trend which showed that the overall reported RPE for deception was higher than the knowledge condition, the difference was not significant for the actual overall performance. In addition, the deception conditions performance was worse compared to the knowledge condition, which was not supportive of our second hypothesis.

	Performance	
	Sprint 4	Sprint 6
Knowledge	11.4 (1.6)	11.5 (1.2)
Deception	11.6 (1.2)*	12.3 (1.5)*
Lack of Knowledge	12.4 (1)	12 (1)
	RPE	
	Sprint 4	Sprint 6
Knowledge	12 (1.8)*	13.2 (2.4)*
Deception	11.8 (2.3)*	13.7 (2.4)*
Lack of Knowledge	10.3 (2.5)*	12.1 (3)*

Table 2: Difference of RPE and performance between sprints 4 & 6 The difference between sprints 4 and 6 for mean performance (seconds) and mean RPE at the moment of deception (sprint 5) are listed above. Significant differences between sprint 4 and sprint 6 are marked with an asterisk. Standard deviations are in parentheses.

Our results are consistent with a study by Billaut, who examined the effect of prior knowledge of the number of sprints during a repeated sprint exercise (10). Billaut hypothesized that anticipation of having to do fewer sprints would lead to higher skeletal muscle recruitment and that lack of knowledge on a number of sprints to be performed would result in more conservative pacing strategy. It was found that there was more muscle recruitment, higher power, and more work done in the deception trial than in trials control and unknown due to the fact that they believed they were doing fewer sprints during the first five sprints. The deception trial in the second half of the sprints was lower than the others in terms of muscle EMG, work, and power, but the average for the entire workout was higher. In our experiment, we found that overall performance was higher in the knowledge condition but like Billaut's study, lack of knowledge was still last. For RPE, all three trial groups had a positive linear pattern throughout the sprints but there was no difference within those groups. Billaut's groups consisted of in-shape members of a university's track team. Our results revealed the same trend between all trial groups while our groups consisted of average high school students. It is shown that through both studies, not telling people how much exercise they will be doing, is a sure way for them to not work as hard compared to lying to them or telling them the truth. Results on using deception are inconclusive. If used, it might help improve performance, but a proven way to get people to work their hardest is to tell the truth about exercise duration.

One possible reason many of the results of the study were not significant may be due to the number of participants as well as the length of the exercise. If the exercise was longer, the effect of deception would be greater since their attitude towards having to do more exercise than initially planned would be more negative. If there were more participants in

the study, there would be more data which would affect the averages enough for the results to possibly be significant. Another limitation was the participants' knowledge that we would only be recording every other sprint, so they may not have fully sprinted on the sprints that we would not record. They ran full speed on the sprints we recorded so the results would be better, which was not the purpose of the experiment.

To improve this study, it would be beneficial to have a fully planned schedule for the entire experiment for each participant. During our research, the times at which participants took part in the study were not consistent, although they did have enough days in between for rest. Also, it would improve data collection if we ensured that all participants had appropriate clothing on for running. Due to the school's uniform policy, runners sometimes complained that their attire could have slightly held them back. Another possible limitation was that the order of the three different conditions was not random, which might have caused an undesired effect. However, we did so to be consistent with other studies' methods (5,10). Future researchers should consider counterbalancing the order of the conditions for different participants, to see if the order of the conditions plays a role in the results. In particular, varying the lack of knowledge condition to see if it actually produces the slowest speed due to the lack of knowledge of sprint duration and not because it is the last condition.

Overall, based on our findings as well as those from other researchers, we recommend that high school coaches should tell their players the truth about workout length if they want them to work their hardest. It was found that not telling people how much exercise they will be doing has the most negative effects on both RPE and sprint performance, of the three conditions we tested. Lying to the athletes is an option that may work at times, as it produced similar or improved results in certain studies (8). There will likely be a drop in performance after the deception and if lied to too many times, the players may not believe the coach's instructions. We conclude that telling the truth by providing details of the duration and endpoint was found to be the best choice for coaches wishing to maximize sprint performance.

MATERIALS AND METHODS

A total of 11 students in a high school athletic activity participated in the study. All participants in this study were males between the ages of 13 and 17. Athletes were well conditioned, with conditioning practice five days a week for an hour each time for nine weeks prior to the study. In order to help collect data, assistants were recruited from the student body who did not participate in the exercise. Assistants were not aware of the study's hypotheses. The research assistants used a data sheet with three columns to record the sprint number, sprint time, and the RPE. The assistants were instructed to record data for the participants' sprint time for every other sprint only, by using a stopwatch on their phone.

The participants were asked to provide their availability to participate in the study either during the conditioning part of their practice or gym class, with at most four participants at a time. They started from midfield line of an indoor soccer field and ran to the end and back to midfield ten times for all conditions. While on their way back, they reported their RPE to their assigned assistant who was timing them. A 15-second break was given between each sprint. The order of the conditions was knowledge, deception, and then lack of knowledge. Conditions were in this order because knowledge was the controlled condition. It is likely that the participants will believe they will not do the same exercise two times in a row, so the deceiving them would be most appropriate condition to do next. This order is consistent with a similar study (9). In the deception condition, they were told that they would be only running five sprints, but after the fifth, they were told to run five more. Lack of knowledge was the last condition. Between each condition, participants waited at least three days before taking part in the next condition while also taking into consideration their availability. After each trial, participants were asked not to share information about the length of the exercise they did.

In order to analyze the collected data, differences between conditions for each sprint number were analyzed with a one-way ANOVA with correlated samples with a Tukey HSD post-hoc analysis to locate individual differences. Differences at the moment of deception were investigated for each condition used dependent t-tests, and overall differences in RPE and performance across the three conditions were also analyzed using a one-way ANOVA with correlated samples with a Tukey HSD post-hoc analysis to locate individual differences.

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