Does Rate of Perceived Exertion moderate the Relationship between Self-Efficacy and Self-Rated Performance?

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Abstract

Previous studies have extensively investigated the relationship between self-efficacy and objective performance measures, while self-rated performance in relation to self-efficacy has hardly been studied at all. Both concepts have been examined individually for their relationship with perceived training load, but not for a general moderating effect of load on the relationship. The present study aimed to add to the body of literature by investigating the relationship between self-efficacy and self-rated performance, as well as the moderation of the relationship through the rate of perceived exertion. The data set consists of 41 male players from the youth department of a first-league Eredivisie football club in the Netherlands from Under-16, Under-18, and Under-21 teams. The three concepts were assessed through single-item questions in the form of a daily questionnaire at the club level throughout two competitive seasons. Self-efficacy before and the rate of perceived exertion, as well as self-rated performance after training sessions. Self-efficacy and self-rated performance were significantly positively correlated (F (1,38) = 6.153, p = .018, R^2 = .139); however, the rate of perceived exertion was found to have no significant effect as a moderator of this relationship (t = -1.28, p = .209). The relationships between self-efficacy and the rate of perceived exertion (F (1, 38) = 1.91, R^2 = .048, p = .175), as well as self-rated performance and the rate of perceived exertion (F (1,38) = .006, p = .939, R^2 = .000), were both found not to be significant. These findings suggest that self-efficacy remains important even if self-rated performance is used, and should be given due consideration concerning the training approach.

Keywords: self-efficacy, self-rated performance, rate of perceived exertion, youth football

Does Rate of Perceived Exertion moderate the relationship between Self-Efficacy and Self-Rated Performance?

The present study aims to investigate if the rate of perceived exertion, a measure capturing how hard the training is, has a moderation effect on the relationship between self-efficacy and self-rated performance. Since only a few studies have been conducted using self-reported measures of performance in association with self-efficacy (Udayar et al., 2020; Moritz et al, 2000; Neumann et al., 2024), an additional goal is to expand the current body of literature. This paper theorizes that the relationship between self-efficacy and self-rated performance changes depending on the perceived level of exertion. Heightened or diminished perception would lead to a change in the direction and strength of the correlation. The findings could influence the future approach to individualized training. The training exertion could be adapted on a player-to-player basis; depending on a player's previous scores on measures of self-efficacy and perceived performance, the training load may be altered to stabilize or heighten these aforementioned scores before an important match. This certainty or boost in perception of own abilities could subsequently lead to healthy confidence, and ultimately stabilize and optimize player performance.

Self-efficacy is most commonly defined using Banduras' (1997) social cognitive theory, which describes it as people’s belief in their capabilities to achieve something. This belief then influences one's interpretation of their own performance, meaning that if one's self-efficacy beliefs are low, performance will likely be interpreted worse than objectively true (Moritz et al., 2000). Self-efficacy is one of the most researched variables within sport science (Feltz, 1988), and is strongly correlated with perceived performance (Udayar et al., 2020). Furthermore, self-efficacy and the perception of one's own performance are likely to be affected by daily psychological stressors. To account for that, stress could be measured in a controlled environment like regular training sessions. The training load measurement is used

to operationalize training stress. Den Hartigh and colleagues (2022), defined load as a combination of external and internal components, measuring the overall workload and the player's response to it. The internal load measurement deployed in the current study is a rating of perceived exertion which, according to Borg (1982), is defined as a psychological measure of exertion and fatigue. Therefore, in this study the terms rate of perceived exertion and (internal) load are interchangeable. Despite recording external load in the original data set, no indicator was recorded to infer what kind of training program was employed on the given day. Based on that, the recorded values cannot be put into perspective properly, thus rendering the raw values meaningless.

The Relationship between Self-Efficacy and Performance

The relationship between self-efficacy and objectively measured performance is well documented, with predominantly positive associations (Martin and Gill, 1991; Moritz et al., 2000). Unfortunately, this relationship has not been thoroughly investigated for self-reported performance measures. However, the studies that have been conducted found a strong positive correlation between self-efficacy and self-rated performance (Udayar et al., 2020; Moritz et al, 2000; Neumann et al., 2024). Furthermore, one study found self-assessed performance to have an even stronger positive correlation with self-efficacy than objectively measured performance (Moritz et al., 2000). In contrast to the previously positive findings, concerns have been raised about a potential negative influence of heightened self-efficacy in the long term due to overconfidence through overestimation of abilities (Stone, 1994; Bandura, 1977; Bandura, 2011).

The positive relationships noted in the aforementioned studies are expected to be reflected in the present study, based on the overwhelming body of literature reporting on the association. In addition, self-report measures may further increase the strength of the expected

positive association between self-efficacy and self-rated performance as reported by Moritz and colleagues (2000). Results of a positive relationship would indicate that an increase in self-efficacy could lead to an increase in self-rated performance.

The Relationship between Self-Efficacy and Rate of Perceived Exertion

Bandura (1986) suggested cognitions such as self-efficacy can be used to predict subjective feelings of exhaustion. Furthermore, previous literature suggests that high self-efficacy leads to more successful outcomes and less perceived exertion, whereas low self-efficacy is associated with giving up more quickly and a heightened perception of exhaustion (Bandura, 1977; Bezoian, 1994). Past research found evidence that shows that heightened self-efficacy is a significant predictor for lower perceived training intensity, and vice versa (Robbins et al., 2004; McAuley & Courneya, 1992; Bezoian, 1994). Other studies found that heightened self-efficacy leads to different perceptions of exertion in general and even increases the affective response towards exercising (McAuley et al., 1999; Hutchinson et al., 2008). Therefore, the relationship between self-efficacy and perceived exertion will also be examined. Based on these suggestions and findings, we expect to observe a negative correlation between the two variables. This would suggest that due to heightened beliefs in one's ability, the training is perceived as easier and subsequently rated lower on the rate of perceived exertion scale, making the perceived exertion score lower as well.

The Relationship between Performance and Rate of Perceived Exertion

The relationship between performance and load has been studied extensively. In older studies, there was a rather static approach that higher load leads to higher performance output in individual sports (Foster & Daniels, 1977). Unfortunately, this approach was copied for team sport training which had the rather negative result of an increase in injuries (Gabbett, 2004; Bowen, 2016). Other studies have taken a more dynamic approach and suggest a

player-to-player variance in optimal workload for heightened performance (Borresen & Ian Lambert, 2009). This suggests that a player-based approach should be taken, which could be implemented by using self-rated measures of the performance of each individual player.

Unfortunately, the research conducted on the association between self-rated performance and perceived exertion is rather scarce. One study indicated a fairly strong positive correlation between the two (McCrary et al., 2022). Research done in similar fields has found that the correlation between self-assessed performance and training intensity/workload ranges from slightly positive (De Cuyper & De Witte, 2006) to negative (Reder et al., 2023; Sandrin, 2019). Here, the aim is to add to the current body of sports literature. A positive correlation between perceived exertion and self-rated performance is expected, indicating that a heightened training exertion increases the assessment of one's performance, whereas a comparatively lower training exertion diminishes self-assessed performance.

In conclusion, it is expected that the rate of perceived performance influences both self-efficacy (Robbins et al., 2004; McAuley & Courneya, 1992; Bezoian, 1994), as well as self-rated performance (McCrary et al., 2022) respectively. Due to this, it is hypothesized that perceived exertion has an overall effect on the strength and direction of the relationship, moderating between self-efficacy and self-rated performance.

Given the current understanding of the variables, the hypotheses are as such:

I. There is a positive relationship between self-efficacy and self-rated performance.
II. There is a negative relationship between self-efficacy and rate of perceived exertion.
III. There is a positive relationship between self-rated performance and rate of perceived exertion.

IV. Rate of perceived exertion moderates the relationship between self-efficacy and self-rated performance.

Methods

Participants

The participants of this study are male members of an Eredivisie club's youth academy, which is currently competing in the first league of Dutch football. The data was collected over two consecutive competitive seasons. The subjects are from Under-16, Under-18, and Under-21 teams. Further information is not reported due to personal data protection. The players trained up to four days a week with a maximum of two sessions a day and possible match days on the weekend. Initially, the study was started with 94 players and a total of 17058 observations, with 54 players excluded due to insufficient data, leaving 40 players and a total of 11664 observations for the analysis, with a range of 320 and an average of 288.3 observations per player. Data was considered to be insufficient for analysis when a player was missing more than 20% of values in one of the three measured variables or had less than 100 days of data collection. The 20% cut-off was chosen because Enders (2003) argued that a missing values approach between 15% to 20% was normal in psychological research. Furthermore, this study only takes perceived exertion values from training days into account. The study was conducted and approved by the ethics committee of the University of Groningen (research code: PSY-2425-S-0016) and in accordance with the Declaration of Helsinki. All subjects in the present study have signed an informed consent form before the start of data collection at the club level, stating they acknowledge and allow the usage of their data for research purposes. The study was supported by The Netherlands Organization for Health Research and Development (ZonMw, Grant Number 546003004).

Research Design and Procedure

The present data was collected through a questionnaire at club level. The players were introduced to the club routine of filling in the questionnaire on a tablet in the locker rooms of the team before and after training each day. As such, the presence of other players and staff was possible and players were not alone when answering. Since the data collection is over the course of two competitive seasons and only includes elite youth football players from one club, the present study is a cohort study.

The variables were measured through single-item questions. Self-efficacy was assessed at the start of the training day by positioning a slider between 1 (not at all confident) to 100 (very confident) as a response to the single-item question “How confident are you that you can perform maximally today?”. Performance was determined similarly at the end of the training day by positioning a slider between 1 (very bad (far below my capabilities)) to 100 (maximally (to the best of my capabilities)) as a response to the single-item question “How well did you perform today?”. The overarching measurement scale for both variables was the visual analog scale. The rate of perceived exertion, asked post-training session, was filled in by positioning a slider between 6 (very, very light) to 20 (very, very hard) when answering the single-item question “How hard was the training?”. The scale used for the assessment was the category ratio scale.

All three questions were validated. The self-efficacy question was proposed by Bandura (Pajares & Urdan, 2006). The other questions were tested by previous research. The perceived performance question was used in the study by Den Hartigh and colleagues (2022) and the question assessing exertion was developed by Borg (1982). Single-item questions were chosen to on the one hand lower time and cost spent for the researchers while on the other hand limit questionnaire fatigue as it is presented repeatedly on a daily basis (Cohen et al., 2006). Lastly, single-item assessment is a literature-supported approach as concluded by Song and colleagues’ study (2022). Subjective measurements were used, as objective

measurements were not recorded during data collection. The only alternative point of reference was the coach's weekly performance evaluation, which was not based on an objective assessment but primarily on the subjective opinion of the coach. In addition, using self-assessed measures for all 3 concepts allowed us to focus on the player's self-perception as opposed to external estimations.

Statistical Analysis

Statistical analysis was performed using SPSS Version 30.0. As per Enders (2003), the data was cleaned to only include cases with 100 or more entries and under 20% of observations missing per measurement. After that, the data was aggregated, meaning individual averages were calculated per variable. It is acknowledged that a time-series approach would have been more appropriate, unfortunately, it is beyond the scope of a bachelor thesis.

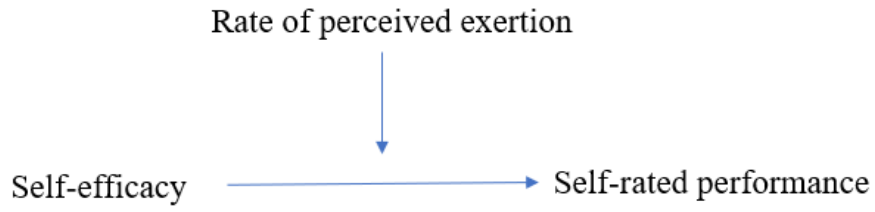
The assumptions of linear regression analysis were checked and not violated. The moderation analysis was checked in addition for multicollinearity with the variance of inflation factor (ViF), using the default cutoff value of 5. The assumption was found to be heavily violated in model two, the other assumptions were met. The rate of perceived exertion had a ViF of 117.81, self-efficacy one of 391.74 and the interaction effect was at a ViF of 601.9. Since this violation would lead to unstable and harder-to-interpret coefficient estimates, a decision was made to use mean-centered variables for the moderation analysis. The ViF stayed the same, leading to possible inflation of standard errors and subsequently p-values, so the data must be interpreted with that in mind.

For hypotheses 1 to 3 a linear regression analysis was run to check associations between variables. For H1, self-rated performance was used as the dependent and self-efficacy as the independent variable. For H2, the rate of perceived exertion was the dependent

variable again with self-efficacy as the independent variable. H3 had self-rated performance as the dependent variable with rate of perceived exertion as the independent variable. Lastly, H4 consisted of a moderation regression analysis using self-rated performance as the dependent variable, with self-efficacy as the independent, and rate of perceived exertion as the moderator variable (see Figure 1).

Figure 1

Model of Moderation Analysis



Results

Descriptives

Self-efficacy was found to have a mean of 75.6 and a standard deviation of 7.13. The self-rated performance had a mean of 72.63 and a standard deviation of 5.23. And lastly, the rate of perceived exhaustion had a mean of 18.43 and a standard deviation of 0.94. The nature of the data collection did not allow for further or more detailed descriptives due to the privacy protection agreement.

Regression Analyses

For H1, a simple linear regression analysis was conducted to examine the relationship between self-efficacy and self-rated performance. The model fit was found to be statistically significant (F (1,38) = 6.153, p = .018, R^2 = .139). This suggests that self-efficacy could explain around 13.9% of the variance in self-rated performance. In addition, the standardized

coefficient value for self-efficacy (B = .273, β = .373) indicates that for every point in self-efficacy, self-rated performance increases by 0.373 per point gained.

For H2, no significant relationship was found between self-efficacy and the rate of perceived exertion (F (1, 38) = 1.91, R^2 = .048, p = .175). Equally, the relationship between the rate of perceived exertion and perceived performance (H3) was also non-significant (F (1,38) = .006, p = .939, R^2 = .000).

Moderation Analysis

The moderation analysis assessed the effect of perceived exertion and self-efficacy on self-rated performance alongside whether perceived exertion moderates the relationship between self-efficacy and self-rated performance (H4). The first regression model included self-efficacy and rate of perceived exertion, both mean-centered, as predictor variables. The overall model fit was non-significant (F (2,37) = 3.23, p = .051, R^2 = .149). The second model added the interaction effect, resulting in a non-significant model as well (F (3,36) = 2.737, p = .058, R^2 = .186).

In the second model, the centered independent variable self-efficacy had a non-significant effect on self-rated performance (B = 3.1, SE = 2.179, t = 1.411, p = .167). The centered moderator variable rate of perceived exertion was found to have a non-significant effect on self-rated performance (B = 10.99, SE = 9.05, t = 1.214, p = .233). Furthermore, the interaction effect was also found to be a non-significant predictor of self-rated performance (B = -.151, SE = .118, t = -1.28, p = .209) which suggests that the rate of perceived exertion does not moderate the relationship between self-efficacy and self-rated performance.

Discussion

The study aimed to examine if the perceived training exertion of players affected self-rated performance ratings, and further if the exertion levels had an effect on the self-efficacy and self-rated performance relationship. This is investigated through the relationship between self-efficacy and self-rated performance, as well as the possible influence of the rate of perceived exertion on this relationship as a moderating variable. The correlations between the variables were also examined. It was theorized that the rate of perceived exertion is a significant moderator of the relationship (H4). This implies, that different levels of perceived exertion would influence the strength and direction of the relationship between self-efficacy and self-rated performance. Without perceived exertion as a moderator, the base state relationship between self-efficacy and self-rated performance is positive according to previous studies on this relationship. In addition, the linear relations between the three variables were hypothesized, based on existing literature, to be as follows: a positive relationship between self-efficacy and self-rated performance (H1), a negative relationship between self-efficacy and the rate of perceived exertion (H2), and a positive relationship between self-rated performance and the rate of perceived exertion (H3).

The sample data consisted of 41 players from the youth department of a first-league Eredivisie club in the age brackets of Under-16, Under-18 and Under-21. The main concepts were assessed through single-item questions, which were answered through a questionnaire available in the locker room before and after every training session (up to four per week). Three linear regression analyses (H1 to H3) were performed, as well as a moderation analysis (H4). Since the data was taken from a professional club's youth department, sample data was not randomly collected. That was especially visible when looking at the assumptions for linear regression analysis, which were mostly violated. This led to the decision of aggregating our data, to have more stable results for the statistical approach chosen for this paper.

The rate of perceived exertion was found to be not significant as a predictor in the regression model, as was the interaction effect (H4). This indicates, that the rate of perceived exertion does not have a moderating effect on the relationship between self-efficacy and self-rated performance. However, self-efficacy was found to be a significant predictor of self-rated performance (H1). The relationships between self-efficacy and rate of perceived exertion (H2), as well as the rate of perceived exertion and self-rated performance (H3) were found to not correlate.

Results in perspective

Self-efficacy has been reported to correlate with performance over and over (Martin and Gill, 1991; Moritz et al., 2000). As mentioned in the introduction, the association using self-rated performance has been comparatively scarcely explored (Udayar et al., 2020; Moritz et al, 2000; Neumann et al., 2024). The results provided by this study further add to the current body of literature supporting the notion that the association is significantly and positively related, even when using self-report measures. Thus, the first hypothesis is supported by the present findings.

The second hypothesis is not supported by the results of this paper. Despite research indicating that self-efficacy can lead to different perceptions of exertion (Hutchinson et al., 2008; McAuley et al., 1999), or even be a significant predictor for training intensity (Robbins et al., 2004; McAuley & Courneya, 1992), the present study did not find evidence supporting these claims. Self-efficacy, according to the findings of this paper, had no impact on the rate of perceived exertion. In comparison to previous literature, this finding is very surprising even in the context of this paper alone. A possible reason for this deviation is that player self-efficacy was increased due to several factors. Literature suggests that elite youth football players have heightened self-efficacy in comparison to non-elite athletes (Toering et al.,

2009), or another possible factor could be fear of being evaluated by those values by coaches or peers (Pajares & Urdan, 2006). This could have led to a reduction in variance between the self-efficacy and perceived exertion scores, leading to diminished correlation findings.

The third hypothesis also did not find support in the results. The findings present showed a non-significant relationship between the two, indicating that the rate of perceived exertion does not impact perceived performance. The few previously conducted studies investigating the association were contradictive in their findings. In different research contexts, some colleagues found a relatively strong positive correlation (McCrary et al., 2022) while others reported a negative correlation (Reder et al., 2023; Sandrin, 2019). In the context of sports research, the findings do align with previous research. Brink and colleagues (2010) did not find the rate of perceived exertion to be predictive of performance either. In addition, a finding in their study showed that the complete concept of training load was significant to the model. Due to this, a possible reason for the non-significant findings in the present study could be that the load concept was not applied fully. Lastly, the fourth hypothesis was also not supported. Both self-efficacy and the rate of perceived exertion were non-significant predictors in the model. This suggests that the rate of perceived exertion does not moderate the relationship between self-efficacy and self-rated performance in any way.

A more general explanation for the deviation from existing literature could be the disregard of data differences on the individual level due to aggregation of data. As a result of that, scores in self-efficacy, training scores, and perceived performance are summarized to one data point per player respectively and individual variances are likely to be overlooked. The findings, although mostly non-significant, do not mean that this study was without merit. With the groundwork already done, the study could be used as a building block for future approaches using the suggested improvements mentioned in further research.

Limitations

Several limitations should be kept in mind when interpreting the results of this thesis. In the following text, the most important limitations will be mentioned. It is nonetheless acknowledged that more limitations could be named but are not as influential.

There are a few general limitations in this study. First, the missing demographic data in general, meaning no information is given about age, education, income, and so on. This diminishes generalizability and makes it harder to relate findings to other studies. Furthermore, age has been found to influence self-efficacy beliefs (Bausch et al., 2014) and the lack of precise age data prevents controlling for the possible influence of age on the relationships examined in this study. Second, the data only applies to male footballers in The Netherlands, making the findings also less generalizable, since culture possibly had an effect on them (Gebauer et al., 2021, Mishra & Roch, 2013). Lastly, the self-report design of the study is a limitation due to the non-neutral environment in which the questionnaire was filled out – a locker room. Adolescents could be distracted while filling out the short questionnaire or influenced by peers (Pajares & Urdan, 2006). Additionally, despite telling them that the data will not be used by the coach for evaluation, the underlying concern could still be present influencing the answers unconsciously (Pajares & Urdan, 2006). One or both of those possibilities could lead to the response being biased by social desirability.

A more specific limitation was the difficulty of applying the data to a statistical format taught in the bachelor's. Due to the collection of individual player data, the study was highly correlational in itself, thus the data had to be aggregated which meant losing out on a lot of details in the data. The sample size was cut down from over 11.000 observations to 40 observations – one average per player. A better approach would have been an explanatory time-series analysis (Lipovetsky, 2022), with a focus on how the rate of perceived exertion

moderates the relationship over time on an individual level. Unfortunately, this approach would have been beyond the scope of a bachelor thesis, thus the data was unable to be used fully.

The data used for this study did not record training information, what kind of training program was used on that day, or how long a session was due to a privacy agreement. These would have been important to put the existing external load measurements into perspective since players might rate themselves higher on performance when the training was physically exhausting. The consequence was that only internal load could be used to represent the full load concept, therefore reducing the strength of conclusions drawn. Despite having measurements of various external load components, because there were no recordings of session duration it was unknown if the recorded heart rate resulted from a light 15-minute warm-up or a full 90-minute training. Therefore, the inability to infer in what context they came about made them unusable. A heart rate measurement can only be used to infer external load if it can be put into the context of e.g., recovery training. Only then, there are pre-existing heart rate values that can be used to compare.

Practical implications

Practical implications are rather limited due to several non-significant findings. Nonetheless, due to the support found for the first hypothesis, it can be said that self-efficacy is a very important predictor for self-rated, as well as objective performance. Based on this, training programs should take into consideration, how self-efficacy can be improved or kept as steady as possible. This could be achieved through regular positive feedback, as well as providing opportunities for mastery experiences (Bandura, 1977).

Directions for future research

Due to the limitations mentioned above, several aspects of the present study could be improved upon by either exploring concepts more openly or choosing to apply a different method to analyze the results. A possible opportunity for the latter would be choosing an explanatory time-series analysis (Lipovetsky, 2022), which could yield more reliable results due to the data not having to be aggregated. Additionally, it could provide a more in-depth understanding of why aggregating data is not the right approach for understanding correlations between consecutively measured data points in individuals. An interesting area to explore is if the relationship between self-rated performance and self-efficacy is also correlated when looking at the next day's data e.g., investigating if self-rated performance scores also influence the next day's self-efficacy scores. This could give a clearer overview of the association in general, and open new avenues for coaches to influence player self-efficacies i.e., through vicarious experiences. In addition, one could look at the change in load scores and if they turn out to be influential when looking at the same data using the explanatory time-series approach. Examining the relationship between self-efficacy and self-rated performance and the possible moderating influence of load using this method may yield different, and possibly more reliable, results. Training programs may then be more accurately altered. Lastly, one could observe the evolution of self-efficacy scores over time in an individual with a specific focus on the relation of self-efficacy and performance scores, as well as objectively measured performance scores. This could provide evidence for the concept of heightened self-efficacy leading to negative performance due to overconfidence (Bandura, 1977; Bandura, 2011).

As mentioned in the introduction, a plethora of studies already investigated the concept of self-efficacy in and of itself as well as the relationship with (self-rated) performance (Udayar et al., 2020; Moritz et al, 2000; Neumann et al., 2024). While it is not a well-researched area, especially regarding differences between adolescent ages, there are

studies indicating that advanced age could have a negative effect on self-efficacy (Bausch et al., 2014). Possible avenues for future research are differences in self-efficacy between age groups and whether the impact of self-efficacy on performance differs with age. Moreover, is perceived exertion influenced by age, and does the moderation effect differ depending on age? This could help extend the knowledge about the effect of age on exertion, self-efficacy, and performance, leading to a more appropriate approach to youth coaching.

When it comes to the exploration of concepts, an interesting one would be the implementation of the full load concept. The combination of internal and external scores, and putting them into perspective using the training session they were recorded in, could be used to investigate if moderation occurs in different sessions (e.g. rehabilitation vs strength). Another concept would be taking age into account and looking at a possible overestimation of load across different ages.

Conclusion

In alignment with previous research, self-efficacy is found to significantly correlate with self-rated performance. However, perceived exertion had a relationship with neither self-efficacy nor self-related performance. Moreover, perceived exertion did not moderate the relationship between self-efficacy and self-rated performance. It is debatable whether this is due to the actual lack of a moderation effect or simply to methodological problems in this study. Despite the limited findings in the present study, the validation of the self-efficacy – self-rated performance relationship leads to a strengthened emphasis on the importance of player self-efficacy in training. Future research may endeavor to look into the relationships between perceived exertion, self-efficacy, and self-rated performance using an explanatory time-series approach.

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