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Formative feedback for the coach reduces mismatch between coach and players’ perceptions of exertion

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\textbf{ABSTRACT}

\textbf{Objective:} The aim of the present study was to investigate the influence of formative feedback for the coach on the agreement between intended, observed and perceived exertion in soccer.

\textbf{Methods:} A quasi-experimental study design was conducted using a feedback intervention. Agreement between coach and players was assessed with and without feedback. The coach filled in the Rating of Intended Exertion (RIE) before training and the Rating of Observed Exertion (ROE) after the training for all individual players. Twelve U23 (age 20.3 ± 1.5; height 180.5 ± 4.8 cm; weight 74.8 ± 6.6 kg) soccer players registered Rate of Perceived Exertion (RPE). Furthermore, training duration (minutes), total distance (km), average speed (km·h\textsuperscript{-1}), number of sprints, distance >14.4 km·h\textsuperscript{-1} (km), TRIMP and time >85% maximal heart rate (min) were collected.

\textbf{Results:} About 231 RPEs were collected and paired with RIE and ROE of the coach. The average discrepancy between ROE and RPE, decreased from 1.0 ± 0.89 without feedback to 0.7 ± 0.73 with feedback (p < 0.003, ES 0.4). Further analyses revealed that this reduction in mismatch was particularly present in hard training sessions (p < 0.004, ES 0.6), but not for easy and intermediate sessions. The mismatch between RIE and ROE did not improve.

\textbf{Conclusions:} The results indicate that feedback improves the ability of a soccer coach to observe individual player exertion for most players, with small to moderate effect sizes. The mismatch between intended and perceived exertion did not improve with feedback. The use of formative feedback about load to coaches is recommended, particularly after hard sessions.

\textbf{Introduction}

Ideally, players execute training sessions as intended by the coach based on a periodization plan. A discrepancy between the training load intended by the coach and the training load perceived by players could have severe consequences. Loads higher than initially intended by the coach, along with insufficient recovery, could lead to injuries, illness (Brink et al. 2010; Dupont et al. 2010) and non-functional overreaching (Meusen et al. 2013). Furthermore, loads lower than intended lead to a non-optimal performance as well (Morton et al. 1990).

In team sports like soccer, players often train in small sides games to mimic tactical and technical match demands (Aguiar et al. 2012). However, these group exercises also result in large variation in training load (Brink et al. 2014). If coaches are not provided with structured feedback about external and internal load, it is difficult for the coach to plan future training on an individual level. Indeed, a mismatch is seen between the training load intended by coaches and the perceived load by players (Manzi et al. 2010; Andrade Nogueira et al. 2014; Brink et al. 2014, 2017; Rodríguez-Marroyo et al. 2014; Rabelo et al. 2016; Redkva et al. 2017). When assessing this lack of agreement in more detail, findings indicate that sessions intended as easy or intermediate by the coach are perceived as harder by the players, whereas sessions intended as hard are perceived as less hard (Andrade Nogueira et al. 2014; Brink et al. 2014).

Next to the intended-perceived mismatch, a discrepancy was found between players’ perceived exertion and coaches’ observed ratings of exertion after training (Brink et al. 2017). Although aerobic fitness of players and external training load did explain coaches’ estimations of intended and observed exertion, this was only about 30%. This means that when monitoring systems are not in place in soccer practice and coaches do not receive structured feedback about external and internal load, they likely misjudge intensity on an individual level. As a consequence, future planning may lack accuracy. To reduce the discrepancy between coaches’ and players’ perceptions of exertion, it might be expected that when provided with regular feedback on internal and external training load of the players, coaches can learn to resolve the mismatch.

Feedback can be defined as information communicated to the learner, the coach in this study, that is intended to modify their thinking or behaviour to improve learning (Shute 2008). For such feedback to be effective, several criteria have to be met. It should be non-evaluative, supportive, timely and specific (Shute 2008). In this case, specificity means that feedback about training load should comprise both external and internal load indicators that are known to be associated with the Rating of Perceived Exertion (RPE) (Casamichana et al. 2013;...
Gallo et al. 2015; Kelly et al. 2016). Although there is no specific evidence in soccer, feedback has been shown effective in teaching areas (Scheeler et al. 2004). Therefore, providing feedback on training load to a coach could improve their ability to administer training stimuli, which can be seen as soccer-specific teaching behaviour. When all feedback criteria are met, it is expected that feedback could help to resolve the mismatch between coach and players.

In sum, no study has aimed to minimize the discrepancy between coaches’ intended and observed training load and players’ perceived training load. Therefore, our aim is to provide regular feedback to the coach with a report that contains specific external and internal load information for the individual players. We hypothesize that this positive, corrective and well-timed feedback results in better agreement between coach and players’ perceptions of exertion compared to no feedback. Furthermore, we explore potential improvement of agreement during easy, intermediate and hard sessions.

**Methods**

Twelve under-23 soccer players (age 20.3 ± 1.5 years, height 180.5 ± 4.8 cm, weight 74.8 ± 6.6 kg) participated in the study. Players were part of a youth academy of a Dutch professional club playing at the highest level. The team had five field training sessions a week that contained technical, speed, agility, aerobic and tactical exercises on varying days. The coach, a 50-year-old former professional player, was certified by the Royal Dutch Football Association to coach at the highest level and had 13 years of experience as a coach in professional soccer. All participants were informed of the procedures of the study, and signed an informed consent. The ethical committee of the Center for Human Movement Sciences at the University of Groningen approved the study.

**Protocol**

A quasi-experimental study design was conducted that consisted of two 4-week mesocycles (February and March) with comparable training schedules. During the first mesocycle, feedback to the coach was absent (the no feedback period) meaning that the coach was blinded to any information about external and internal training load. During the second mesocycle (feedback period), the coach received formative feedback. Agreement between coach and players was evaluated during both mesocycles.

**Data collection**

During both mesocycles, the coach scored a Rating of Intended Exertion (RIE) for each individual player before training and a Rating of Observed Exertion (ROE) 30 min after training, ranging from 6 (very, very light) to 20 (very, very hard) (Brink et al. 2017). The rating covered the whole session, from the warming-up until the end of the training. The players scored the RPE also on a scale from 6 to 20 and approximately 30 min after the training ended (Foster et al. 2001a; Brink et al. 2014). POLAR TeamPro (Polar Team system, Polar Electro Oy, Kempele, Finland) was used to monitor external load with GPS (10 Hz) and accelerometers (200 Hz), and internal load with a heart rate monitor. The coach and players were familiarized with the experimental procedures of the study several days before the start of the study. To prevent biased perceived exertion ratings, the players were unaware that the coach gained insight into their perceived exertion scores.

**Formative feedback**

In the second mesocycle, feedback was presented to the coach aimed at increasing his knowledge and correcting misconceptions. At the beginning of the feedback period, reports were shown for all training sessions of the first mesocycle to make optimal use of the feedback period. Thereafter, immediate verification feedback (not normative) was provided at the earliest opportunity after each training session (Shute 2008) and contained a specific comparison of both intended and observed exertion scores of the coach and perceived exertion of players. In addition, more detailed elaboration feedback was presented twice a week. This frequency was considered ideal by the coach and could be fit into the training programme. The detailed feedback consisted of the comparison of coach and players’ ratings, along with individualized descriptive data of players’ external and internal training load characteristics. For this detailed feedback report to be most specific (Shute 2008), only load variables that have shown association with RPE in previous research were included in the feedback, i.e., total distance covered and average speed (Casamichana et al. 2013), distance covered above 14.4 km·h⁻¹ and number of sprints (Gallo et al. 2015), time spent above 85% of maximal heart rate (Kelly et al. 2016) and Training Impulse (TRIMP) (Casamichana et al. 2013; Kelly et al. 2016). All variables are known to be reliable and valid. To calculate TRIMP and time spent above 85% maximal heart rate (HRmax), HRmax values were determined as the highest value obtained whilst performing a maximal interval Shuttle Run Test until exhaustion (Lemmink et al. 2004).

**Statistical analysis**

Means and standard deviations of RIE, ROE, RPE and all load variables were calculated in both mesocycles using SPSS version 23 (IBM Corporation, New York, USA). Only the data of players who executed the whole training and who were rated by the coach before and after the training were included. Pearson correlation coefficients were calculated to examine the association between RPE and all load indicators to support the use of feedback variables. The following criteria for degree of correlation were set: 0 (zero association), 0–0.3 (weak association), 0.4–0.6 (moderate association), 0.7–0.9 (strong association) and 1 (perfect association) (Dancey and Reidy 2004). A multivariate analysis of variance was performed to rule out potential differences in training load between the no feedback and feedback period.

To calculate agreement between coach and players, RPE was subtracted from RIE and ROE. Agreement was established if the two quantitative methods that aimed to measure the same were equal (Bland and Altman 1986), i.e., zero. After that, negative values were transformed into absolute values to identify true differences between coaches and players and avoid masking caused by the combination of overestimations and underestimations. Further, mean scores for all exertion
and load variables were calculated for both periods, after dividing sessions into easy (RIE<13), intermediate (RIE 13–14) and hard (RIE >14) based on the anchors of the scale (Foster et al. 2001b; Brink et al. 2014). One-way analyses of variances were conducted to test differences in agreement for RIE-RPE and ROE-RPE between no feedback and feedback periods. The same procedure was followed for the intensity levels with correction for multiple comparisons. In addition, effect sizes (ES) were calculated to measure the magnitude of the effect of feedback on the total group, as well as for intensity categories. The criteria for interpretation of ES were set according to Cohen’s d (Cohen 1988): 0.2 (small), 0.5 (moderate) and 0.8 (large). Finally, individual differences were plotted and the number of perfect matches (zero difference between coach and player) were counted and presented as percentages between no feedback and feedback periods for RIE and ROE.

### Results

About 231 exertion scores were collected during 26 training sessions, and the number of players varied from 6 to 12 per session. Causes for missing scores were rehabilitation, training with another team, match events, other training types, sickness, dropping out and unexplained absence. The average maximal heart rates were 196 ± 7 beats per minute and ranged from 185 to 205.

Correlations were calculated between RPE and all external and internal load indicators to confirm the usefulness of the feedback report (Table 1).

Table 2 presents all external and internal load indicators in the no feedback and feedback period. No significant differences were found between both periods indicating comparable training loads during both mesocycles.

The mean discrepancy between RIE and RPE was the same between periods of no feedback and feedback (Figure 1). Yet, the discrepancy between ROE-RPE was significantly smaller in the feedback period (F(1.229) = 9.16, P = 0.003, ES 0.4).

The mean difference between ROE and RPE on sessions intended as easy, intermediate and hard are shown in Figure 2. The mismatch between coach and players was smaller in the hard sessions (F(1.113) = 8.53, P = 0.004, ES 0.6), but not in the easy and intermediate sessions.

Finally, agreement between the coach and the 12 individual players was plotted for RIE and ROE (Figure 3). For 8 out of 12 players, agreement improved. In four cases, the feedback resulted in a larger discrepancy in the feedback period. Total number of perfect matches between the coach and players for RIE and RPE was 32 out of 114 (29%) in the no-feedback period and 31 out of 117 (28%) in the feedback period. For ROE and RPE, this was 31 out of 114 (27%) and 46 out of 117 (39%) in the no-feedback and feedback periods, respectively.

### Discussion

The aim of present study was to minimize the mismatch between coach intended and observed exertion and players’
perceived exertion, by means of feedback to the coach about external and internal load of the players. The primary outcome of this study is that feedback significantly improved the match between coach-observed exertion and exertion perceived by players. Feedback improved especially in hard sessions and not in easy and intermediate sessions. Finally, the positive effect of feedback seen at team level varies across individuals.

When the coach was provided with formative feedback, a significant improvement in agreement between observed and perceived exertion was found. This reduction is less than the unit of measurement (1.0) and has a small ES. Although we found a mismatch between coach and players’ training load similar to previous research (Brink et al. 2014, 2017), the discrepancy was limited prior to the feedback period. This might be due to the quality and experience of the coach involved, but could also be the result of the age of the players that participated (Barroso et al. 2014; Redkva et al. 2017). The players were older and more mature than in previous studies making the sample more homogeneous. Although the agreement between ROE and RPE improved, this was not the case for RIE. An explanation could be that the feedback was more specific for learning to evaluate the intensity of session, rather than on planning future sessions. However, the overall tendency pointed in the expected direction.

The feedback to the coach appeared particularly effective in better observations of individual exertion of players in hard training sessions and not in easy and intermediate sessions. Although the reduction remained within the unit of measurement, the ES was moderate for these hard sessions. It can be argued that in these hard sessions the coach verbally motivated players for the development of fitness (Aguiar et al. 2012). As a consequence, the coach might be more focussed on the response of players to their training stimuli. These responses may also be more visible to coaches (e.g., face colour, sweating, breathing, movement kinematics) in hard sessions compared to easy and intermediate session (Ramenzoni et al. 2008). This could make it easier for the coaches to anchor these signals to individual perceptions of exertion. Although different training modalities were included in the current study, technical and tactical training could be more dominant in easy and intermediate sessions and physical training in hard sessions (Campos-Vazquez et al. 2015). The cognitive load of these technical and tactical exercises may be less visible to coaches and therefore difficult to learn (Vaquera et al. 2017).

Although we found improvements in agreement between coach and players at a team level, evaluations at player level are theoretically and practically relevant. Our findings demonstrate that feedback improved agreement between RIE and ROE with RPE for eight and nine players, respectively. This indicates that for the majority of the players, feedback resulted in improved agreement. Particularly for ROE, the number of perfect matches improved (12%), which can be considered relevant since it equals the unit of measurement. However, for the remaining players, feedback worsened the coach’s ability to estimate exertion. For RIE, agreement reduced in four players (33%) and for ROE in three cases (25%). A possible explanation for this reduced agreement is improved or reduced fitness over time. A similar external training load could then result a different internal training load. Coaches may be unaware of these changes, if fitness is not frequently assessed. An alternative explanation is a person bias (Gray 2011). Following this phenomenon, the coach would focus too much on the person in comparison with the context (e.g., training intensity). For example, highly motivated players are expected to display more effort during training. As a consequence, the coach may give too much weight on the person and not to the situation and thus overestimate
exertion. Finally, the validity of RPE may differ across individuals, because some players might experience more difficulty in converting physiological processes into exertion ratings (Impellizzeri et al. 2004; Kelly et al. 2016).

This is the first study that aims to intervene in the relationship between coach and players’ perception of exertion. We used recent theory-based recommendations to provide the most effective formative feedback to the coach about training load (Shute 2008). Furthermore, all load indicators that were part of the feedback were associated with RPE, which supports the quality of the content of feedback. In line with previous research, RPE correlated with total distance (Casamichana et al. 2013), distance >14.4 km·h⁻¹ (Gallo et al. 2015), TRIMP (Garcia-Ramos et al. 2015) and with changes in heart rate (Kelly et al. 2016). There is however no perfect relationship between RPE and the load variables. Therefore, they provide additional information for the coach about the perceived training load of players to help estimate the perceived training load.

The downside of this high-performance environment is the impossibility to match a control group, since there was no team of corresponding age and level at the same club following the same training regime. Another limitation of training studies with top-level football players is dropout, for example, caused by injuries. This is inevitable in an applied setting with longitudinal data collection and also occurred in our study. Even though we collected a large amount of training data which was evenly distributed over the two mesocycles, selection bias cannot be ruled out. Furthermore, since only one coach participated, generalizability is limited. Finally, we do not know to what extent each of the external and internal load indicators contributed to the reduced mismatch. Future research could investigate different feedback templates and assess if the improved agreement between coach and players is temporary or permanent by including a follow-up measurement in a retention period. To improve the agreement between RIE and RPE, feedback could be extended with the degree of recovery from a previous training session (Doeven et al. 2017). The coach could then integrate both the previous training load and the individual recovery to better estimate the response to future training. Finally, it needs to be investigated whether the small improvement in agreement between coach and players actually leads to improved performance or reduction of injuries.

Conclusions
Providing formative feedback improved the agreement between this coach’s observed exertion and perceived exertion of players with small to moderate ES. This seems particularly effective for hard sessions where the largest improvements in agreement were found, and for the majority of the players that participated.

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Disclosure statement
No potential conflict of interest was reported by the authors.

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