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Citation for published version:
Bam, J, Watson, N, Parker, N, Lambert, M, Jones, B, Weston, M & Hendricks, S 2023, 'Coach and player rating of perceived challenge (RPC) as a technical skill monitoring tool in Rugby Union', *International Journal of Sports Science & Coaching*. https://doi.org/10.1177/17479541231166287

Digital Object Identifier (DOI):
10.1177/17479541231166287

Published In:
International Journal of Sports Science & Coaching

Coach and player rating of perceived challenge (RPC) as a technical skill monitoring tool in Rugby Union

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Abstract

Objective: To determine the relationship between player and coach rating of perceived challenge (RPC) for different training sessions over a competitive rugby union season. A secondary aim was to explore the relationship between player RPC and player session rating of perceived exertion (RPE).

Methods: We used an observational longitudinal study design to monitor 51 male highly-trained under 21 rugby union players and four coaches over an 11-week competitive rugby season (a total of 1798 training session observations). Player RPC (0 to 10 arbitrary units (AU)) and RPE ratings (0 to 10 AU) were collected after team sessions (a technical and tactical field-based session with all players training together), split sessions (a technical and tactical field-based session where players trained separately according to their positional grouping (forward and backs)) and gym sessions (non-field-based session with all players training together). Coach RPC ratings were only collected after team sessions and split sessions.

Results: A weak positive relationship (rho= 0.26, 95%CI 0.09-0.42; p<0.001) was found for split sessions (player RPC 4.40 95%CI 3.87-4.87 AU; coach RPC 4.25 95%CI 3.92-4.60 AU), while a moderate positive relationship (rho= 0.37, 95%CI 0.31-0.43; p<0.001) was found between player RPC (4.29 95%CI 4.00-4.55) and coach RPC (4.96 95%CI 4.89-5.05) for team sessions. Forwards had a higher RPC (5.33 95%CI 4.50-5.65) compared to backs (3.45 95%CI 2.88-4.00)) for split (p<0.001) and team sessions (forward's RPC 4.66 95%CI 4.37-4.94; back's RPC 3.84 95%CI 3.38-4.26; p< 0.001).

Conclusions: In conclusion, using a rating to quantify the perceived challenge of training, we found coaches may be overestimating how challenging their training sessions are. Forwards rated field sessions more challenging than backs, which likely represents their additional technical and tactical demands from training scrums, line-outs and mauls. While the RPC has strong theoretical justification as a rating tool to potentially fulfil the gap of quantifying the perceived challenge of training, thoughtful validity studies are yet to be conducted on the scale, which are the required next steps if the RPC is going form part of a coach's and practitioner's toolbox to optimise skill training.

Introduction

The goal of monitoring physical training is to ensure players adapt positively to the training stimulus and are physically prepared for competition.[1] It follows that the goal of monitoring skill training should be to optimise skill learning, maintenance, adaptation and transfer to competition.[2-4] However, skill training is not periodised and monitored to the same extent as physical training.[2] When monitoring physical training, both the external load and the player's response to this load (internal load) are recorded.[1] In contrast, the monitoring of skill training is usually limited to capturing training time, training frequency and movement repetitions.[2 5]

A simple, inexpensive, and quick method to quantify players' global experience of the physical load is to ask players to rate their perceived level of exertion using the rating of perceived exertion (RPE) scale.[6 7] RPE was first constructed by Borg (Borg RPE scale) primarily for steady state aerobic work on a bicycle ergometer, with numbers and verbal anchors adjusted to give number responses that increase linearly with stimulus intensity, heart rate and oxygen consumption.[7] Because of this linearity, the number range for the Borg RPE scale is from 6 (No exertion at all) to 20 (Maximal exertion), which corresponds to a heart rate range of 60 to 200 beat per minute in healthy individuals. Borg noted the drawbacks of the Borg RPE scale, and subsequently developed a scale that combines the advantages of a ratio scale with those of a labelled category scale – known as the Borg Category Ratio scale 10 (Borg CR 10).[7 8] The Borg CR 10 is considered a general scale for perceived intensity and ranges from 0-10, where 0 represents "nothing at all" and 10 represents "maximal" exertion.[7 8] Subsequently, Borg also developed a finer graded scale ranging from 0-100 called the Borg Category Ratio scale 100 (Borg CR 100).[8] Weston and colleagues however recognised that a general single rating may not be sensitive enough for the range of training modalities within team sports.[9-11] In response, they proposed that the RPE be differentiated into breathlessness (RPE-B), leg (RPE-L) and technical (RPE-T).[9-11] From a skill training perspective, the RPE-T is a positive step. However, the instructions and anchors of the category ratio scale still represent physical intensities. As such, the RPE-T arguably characterises how physically hard the skill session was, and not necessarily the technical-tactical demands of the session.

To quantify the technical and tactical demand of a skills session and complement RPE ratings, Hendricks et al. (2019) proposed the rating of perceived challenge (RPC).[5 12] The RPC is based on skill acquisition theories and frameworks and therefore has skill-specific instructions and anchors on a 0 – 10 category ratio scale.[2 13 14] The perceived challenge for the rating is grounded on the Challenge Point Framework, which describes the "challenge" as a function of the potential available information and functional task difficulty (how difficult is the task is relative to the skill level of the athlete and conditions).[13] In team sports, technique and tactics are interdependent.[15] Skilled performances in team sports require the player to "read the play" (tactical knowledge and awareness) and efficiently execute a set of actions (techniques) based on their tactical interpretation of the situation.[15] Conceivably, from the Challenge Point Framework perspective, tactical knowledge and awareness is the ability to interpret the potential available information, while functional task difficulty is the athlete's technical abilities to meet the demand of the situation. Hence, the RPC provides a gestalt rating for the technical and tactical demands of a skills session. Recently, like Hendricks et al.[5 12 16], Hodges and Lohse [4] depicts competition representativeness and specificity as a proxy for available information. The authors also outline "zones" along the challenge spectrum where different training goals (transfer, learning, or/and maintenance) can be achieved, and highlights the importance of motivation on achieving these training goals. [4] The difficulty of the task and the amount of information available to the player is typically set by the coach or trainer, with the aim of creating the optimum challenge to achieve the specific training goal.[5] Skill sessions (sessions with both technical and tactical components) may contribute to a high RPC as well as a high RPE, whereas sessions that involve a high level of physical activity only but no technical or tactical demand (e.g., straight line running) may warrant a low RPC but high RPE. The RPC has potential use as: a skill load measurement for skill periodization,[3] a coaching tool for long-term athlete development,[17] injury prevention training,[18] and as a tool to prescribe training for athletes recovering from injury.[19]

Using RPE, studies within team sports have shown a mismatch between coach and player perceptions of training.[20-23] Coaches both underestimate and overestimate players' perceived ratings of the session intensity.[20-23] These incongruencies between the player and coach may expose players to maladaptation, errors in periodisation, illness and injury.[23] If a coach overestimates the intensity of the session, players may undergo deconditioning because of

an insufficient training stimulus to promote adaption. If a coach underestimates the intensity of the session, players may be at risk of overuse injuries or non-functional over-reaching because of the inability to handle the excessive loads.[23] Mismatches between coaches and players perception of training may be influenced by factors related to the coach (eg., coaching experience, tool familiarity), the player (eg., training age, fitness capacity), or contextual environmental factors.[22] In one exploratory study, differential RPE (breathlessness (RPE-B), leg (RPE-L) and technical (RPE-T)) was used to assess the agreement of coach prescribed and coach observed dRPE with player reported dRPE in one football team over seven consecutive training sessions.[21] The study found an agreement between coach observed and player reported RPE-T scores, and disagreement between coach observed and player reported RPE-B and RPE-L.[21] The authors concluded that perhaps these findings suggest that coaches were able to interpret player technical and tactical external cues (e.g., skill execution or tactical positioning) better than physical cues (e.g., sweating and body language).[21] The authors also noted though that this was an exploratory study with a small sample of training sessions, and that further research is required in the area.[21]

Rugby union is a highly physical, technical, tactical, and psychologically demanding collision-based team sport, popular across the globe. Specific events like the tackle place players at high risk of injury.[24 25] However, these events are also associated with player and team performance.[26 27] To ensure players participate safely and effectively, coaches have the responsibility of physically, technically, tactically, and psychologically preparing their players for competition. However, how do coaches know they are providing the appropriate stimulus for the technical and tactical demands of the game to promote skill learning, maintenance, adaptation, and transfer to competition? Given the growing need to periodise and monitor skill training,[2 3 12] understanding the relationship between coach and player ratings for the perceived challenge of training sessions will be a timely contribution to the literature and may advance practice. A mismatch between player RPC and coach observed RPC may lead to an early or late progression to the next skill level. Early progression could result in injury, whereas a late progression could lead to underperformance.[12] Therefore, the purpose of this study was to determine the association between player and coach RPC for different training sessions over a competitive rugby union season. Also, considering that RPC is intended to

complement RPE, a secondary aim was to explore the relationship between player RPC and RPE.

Methods

An observational longitudinal study design was used to monitor 51 male highly-trained under 21 rugby union players and four coaches over an 11-week competitive rugby season (South Africa's annual premier U21 domestic rugby union competition). This equated to 66 training days and a total of 1798 training session observations. Thirteen sessions were completed on Match Day (MD) +2 days, 26 sessions were completed on MD+3 days, 8 sessions were completed on MD-4 (when matches were on Fridays), and 19 sessions were completed on MD-2. Forwards (n=25) and backs (n = 26) participated in the study. All participating players provided consent to have their training data collected, stored, and analysed for research purposes, and the study was approved by the University's Human Research Ethics Committee (HREC REF 171/2021).

At the start of the season, an information session was held for the players and coaches to familiarise themselves with the RPC[5] and RPE[6] scales, in particular, the purpose and anchors of each scale. During the season, about 15-30 minutes after each training session, players were asked to indicate their RPC and then RPE (in this order), and coaches were asked to provide an RPC based on their observation of the training session. Player RPC and RPE ratings were collected after team sessions (a technical and tactical field-based session with all players training together), split sessions (a technical and tactical field-based session where players trained separately according to their positional grouping [forward and backs]) and gym sessions (a non-field-based session with all players training together). Player ratings were collected independently and confidentially, and players had the choice of providing the rating verbally or by indicating a point on the RPE and RPC scales. Coach RPC ratings were also collected independently and confidentially, after split sessions (based positional grouping) and after team sessions. For this study, the coach's overall RPC rating of the session was of interest (i.e. how challenging it was across all players), therefore coaches provided a single overall RPC rating for each session. Coaches also had the choice of a verbal rating or indicating a point on the RPC scale. All ratings were recorded manually using pen and paper, after which they were captured onto a password protected electronic database. The (mean±standard

deviation) of number of observations per player per session type was: gym sessions (16±6), split sessions (6±1) and team sessions (18±7). Coach RPC ratings were only collected after team sessions and split sessions due to coaches not always being present during the gym session.

Repeated measures correlation (rho) was used to determine the relationship between player RPC and coach RPC, and player RPC and player RPE using the *rmcorr package* [28 29] in the R programming language. [30]. Associations were tested over the 11-week period, by session type (team, split and gym). Within each session type, players with fewer than three observations were removed from the analysis. The significance level (p) was set at 0.05 and data are reported as rho and its 95% confidence interval (95%CI). The strength of the relationship was determined using the standard correlation coefficient interpretation scale where rho 0 = no relationship, 0.1 - 0.3 = weak, 0.4 - 0.6 = moderate, 0.7 – 0.9 = strong, and 1.0 = perfect.[31] Bland-Altman plots and the Concordance Correlation Coefficient were also used to test the agreement between player RPC and coach RPC by session type. The acceptable limits of agreement were set at (-1;1), implying that the two measures being compared 'agree' if the difference between them was greater than -1 and less than 1 for each pair of observations.[32] The Mann-Whitney test was used to test for differences in RPC and RPE, and coach RPC between forwards and backs within each session, with the significance level (p) set at 0.05. Median with 95%CI are reported for RPC and RPE data in arbitrary units (AU). The median was preferred to the mean as the data were ordinal and not normally distributed.

Results

A weak positive relationship (rho= 0.26, 95%CI 0.09-0.42; p<0.001) was found for split sessions (player RPC 4.40 95%CI 3.87-4.87 AU; coach RPC 4.25 95%CI 3.92-4.60 AU) (Figure 1A), while a moderate positive relationship (rho= 0.37, 95%CI 0.31-0.43; p<0.001) was found between player RPC (4.29 95%CI 4.00-4.55 AU) and coach RPC (4.96 95%CI 4.89-5.05 AU) for team sessions (Figure 1B). The Bland-Altman plots for split sessions (Figure 2A) and team sessions (Figure 2B) show moderate disagreement and strong disagreement between player RPC and coach RPC, respectively. The Concordance Correlation Coefficient between player

RPC and coach RPC for was 0.50 (95% CI 0.42-0.58) for split sessions and 0.26 (95% CI 0.22-0.30) for team sessions.

A moderate positive relationship (rho= 0.48, 95%CI 0.33-0.60; p<0.001) was found between player RPC (4.40 95%CI 3.87-4.87 AU) and player RPE (4.64 95%CI 4.25-5.00 AU) for split sessions, as well as for team sessions (RPC 4.29 95%CI 4.00-4.55 AU; RPE 5.44 95%CI 5.29-5.62 AU; rho= 0.46,95%CI 0.40-0.51; p<0.001). A weak positive relationship (rho= 0.13, 95%CI 0.06-0.20; p<0.001) was found between player RPC and RPE for gym sessions (player RPC 3.62 95%CI 3.37-3.86 AU; RPE 5.17 95%CI 5.00-5.37 AU).

Forwards had a higher RPC (5.33 95%CI 4.50-5.65 AU) compared to backs (3.45 95%CI 2.88-4.00 AU) for split (p<0.001) and team sessions (forward's RPC 4.66 95%CI 4.37-4.94 AU; backs RPC 3.84 95%CI 3.38-4.26 AU; p< 0.001) (Figure 3), while no differences were observed between the two positional groupings for gym sessions (forwards 3.60 95%CI 3.29-3.86 AU; backs 3.67 95%CI 3.20-4.17 AU, p>0.05). For split sessions, coaches reported higher RPC ratings for forwards (forwards coach RPC 5.26 95% CI 5.00-5.60 AU; backs coach RPC 3.36 95%CI 3.10-3.61 AU; p< 0.001), while during team sessions, coaches reported higher RPC ratings for backs (forward coach RPC 4.89 95%CI 4.76-5.02 AU; backs coach RPC 5.02 95%CI 4.93-5.16 AU; p< 0.05) (Figure 3). Forwards also reported a higher RPE for split sessions (forwards RPE 5.40 95%CI 5.00-5.78 AU; backs RPE 3.92 95%CI 3.50-4.33 AU; p< 0.001) and team sessions (forwards RPE 5.64 95%CI 5.40-5.89 AU; backs RPE 5.26 95%CI 5.03-5.50 AU; p<0.05) (Figure 3), while backs reported a higher RPE for gym sessions (forwards 5.00 95% CI 4.76-5.28 AU; backs 5.33 95% CI 5.11-5.58 AU, p<0.05).

Discussion

Over the season, overall, players' RPC did not match the coach's RPC. These findings suggest that from a technical and tactical perspective in rugby union, coaches may be overestimating how technically and tactically challenging their training sessions are. During both split and team sessions, forwards rated their training sessions more technically and tactically challenging and physically harder than backs rated their training sessions. Coaches however,

reported a higher observed RPC for backs than forwards during team sessions, which further supports the mismatch between what players are perceiving and what coaches are observing.

As this is the first study in rugby union to compare the relationship between players' perceived technical and tactical challenge of a session and the coaches' observed perception of said technical and tactical challenge, it is not possible to make any comparisons to previous literature. With that said, we can draw some logical speculations as to why discrepancies exist between players' RPC and coaches' RPC. Before we attempt to explain these discrepancies, we need to acknowledge that our assumption is that player RPC and coach RPC should be congruent for skill training adaptations to occur. This assumption, however, is yet to be tested. Coaches may have also experienced the Hawthorne Effect by becoming self-aware of their training sessions.[33] It is not typical for a coach to rate their perception of the technical and tactical demands of a skills session. In this study, this was the first time coaches provided ratings after a session. This new coaching practice may have therefore made the coaches self-aware when observing and providing subjective ratings of how challenging the sessions were. In contrast, players regularly provide subjective ratings (RPE) after sessions, and are familiar with the process. Also, coaches anecdotally reported that they found utility in providing RPC ratings after the sessions. Generally, coaches rely on narrative records to assess the technical and tactical demand of a training session. While these narrative records offer insight into the complexities of coaching, they are limited when it comes to monitoring, testing relationships (to players, performance and injury outcomes and contextual factors), and planning. As such, the regular RPC requests may have empowered the coaches as they realised their perceptions of the session can be quantified and potentially be used for their planning, monitoring and relationship testing.

The RPC is intended to compliment internal physical load measurements such as the RPE.[5] The moderate positive relationship during teams sessions, and the moderate relationship for split sessions suggest that there is a relationship between the two perceptual constructs. This is not surprising considering that the spilt and team sessions had technical and tactical components, as well as physical components. The value of differentiating perceptual constructs during training has been highlighted before,[9 10 21] and considering that RPC and RPE have separate monitoring goals (RPC – to quantify the technical and tactical demands of

a skill session ; RPE – to quantify the subjective aspect of internal load), the recommendation to capture RPC (along with RPE) during skills sessions may be justifiable. Gym sessions were focused on players' physical conditioning and did not impose a high technical and tactical skills challenge. As a result, a weak relationship between RPC and RPE was found for gym sessions. This finding is encouraging in terms of the RPC's construct validity as it indicates that the two scales represent distinct yet complimentary internal load measurements. With that said, further work into the construct validity of the RPC is required. For example, factor analysis (exploratory or confirmatory) with external load and contextual variables could be used to examine the underlying psychometric properties of the RPC scale to estimate its construct validity.[34 35]

Within the split and team sessions, forwards reported higher RPC ratings than backs, while similar RPC ratings were recorded for gym sessions. During training, in addition to the general skills required by all positions (passing, tackling, ball-carrying, rucking), forwards practice techniques and tactics required for the scrum, line-out and maul.[36] These contact events require forwards to employ position specific techniques (for example, lifting in the line-out) and tactics (for example, which line-out configuration to use) for both safety and performance.[37] The higher RPC ratings reported by forwards within the split and team sessions likely represent these additional technical and tactical demands and offers further support for the construct validity of the RPC. Recently, Otte et al. (2019)[3] described a skill training periodization framework for 'specialist coaches' (i.e. coaches that work with athletes on a one-one basis or in small groups), and suggested that the RPC be used as a potential internal skill load measurement for monitoring player's progression through the framework. The skill training periodization framework outlines three connected training stages based on the level of competition representativeness and perceived task complexity – namely, i) coordination training (exploring coordinated movements within an emerging training environment), ii) skill adaptability (focusing on skill learning, adaptability, and robustness) and iii) performance training (focusing on match performance outcomes, and less on skill development). The first two stages largely operate in a moderate representative training environment with small player groups, while the performance training stage is typically completed in a high representative training environment involving the entire team.[3] Plausibly, the first two training stages in the skill training periodization framework are comparable to

the split sessions in the current study where the focus is on more position specific skills, while the performance training stage is comparable to team sessions. Building on the skill training periodizing framework, our findings suggest that progression through the framework using the RPC ratings in rugby union may be position specific.

A key strength of the current study is that it was conducted within a team setting over a full season. However, this applied research design had limitations. A noteworthy one is the absence of an external measure(s) to objectively describe the technical and tactical demands of the training sessions. Currently, objective external measures of the quality skills training in rugby union are not well described and are limited to estimates such as movement repetitions. In the context of the current study, objective external measures may have added another dimension to the interpretability of our findings. Other potential approaches to objectively describe the technical and tactical demands of training sessions are the use of video analysis and systematic observation.[38] To use these methods effectively though, a framework of training descriptors and definitions need to be developed for rugby union, similar to the framework for analysing matches.[38] Recently, Dalton-Barron et al. showed that sRPE is influenced by contextual factors such as the length of the recovery period between matches and the outcome of the previous match.[39] Specifically, higher sRPEs were reported for longer recovery cycles and when losing the previous match. This suggests similar contextual factors and potentially others (for example, technical and tactical performance within matches) will also influence RPC ratings. Another limitation is that players were not present at every field and gym session. This resulted in only a small number of players being able to attend every training session of the season. This, in conjunction with the data being ordinal, limited the choice of more robust statistical methods to analyse the data. Lastly, another potential limitation of this study was the non-randomisation of collecting RPC and RPE. RPC was consistently collected before RPE, which may have increased the potential for systematic bias. Randomisation when collecting the two ratings is therefore recommended in future studies.

In conclusion, using a rating to quantify the perceived challenge of training, we found coaches may be overestimating how challenging their training sessions are. Forwards rated field sessions more challenging than backs, which likely represents their additional technical

and tactical demands from training scrums, line-outs and mauls. A relationship between RPC and RPE was found for both split and teams' sessions, but not for gym sessions. This finding may be indicative of the RPC's construct validity as it demonstrates the two scales represent different yet complimentary internal load measurements. With that said, and while the RPC has strong theoretical justification as a rating tool to potentially fulfil the gap of quantifying the perceived challenge of training, thoughtful validity studies are yet to be conducted on the scale. For examples, experimental studies where athletes perform tasks with a pre-determined RPC and RPE ratings, and observational studies using video analysis and systematic observation to objectively describe the skill demands of training sessions. These robust validity studies are the required next steps if the RPC is going form part of a coach's and practitioner's toolbox to optimise skill training.

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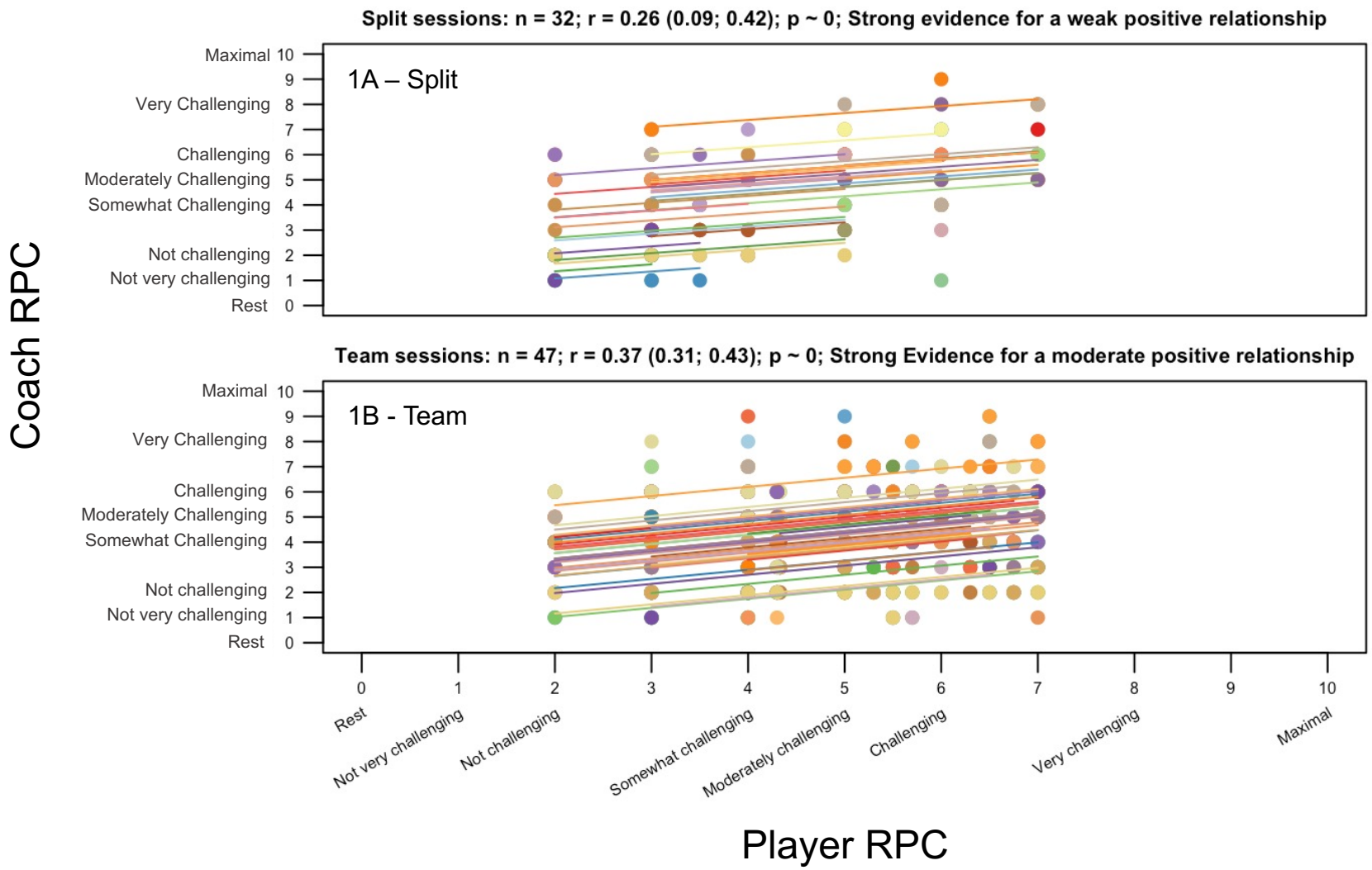

Figure 1: Repeated measures correlation between Player RPC and Coach RPC for Split (A) and Team sessions (B). r=rho.
The different colours represent the different players, and each dot of a colour represents an observation for that player. The line of the same colour represents the estimated repeated measures correlation for that player.

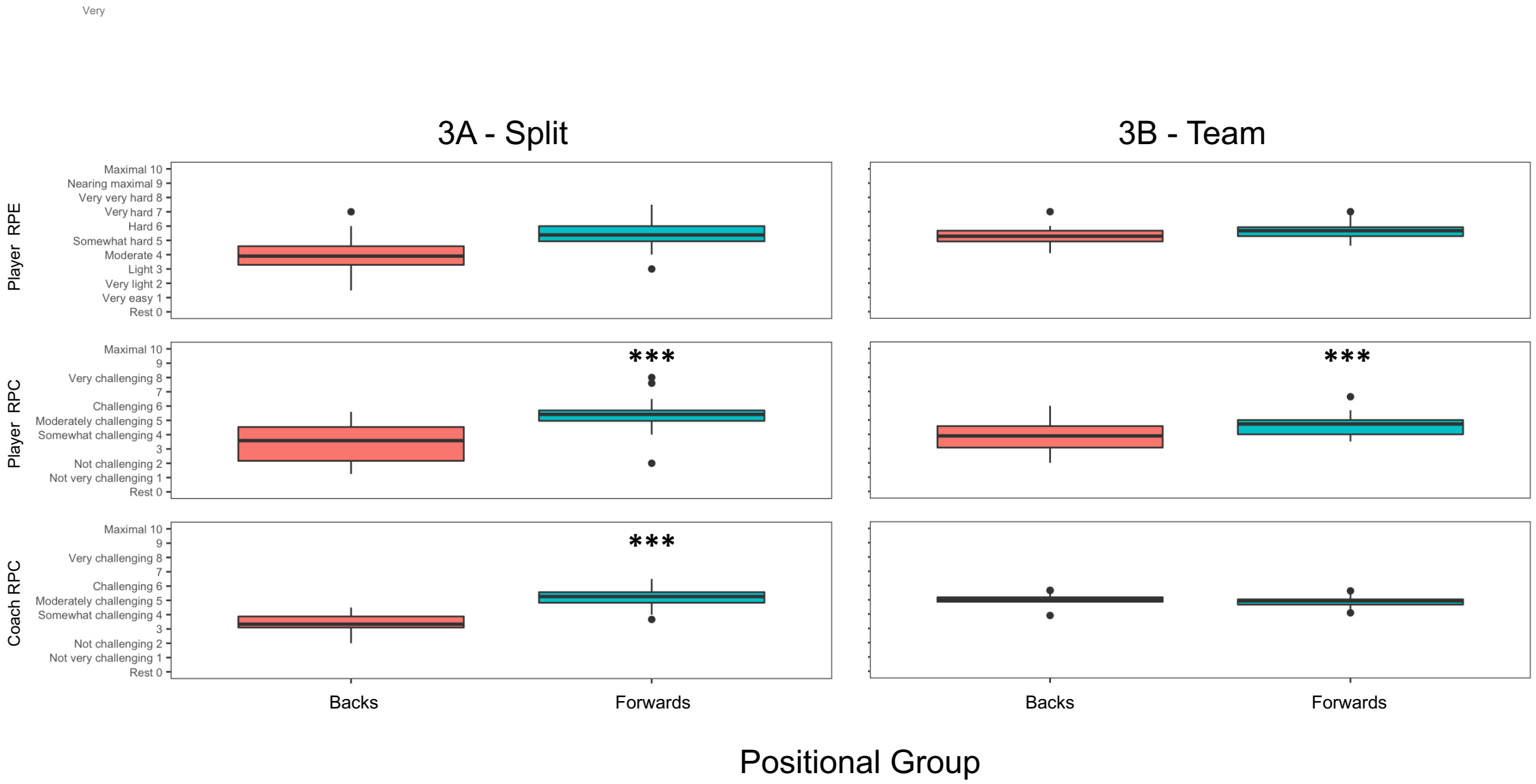

Figure 3: Differences between forwards and backs for Player RPE, Player RPC and Coach RPC for Split (A) and Team sessions (B). Data are reported as median with 95%CI.