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► **To cite this version:**

Quentin Bourgeais, Guillaume Hacques, Rodolphe Charrier, Eric Sanlaville, Ludovic Seifert. Identify team sport team signature through passing network. European College of Sport Science, Jul 2023, Paris, France. hal-04159194

HAL Id: hal-04159194

<https://hal.science/hal-04159194v1>

Submitted on 11 Jul 2023

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Identify team sport team signature through passing network: the effect of defensive imbalance on players interactions in basketball and in rugby

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Framework

A team sport team can be considered as a **complex adaptative system**¹ as there are entities (players) in **interaction** that produce a **collective behavior** that must be adapted to the surrounding **constraints**.

⇒ Network analysis helps to understand such system by highlighting the interactions. For example, we can build a **passing network** with the passes between the players to characterize the collective behavior.



Each team can have preferences in the way they organize and reorganize their collective behavior to a constraint: we define it as a **team signature**².

⇒ We can analyze **patterns of interaction** using **graphlets** (= connected networks with a small number of nodes³ – see figure above) to assess collective behavior and compute their frequency to obtain a network **profile**.

Experimental situation & Data

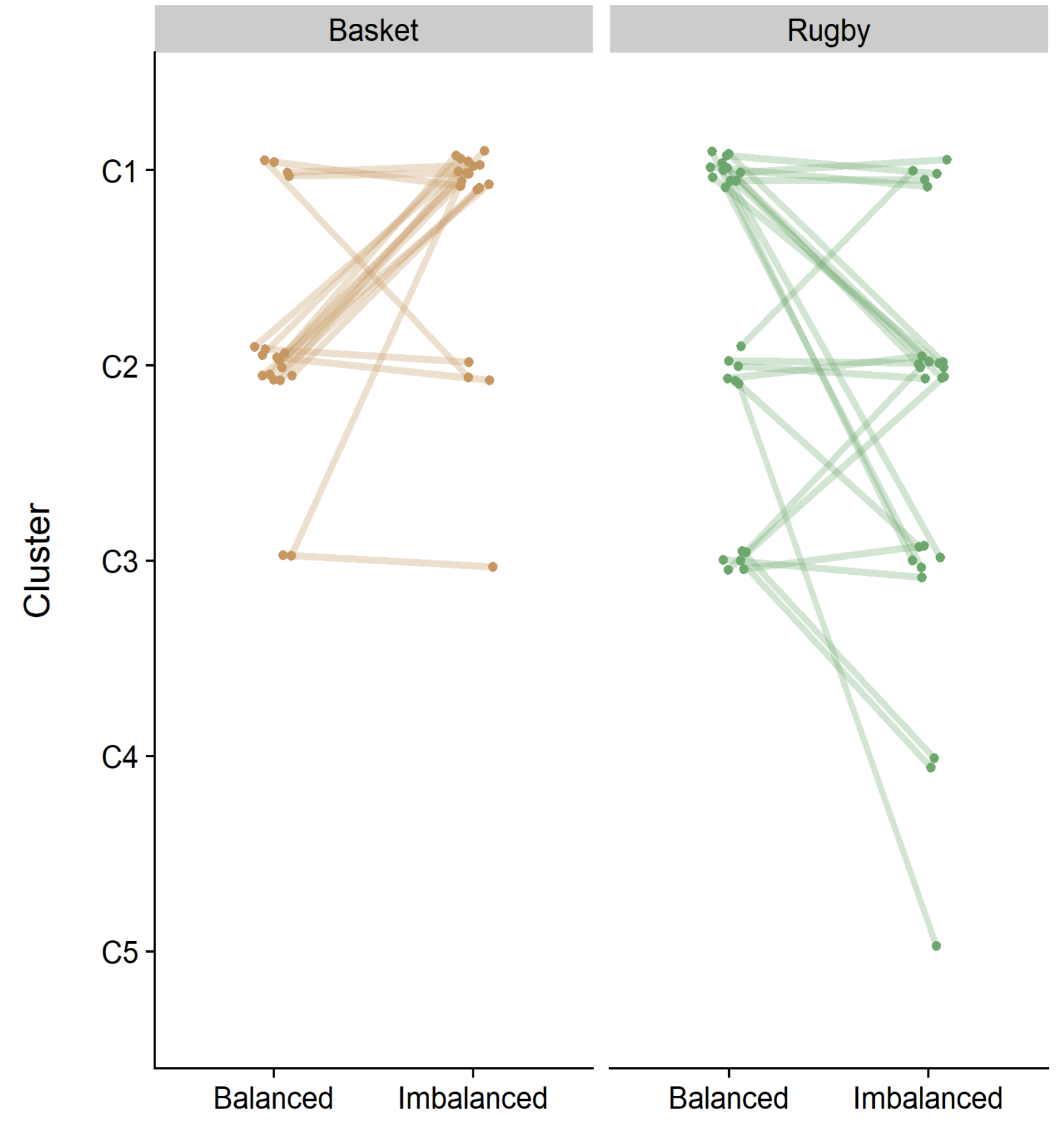
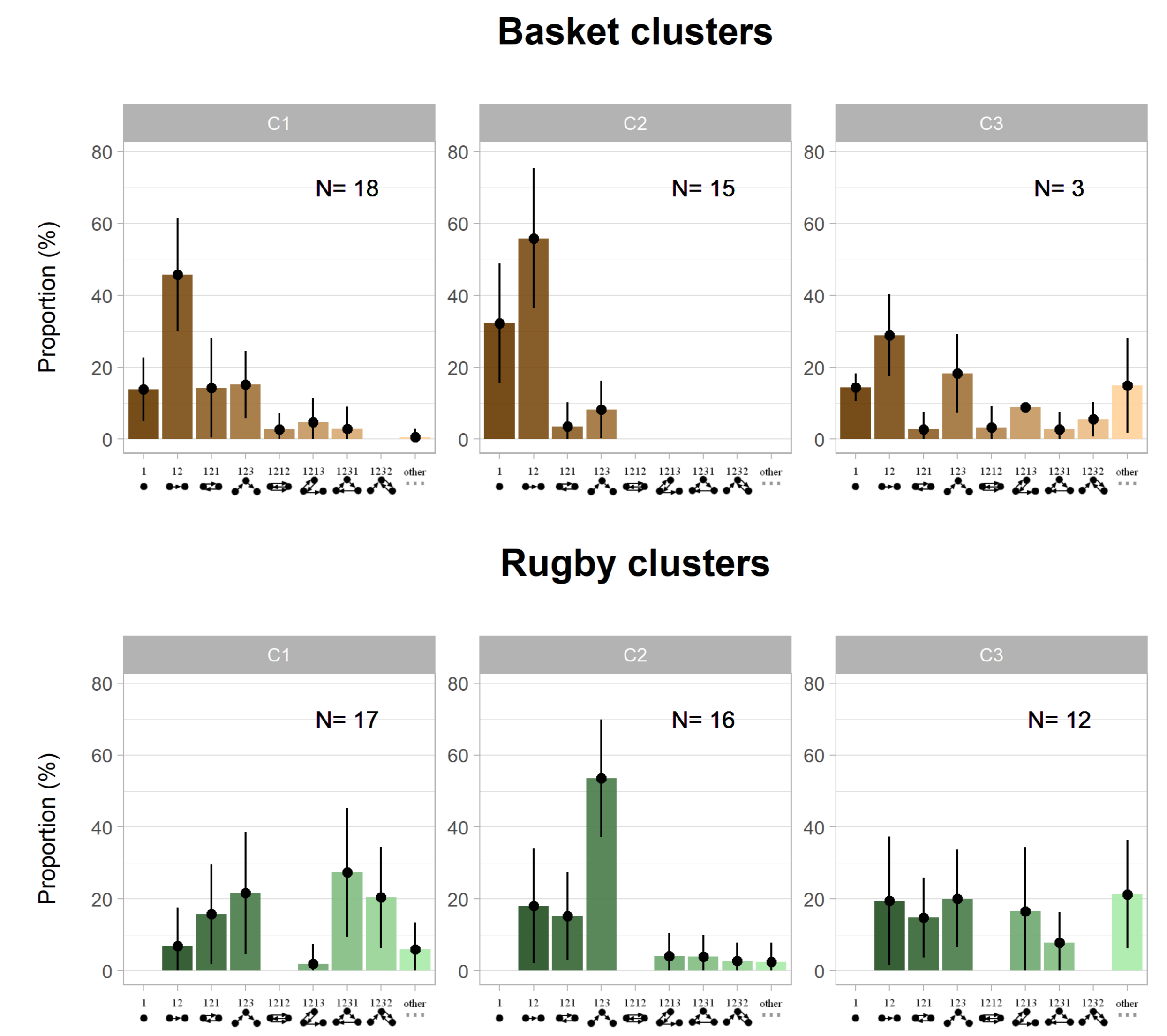
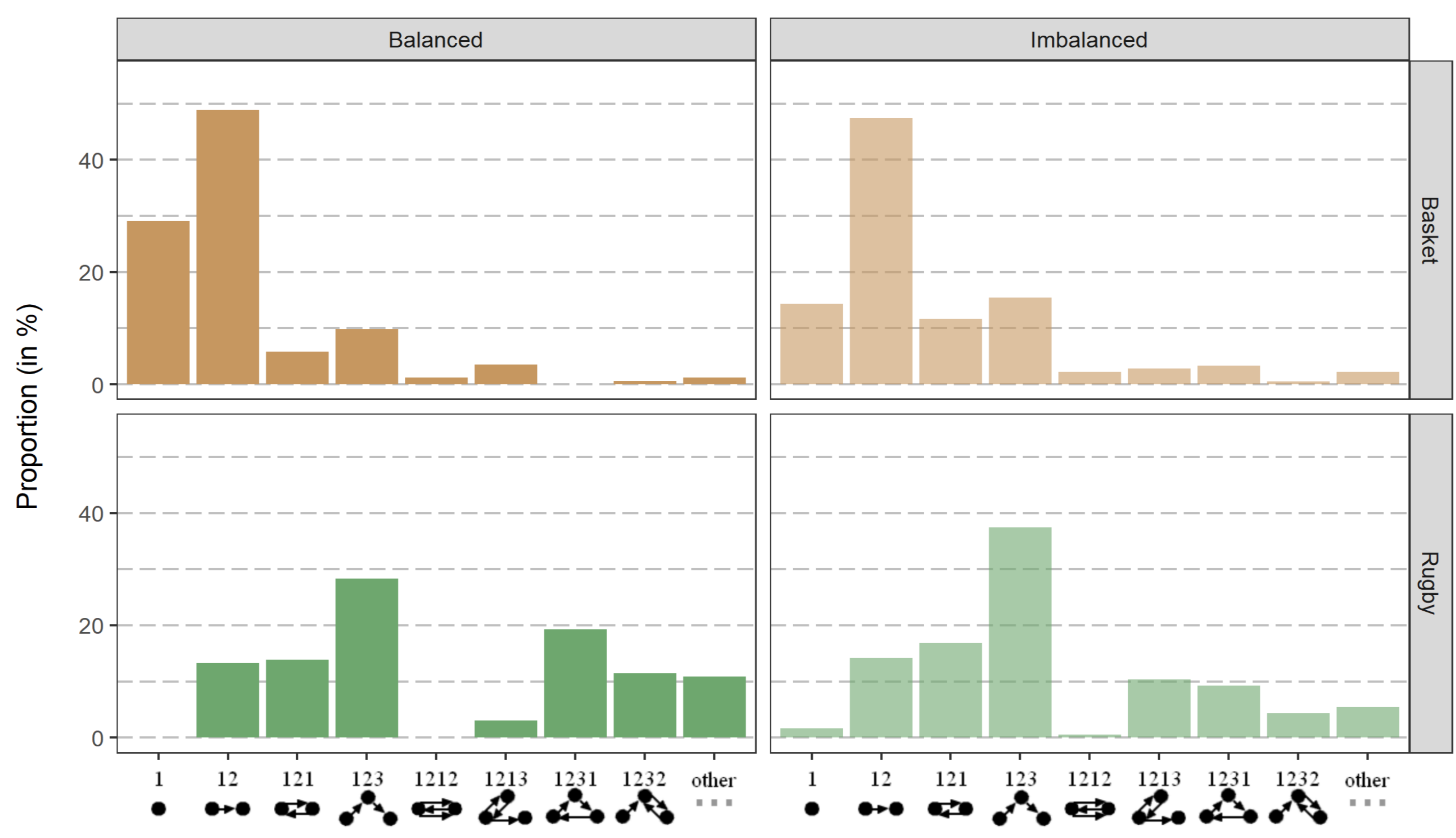
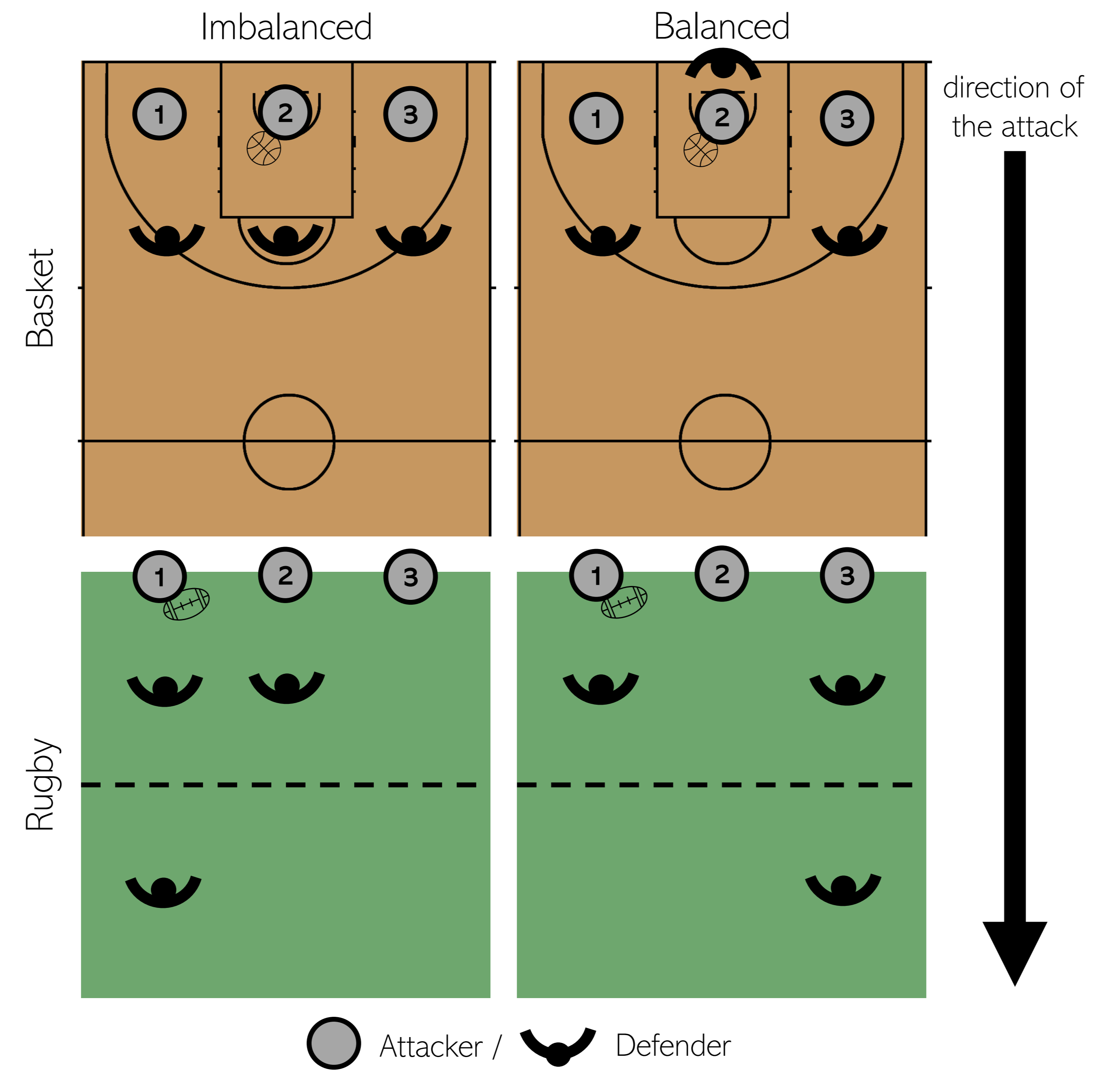
24 rugby and 18 basketball teams of 3 young elite players repeated 24 times a controlled SSG (Small-Sided Game) played in 2 different situations (= 12 times each) characterized by 2 different levels of **defensive imbalance** (= high/low) induced by the defenders' positioning – see top/center figure.

Objectives & Methods

Each trial is characterized by a graphlet, then we computed **team profiles** (= 1 profile for the 12 trials of 1 team in 1 situation) and **average profiles** (= 1 profile for all trials in 1 situation, including all teams) on each sport...

- By comparing average profiles (with the χ^2 independence test) we compare sports, and we investigate the effect of defensive imbalance on the emergence of the collective behavior – see bottom/center figure.
- By clustering team profiles (with the Hartigan-Wong algorithm) and looking at the assigned cluster of each team in each situation, we aim to identify team signatures – see figures on the right part.

Note: we kept only trials in which rugby team scores a try (excluding 39% of the trials) and in which basketball team takes a shot (excluding 18%).



Basketball:
 14/18 (77.8%) assigned in C2 for 'imbalanced'
 12/18 (66.7%) assigned in C1 for 'balanced'
 with 10/18 (55.6%) sharing both assignment

Rugby:
 12/24 (50.0%) assigned in C1 for 'imbalanced'
 10/24 (41.7%) assigned in C2 for 'balanced'
 with 5/18 (20.8%) sharing both assignment

Discussion

On average profiles...

- Basketball and rugby teams can be differentiated by the patterns of passes used by the players (here with more complex ones and with more diversity in rugby).
- Playing situation affects collective behavior in both sports with a reinforcement of the main pattern's prevalence ('12' in basket, '123' in rugby) as the level of imbalance increases.

⇒ Differences may be due to the nature of the two sports, but also to differences in the design of our situations as it is impossible to have the exact same 2 situations in 2 different sports (e.g. basketball situations looked like counter-attacks while rugby ones were more like transition).

On team profiles...

- The basketball teams' clustering mostly matches to the level of defensive imbalance, showing a significant effect of this constraint.
- The rugby team's clustering solution is more complex, but it explains a greater proportion of the variance, and reveal more teams signature, with more diversity of behavior,

References:
¹ Silva, P. et al (2016). Sports teams as complex adaptive systems: manipulating player numbers shapes behaviours during football small-sided games. *SpringerPlus*, 5, 1-10.
² Hughes, M., & Franks, I. (2005). Analysis of passing sequences, shots and goals in soccer. *Journal of sports sciences*, 23(5), 509-514.
³ Pržulj, N., Corneil, D. G., & Jurisica, I. (2004). Modeling interactome: scale-free or geometric? *Bioinformatics*, 20(18), 3508-3515.