

Head Acceleration Events:

a training perspective



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10:10 to 10:55

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Structure.

1. Innovation Hub Data:

- training HAE numbers relative to match HAEs.
- Data into decisions.

2. Translation.

- In support of player load management and coach education, how can we translate and create messages that help coaches understand HAE risk in order to manage it better?
- Challenging assumptions.

3. Feed forward.

- What do we do next, as a follow up, with the intention of trying to answer what is unknown?

Purpose



Cardiff Met MetCaerdydd



To assess HAEs in contact training and match play and use these data to

enhance coach-player learning linked to technique and skill development.

iMG Data.

- 39 players
- 62 training sessions
- 18 games
- Total number of impacts over the duration of the study = 3822



Findings.

Objective 1: Differences between training & competition

PAA values much greater
in games ($p < 0.001$).



Objective 2: Differences between four positional groups.

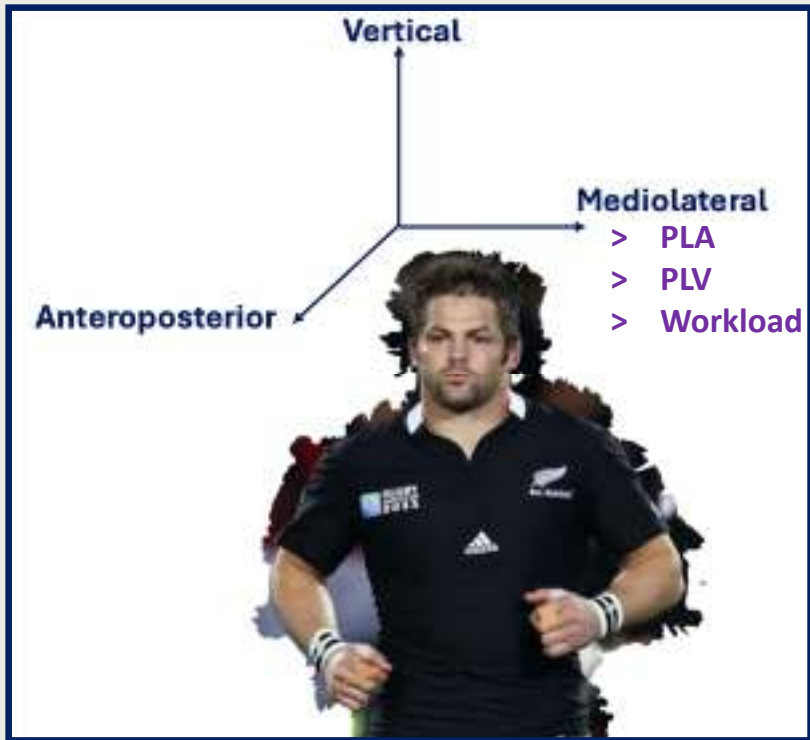
Front Five greater values for PAV
($p < 0.001$).

Back row significantly greater values for
PLA & PAA ($p < 0.001$) compared to
front row, inside & outside backs.

Back row significantly greater for all
data compared to inside backs, &
greater PLA & PAA values compared to
outside backs ($p < 0.001$).



Objective 3: Differences between directions of head contact.



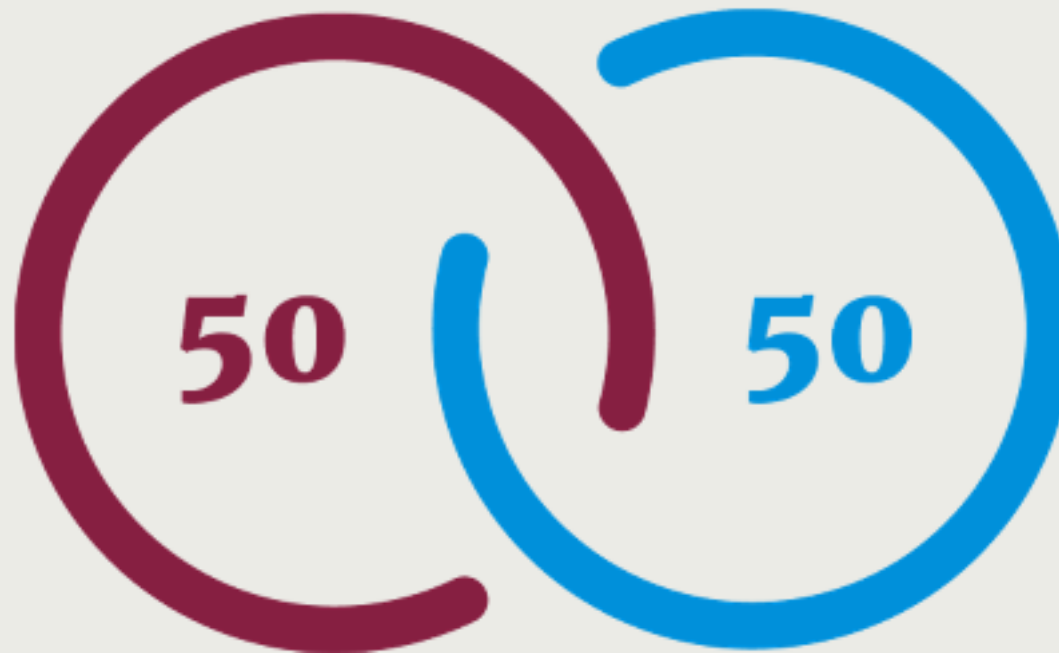
Mediolateral contacts significantly greater ($p < 0.001$) than vertical & anteroposterior in relation to PLA, PLV & Workload.

Consistency in contact & the need 'to get lower'



Challenging Assumptions

Little HAE in training so why does contact need to be reduced?

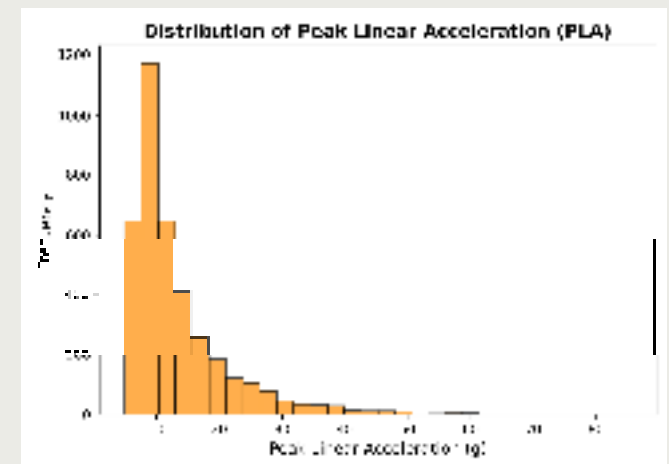
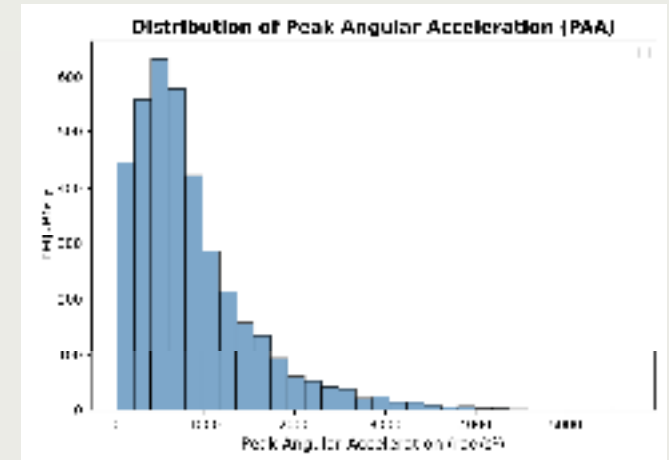
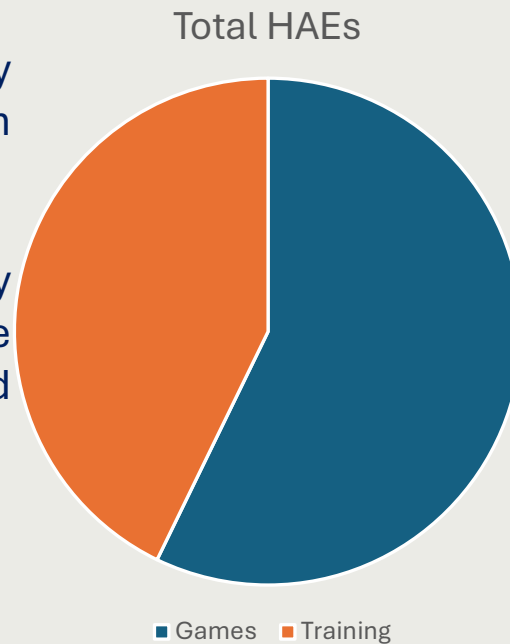


Training: n = 1921

Distribution of HAEs (n = 3,822)



- **Linear accelerations:** tightly clustered, less variation between impacts.
- **Angular accelerations:** widely distributed — important because rotational forces drive brain strain and help identify higher-risk events.



Takeaway:

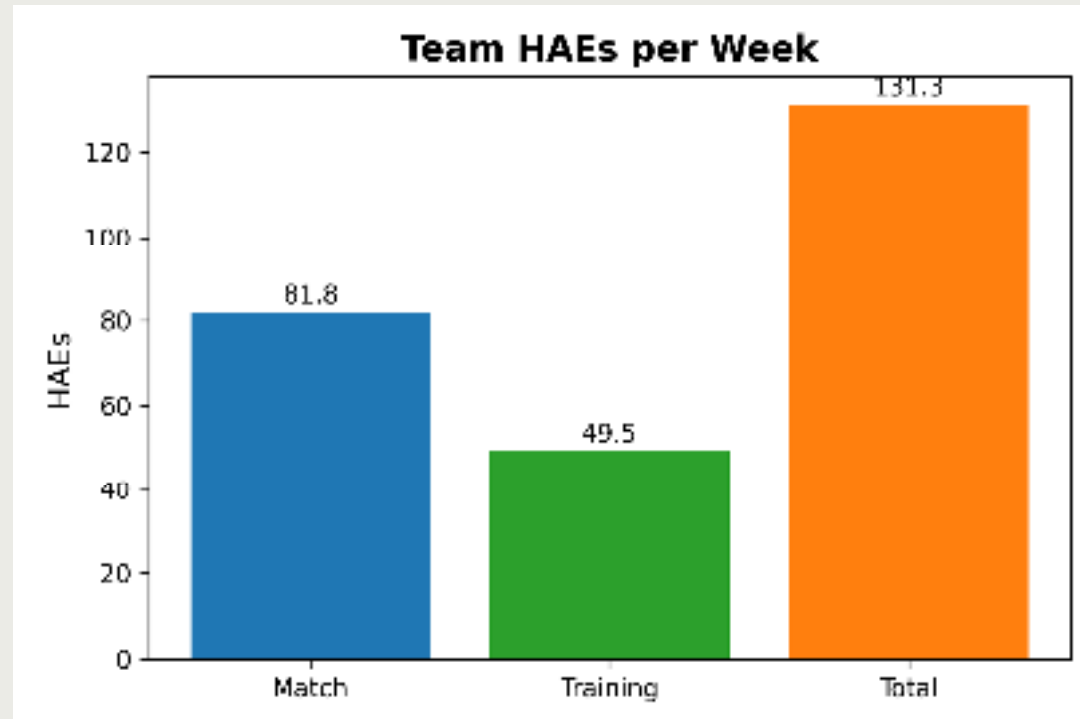
- Matches account for most HAEs, but **training remains a significant contributor to exposure.**

Team Level Exposure

Team: 82 HAEs per match → The total number of head acceleration events for the team in a 'average' single match.

Training HAEs (per week): 49.5 → The total number of HAEs the team experiences across all training sessions in a week.

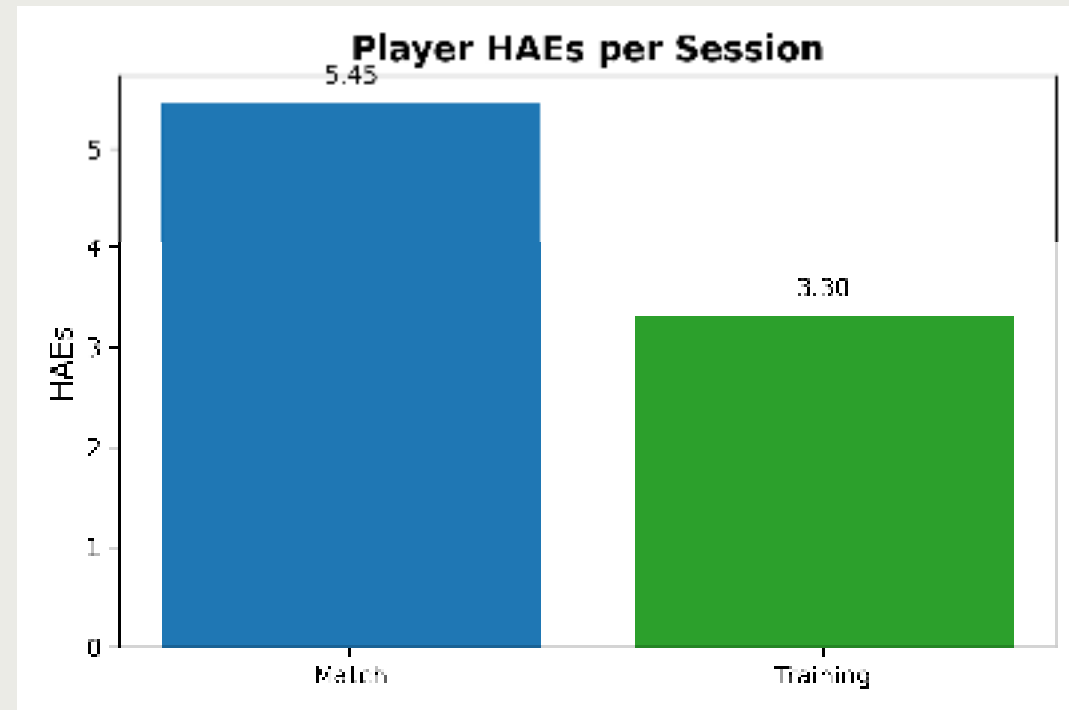
Total weekly HAEs (team): 131.3 → Combined team exposure from both matches and training within one week.



Player-Level Exposure

HAEs per match (per player):
5.45 → Average number of HAEs
 a single player experiences in
 one match.

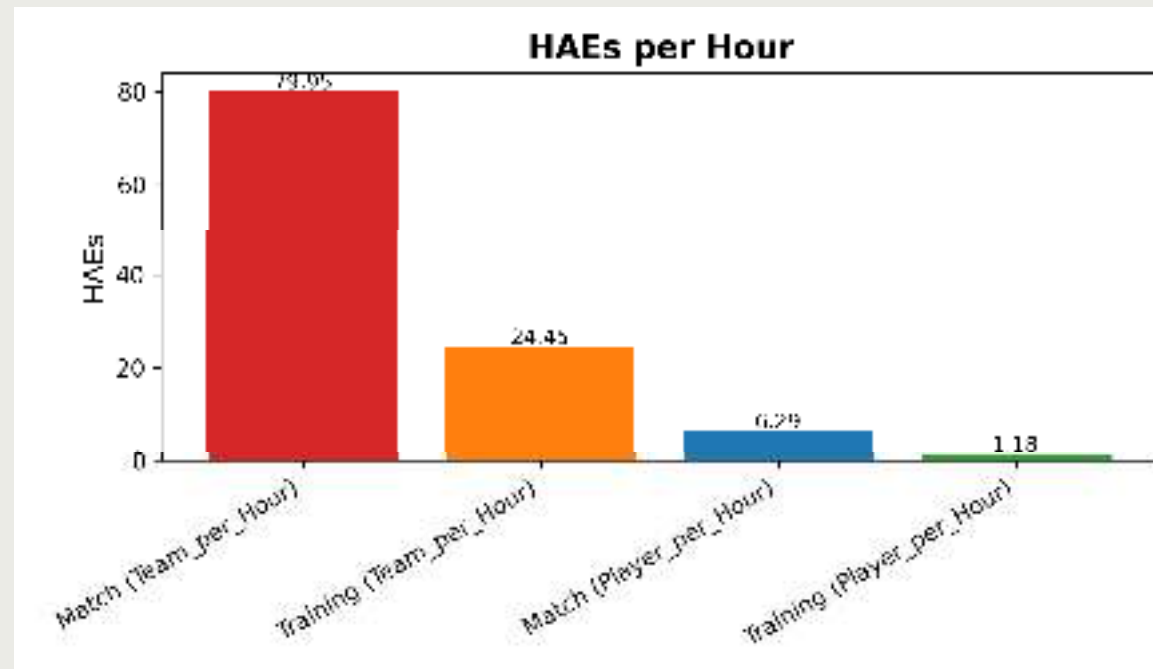
HAEs per training (per player):
3.30 → Average number of HAEs
 a single player experiences in
 one training session



HAEs per Hour



- Team per hour (match): 79.95 → The team experiences **about 80 HAEs for every hour of match play.**
- Team per hour (training): 24.45 → The team experiences about **24 HAEs for every hour of training.**
- Player per hour (match): 6.29 → A single player averages about **6 HAEs per hour of match play.**
- Player per hour (training): 1.18 → A single player averages about **1 HAE per hour of training.**

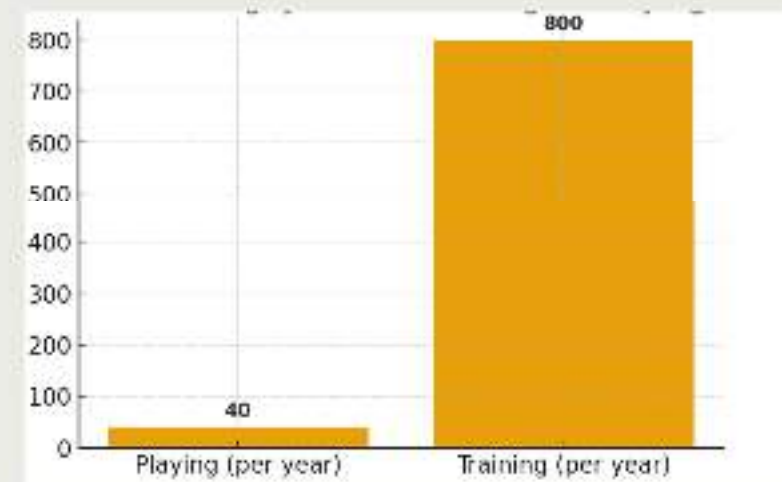


Training summary

- Matches drive peak exposure: $\sim 2\times$ more HAEs per hour than training $\rightarrow$ explains why matches dominate despite less total time spent in them.
- **Training still significant ($\sim 40\%$ of weekly HAEs) because of higher overall volume.**
- Hourly rates highlight matches as highest-risk periods.
- Player view: $\sim 5\text{--}6$ HAEs per match vs ~ 3 per training session.
- **Both contexts must be considered in player welfare management**

Training reality

- **Playing time**
 - 20–30 matches per season
 - 30–40 hours of actual game time per year.
- **Training time**
 - 4–6 days a week during the season.
 - 15–25 hours of structured work per week.
 - 600–1,000+ hours of training and preparation.
- **Ratio of training to playing**
 - 20:1 or more geared to training.
 - For every minute spent competing in a match - **20+ minutes training.**



Training Drill Intensity

Objective 4: To develop a contact skills model as an exemplar of best practice.



Activity	Peak Linear Acceleration (PLA, g)	Peak Angular Acceleration (PAA, rad/sec ²)	
1-1 (Prep) Clamp-Drive-Roll	6.6	376	<10g
8-1 (Prep) Win The Corner - Stay Square	6.6	410	
3-1 (Prep) Shoulder Settle	6.7	430	
6-1 (Prep) Shoulder Settle - Roll-out	6.8	480	
3-1 (Prep) Hook & Handle	6.9	447	
7-1 (Prep) 4 Way Angle Drive	7.1	470	
23-1 (Tel Fatigue) 2 mtr TEST	7.1	499	
19-1 (Tel Prep) D&R Pop Ups 2	7.3	470	
38-1 (Tel Multi) Multi Drill 2	7.3	616	
9-1 (Prep) Pummel-Under-Over - 1	7.4	528	
18-1 (Tel Prep) D&R Pop Ups	7.4	528	
3-1 (Prep) Roll & Re-Roll	7.5	489	
11-1 (Prep) Pummel-Tight	7.7	353	
22-1 (Tel Fatigue) 1 mtr TEST	7.7	673	
10-1 (Prep) Pummel + Bounce	7.8	305	
21-1 (Tel Prep) D&R Pop Ups 3	7.8	305	
4-1 (Prep) Roll & Counter	7.9	596	
20-1 (Tel Prep) D&R Pop Ups Ground	7.9	570	
37-1 (Tel Multi) Multi Drill 1	8.2	826	
24-1 (Tel Fatigue) 3 mtr TEST	8.3	306	
12-1 (Prep) High 2 Front-Clamp]	8.7	309	10-13.5g
28-1 (Tel Fatigue) 5 mtr TEST 3	8.7	309	
39-1 (Tel Multi) Multi Drill 3	9.6	139	
29-1 (Tel Fatigue) 5 mtr TEST 4	10.3	403	
26-1 (Tel Fatigue) 4 mtr TEST	10.4	540	
32-1 (Tel Efforts) Bounce & 3 Tackles + Override]	10.5	940	
28-1 (Tel Fatigue) 5 mtr TEST	10.7	522	
43-1 (BrkD) L&R Clean-outs	11	535	
34-1 (Tel Efforts) Bounce & 3 Tackles + Override 2	11.1	688	
13-1 (Tel Prep) W&R Heavy- Straight Drive]	11.3	634	
16-1 (Tel Seq) W&G L3 - Bounce-Angle-Connect	12	701	
47-1 (BrkD) Triple Fatigues 4 + TH	12	778	
46-1 (BrkD) Triple Fatigues 3 + TH	12.1	826	
17-1 (Tel Seq) W&G L2 - Bounce-Angle-Connect	12.2	652	
41-1 (Tel Mat) 2 Player Decision TH	12.2	575	
44-1 (BrkD) Triple Fatigues	12.6	658	
35-1 (Tel Efforts) Bounce & 3 Tackles + Override 4	13.2	967	13.5+
31-1 (Tel Efforts) Bounce & 3 Tackles	13.4	466	
14-1 (Tel Prep) W&R Heavy-Angle Tackle	13.5	561	
27-1 (Tel Fatigue) 5 mtr TEST 2	13.5	561	
45-1 (BrkD) Triple Fatigues 2	13.6	758	
40-1 (Tel Mat) Bounce L&R Shoulder	14	953	
42-1 (BrkD) Low Level Clean-out	14	953	
49-1 (BrkD) Micros-Live	14	953	
33-1 (Tel Efforts) Bounce & 3 Tackles + Override 2	14.1	1126	
48-1 (Tel-BD) Tackle Mini Back	14.3	500	
36-1 (Tel Efforts) Bounce & 3 Tackles + Override 5	14.4	887	
35-1 (TH Seq) W&R Heavy-Roll & Counter	16.8	1578	
50-1 (BrkD) Tackle + Mini BD	17.2	992	
52-1 Micro Live Tackle + Mini BD	18.3	1082	
51-1 (BrkD) Tackle + Mini BD 1	18.8	1244	
53-1 Micro Live Tackle + Mini Def BD	19	707	
54-1 Tunnel Pressure + Stay Strong	19.1	869	
55-1 Live Mat Tackle Micros	19.3	1589	



World Rugby Drills v CMU Drills – *differences.*



Higher contact load and intensity at >10g drills.

Greater demands on backward, down & up movements, & chasing feet once tackle is made.

Use of low-level heavy tackle bag.

Greater onus on grip strength in grappling drills using modified equipment.

Greater reactive agility demands.

Greater demands on decision making & judgement due to the use of over-ride contact calls.

Contact Skills Model?

1.

- Movement

2.

- Body Position / Level of Change

3.

- Grappling

4.

- Controlled Contact (equipment)

5.

- Full Contact

A five-level model could be implemented to enhance player, coach & match official learning, and a contact loading monitoring 'tool.'



Until they have the technique, how can they play a game?

Players seem to ***choose the wrong “technique”*** at key moments.

Many of the ***drills used do not transfer to the real game.***

Techniques seem to ***break down under pressure.***

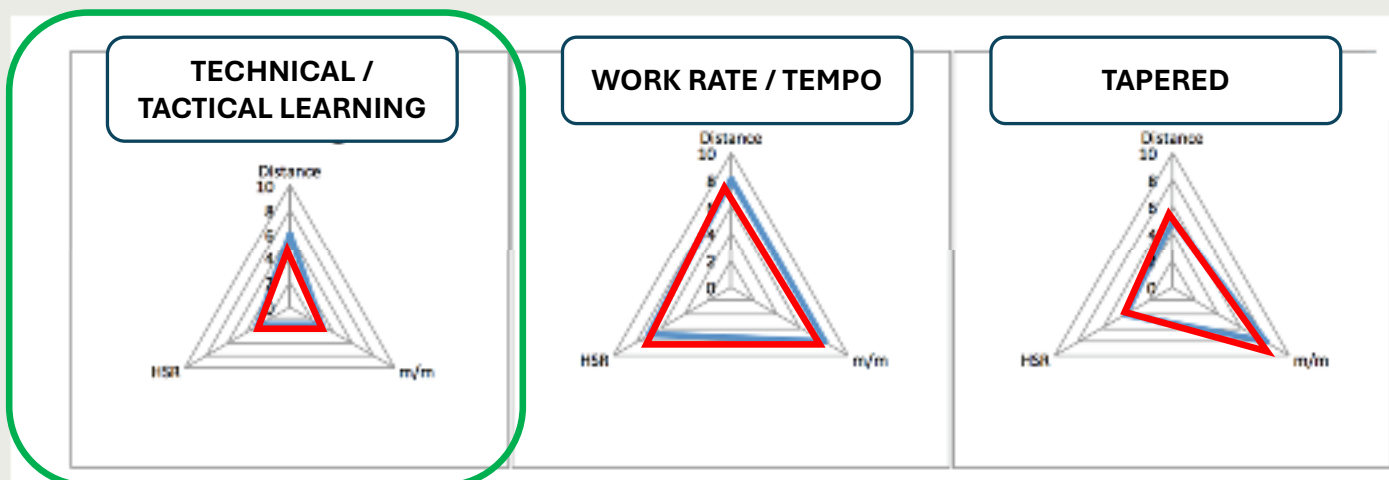
How much time do we spend on **Tackle Technique & contact skills?**



Planning changes:

Week	11	12	13	14	15	16	17	18	19	20
Date	1/9	8/9	15/9	22/9	29/10	6/10	13/10	20/10	27/10	3/11
	Tactical Periodisation:									
	ATTACK			DEFENCE				TRANSITIONS		
	Technical Periodisation:									
	CORE			UNIT				POSITIONAL		
	Physical Periodisation:									
	Physiological			Strength / Power				Functional		

Precautionary Principle – micro





- Re-design of session structure to chase the continued development of individual contact skills using a Micro/Meso/Macro theme.
- Rationale: following a discussion between coaches and players there was a consensus that sessions would often have the feel of continued game prep as opposed to any focus on individual, unit or team development.
- micro detail of specific skills to develop player abilities, these sessions would progress into –
- Meso activities which would be small-sided games/scenarios designed to develop and focus on the skill,
- Macro sessions which are your more 15v15 activities.



Pre-Season

WEEK 1 THEME: HONESTY

Monday			Tuesday	Wednesday	Thursday		Friday
29th			30th	31st	1st		2nd
Physio & Admin Team Meeting (LT1)			Physio & Admin	No Training	Physio & Admin		Physio & Admin
S&C - Flip Flop (APC)	Rugby Skills (3G)		S&C - ALL (APC)		S&C - Flip Flop (APC)	Rugby Skills (3G)	S&C - ALL (APC)
BREAKFAST 09:30 - 10:15					BREAKFAST 09:30 - 10:15		
Mental Reset Meeting (LT1)			Team Meeting (LT1)		Team Meeting (LT1)		Team Meeting (LT2)
Rugby - Micro Attack (3G)			Rugby - Meso Attack (3G)		Rugby - Micro Defence (3G)		Rugby - Meso Defence (3G)
Rugby - Meso Attack (3G)			Hybrid Session (3G)		Rugby - Meso Defence (3G)		Hybrid Session (3G)
LUNCH 12:30 - 13:15					LUNCH 12:30 - 13:15		
S&C - ALL (APC)			Expectations Workshop (LT1, C014, C015, C017, V007, V008)		S&C - ALL (APC)		Team Meeting (LT2)
							Frappe Friday



Maximising Welfare and Minimising Harm....

- Pre-season sessions were broken into 45min Micro, Meso or Macro sessions. The sessions were well received and subjectively it appeared to give the response that we were looking for.
- Inevitably when moving into the season, time constraints were a factor and session design changed to include a variety of combinations across the 3 weekly sessions.

In-Season



	BSR	Prem
Monday	30 min Units 20 min Micro (3 stations) 15 min Meso 15 min Macro	
Tuesday	Team Prep	15 min Micro 10 min Meso 10 min Team Prep Mixed with blocks of running
Friday	15 min Micro 10 min Meso 10 min Team Prep Mixed with blocks of running	Team Prep



1. Being in control at the tackle area and breakdown.
2. Level change - dropping under the ball in defence.
3. Consistency of contact load & intensity.
4. Quality of execution – managing contact not creating collision.

- **5hrs per week** on Micro skills, this will include a variety of basic skills such as handling, tackling, contact area, etc.
- **Contact skills (Tackling & breakdown) will be about 50% of the work.** Looking through footage from last season for some of our micro blocks around contact area and tackle, the average player would spend 10minutes in a tackle block which would probably consist of 2/3 different activities for up to 3 mins a piece – in these blocks a player would likely make between **8-10 tackles per 3 mins**, therefore in the total **10 min block** they are likely to have about **25-30 tackle opportunities**.
- In a normal **Contact Area block of 10 minutes** a player would typically be involved in between **12-15 breakdowns**.



Mid Point - Season



Compared to mid point of previous season: **end of season**

- Concussions 44% decrease - **< 34%**
- Upper Body Injuries 80% decrease - **< 67%**
- Lower Body Injuries 12% decrease - **< 12%**
- Contact injuries 51% decrease. – **< 46%**
- **Key factor in injury reduction** – coaches spending twice as much time on micro (individual contact technique) compared to meso (5 v 3 or 6 v 4) and macro (15 v 15).



Coaching reality:

- Building up the game (understanding).
- Breaking down principles – (to ensure clarity).
- All training factors emerge from, and contribute to, tactical performance (Alfonso *et al.*, 2020).
- Therefore, analyse training.....

Player Availability



Inclusive process:



High quality technical coaching



Coaching

Laws

Medical

Science

Coaching

*Changing coaching behaviors by connecting with tangible
performance benefits*

Feed forward

- How do we balance maximising player safety with maintaining the integrity and flow of the game?
- How much uncertainty is acceptable before mandating new tech in training? Is it ethical to delay adoption and risk player health?
- What cumulative training exposure (in magnitude, frequency, and angular vs linear acceleration) is “safe” or tolerable, over a career?
- How do we best set thresholds (possibly different by age, sex, position) that balance sensitivity vs specificity?

Thank you

World Rugby (Player Welfare Guidance):

“Managing and monitoring **training** and match loads is essential to reducing injury risk and supporting player welfare.”

Questions?

