University of Hertfordshire UH

LINCE PLUS

Software for observational studies for Sport and Health

Performance Analysis Workshop

Xavier Iglesias

LINCE PLUS authors: Alberto Soto, Oleguer Camerino, Marta Castañer, Xavier Iglesias & M.Teresa Anguera

inefc Institut Nacional d'Educació Física de Catalunya Barcelona

Generalitat de Catalunya

INEFC Barcelona Sport Sciences Research Group

https://inefcresearch.wordpress.com/

GOBIERNO DE ESPAÑA MINISTERIO DE UNIVERSIDADES

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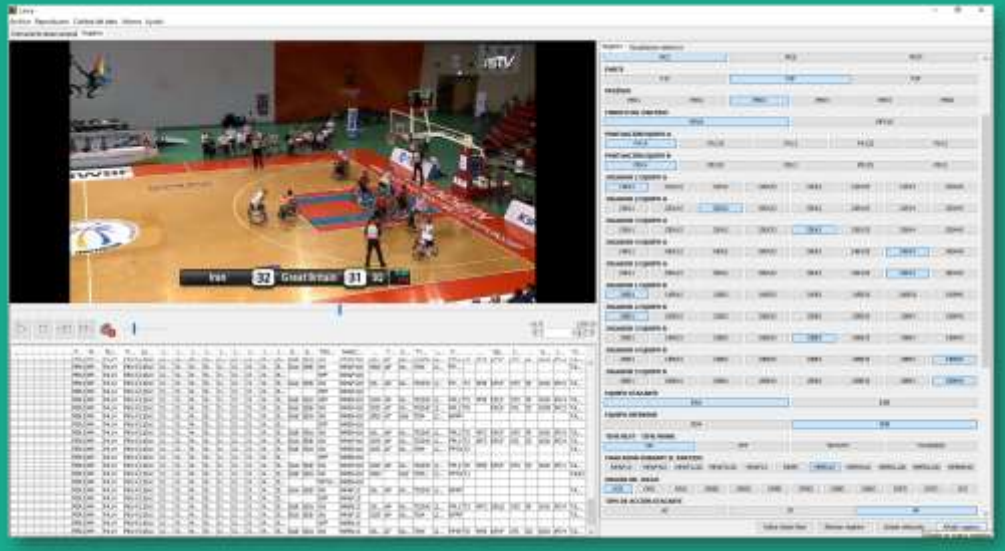
Performance Analysis Workshop

1. Theoretical presentation of the concepts of observational methodology
2. LINCE PLUS operation workshop
3. Examples of research studies conducted with LINCE PLUS

1. Theoretical presentation of the concepts of observational methodology

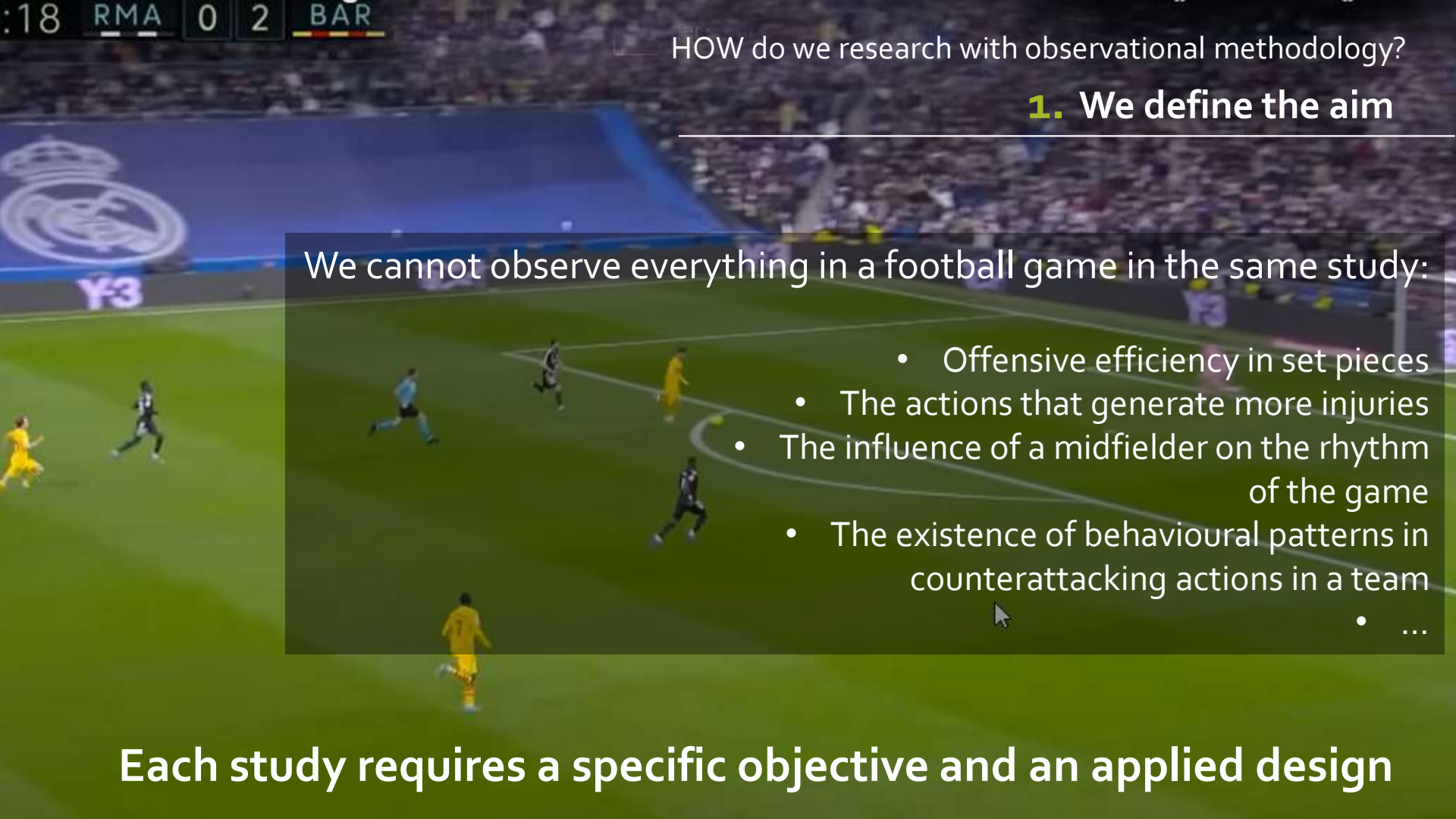
WHAT is observational methodology?

- The procedure by which we perform an objective and systematic record of the behaviours generated in certain contexts.



HOW do we research with observational methodology?

1. We define the aim
2. We define the type of design
3. We select/create the observation instrument
    a) We define the unit of observation
    b) We determine criteria and study categories
4. We decide the registration instrument
5. We analyse the Validity & Realiability
6. We record the behaviours
7. We analyse the results
8. We interpret the results (discussion)



HOW do we research with observational methodology?

1. We define the aim

We cannot observe everything in a football game in the same study:

- Offensive efficiency in set pieces
- The actions that generate more injuries
- The influence of a midfielder on the rhythm of the game
- The existence of behavioural patterns in counterattacking actions in a team
- …

Each study requires a specific objective and an applied design

2. We define the type of design

Research design is the methodological strategy that we decide to respond to our objective

The structure of observational designs is configured based on three criteria:

- Temporality
  - **Punctual:** Static (One session)
  - **Follow-up:** Dynamic (Different sessions - progression)
- Observed units
  - **Idiographic:** A participant or a team as a whole
  - **Nomothetic:** More than one participant or team simultaneously
- Dimensionality
  - **One-dimensional:** One level of response
  - **Multidimensional:** Two or more levels of response

(Anguera, Blanco-Villaseñor, Hernández Mendo, & Losada, 2011)

3. We select/create the observation instrument

a) We define the unit of observation

As the behaviours are continuous in time, we have to observe them in segments that give coherence and systematics to the observation system.
Each "observation unit" corresponds to a record; a "line" of the data matrix resulting from our analysis

For example, we can analyse as a unit of observation in basketball:
Only throwing actions where points are scored
Shooting actions for a basket, whether or not they are effective
All behaviours during possession of the ball

1	[illegible]	Acción	ICACIA MARCA	ICACIA TACT	n ofensiva	Defensa utilizada	defensor de b1	defensor de b2	Tiempo	posición	ZONABLOQ	forma	tipo de bloqueo	Transicion ofensiva
2	Rival	Bloqueo	NO_CAN	SI_TAC	1CUAR	HH	PERS	F_HOR	B16	C9	C	FREN	VER	A_POS
3	Rival	Tiro	NO_CAN	SI_TAC					C8		B			
4	UNICAJA	Bloqueo	NO_CAN	SI_TAC	1CUAR	HH	PAS_2	F_VER	B16	B6	B	FREN	VER	A_POS
5	UNICAJA	OTRA	NO_CAN	SI_TAC					C8					
6	Rival	Tiro	CAN	SI_TAC	REC				C8		A			CONT
7	UNICAJA	OTRA	NO_CAN	SI_TAC	1CUAR				B16					A_POS
8	Rival	OTRA	NO_CAN	SI_TAC	MED				B16					A_POS
9	Rival	Tiro	CAN	SI_TAC					C8		B			

TFr	DFr	Ts	Ms	PACIENT	INJ	TEST	EXO	FASE	EXEC	A.P.	A.M.
0	75	0:0:0.000	0	1	T4	6MWT	ABLE	PREP	PEU2	NO	NA
75	1325	0:0:3.000	3000	1	T4	6MWT	ABLE	EX	CAMI	NO	NA
1400	325	0:0:56.000	56000	1	T4	6MWT	ABLE	EX	GIR	NO	NA
1725	675	0:1:9.000	69000	1	T4	6MWT	ABLE	EX	PEU2	NO	NA
2400	125	0:1:36.000	96000	1	T4	6MWT	ABLE	EX	EST	NO	NA
2525	125	0:1:41.000	101000	1	T4	6MWT	ABLE	EX	PEU1	NO	NA
2650	725	0:1:46.000	106000	1	T4	6MWT	ABLE	EX	CAMI	NO	NA
3375	100	0:2:15.000	135000	1	T4	6MWT	ABLE	EX	PEU1	NO	A_AB
3475	100	0:2:19.000	139000	1	T4	6MWT	ABLE	EX	PEU2	AM	A_AB
3575	125	0:2:23.000	143000	1	T4	6MWT	ABLE	EX	CAMI	NO	A_AB
3700	575	0:2:28.000	148000	1	T4	6MWT	ABLE	EX	GIR	NO	A_AB
4275	300	0:2:51.000	171000	1	T4	6MWT	ABLE	EX	PEU2	NO	A_AB
4575	250	0:3:3.000	183000	1	T4	6MWT	ABLE	EX	EST	NO	NA
4825	450	0:3:13.000	193000	1	T4	6MWT	ABLE	EX	PEU1	AM	NA
5275	725	0:3:31.000	211000	1	T4	6MWT	ABLE	EX	CAMI	NO	NA
6000	75	0:4:0.000	240000	1	T4	6MWT	ABLE	EX	PEU1	NO	NA

3. We select/create the observation instrument

b) We determine criteria and study categories

Its structure consists of two elements:

- **CRITERIA:** are the different dimensions of the study. The "variables" of analysis.
  Examples: Type of defense, type of attack, technical execution...

- **CATEGORIES:** are the different manifestations that can exist within the same criterion.
  Example: In the criterion Type of defense: Individual, zone, mixed

The CATEGORIES of the CRITERIA must meet the following conditions:

- **Exhaustiveness:** all the CATEGORIES (behaviours, situations…) of a CRITERION necessary for our objective must be included.

For example: If in the criterion "Type of action" we define the categories: 1) Offensive and 2) Defensive … in some sports we make a **MISTAKE**, since we lack the category: **3) Counteroffensive**

- **Mutual exclusivity:** each one of the CATEGORIES of the same CRITERION corresponds to a specific behaviour of that criterion. We cannot select 2 categories (behaviours) of the same criteria.

For example: in the above criteria, we cannot include the categories: 1) Offensive, 2) Defensive, 3) Counteroffensive, 4) Effective 5) Not effective → We must build 2 criteria for those categories:

a) **Type of action:** 1) Offensive, 2) Defensive, 3) Counteroffensive
b) **Effectiveness:** 1) Effective 2) Not effective

Example of criteria and categories in tactical analysis of wheelchair fencing

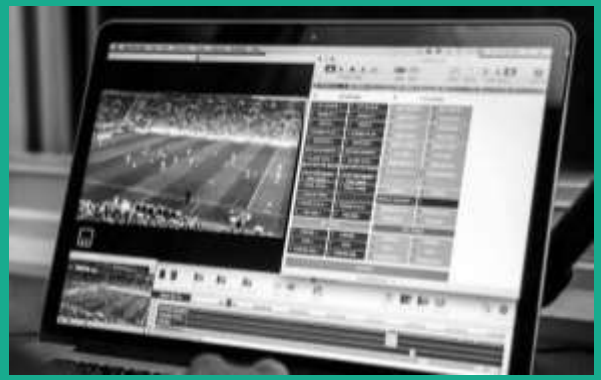
Criteria	Code	Category	Category definition	Type
TIME	ALLEZ	Allez	Allez/Play (The referee starts the bout)	Variable
TIME	HALT	Halt	Halt (The referee stops the bout)	Variable
ACTION 1	1OF_L	Offensive action Left (1)	Offensive action by the fencer on the Left (Action 1)	Variable
ACTION 1	1OF_R	Offensive action Right (1)	Offensive action by the fencer on the Right (Action 1)	Variable
ACTION 1	1DEF_L	Defensive action Left (1)	Defensive action by the fencer on the Left (Action 1)	Variable
ACTION 1	1DEF_R	Defensive action Right (1)	Defensive action by the fencer on the Right (Action 1)	Variable
TARGET 1	1ARM	Arm (1)	Arm (Action 1)	Variable
TARGET 1	1TRUNK	Trunk (1)	Trunk (Action 1)	Variable
TARGET 1	1HEAD	Head (1)	Head (Action 1)	Variable
TARGET 1	1UNDER	Under (1)	Off target: wheelchair or legs (Action 1)	Variable
DISPLACEMENT 1	1BACK	Lean Back & Recovery after lunge (1)	Lean Back & Recovery after lunge (Action 1)	Variable
DISPLACEMENT 1	1LUNGE	Lunge (1)	Lunge (Action 1)	Variable
DISPLACEMENT 1	1FORW	Lean forward (1)	Lean forward without lunge (Action 1)	Variable
DISPLACEMENT 1	1GUARD	On guard (1)	On guard or without leaning the body forwards or	Variable
TOUCHE 1	1T_V	Touche valid (1)	Touche valid (Action 1)	Variable
TOUCHE 1	1NV	Non-valid target (1)	Non-valid target (Action 1)	Variable
TOUCHE 1	1NT	No touche (1)	No touche (Action 1)	Variable

4. We decide the registration instrument

It is the means by which we record the behaviours defined in the observation instrument

It can be a template and a pencil…
or a computer program

DARTFISH
sportscode ANALYTICS
ERIC



Some of these programs are widely used, but sometimes they can be very expensive for some teachers, students, coaches or sports clubs with low budgets.

That is why we have created **LINCE PLUS**

Lince

Observation Tool

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SCAN ME

2. LINCE PLUS operation workshop

SCAN ME

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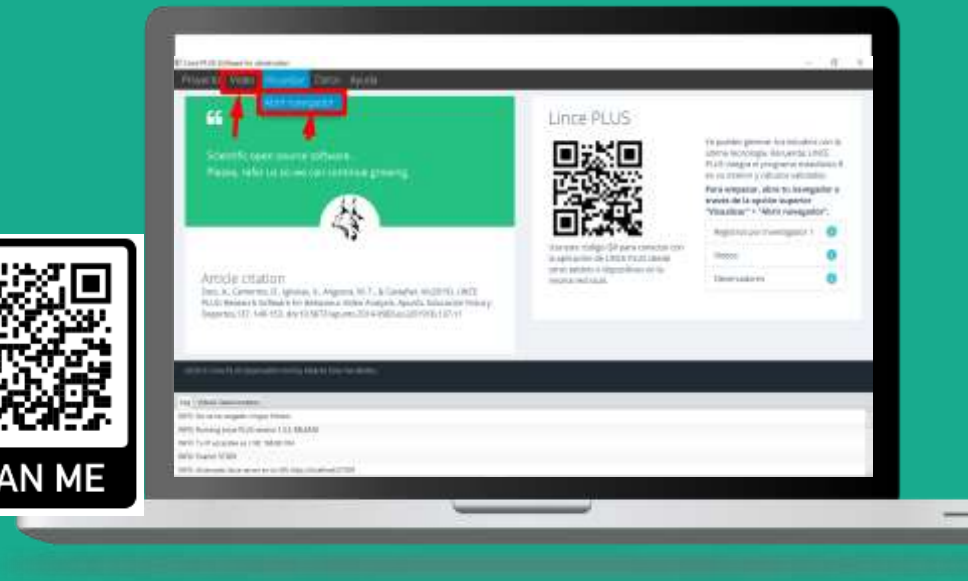
LINCE PLUS
Installation & execution

- Go to the download website
- Download the latest version for MacOS or Windows
- Accept the installer
- Run as an application
- Upload the videos you want

SCAN ME



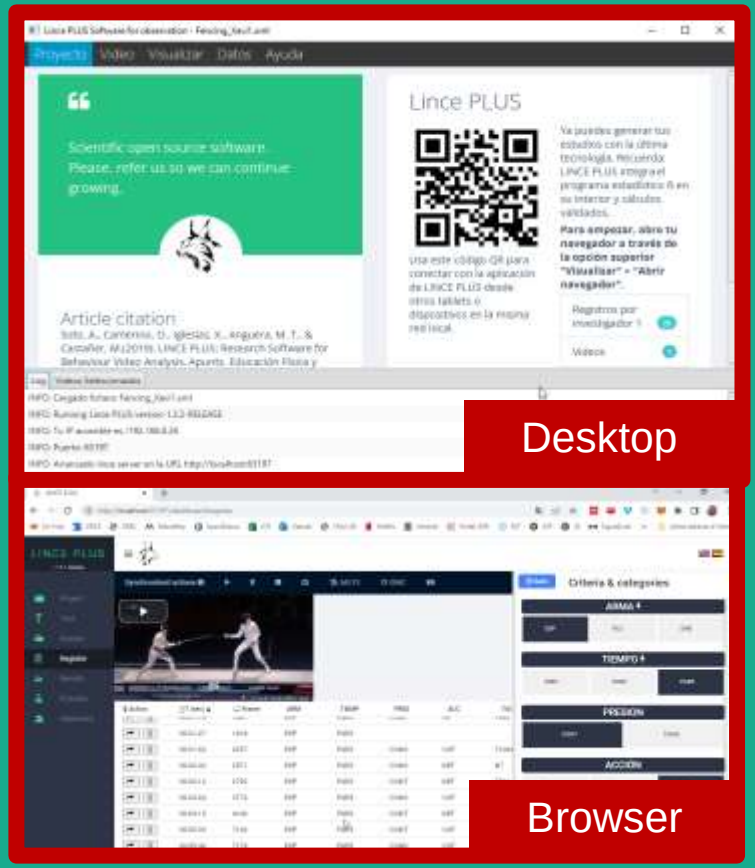
https://observesport.github.io/lince-plus/

LINCE PLUS
Desktop & browser

- Desktop program and web application, in the browser

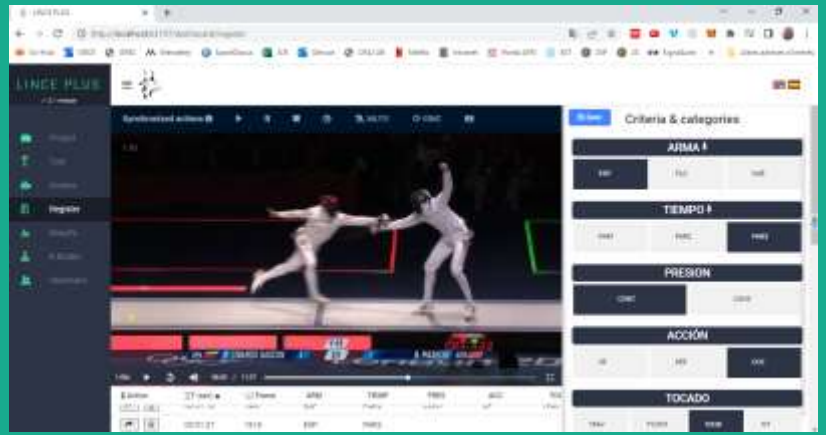
- We will always work in the browser window.You need to refresh the browser to save some changes

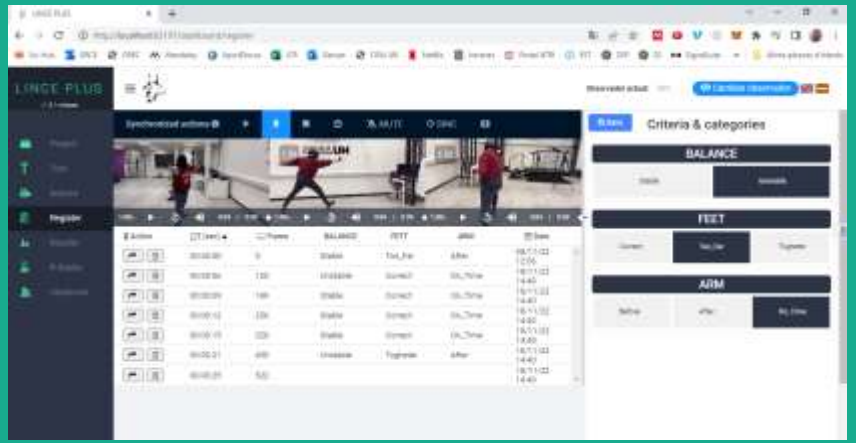
- It is important to SAVE the file in the desktop app



LINCE PLUS
Videos

- Videos must be uploaded.
- The videos are displayed in MP4 but can be uploaded in any format.
- The program converts the uploaded video to MP4 format, so the first time the process may take a little time.
- Can be recorded with 1, 2 or 3 synchronized videos

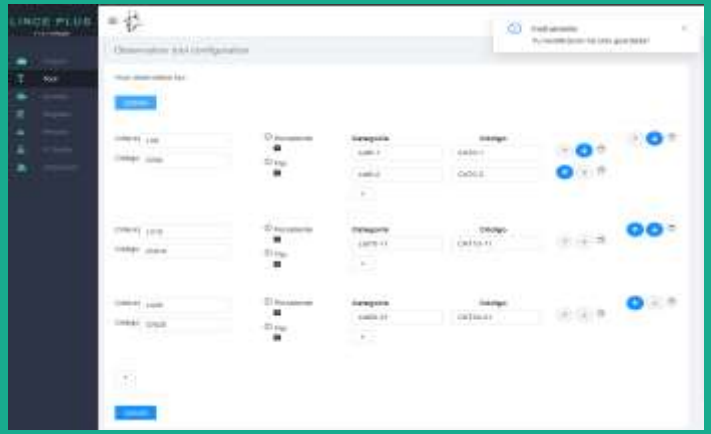




LINCE PLUS
Observation tool design

SCAN ME

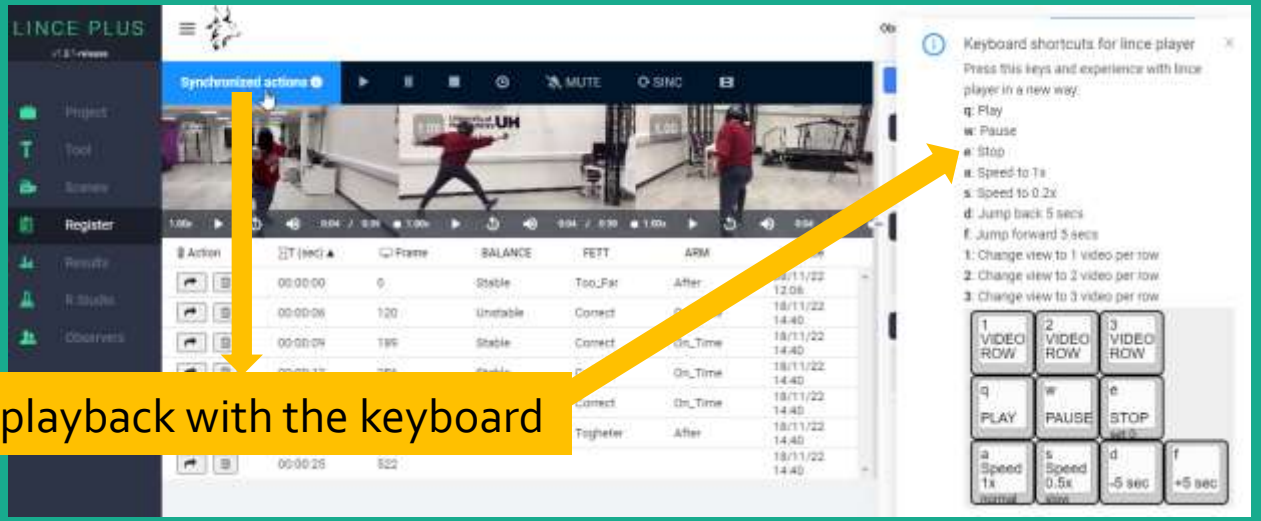
- The instrument can be generated automatically
- You can also import any previous design
- Please remember: It must be a stable instrument. If you do episode recording and remove observed criteria…inconsistency in the study!
- You can add additional observers in the project option.



LINCE PLUS
Recording

SCAN ME

- Access the "Register" menu option to define the criteria and categories observed for each observation unit.
- Define your watched criteria and update the register



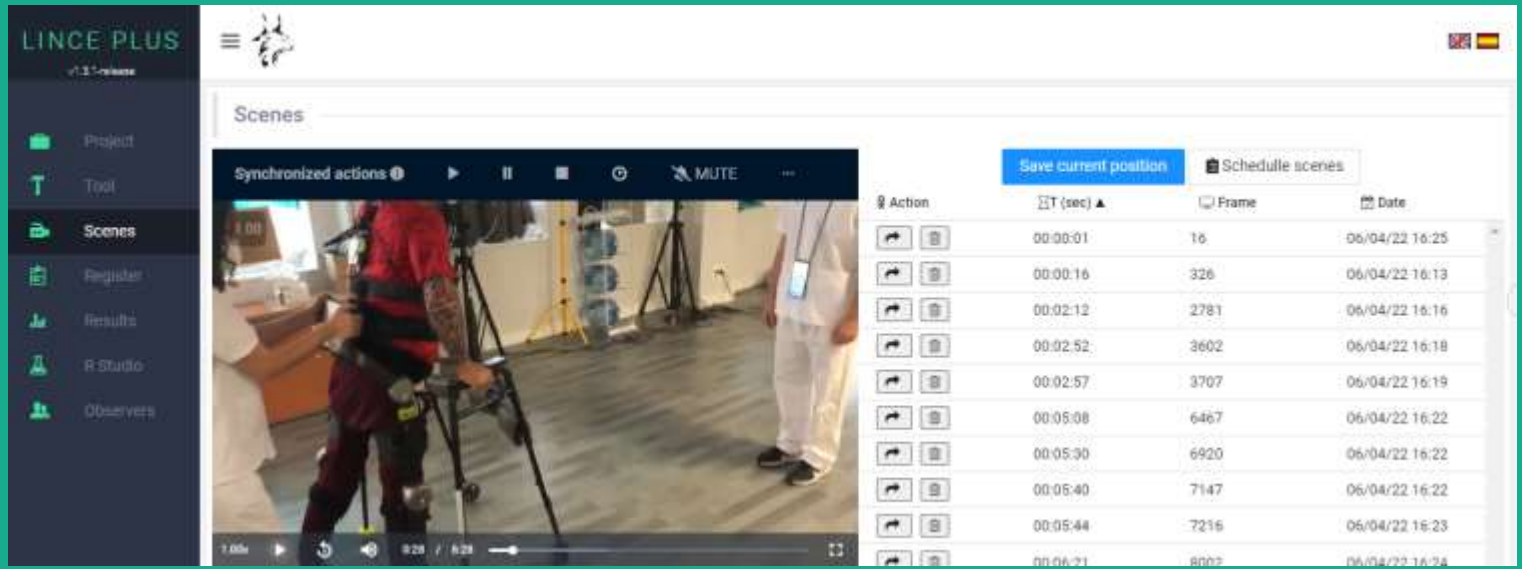
- Control playback with the keyboard

LINCE PLUS
Recording

SCAN ME

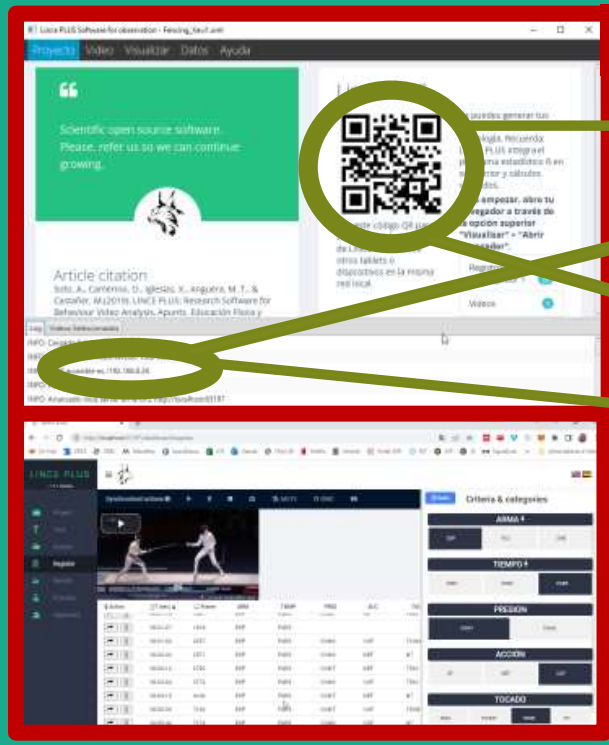
- Access the “Scenes” menu option to define observation episodes
- A "template" file can be created to be recorded by different observers

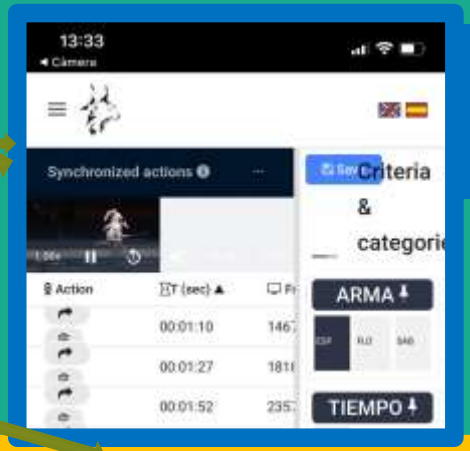
(researchers, students, coaches…) and complement or compare observations

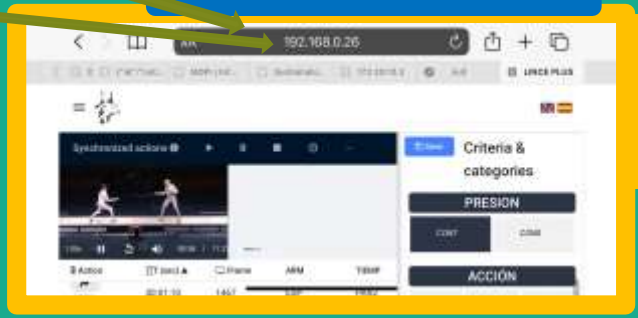


LINCE PLUS
Observers & Devices

- Two or more observers
- Different devices
- Simultaneous or consecutive analysis







LINCE PLUS
Results

SCAN ME

- At any time and in real time you can check progression graphs or basic charts.

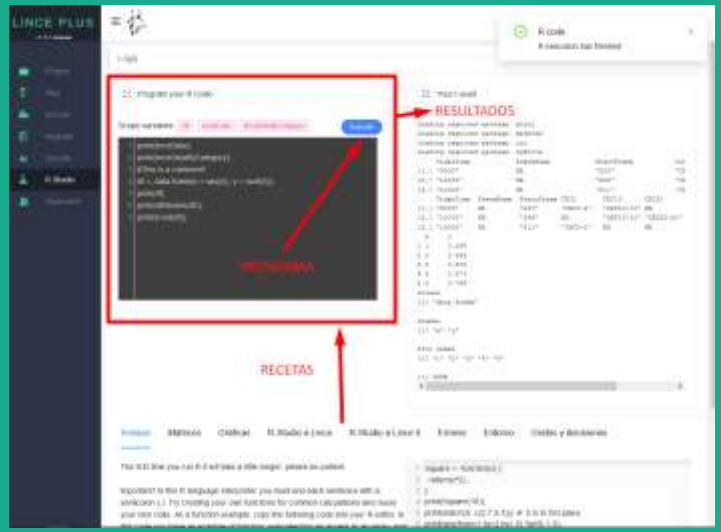
- You can also calculate the percentage of agreement between several observers.

- You can run your own code in the R interface for statistical calculations.

LINCE PLUS
R engine for statistics

SCAN ME

- The R module has won the national Digital Challenges competition at OpenExpo.
- Allows you to program your results based on the study
- It also allows you to integrate LINCE PLUS in R-Studio if you want to generate more complete graphs or reports.
- All in real time!



LINCE PLUS
Inter/Intra observer agreement

- LINCE PLUS allows multiple observers
- The calculation of inter/intra observer reliability using Kappa is a direct click: select the observer and run the test.

- The records of other observers can be incorporated through the menu:

DATA / LINCEPLUS / Add external observational record

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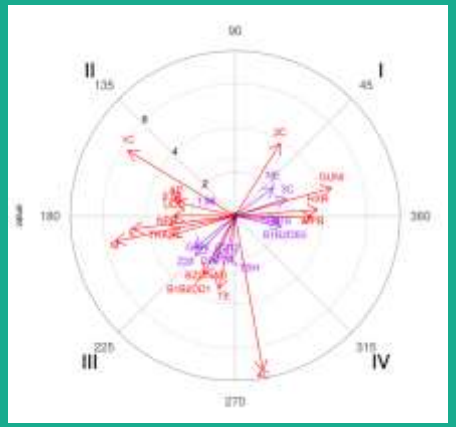
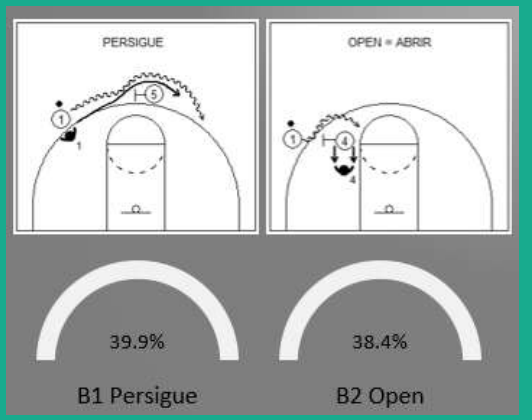
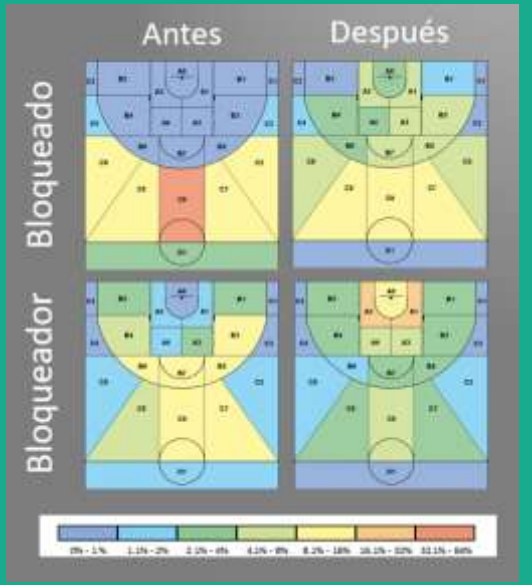
The Pick-and-Roll in Basketball

Data analysis:

- Descriptive analysis
- Polar coordinates and sequential analysis





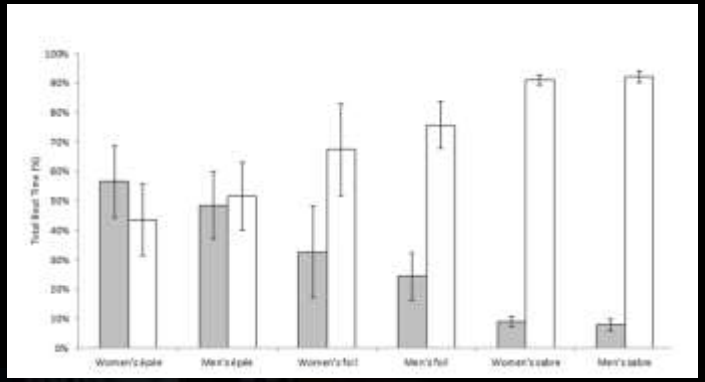


Nunes, H., Iglesias, X., & Anguera, M. T. (2021). Decision Making and Defensive Effectiveness of Ball Screen in Top-Level Basketball. *Journal of Sport Psychology*, *30*(2).

Nunes, H. (2020). Analysis of Pick and Roll in Top-Level Basketball. PhD thesis, University of Barcelona.

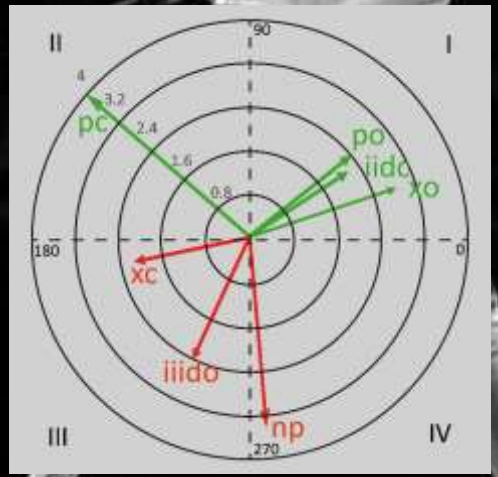
Work-to-rest Ratio in Elite Fencing

	Women's épée	Men's épée	Women's foil	Men's foil	Women's sabre	Men's sabre
Bouts (n)	15	15	11	12	15	15
TBT (s)	841,0 ± 214,3	1016,1 ± 284,6	992,3 ± 316,9	977,4 ± 322,0	715,7 ± 156,9	832,8 ± 286,0
WT (s)	433,8 ± 103,8	444,3 ± 88,0	280,6 ± 112,5	233,9 ± 123,8	70,3 ± 16,6	63,3 ± 14,6
TPT (s)	407,2 ± 121,2	571,9 ± 215,9	711,6 ± 253,0	743,5 ± 236,9	645,4 ± 143,2	769,5 ± 276,8
PRT (s)	262,6 ± 76,5	417,2 ± 190,0	615,7 ± 236,9	677,7 ± 210,9	548,6 ± 139,3	673,4 ± 279,4
PTBP (s)	144,6 ± 51,5	154,7 ± 39,1	95,9 ± 43,2	65,8 ± 65,4	96,8 ± 15,6	96,2 ± 39,6
Halte (n)	24,2 ± 4,3	24,9 ± 5,3	43,5 ± 7,0	44,8 ± 5,5	37,4 ± 7,7	42,3 ± 15,1
AAT (s)	17,8 ± 2,8	18,1 ± 3,5	6,5 ± 2,6	5,1 ± 2,3	1,9 ± 0,3	1,6 ± 0,5
AHT (s)	12,4 ± 2,0	18,6 ± 6,2	14,5 ± 3,6	15,6 ± 3,8	15,5 ± 2,5	16,6 ± 3,4
W/R	1 : 0,7	1 : 1,0	1 : 2,2	1 : 3,0	1 : 8,2	1 : 10,4



(In press)

Analysis of diachronic relationships in successful and unsuccessful behaviours by world fencing champions



behaviours that benefit the champion:

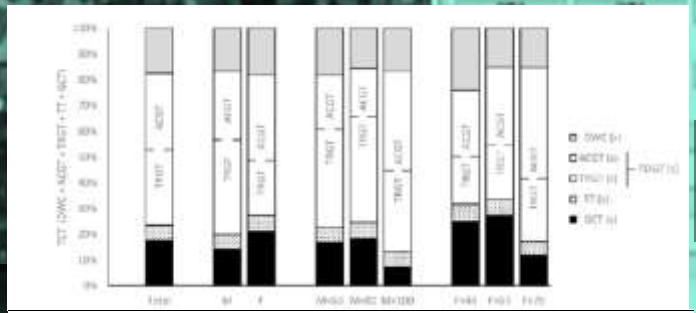
- Opponent`s pressure (reinforces that the champion gets a hit)
- Opponent's preparation (reinforces the champion getting a hit)
- Champion's defensive action (reinf. the champion getting a hit)
- Champion's pressure (inhibits the opponent from getting a hit)

Tarragó, R., Iglesias, X., Lapresa, D., Anguera, M.T., Ruiz-Sanchís, L., y Arana, X. (2017). Analysis of diachronic relationships in successful and unsuccessful behaviours by world fencing champions using three complementary techniques. Annals of Psychology, 33(3), 471-485

Analysis during elite judo combats

Data analysis:

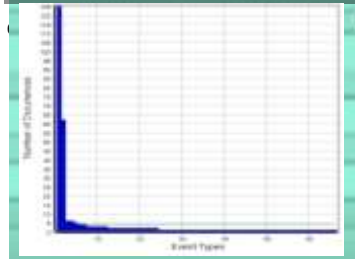
- Descriptive analysis
- T-Patterns

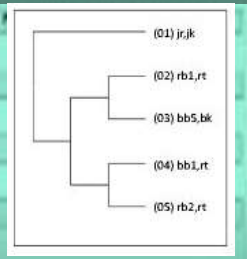


Order	Pattern	Occurrences	Combats
1	((NC,STA_I_C NC,OSG_I_C)(NC,STG_I_C NR,SON_I_R))	2	1-2
2	((NR,ISN_I_R NR,ISN_I_R)(NC,OSG_I_C NR,ISN_I_R))	2	1-6
3	(NC,KGU_I_C (NC,OSG_I_C NR,ISN_I_R))	2	1-2
4	(NC,STA_I_C (NC,OSG_I_C NR,ISN_I_R))	2	1-2
5	(NR,ISN_I_R (NC,STG_I_C NR,SON_I_R))	2	1-2
6	(NR,OSG_I_R (NR,ISN_I_R NR,ISN_I_R))	2	6-6
7	((NC,STA_I_C NC,OSG_I_C) NC,STG_I_C)	2	1-2
8	((NR,ISN_I_R NR,ISN_I_R) NC,OSG_I_C)	2	1-6
9	(NC NR,SON_I_R)	2	1-2
10	(NC,KGU_I_C NC,OSG_I_C)	2	1-2
11	(NC,OSG_I_C NR,ISN_I_R)	4	1-1-2-6
12	(NC,UMA_I_C NC,UMA_I_C)	2	2-3
13	(NR,DAB_I_R NC,STA_I_C)	2	5-5
14	(NR,ISN_I_R NC,STG_I_C)	2	1-2
15	(NR,ISN_I_R NR,ISN_I_R)	5	1-1-6-6-6
16	(NR,UMA_I_R NR)	2	1-3

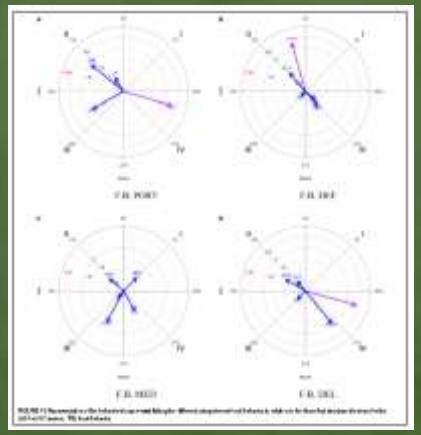
Soriano, D., et al. (2019). Time-motion analysis during elite judo combats. ARCHIVES OF BUDO, 15, 33-43.

Soriano, D., et al. (Nowadays)





Regarding the analysis of polar coordinates... This highlights the choice by **Real Madrid** to develop its offensive action from the most backward positions, the goalkeeper in this case, to develop the action progressively and gradually, in such a way that the opposing team sees itself with the obligation to separate their defensive lines either from each other, or ...



frontiers in Psychology

ORIGINAL RESEARCH

Differences in Technical Development and Playing Space in Three UEFA Champions Leagues

OPEN ACCESS

...This is indicated by the scarce elaboration of the actions and the underdeveloped game by **Liverpool** in this final, where the defenders relate to each other, without evaluating the possibility of combining with the other lines of the team to develop their offensive action...

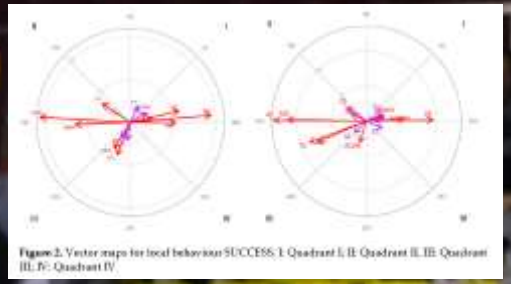


Figure 2. Vector maps for local behaviour SUCCESS. I: Quadrant I; II: Quadrant II; III: Quadrant III; IV: Quadrant IV.

These results suggest that it is necessary for teams to train at a high pace of play, linking the different phases of the game in order to recover the ball in the defensive phase and attack in the shortest possible time against an unstructured defence to achieve succés in the match and the final victory.

sustainability

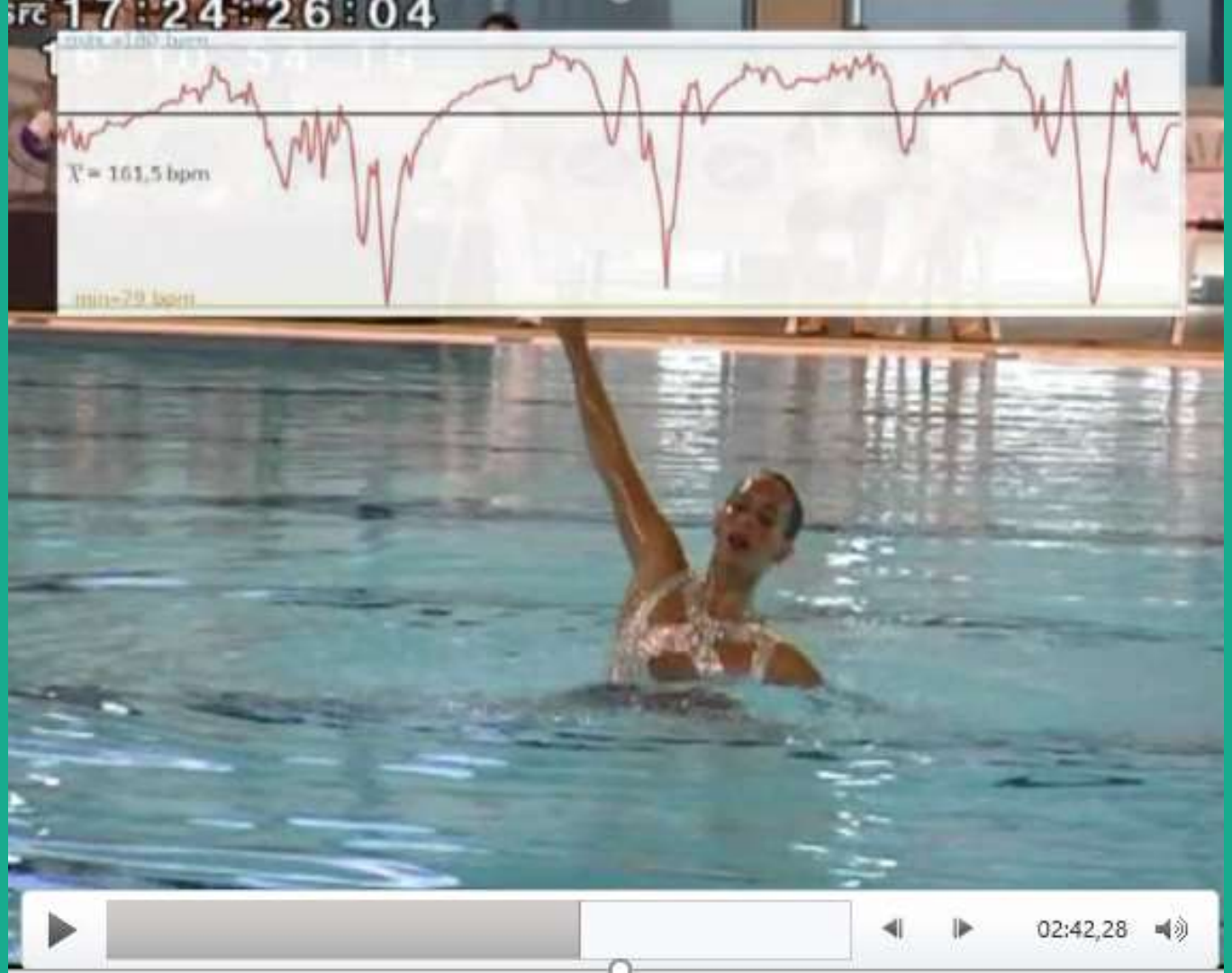
Article Menu

Academic Editors

Analysis of the Variables Influencing Success in Elite Handball with Polar Coordinates

FASE DE RUTINA	Solo Técnico (n = 9)	Solo Libre (n = 11)	Dúo Técnico (n = 10)	Dúo Libre (n = 9)
Puntuación (puntos)	83.6 ± 7.2	82.8 ± 7.5	83.8 ± 6.3	78.6 ± 3.2
Rutina (s)	124.6 ± 8.4 &#¶	178.0 ± 6.5 *#¶	148.6 ± 6.2 *&¶	207.7 ± 9.6 *&#
Fase playa (%)	2.8 ± 1.0	2.8 ± .9	2.4 ± 1.1	2.1 ± .6
Fase aérea (%)	.2 ± .0 &¶	.2 ± .0 *#	.2 ± .1 &	.1 ± .0 *
Fase acuática (%)	24.1 ± 5.0 &#¶	29.5 ± 4.9 *	34.3 ± 5.2 *	34.1 ± 5.4 *
Fase subacuática (%)	72.9 ± 4.3 &#¶	67.5 ± 4.8 *	63.0 ± 4.9 *	63.6 ± 5.3 *
Cara dentro (s)	85.1 ± 7.6 &¶	111.1 ± 10.1 *#	85.0 ± 8.6 &¶	121.4 ± 8.2 *#
Cara dentro (%)	68.3 ± 4.7 &#¶	62.3 ± 4.4 *	57.2 ± 5.9 *	58.6 ± 5.0 *
Tiempo máximo cara dentro (s)	20.7 ± 4.2	23.4 ± 3.3 #	18.8 ± 3.6 &	21.4 ± 4.1
Elementos cara dentro > 10" (*n*)	2.9 ± .6 ¶	3.9 ± .9	3.8 ± .8	5.2 ± 1.3 *
Elementos cara dentro > 10" (s)	47.5 ± 10.6 ¶	62.3 ± 15.7	53.5 ± 8.0	77.2 ± 18.8 *

Iglesias, X., et al. (2015). Diversification of patterns in solo routines in high-level synchronized swimming. Journal sport psychology, 15(1), 89-98.
Rodríguez-Zamora, L., et al. (2014). Perceived exertion, time of immersion and physiological correlates in synchronized swimming. International journal of sports medicine, 35(05), 403-411.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X = 161,5 bpm
min=79 bpm
02:42,28

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Comparing walking with knee-ankle-foot orthoses and a knee-powered exoskeleton after spinal cord injury: a randomized, crossover clinical trial

Antonio Rodríguez-Fernández[1,2*], Joan Lobo-Prat[3], Rafael Tarragó[4], Diego Chaverri[4], Xavier Iglesias[4], Lluis Guirao-Cano[4] & Josep M. Font-Llagunes[1,2]

Recovering the ability to stand and walk independently can have numerous health benefits for people with spinal cord injury (SCI). Wearable exoskeletons are being considered as a promising alternative to conventional knee-ankle-foot orthoses (KAFOs) for gait training and assisting functional mobility. However, comparisons between these two types of devices in terms of gait biomechanics and energetics have been limited. Through a randomized, crossover clinical trial, this study compared the use of a knee-powered lower limb exoskeleton (the ABLE Exoskeleton) against passive orthoses, which are the current standard of care for verticalization and gait ambulation outside the clinical setting in people with SCI. Ten patients with SCI completed a 10-session gait training program with each device followed by user satisfaction questionnaires. Walking with the ABLE Exoskeleton improved gait kinematics compared to the KAFOs, providing a more physiological gait pattern with less compensatory movements (38% reduction of circumduction, 25% increase of step length, 29% improvement in weight shifting). However, participants did not exhibit significantly better results in walking performance for the standard clinical tests (Timed Up and Go, 10-m Walk Test, and 6-min Walk Test), nor significant reductions in energy consumption. These results suggest that providing powered assistance only on the knee joints is not enough to significantly reduce the energy consumption required by people with SCI to walk compared to passive orthoses. Active assistance on the hip or ankle joints seems necessary to achieve this outcome.

Most people with a spinal cord injury (SCI) have permanent paralysis of the lower limbs and lose their ability to stand and walk. This functional limitation often leads to wheelchair dependency and sedentary behaviour that increases the risk of developing secondary health conditions[1–3]. Therefore, recovering the ability to stand and walk independently can have numerous health benefits for people with SCI[4–6], and has been a priority in rehabilitation medicine[7].

Passive gait orthoses, such as knee-ankle-foot orthoses (KAFOs), are often used in clinical practice and also

Currently: analyzing (bioenergetics & behaviour) the Sports Therapist or physiotherapist's aids depending on the type of exoskeleton (more or less articulated) in people with spinal cord injuries

Rodríguez-Fernández, A., et al. Comparing walking with knee-ankle-foot orthoses and a knee-powered exoskeleton after spinal cord injury: a randomized, crossover clinical trial. Sci Rep 12, 19150 (2022).

INEFC Barcelona Sport Sciences Research Group
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THANK YOU

Performance Analysis Workshop

Xavier Iglesias

xiglesias@gmail.com