



A Complementary Study of Elite Fencing Tactics Using Lag Sequential, Polar Coordinate, and T-Pattern Analyses

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Introduction

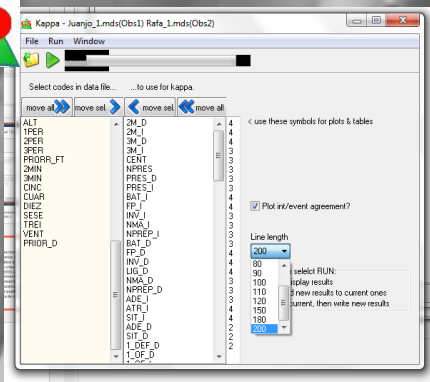
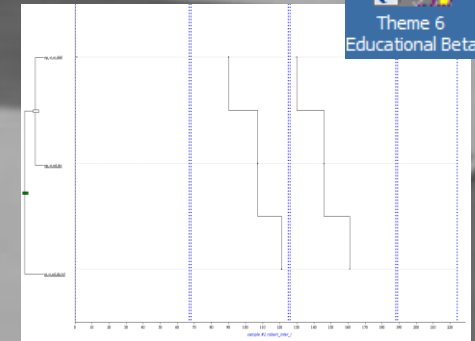
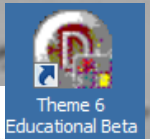


Sequentiality: ¿a complementary vision of reality?

*Polar
coordinate
analysis*

*T-Patterns
analysis*

*Lag
sequential
analysis*





FENCING PHRASE (definition)

Objectives:

In the first case, the objective is to determine what happens within each fencing phrase



In the second case, the objective is to determine how these fencing phrases evolve throughout the bout



Method



Design

Observational

**Nomothetic
Point
Multidimensional**

Method

**Observational tool
ESGRIMOB
(Tarragó, et al., 2015)**

**Recording and coding
LINCE v. 1.1**

**Reliability
of the
dataset**

0,71 intra / 0,74 inter
Construct validity: 17 fencing masters -canonic agreement
of 0.81 (Krippendorff, 2004)-

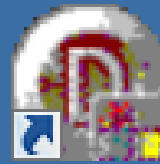
Sample

4 last bouts (Round of sixteen, quarter-finals, semi-final and final)
a) World champion in 2014 (Fencer on the right)
b) Sub-champion of the World in 2013 (Fencer on the left)

Observational tool
ESGRIMOBBS
 (Tarragó, et al., 2015)

Dimensions or criteria	Category systems	Code
Pressure	Right pressure	PD
	Left pressure	PI
	No pressure	NP
Preparation	Right preparation	XD
	Left preparation	XI
1 st Action	1st action: right offensive	OD
	1st action: left offensive	OI
	1st action: right defensive	DD
	1st action: left defensive	DI
2 nd Action	2nd action: right offensive	DOD
	2nd action: left offensive	DOI
	2nd action: right counteroffensive	DCD
	2nd action: left counteroffensive	DCI
	2nd action: right defensive	DDD
	2nd action: left defensive	DDI
3 rd Action	3rd action: right offensive	TOD
	3rd action: left offensive	TOI
	3rd action: right counteroffensive	TCD
	3rd action: left counteroffensive	TCI
	3rd action: right defensive	TDD
	3rd action: left defensive	TDI
Touch	Left touch	TI
	Right touch	TD
	No touch	NT
	Double touch	DT

T-Patterns analysis (THEME)



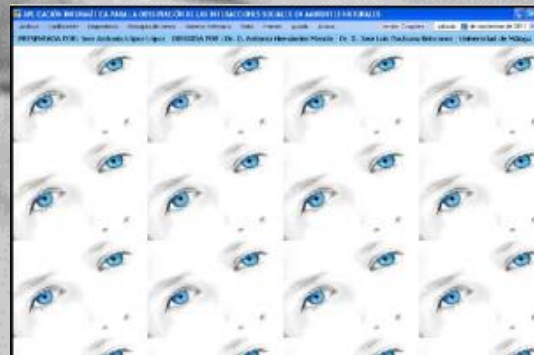
Theme 6
Educational Beta

Analysis

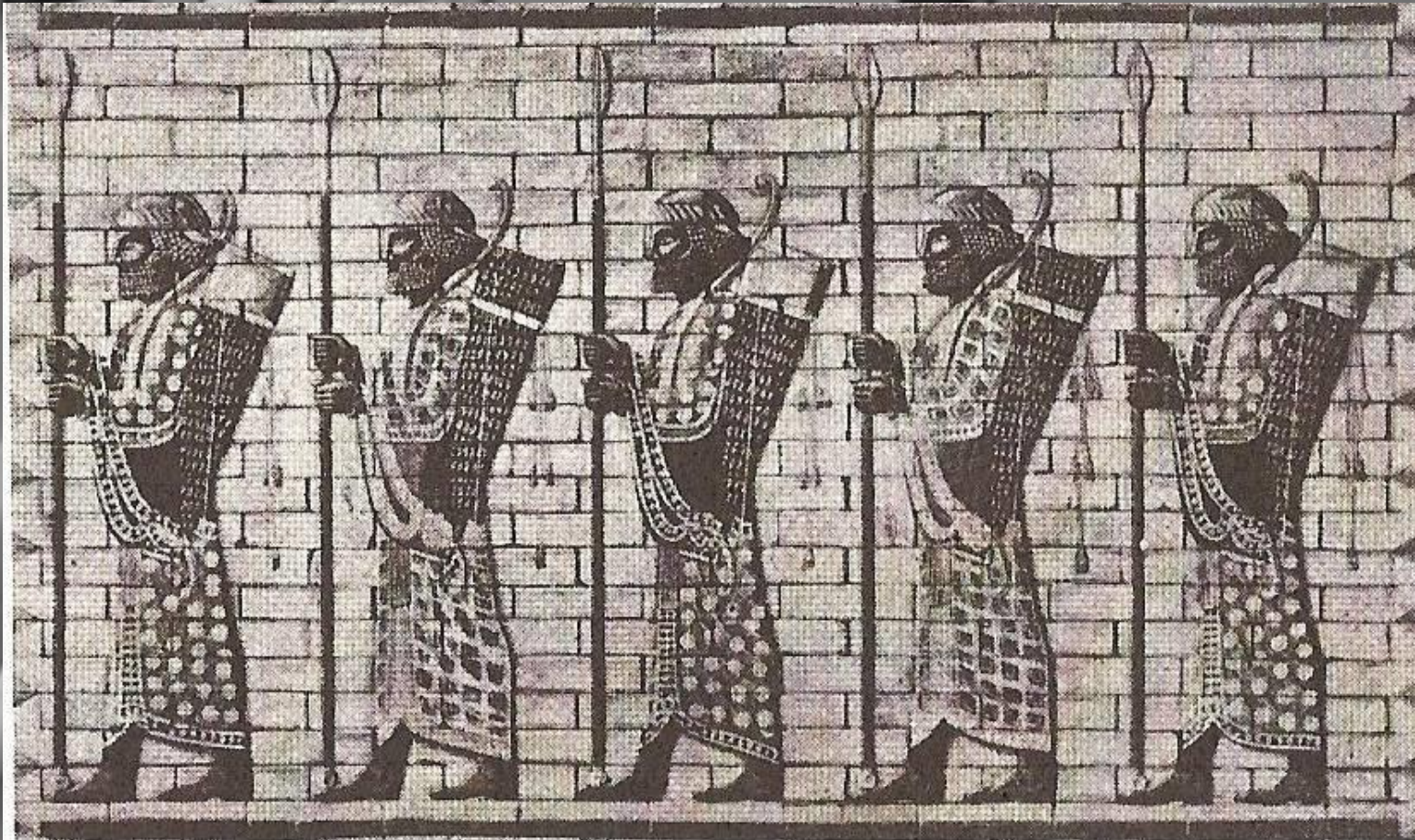
Lag sequential analysis (GSEQ)

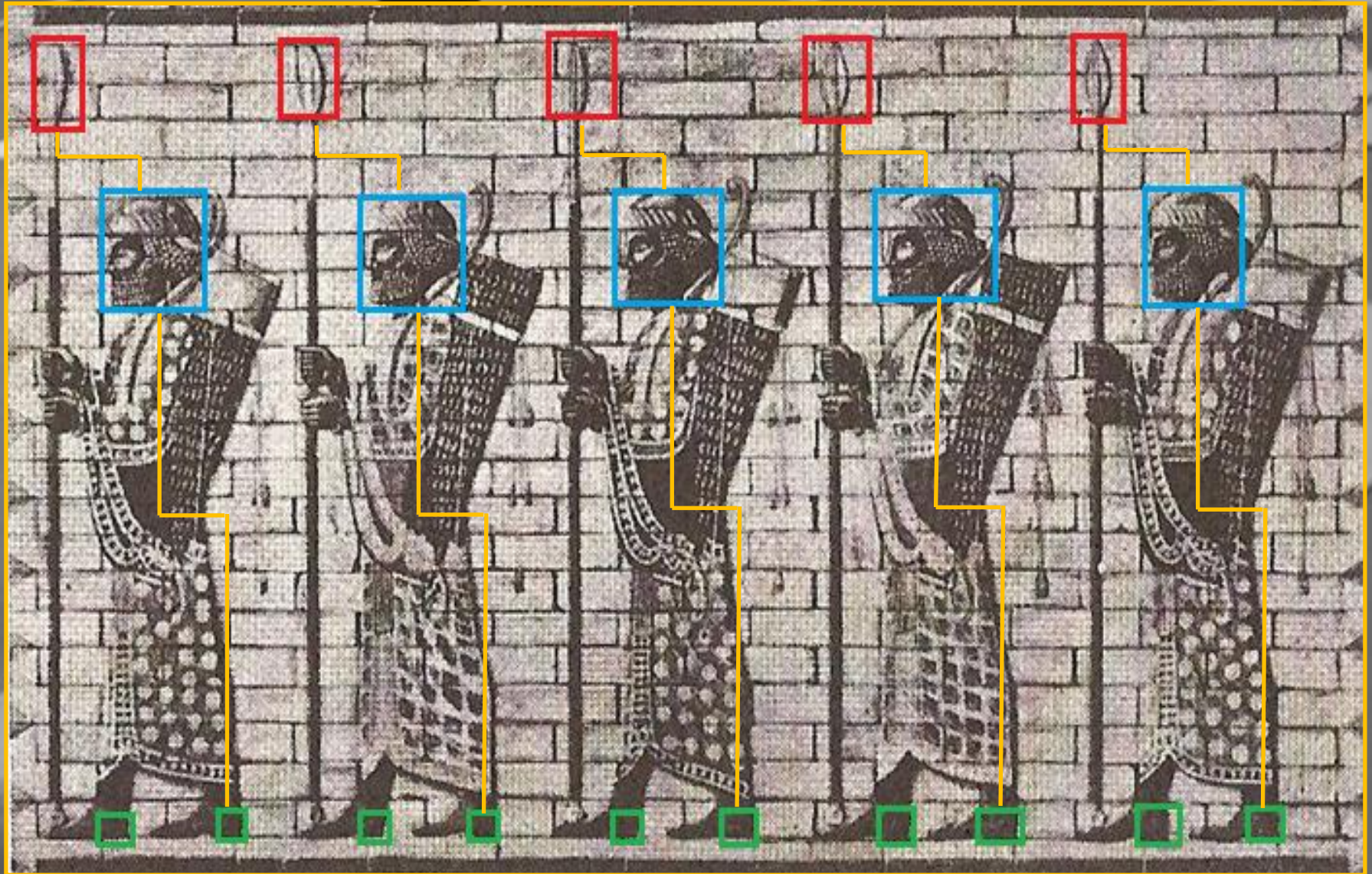


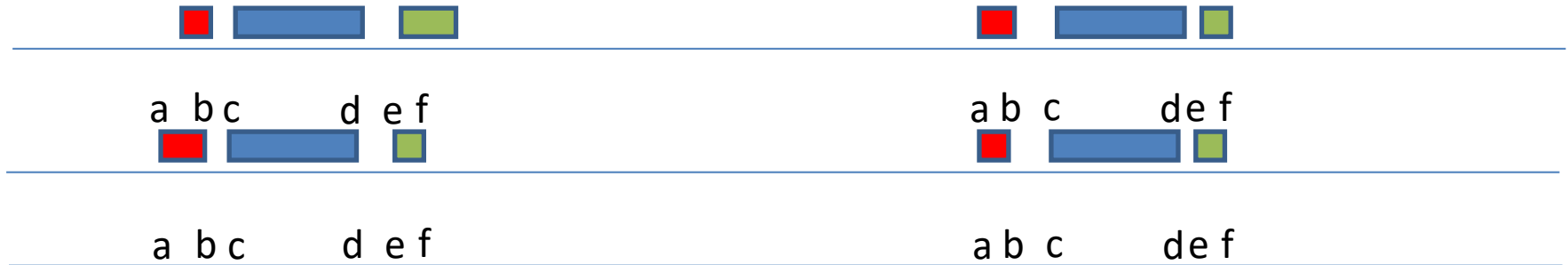
Polar coordinate analysis (HOISAN)



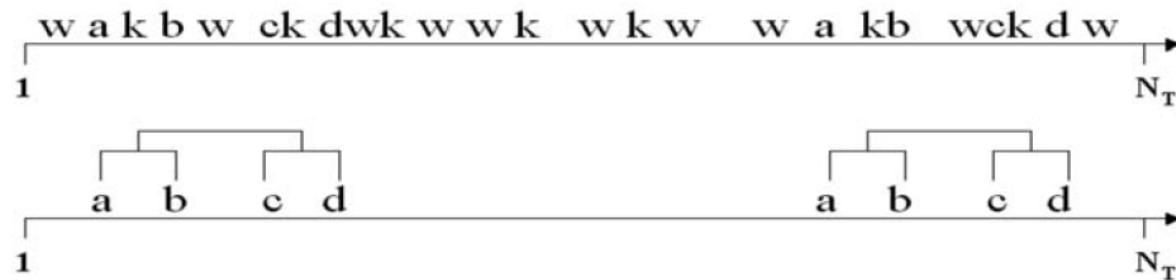
The assumption underlying the T-pattern detection method is that complex human behaviors have a temporal structure that cannot be fully detected through traditional observational methods or mere quantitative statistical logic.







A T-pattern is a “statistical construction” that is detected from a combination of events, occurring in the same order with temporal distances between each other that remain relatively invariant in relation to the null hypothesis that each registered behaviour code is independent and is randomly distributed in time.



According to Magnusson (2000, p. 94), “that is, if A is an earlier and B a later component of the same recurring temporal pattern then after an occurrence of A at t , there is an interval $[t+d_1, t+d_2]$ ($d_2 \geq d_1 \geq d_0$) that tends to contain at least one occurrence of B more often than would be expected by chance”.

	A	B
1	Time	Event - - - ➤ fencing phrases
2	1	:
3	2	PI,XI,OD,DCI,TDD
4	3	PI,XD,DI,DDD,TI
5	4	PI,XI,DD,DDI
6	5	NP,OI,DDD
7	6	PI,XI,OD,DCI,TDD
8	7	PI,XD,OI,DDD,TCI,TI
9	8	PI,OI,DDD
10	9	PI,XD,OI,DDD
11	10	PI,XI,OD,DDI,TD
12	11	PI,XI,OI,DDD
13	12	PI,OI,DCD,TDI
14	13	PI,XI,OD,DDI,TDI
15	14	PI,OI,DDD
16	15	PI,XI,OI,DOD,TID

The main contribution of THEME is the detection of temporal patterns



The software also allows the possibility of focusing its analysis on the detection of sequential structures in a data set

Lapresa, et al.(2013)

Search parameters

The fast requirement at all levels was disabled.

Significance level: $p .005$.

Minimum of occurrences

Activation of the redundancy reduction tool

For further information see Reference Manual (PatternVision Ltd & Noldus Information Technology bv, 2004)

Theme - Robeirdosocurr.tpf

File Edit Project CurrentFile Search General Selection Syntax Symmetry CurrentNode Preferences Tools Help

1 14 128

DATANAME
X Robeirdosocurr

Critical Interval
Critical Interval Type: Free
Base-Line Prob. Type: NX / T
Univariate Patterns: Include
Significance Level: 0,005
Minimum Occurrence: 2
☐ Minimum d1: 0
☐ Maximum d1: 2147483647
☐ Burst Detection Sign. Level: -1
Burst Min. Occurrences: -1
☐ Max Search Levels: 999
☐ FARR: 90
☐ Lumping Factor: 999,00
☐ Left or Right Has Burst (levels > 1): 0
☐ Minimum % Of Samples: 0
☐ Exclude Frequent E-T's: 999,00
Top Percent Kept Per Level: 100

T-Packet Detection
Packet Base Type: Off
Packet Significance Level: -1
Minimum Occurrence: -1
Maximum Occurrence: -1
Random Simulation
Types of Randomizations: Off
Number Of Runs Per Type: -1
Set Currently Shown Parameters for All Files
Adapt Minimum Occurrences To Data Sets

Select Files For Analysis
☒ Current Data Set
☐ From Current Data Set
☐ All Data Sets
☒ Increased speed and memory use
Pause Stop Start

Lag sequential analysis (GSEQ)



Sequential

Concurrent

B
D
A
B
D
C

Event-based

I

II

B W
D X
A Y
B
W
C W

Time-based

III

IV

B 4'
D 3'
A 5'
B 3'
D 1'
C 6'

B W 4'
D X 3'
A Y 5'
B 3'
W 1'
C W 6'

Bakeman (1978)

Anguera (2015)

Lag sequential analysis (Bakeman and Quera, 2011) was used to investigate association relations between categories based on the calculation of observed and expected probabilities, , and to compare them using a corrected binomial test.



Adjusted residuals were calculated to determine the strength of association between behaviors, as we applied the correction established by Allison and Liker (1982) to the binomial test.

R	number of rows (<i>givens</i>)
C	number of columns (<i>targets</i>)
x_{rc}	observed joint frequency for cell in r -th row and c -th column of a $R \times C$ table
x_{+c}	sum of the counts in the c -th column
x_{r+}	sum of the counts in the r -th row
$N = x_{++}$	number of counts total for the $R \times C$ table
p_c	probability for the c -th column = $x_{+c} \div N$
p_r	probability for the r -th row = $x_{r+} \div N$
e_{rc}	expected frequency , by chance = $p_{+c} \times x_{r+}$
g_r	code for the r -th row (the given)
t_c	code for the c -th column (the target)
$P(t_c g_r)$	conditional probability of (t_c given g_r) = $x_{rc} \div x_{r+}$
y_{rc}	raw residual = $x_{rc} - e_{rc}$
z_{rc}	adjusted residual = $\frac{x_{rc} - e_{rc}}{\sqrt{e_{rc}(1 - p_c)(1 - p_r)}}$

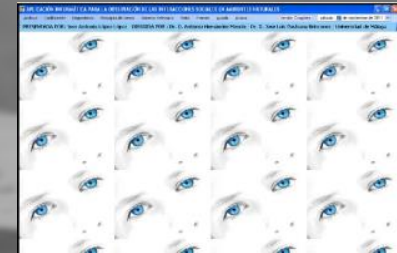
Bakeman and Quera (2011, p. 105)

Drawing from the experience of many studies conducted in the behavioral and social sciences (Lapresa, Arana, Anguera and Garzón, 2013), it was decided to use just ten lags (lag -5 to lag -1 and lag +1 to lag +5), as patterns appear to become diluted when more are used.

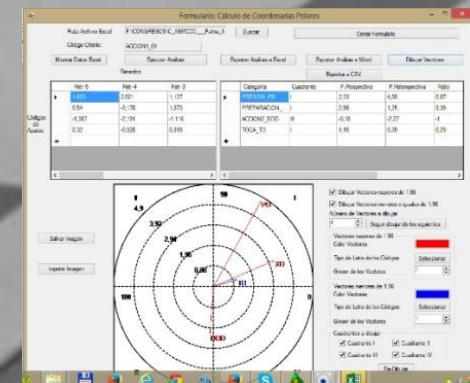
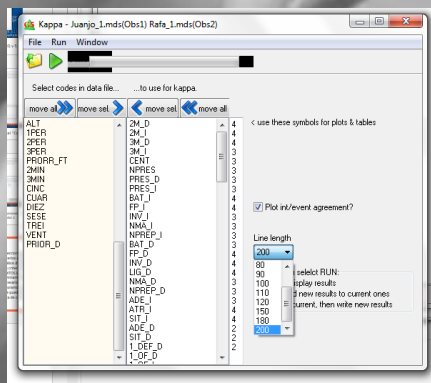




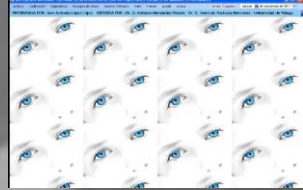
Lag sequential analysis (GSEQ)



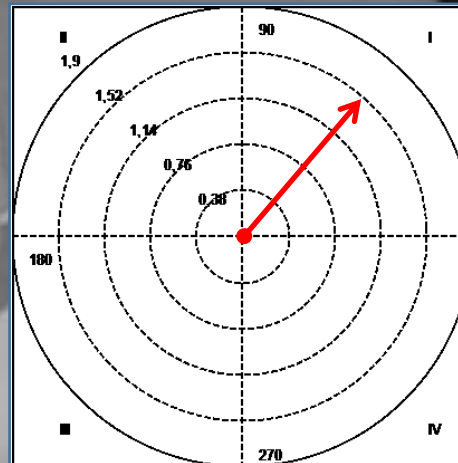
Polar coordinate analysis (HOISAN)



Polar coordinate analysis (HOISAN)

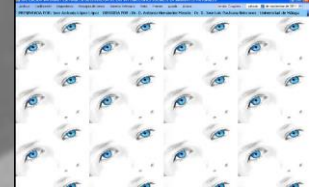


Polar coordinate analysis is an elaborate data reduction technique. It also produces a vectorial image of the complex network of interrelations between the focal behavior, and the other behaviors selected.



The retrospective, or “**backward**” perspective, which incorporates what Anguera (1997) referred to as the concept of “**genuine retrospectivity**”, reveals significant associations between the focal behavior and behaviors that occur before this behavior (i.e., negative lags).





$$\frac{\Sigma z}{\sqrt{n}}$$

Zsum statistic
(Cochran, 1954; Sackett, 1980)

Length of the vector

Is obtained by calculating the square root of the prospective Zsum added to the square root of the retrospective Zsum:

$$\sqrt{X^2 + Y^2}.$$

The relationship is considered significant ($p < 0.05$) when the length exceeds 1.96.

The angle of the vector

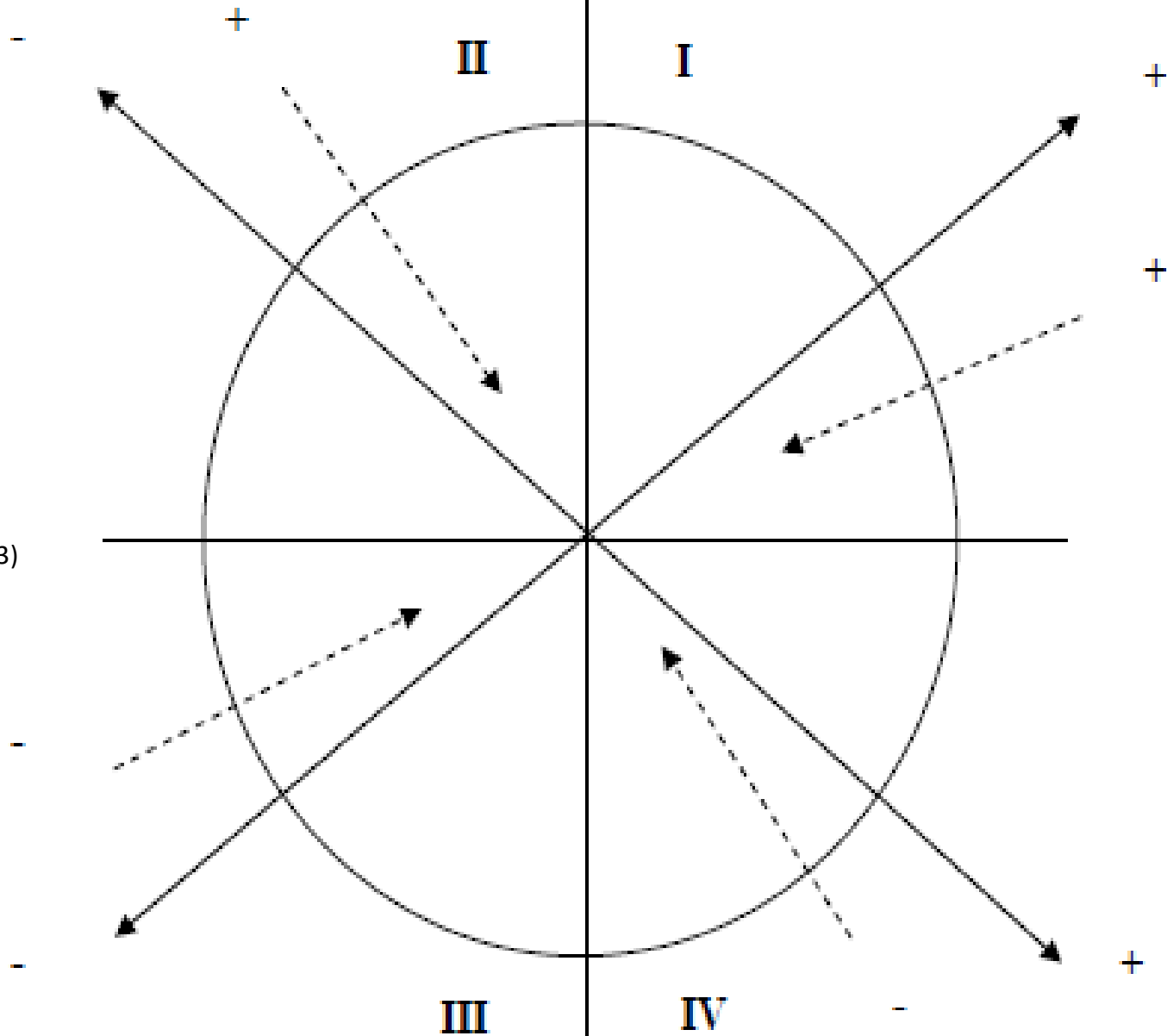
($\phi = \arcsine$ of Y/radius).

The value of the angle will depend on the quadrant in which the conditioned category is located:

- Quadrant I ($0 < \phi < 90$) = ϕ
- Quadrant II ($90 < \phi < 180$) = $180 - \phi$
- Quadrant III ($180 < \phi < 270$) = $180 + \phi$
- Quadrant IV ($270 < \phi < 360$) = $360 - \phi$

The focal behavior inhibits and is activated by the conditional behavior

The focal and conditional behaviors activate each other



Robles (2012, p. 73)

The focal and conditional behaviors inhibit each other

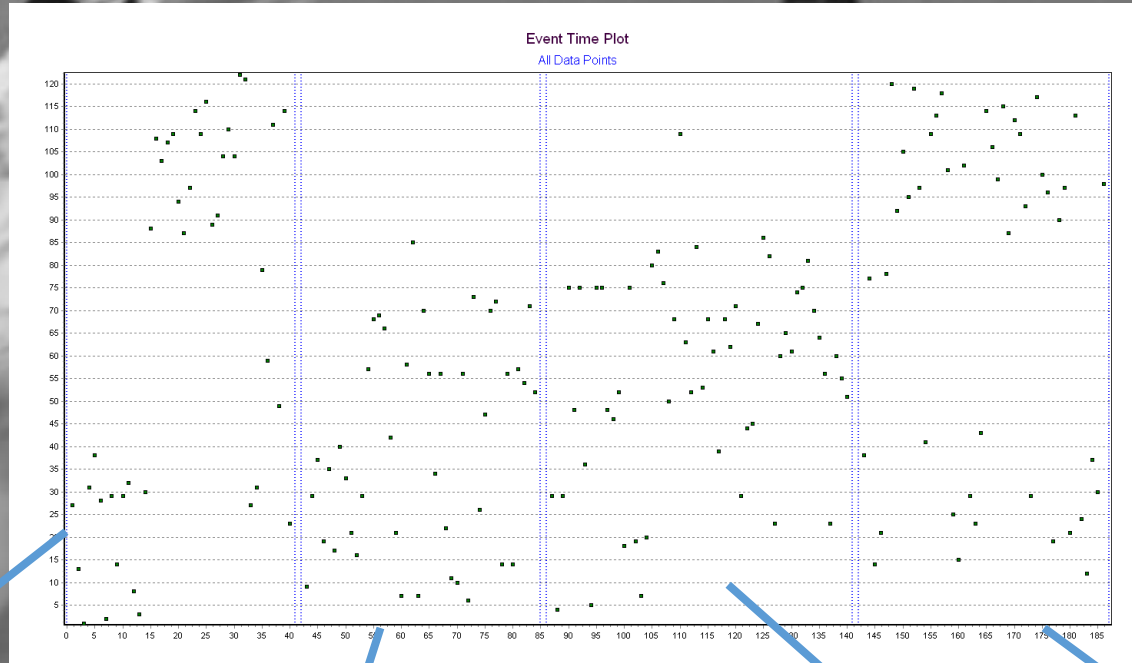
The focal behavior activates and is inhibited by the conditional behavior

Results



Sub-champion of the World in 2013 (Fencer on the left)

Total: 44 categories, 122 events-type= fencing phrase-types ,
180 events= fencing phrases recorded.



Bout 1: 24 categories, 34 events-
type= fencing phrase-types, 40
fencing phrases

Bout 3: 32 categories, 40 fencing
phrases-types, 54 fencing phrases

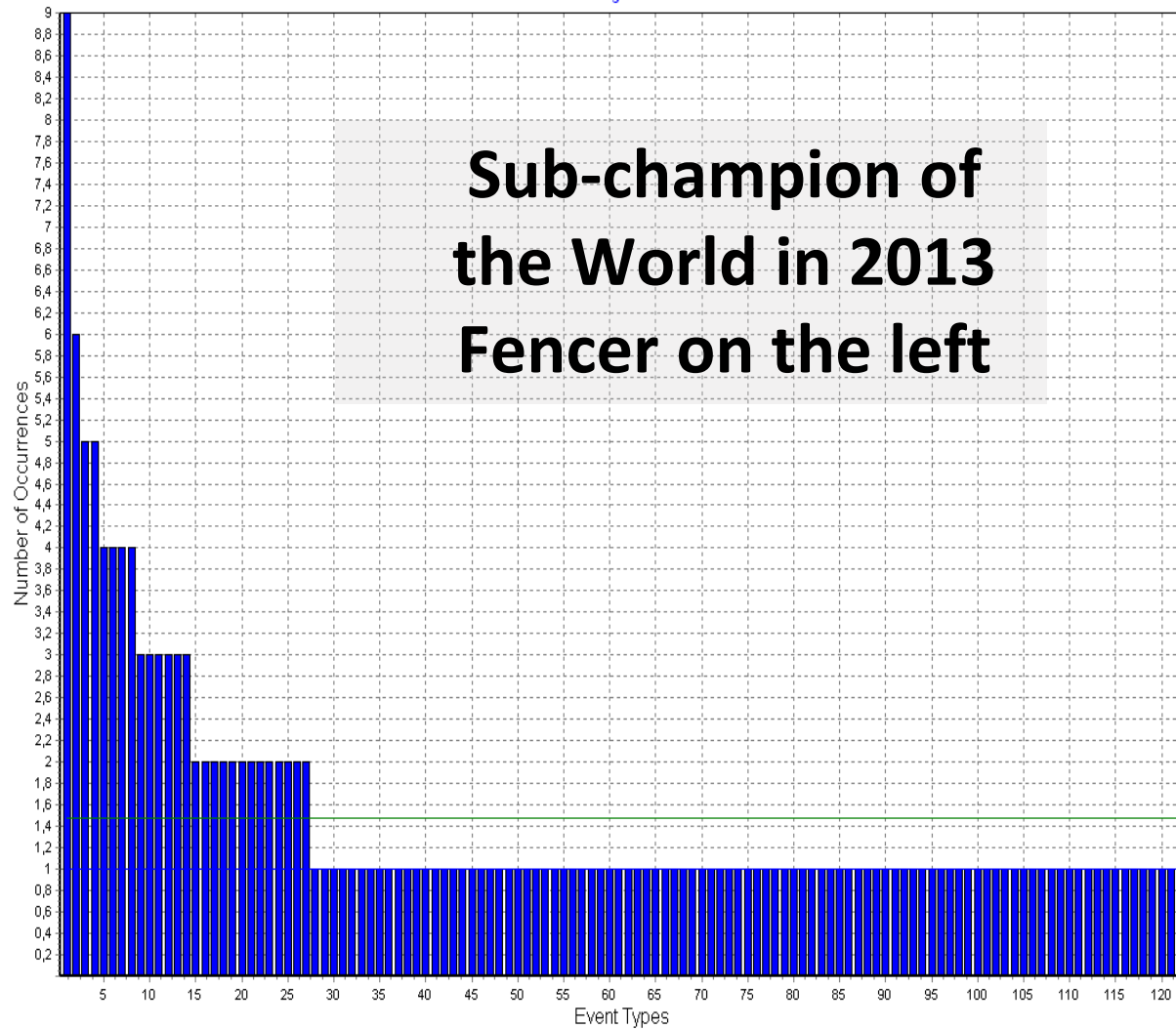
Bout 2: 31 categories, 33 fencing
phrases-types, 41 fencing phrases

Bout 4: 35 categories, 39 fencing
phrases-types, 45 fencing phrases

Fencing phrases
(orderer by frequency)

Event-Type Chart

Data: Limardoglobalidad

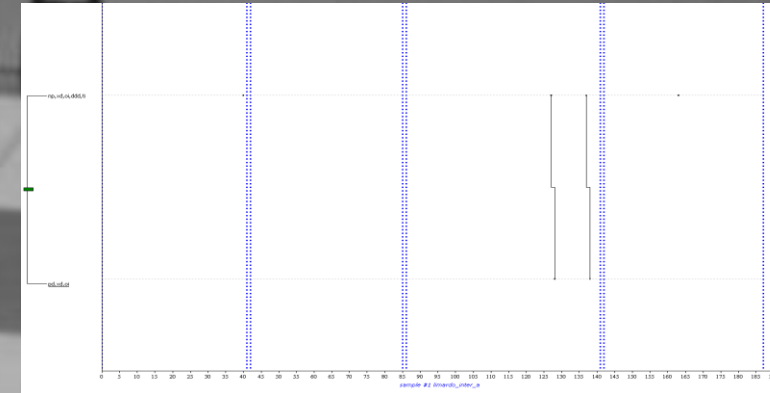


X eventype (N)

- 1 np.xi.od,ddi (9)
- 2 pd.xi.od,ddi (6)
- 3 pd.xd.od,dci,td (5)
- 4 pi.xi.od,ddi (5)
- 5 np.xd.od,ddi (4)
- 6 np.xd,oi,ddd (4)
- 7 np.xd,oi,ddd,ti (4)
- 8 pd.xd,oi,dcd,ti (4)
- 9 np,oi,ddd (3)
- 10 np.xd,oi,dcd (3)
- 11 pd,oi,dcd,td (3)
- 12 pd.xd,oi,ddd (3)
- 13 pi.xd,od,dci,td (3)
- 14 pi.xi,oi,ddd (3)
- 15 np.xi,od,dci,td (2)
- 16 np.xi,od,dci,td (2)
- 17 np.xi,od,ddi,td (2)
- 18 np.xi,oi,ddd (2)
- 19 np.xid,od,ddd (2)
- 20 pd,od,ddi (2)
- 21 pd.xd,od,dci,td (2)
- 22 pd,xd,oi (2)
- 23 pd,xd,oi,dcd (2)
- 24 pd,xd,oi,ddd,ti (2)
- 25 pi,od,dci,td (2)
- 26 pi,xd,oi,ddd,ti (2)
- 27 pi.xi,oi,dcd,ti (2)
- 28 np,od,dci (1)
- 29 np,od,dci,td (1)
- 30 np,od,ddi (1)
- 31 np,oi,dcd (1)
- 32 np,oi,dcd,tci,qdd,vdi,sdd (1)
- 33 np,oi,dcd,ti (1)
- 34 np,oi,ddd,ti (1)
- 35 np,oi,dod,tci,qdd (1)
- 36 np,oi,dod,ti (1)
- 37 np,xd,od,dci,td (1)
- 38 np,xd,od,dci,td,qd,vdd (1)
- 39 np,xd,od,ddd,td (1)
- 40 np,xd,od,ddi,tcd,qd,vcd,td (1)
- 41 np,xd,od,ddi,tdd,qd,vcd,sdi (1)
- 42 np,xd,od,ddi,tdd,qd,vcd (1)
- 43 np,xd,oi (1)
- 44 np,xd,oi,dcd,td (1)
- 45 np,xd,oi,ddd,td (1)
- 46 np,xd,oi,ddd,tci,qdd,vci,sdd (1)
- 47 np,xd,oi,ddi (1)
- 48 np,xd,oi,dod,ti (1)
- 49 np,xi,od,ddd (1)
- 50 np,xi,od,ddi,td (1)
- 51 np,xi,od,dci,tcd (1)
- 52 np,xi,oi,dod,tci (1)
- 53 np,xi,oi,dod,td (1)
- 54 np,xi,oi,dcd,ti (1)
- 55 np,xid,od,ddi,tcd,td (1)
- 56 np,xid,od,ddi,tdd,qd,td (1)
- 57 np,xid,oi,dci,td (1)
- 58 np,xid,oi,ddd (1)
- 59 np,xid,oi,ddd,tci,ti (1)
- 60 pd,od,dci (1)

Sub-champion of the World in 2013 (Fencer on the left) T-Patterns detected

Nº	Chain format pattern	Occ.	Bout	Fencing phrases intra-bout	Fencing phrases interspersed
L1	(np,xd,oi,ddd,ti pd,xd,oi)	2	3	42-43	-
L2	(np,xi,od,dc,td np,xi,od,ddi,td)	2	3	52-53	-
L3	(pd,xd,oi,ddd pd,xd,od,dc,td)	3	1	1-4	2
	<u>VIDEO</u>		1	33-34	-
			2	22-23	-
			2	34-37	2
			3	49-51	1
L4	(pd,xi,od,ddi pd,od,ddi)	2	3	5-6	-
			3	11-12	-
L5	(pd,xi,od,ddi pd,xi,od,ddi)	4	3	5-7	1
			3	7-10	2
			3	10-11	-
			3	11-16	4
L6	(pi,xd,od,dc,td pi,xi,od,ddi)	2	1	22-24	1
			4	12-14	1
L7	(pi,xd,od,dc,td pi,xi,oi,dcd,ti)	2	4	12-15	2
			4	38-40	1



Dendrogram corresponding to T-pattern
with order number L1

T-pattern with the order number L1 (np,xd,oi,ddd,ti pd,xd,oi), has 2 occurrences; in the third bout ([semifinal](#)). First occurrence: fencing phrases nº 42 y 43; second occurrence: fencing phrases nº 52 y 53. On both occurrences, fencing phrases are consecutive (no fencing phrases interspersed).

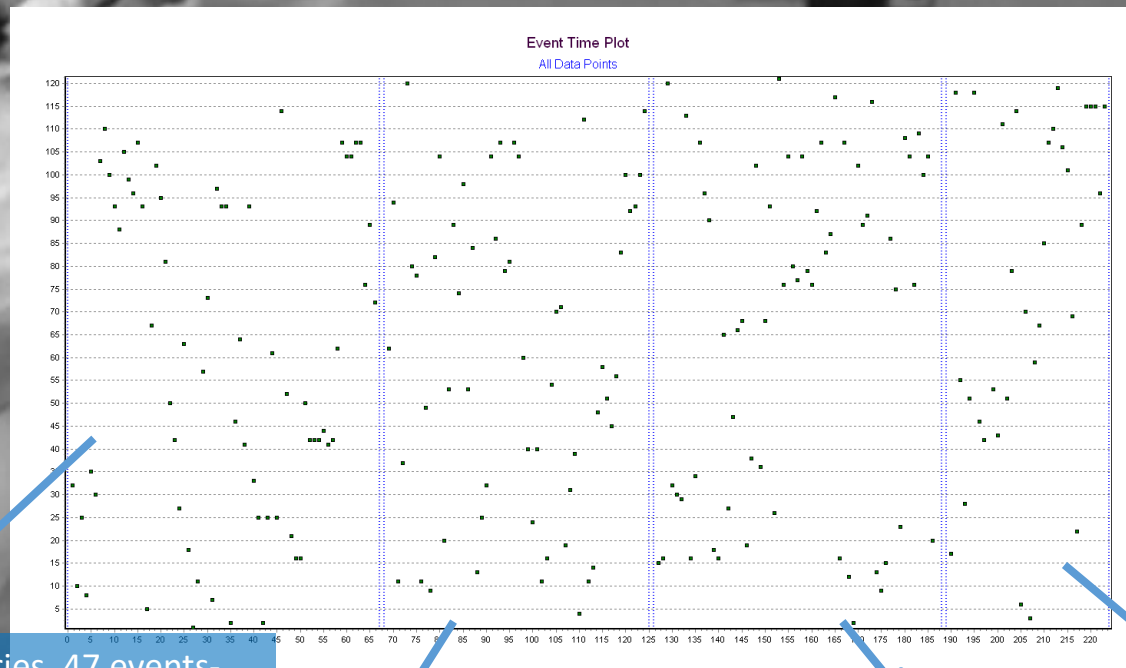
T-Pattern

(pd,xd,oi,ddd pd,xd.od,dci,td)

T-pattern with order number L3

World champion in 2014 (Fencer on the right)

Total: 44 categories; 121 events-type= fencing phrase-types ; 281 events= fencing phrases recorded

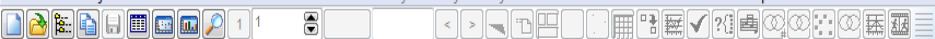


Bout 1: 24 categories, 47 events-type= fencing phrase-types, 66 fencing phrases

Bout 3: 28 categories, 47 fencing phrase-types, 60 fencing phrases

Bout 2: 26 categories, 47 fencing phrase-types, 56 fencing phrases

Bout 4: 27 categories, 28 fencing phrase-types, 33 fencing phrases



DATANAME

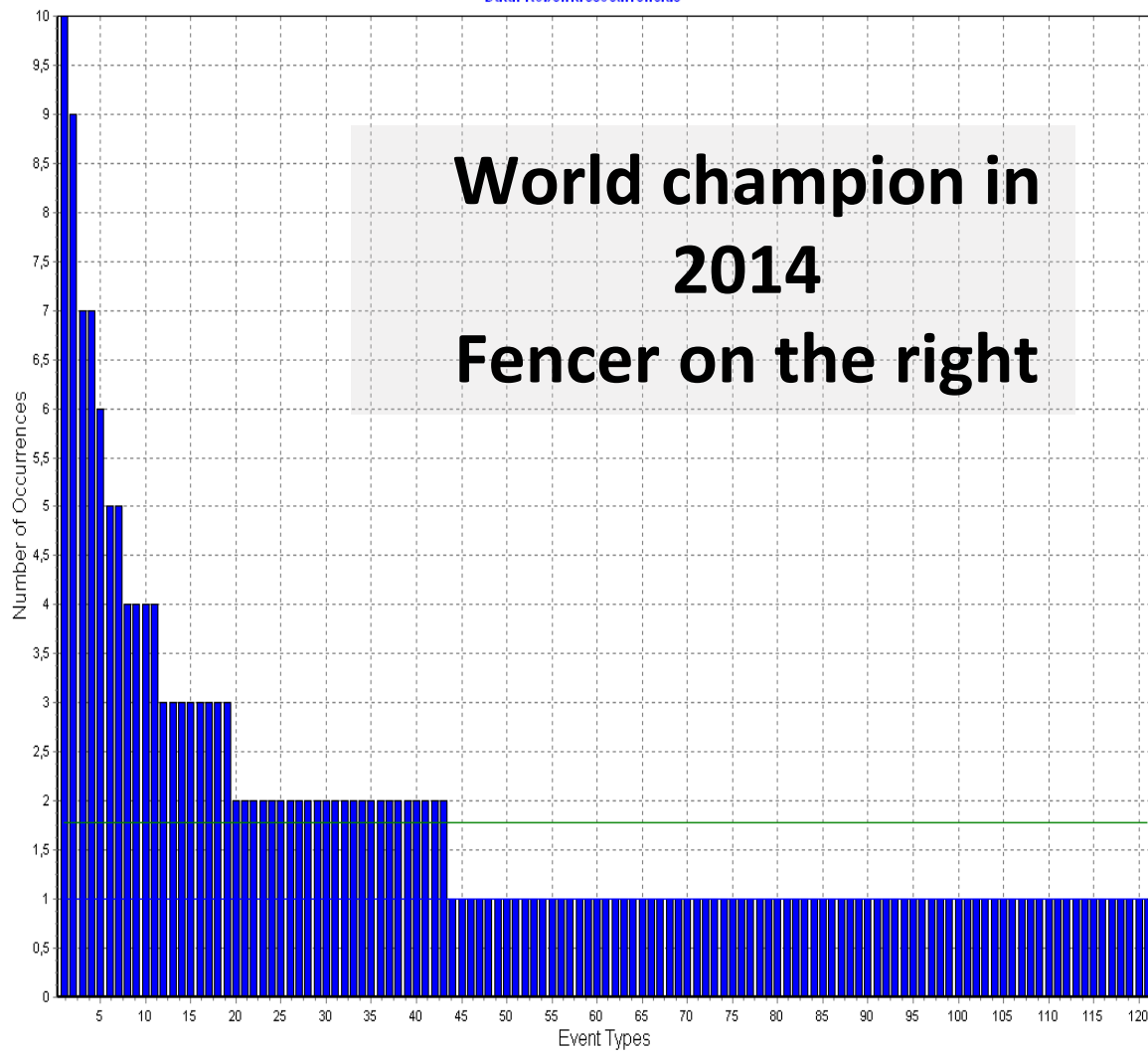
Robeiriresocurrencias

DataSets

☒ Average ☒ Median ☒ Mode ☒ Show Event-Type Names

Event-Type Chart

Data: Robeiriresocurrencias



fencing phrases
(orderer by frequency)



X eventtype (N)

- 1 pi,xi,oi,ddd (10)
- 2 pi,xi,oi,dcd,ti (9)
- 3 np,xd,oi,ddd (7)
- 4 pi,xi,od,ddi (7)
- 5 pd,od,ddi (6)
- 6 np,xd,od,ddi (5)
- 7 np,xi,od,ddi (5)
- 8 pi,oi,ddd (4)
- 9 pi,xi,od (4)
- 10 pi,xi,oi,dcd (4)
- 11 pi,xi,oi,dcd,tdi (4)
- 12 np,od,ddi (3)
- 13 np,xi,oi,ddd (3)
- 14 pd,xd,od,ddi,tdod (3)
- 15 pd,xd,od,ddi,td (3)
- 16 pi,xd,od,ddi,td (3)
- 17 pi,xi,od,ddi,td (3)
- 18 pi,xi,oi,dcd,tci,ti (3)
- 19 pi,xi,oi,dcd,ti (3)
- 20 np,xd,od,dci,tdod (2)
- 21 np,xd,oi,dcd (2)
- 22 np,xd,oi,dcd,ti (2)
- 23 np,xd,oi,ddi (2)
- 24 np,xi,od,dci (2)
- 25 np,xi,od,dci,td (2)
- 26 np,xi,od,ddi,td (2)
- 27 np,xi,oi,dcd,tdi (2)
- 28 np,xi,od,dci,td (2)
- 29 pd,od,dci,tdod (2)
- 30 pd,xd,od,dci (2)
- 31 pd,xd,od,ddi (2)
- 32 pd,xi,od,ddi,td (2)
- 33 pd,xi,oi,dcd,ti (2)
- 34 pd,xi,od,dci (2)
- 35 pd,xi,od,ddi (2)
- 36 pi,xd,oi (2)
- 37 pi,xd,oi,dcd (2)
- 38 pi,xd,oi,dcd,tdi (2)
- 39 pi,xd,oi,ddd (2)
- 40 pi,xi,od,dci,td (2)
- 41 pi,xi,oi,ddd,ti (2)
- 42 pi,xi,od,ddi,td (2)
- 43 pi,xi,oi,dcd,ti (2)
- 44 np,od,dci,tdod (1)
- 45 np,oi,dcd,tdi,ti (1)
- 46 np,oi,ddd (1)
- 47 np,oi,dcd,ti (1)
- 48 np,xd,od,dci (1)
- 49 np,xd,od,dci,tdod,td (1)
- 50 np,xd,od,dci,td (1)
- 51 np,xd,od,dci,tdi (1)
- 52 np,xd,oi (1)
- 53 np,xd,oi,dcd,tdi (1)
- 54 np,xd,oi,ddd,ti (1)
- 55 np,xi,od,dci,tdod (1)
- 56 np,xi,od,dci,tdod,td (1)
- 57 np,xi,od,dci,tdi (1)
- 58 np,xi,oi,ddd (1)
- 59 np,xi,od,ddi,tdod,qci,vdd,sdi (1)
- 60 np,xi,oi,dcd,tci,qod,tdi (1)

World champion in 2014 (Fencer on the right). T-Patterns detected

Nº	Chain formt pattern	Ocurrences	Bout	fencing phrases intra-bout	fencing phrases interspersed
R1	((np,xi,oi,ddd np,xi,od,dci) pi,xi,od,dci,td)	2	2	21-38-53	16, 14
			3	4-20-35	15, 14
R2	((pi,xd,oi np,xd,oi,dcd) pi,xd,oi,ddd)	2	2	6-20-24	13, 3
			3	30-48-51	17, 2
R3	(np,xd,oi,dcd pi,xd,oi,ddd)	2	2	20-24	3
			3	48-51	2
R4	(np,xi,od,dci pi,xi,od,dci,td)	2	2	39-53	13
			3	20-35	14
R5	(np,xi,od,ddi np,xi,od,ddi)	2	1	41-43	1
			1	43-45	1
R6	(np,xi,od,ddi,td pi,xi,od,ddi)	2	1	24-33	8
			3	16-25	8
R7	(np,xi,oi,dcd,tdi pi,xi,od,ddi,td)	2	1	6-14	7
			3	5-11	5
R8	(np,xi,oi,ddd pi,xi,oi,dcd,tci,ti)	2	1	1-19	17
			3	4-22	17
R9	(pd,xd,od,dci pi,xi,oi,dod,ti)	2	1	36-46	9
			4	7-14	6
R10	(pd,xd,od,ddi pd,od,ddi)	2	1	22-23	-
			1	51-52	-
R11	(pi,xd,oi,dcd np,xd,od,ddi)	2	1	21-28	6
			2	27-34	6
R12	(pi,xi,oi,dcd,ti np,xi,od,dci,td)	2	2	12-13	-
			3	59-60	-
R13	(pi,xi,oi,ddd pi,xi,od,dci,td)	2	2	28-53	24
			3	10-35	24
R14	(pi,xi,oi,dod,tid pi,xi,oi,dod,tid)	3	4	29-30	-
			4	30-31	-
			4	31-33	1

Lag sequential analysis (GSEQ)

Sub-champion of the World in 2013 (Fencer on the left)

Participant 1 - Sub-champion of the World in 2013 (Fencer on the left)																						
Right touch (not favor participant 1)												Left touch (favor participant 1)										
Lags												Lags										
-5	-4	-3	-2	-1	0	1	2	3	4	5		-5	-4	-3	-2	-1	0	1	2	3	4	5
Behaviors that FAVOR participant 1																						
PD	-1,70	-0,77	0,63	-0,27	-0,70	0,52	-2,20 &	0,19	-1,20	-1,22	-0,79	-0,45	-0,04	0,01	0,78	2,32 #	0,46	-0,33	-0,36	0,75	-0,42	1,06
XD	-0,06	-0,55	-1,04	0,79	-0,09	0,59	0,57	-0,11	1,67	-1,51	-1,98 &	0,43	0,01	2,56 #	0,01	1,14	1,45	-0,06	1,85	-0,04	1,41	0,26
OI	1,32	-0,03	0,44	0,41	0,44	-5,36 &	1,08	-0,91	0,82	-0,53	0,32	0,91	-0,95	-0,91	1,23	-1,99 &	6,73 #	0,91	1,59	0,46	0,06	-0,34
DCD	-0,56	-0,01	-0,54	0,02	-0,51	-2,73 &	0,46	-1,60	-0,54	-1,63	-1,10	0,80	-0,51	-0,49	0,42	-1,35	4,50 #	-0,01	-0,03	0,40	0,38	-0,09
DDD	2,45 #	0,88	0,40	0,85	-0,13	-3,19 &	0,23	-0,59	1,40	1,88	-0,07	-1,24	-0,88	-0,86	0,31	-0,49	2,42 #	0,34	0,82	-0,03	-0,47	0,84
DOD	1,43	-0,99	0,23	0,24	1,47	-1,00	1,40	0,24	1,45	0,23	3,85 #	0,67	0,68	-0,32	0,70	-1,31	2,73 #	-1,31	1,70	-1,32	1,68	-1,33
TOI	-0,80	-0,90	1,76	0,44	-0,89	-0,91	0,40	0,44	0,43	1,75	-0,90	1,36	0,98	-1,20	-1,20	-0,09	1,02	2,11 #	-1,20	3,19 #	-1,21	-0,12
Behaviors that NOT FAVOR participant 1																						
NP	0,52	0,02	-0,47	0,40	0,36	-0,24	1,14	-1,35	0,50	1,00	-0,33	-0,90	-0,20	-0,63	-1,42	-2,59	-1,44	-0,65	-0,60	-0,92	-0,12	-1,58
XI	-0,08	0,87	2,74 #	-0,55	-0,58	-0,71	-0,22	1,31	-0,10	-0,06	-0,08	-0,11	1,45	-1,97 &	-0,11	0,60	-2,04 &	-0,47	-1,64	-0,52	-0,08	-0,11
DI	-0,40	-0,40	-0,40	-0,40	-0,39	-0,40	-0,40	-0,40	2,54 #	-0,40	-0,40	-0,54	-0,53	-0,53	-0,53	1,91	1,91	-0,53	-0,53	-0,53	-0,53	1,88
OD	-1,52	0,27	-0,20	-0,17	-0,21	5,60 #	-0,84	1,14	-1,46	0,33	-0,96	-0,59	1,27	1,23	-0,91	1,94	-6,78 &	-1,32	-1,64	-0,51	-0,11	0,30
DCI	-1,09	0,72	-0,54	0,07	-1,11	6,29 #	-0,02	1,85	-0,47	1,33	-1,09	-0,10	1,41	1,30	-0,65	1,83	-2,66 &	-0,14	0,34	0,93	-1,08	1,39
DDI	-1,49	-0,99	0,96	-0,47	0,93	1,27	-1,12	-0,05	-1,03	-1,47	-0,53	-0,21	0,61	1,04	-0,13	1,40	-4,54 &	-0,99	-1,80	-1,04	0,61	-1,00
DOI	-0,40	-0,40	-0,40	-0,40	-0,39	-0,40	2,50 #	-0,40	-0,40	-0,40	-0,40	1,88	-0,53	-0,53	-0,53	-0,53	-0,53	-0,53	-0,53	-0,53	-0,53	-0,54
TDD	-0,74	-0,73	1,56	0,78	0,00	-0,84	-0,07	-0,72	0,09	0,20	0,19	-0,07	0,62	-0,84	-0,83	-0,16	-2,12 &	-0,82	-0,03	-0,72	-0,60	0,78
TOD	-0,40	-0,40	-0,40	-0,40	-0,39	2,51 #	-0,40	-0,40	-0,40	-0,40	-0,40	-0,54	-0,53	-0,53	-0,53	1,91	-0,53	-0,53	-0,53	-0,53	-0,53	-0,54

Excitatory behavior (> 1.96)

Inhibitory behavior (< -1.96)

Lag sequential analysis (GSEQ)



World champion in 2014 (Fencer on the right)

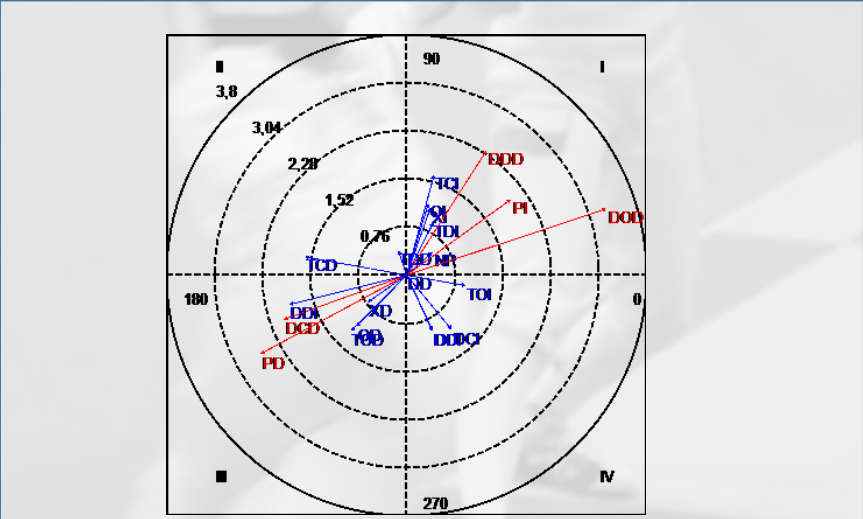
Participant 2 - Champion of the World in 2014 (Fencer on the right)

	Right touch (favor participant 2)											Left touch (not favor participant 2)										
	Lags											Lags										
	-5	-4	-3	-2	-1	0	1	2	3	4	5	-5	-4	-3	-2	-1	0	1	2	3	4	5
Behaviors that FAVOR participant 2																						
NP	0,81	-1,48	-0,80	-1,93	-1,53	-0,74	-1,08	2,05 #	0,29	-0,05	-0,40	-1,66	-1,64	-2,45 #	1,29	-0,35	-1,57	-0,70	-0,66	1,06	-1,84	0,31
PD	-1,45	0,30	0,65	0,67	1,54	1,56	-0,18	-1,48	-0,55	0,30	-0,15	0,91	0,47	0,48	-0,90	-0,88	-2,27 #	-0,88	-0,43	-2,30 #	0,00	-0,94
OD	-1,39	1,15	-0,79	-0,46	1,69	6,32 #	-0,43	-0,75	1,60	0,20	-0,19	0,10	0,13	-0,99	-0,64	-1,37	-6,32 #	-1,37	-0,20	-1,32	-0,14	0,60
DCI	-1,75	1,54	-0,40	0,08	-0,37	2,44 #	-0,37	0,17	-0,24	-1,61	0,77	0,16	0,68	-1,32	0,70	0,21	-2,81 #	0,72	0,79	-1,26	-0,70	-0,20
DDI	0,36	-0,39	-0,87	-1,67	1,39	3,69 #	-0,51	-0,53	2,32 #	1,53	-0,73	-0,07	-0,46	0,79	-0,89	-1,29	-4,15 #	-1,70	-0,89	-1,27	-0,46	0,82
DCI	-0,24	-1,25	1,73	0,74	-0,25	2,77 #	-1,26	-0,26	-0,23	-0,24	1,77	-0,05	-1,13	-1,12	-1,12	-1,12	-1,11	-1,12	-0,04	-0,04	-0,05	-1,13
TCD	-0,01	0,66	-1,36	-1,35	0,63	1,96 #	-0,03	1,28	0,67	-0,67	-0,01	0,33	-1,09	-0,37	-1,07	-0,35	-1,78	1,07	0,35	-1,08	0,33	-1,80
Behaviors that FAVOR participant 2																						
PI	0,64	1,32	0,04	0,72	-0,02	-0,35	0,68	-0,76	0,44	-0,31	0,74	0,58	1,31	1,67	-0,29	0,45	3,55 #	1,22	0,81	1,17	1,91	0,73
XI	0,97	-0,49	-0,69	-2,14 #	1,01	-0,37	0,37	-0,73	-1,24	-0,92	-0,17	-2,07 #	-0,18	0,94	-0,24	0,11	3,20 #	0,55	-0,24	2,09 #	0,14	0,56
CI	1,72	-0,83	0,40	0,07	-2,09 #	-6,32 #	0,10	0,78	-1,58	-0,18	0,22	-0,19	0,16	0,90	0,92	0,89	6,68 #	1,33	0,15	1,28	0,49	-0,25
DCD	1,06	-0,21	-0,71	1,01	-0,68	-3,65 #	-0,25	1,44	-1,05	-1,07	0,63	0,38	-0,07	0,41	-0,04	0,90	7,39 #	1,36	-0,04	0,41	1,31	-1,00
DDD	0,77	-1,61	0,71	-0,22	-0,69	-3,06 #	0,36	-0,62	-1,53	0,88	-0,59	-0,71	0,84	0,34	0,36	0,88	0,38	-0,59	0,96	2,50 #	-0,63	0,92
TCI	0,85	-1,58	0,01	2,44 #	-0,78	-1,58	0,03	-0,79	-1,57	-0,77	0,85	-0,56	-1,42	-1,42	-1,42	0,34	5,60 #	0,34	-0,54	2,07 #	-1,42	-0,56
TOD	-0,94	-0,94	1,68	-0,95	0,37	0,38	-0,94	1,68	-0,93	-0,94	-0,94	1,98 #	1,99 #	-0,84	0,58	0,59	0,59	0,59	0,58	-0,84	1,98 #	

The image displays a 4x4 grid of 16 panels. Each panel shows a close-up of a woman's eyes. The eyes are closed in the top-left panel and gradually open through the subsequent panels in a sequence that moves from left to right and then top to bottom. This sequence is designed for a visual search task where participants must identify the panel in which the eyes are fully open.

Sub-champion of the World in 2013 (Fencer on the left)

Right touch
(focal behaviour: TD)



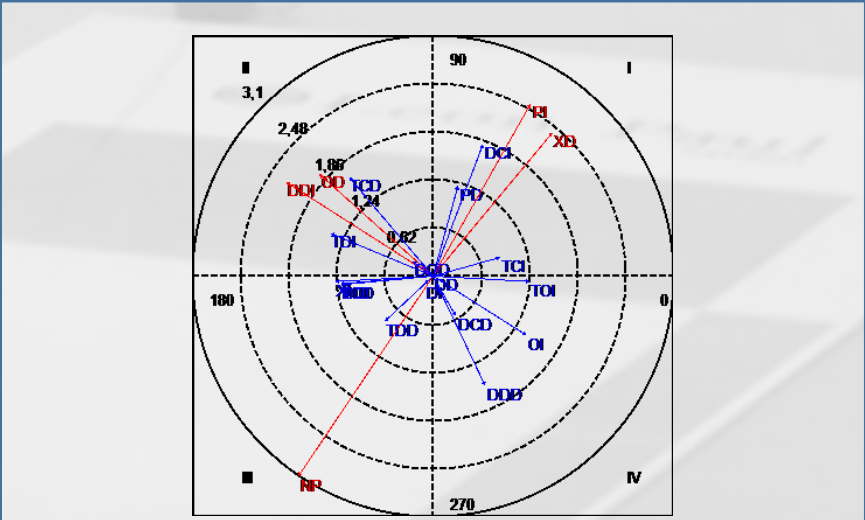
Favor participant 1:

- a) PD - Opponent (right) pressure - III
- b) DCD - 2nd action: Opponent (right) counteroffensive - III

Not favor participant 1:

- a) PI – Own (left) pressure - I
- b) DDD - 2nd action: Opponent (right) defensive- I
- c) DOD - 2nd action: Opponent (right) offensive- I

Left touch
(focal behaviour: : TI)



Favor participant 1 :

- a) PI - Own (left) pressure - I
- b) XD – Opponent (right) preparation- I
- c) OD - 1st action: Opponent (right) offensive - II
- d) DDI - 2nd action: Own (left) defensive- II

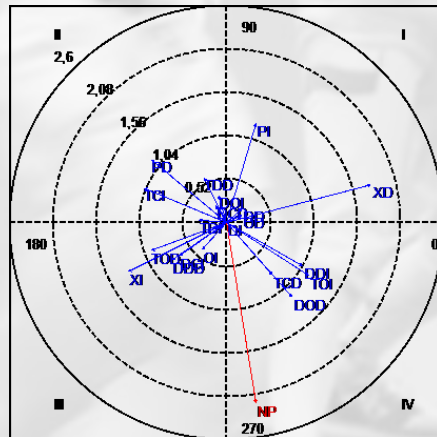
Not favor participant 1:

- a) NP - No pressure - III

Polar coordinate analysis (HOISAN)

World champion in 2014 (Fencer on the right)

Right touch
(Focal behaviour : TD)



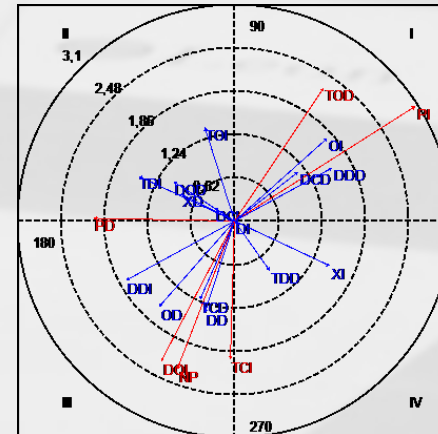
Favor participant 2:

-

Not favor participant 2:

- a) NP - No pressure inhibits the favorable touche (TD) and when it touches (TD) NO PRESSURE behaviors are activated – IV

Left touch
(Focal behaviour : TI)



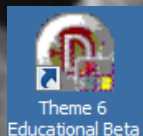
Favor participant 2 :

- a) NP - No pressure - III
- b) DOI - 2nd action: Opponent (left) offensive - III
- c) TCI - 3rd action: Opponent (left) counteroffensive - III

Not favor participant 2:

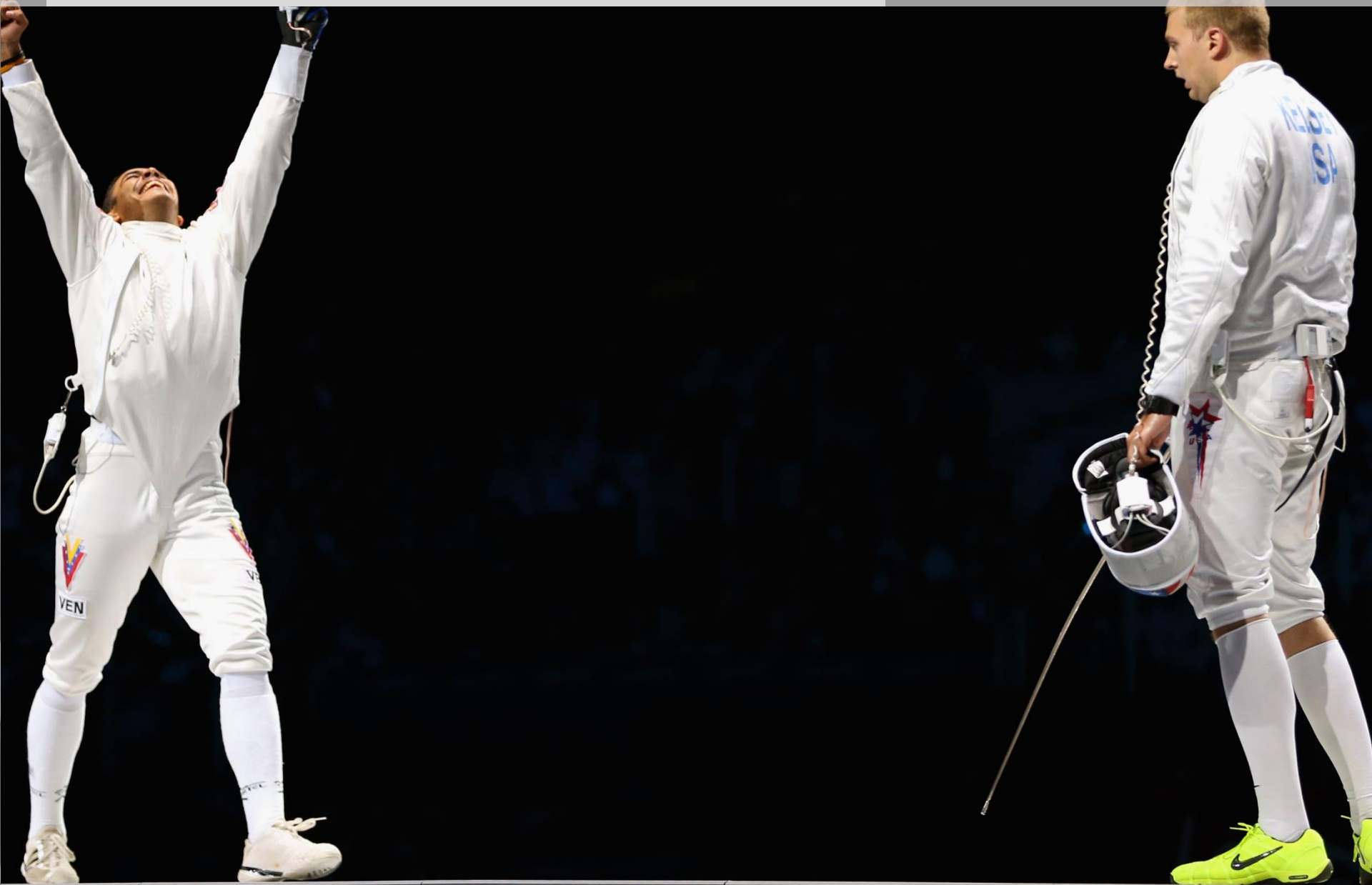
- a) PI – Opponent (left) pressure - I
- b) PD – Own (right) pressure - II
- c) TOD - 3rd action: Own (right) offensive - I

Complementary evaluation of tactical sequences for fencers 1 and 2



T-Patterns	Lags		Polar coordinate	
<u>Behaviors that FAVOR participant 1 (Fencer on the left)</u>				
(NP,XD,OI,DDD,TI PD,XD,OI)	PD	DDD	PD	OD
(PI,XD,OD,DCI,TD PI,XI,OI,DCD,TI)	XD	DCD	PI	DCD
	OI	TOI	XD	DDI
<u>Behaviors that DO NOT FAVOR participant 1 (Fencer on the left)</u>				
(NP,XI,OD,DCI,TD NP,XI,OD,DDI,TDD)	NP	DDI	NP	
(PD,XD,OI,DDD PD,XD,OD,DCI,TD)	XI	DOI	PI	
(PI,XD,OD,DCI,TD PI,XI,OD,DDI)	DI	TDD	DDD	
(PI,XD,OD,DCI,TD PI,XI,OI,DCD,TI)	OD	TOD	DOD	
	DCI			
<u>Behaviors that FAVOR participant 2 (Fencer on the right)</u>				
((NP,XI,OI,DDD NP,XI,OD,DCI) PI,XI,OD,DCI,TD)	NP	DDI	NP	
(NP,XI,OD,DCI PI,XI,OD,DCI,TD)	PD	DOI	DOI	
(NP,XI,OD,DDI,TD PI,XI,OD,DDI)	OD	TCD	TCD	
(NP,XI,OI,DCD,TDI PI,XI,OD,DDI,TD)	DCI			
(PI,XI,OLD,DCD,TI NP,XI,OD,DCI,TD)				
(PI,XI,OLD,DDD PI,XI,OD,DCI,TD)				
<u>Behaviors that DO NOT FAVOR participant 2 (Fencer on the right)</u>				
(NP,XI,OI,DDD PI,XI,OI,DCD,TCI,TI)	PI	DDD	NP	
(PD,XD,OD,DCI PI,XI,OI,DOD,TI)	XI	TCI	PI	
	OI	TOD	PD	
	DCD		TOD	

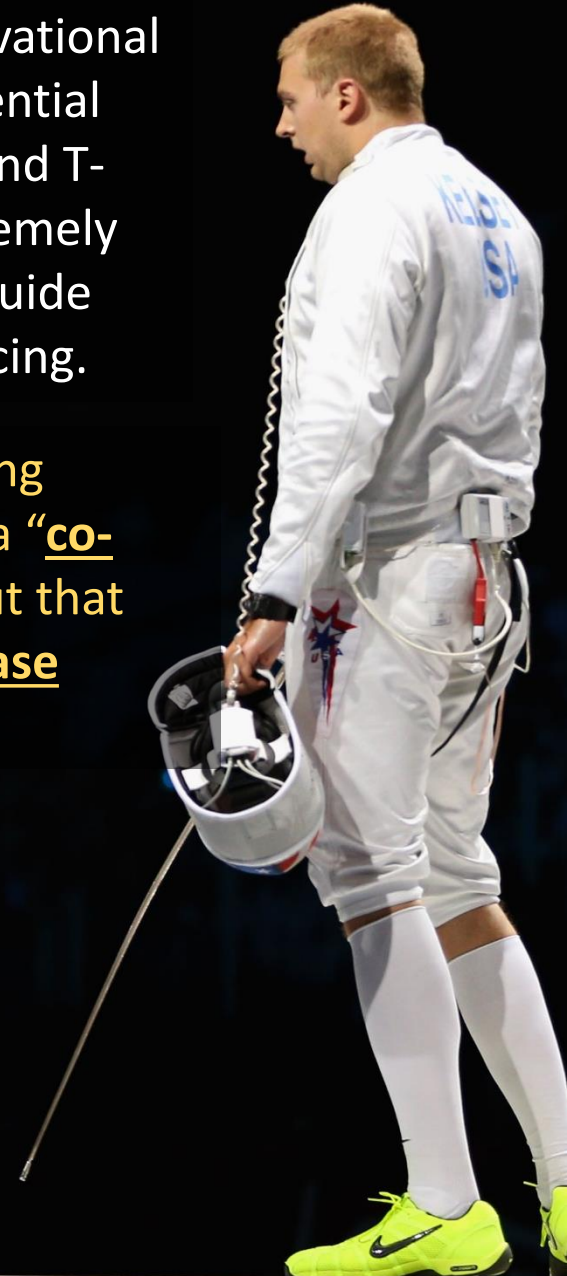
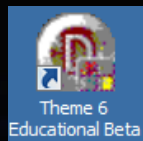
Discussion and conclusion





The main conclusion of this study is that the complementary use of the three observational methodology techniques—lag sequential analysis, polar coordinate analysis, and T-pattern detection— can provide extremely useful insights that can be used to guide **tactical** and **strategic** training in fencing.

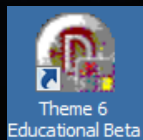
- A) Each dataset corresponds to a fencing phrase, which could be considered as a “co-occurrence” of behaviors or actions but that actually presents internal or intra-phrase sequentiality.





The main conclusion of this study is that the complementary use of the three observational methodology techniques—lag sequential analysis, polar coordinate analysis, and T-pattern detection— can provide extremely useful insights that can be used to guide **tactical** and **strategic** training in fencing.

- B) The **strategical analysis** shows how co-occurrences or events (fencing phrases) influence each other (via T-patterns), and it also shows how different behaviors (actions) influence previous or subsequent behaviors (using sequential analysis of lags -1 to -5 and +1 to +5 and polar coordinate analysis).



Thank you

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