



Behavioral Structure in Sociomotor Sports: Roller-Hockey

ANTONIO HERNÁNDEZ MENDO

University of Málaga

M. TERESA ANGUERA ARGILAGA

University of Barcelona

Abstract. This study, part of a wider research project, presents (1) a category system for observation in roller-hockey, and (2) the results obtained with it. The behavior flow obtained with this category system was analyzed sequentially using the lag technique. The behavior patterns were compared with the results of Exact Permutations analysis of the same data. Finally, the main behavior patterns, and their psychosocial implications, are described. The most distinctive feature of the study is its use of specific software in both the coding and the analysis of the observational categories.

Résumé. Cette étude qui est une partie d'autre recherche plus grande, présente (1) un système de catégories de l'observation en hockey sur patins, et (2) les résultats obtenus avec ce système de catégories. Les patrons de conduite obtenus sont comparés avec les analyses de Permutations Exact réussies avec les mêmes données. À la fin sont décrites les patrons de conduite et leur implication psychosociale. Le plus distinctif caractéristique de cette étude est l'usage de logiciel spécifique pour la codification et pour l'analyse des catégories d'observation.

Key words: Roller-hockey, sociomotor sports, behavioral structure

1. Introduction

Roller-hockey is a sociomotor sport in which Spanish clubs and the national team have met with considerable success in international competitions, both in Europe and worldwide. Curiously, though, outside its strongholds in Galicia, Asturias and Catalonia, the sport is virtually unknown in many regions of the country.

The relatively limited literature on the subject describes roller-hockey as a sport requiring a high level of physical, technical and tactical ability. Players need good control of the equipment – skates, stick, and the ball – and of technical aspects such as shooting, dribbling and passing. Technical and tactical aspects are highly intensive and require great precision if the team's joint activities of defence, attack and counterattack at speed are to function effectively (Arecas, 1987).

As a team sport, its performance structure – matches, players, teams, trainers, training sessions, psychological training, environmental factors – is as complex as

that of other team sports such as soccer or volleyball, and for this reason evaluating performance has proved to be a complicated task.

Without going into the formal structure of roller-hockey in detail, we can say that a team's capacity to combine individual and group tactics should be based on objective knowledge, obtained via an assessment of its performance. In our view, such an assessment can be gained from the study of the patterns of play that arise in the course of a game, using suitable analytical methodology and techniques.

Here, we observe and transcribe several roller-hockey matches at international or top division level, in order to define the different categories on which to base our analysis of game situations. We start with an initial definition of behaviors; this definition is then modified after analysis of the observations. Our results allow us to define a range of categories that result from the operativization of behaviors that differ from those generally used in team sports. On the basis of these results, we generate new conceptualizations of teams' systems of attack and defence and also define a functional model of roller-hockey with which we later develop an analysis of patterns of play, using two different sequential analysis procedures: the lag method, and the exact permutations technique.

2. The Category System

The category system that we propose is inductive; it is based on a system of provisional categories created, revised and improved during a series of observations.

Our description of the category system includes:

- abbreviations of the different categories
- differentiation between **categorical nucleus** and **plasticity degree**
- whenever possible, inside the categorical nucleus a distinction between the **definition of behavior** and the **motor description** of the most important behaviors
- as regards the plasticity degree, the presentation of lists of other possible manifestations of the behavior.

Each of these possibilities is accompanied by a detailed definition.

Here, due mainly to restrictions of space, we will only present the abbreviations of the categories defined. The category system developed contains 38 categories, grouped in four molar categories: shooting actions, technical-tactical actions, goalkeeper's actions, and other incidents. We will now describe each of the macrocategories and the categories that they contain.

2.1. SHOOTING ACTIONS

Shots or shooting actions in sociomotor sports represent the endpoint of an attack, regardless of whether the team has gained numerical or tactical superiority; the aim of the action is to score a goal.

The ways in which shots are made differ according to sport, and are specified in the rules. In roller-hockey “a shot” is when a player hits the ball with his stick towards the other team’s goal.

In a preliminary study, Hernández Mendo, Arces, González Fernández and Garea (1994) defined 18 categories of shot, noting the position from which it is made, where it is aimed, and whether it is the result of an attack or a counterattack. In their second study, they reduced the number of categories to nine, on the basis of location and orientation:

TAMO: Shot from inside the area, off-target

TABO: Shot from inside the area, on-target

TAGO: Shot from inside the area, goal

TPMO: Shot from the side, off-target

TPBO: Shot from the side, on-target

TPGO: Shot from the side, goal

TCMO: Shot from the centre, off-target

TCBO: Shot from the centre, on-target

TCGO: Shot from the centre, goal

2.2. TECHNICAL-TACTICAL ACTIONS

Technical-tactical actions involve individual technique and are related to tactical moves in defence and attack, assuming the interdependence of the two. In socio-motor sports, there are fewer differences in technical-tactical actions than in the other macrocategories.

The preliminary study identified seven behaviors as technical-tactical actions, and the later study defined twelve. Despite their importance inside the tactical actions of the team, we consider them as individual actions and abbreviate them as follows:

REIN: indirect recovery

PERD: loss of ball

REDI: direct recovery

ASIS: assist

DIND: individual defence

DZOC: square zonal defence

DZOR: diamond zonal defence

DMIX: mixed organized defence

DTRA: transitional defence

DINF: defence in numerical inferiority

TIRE: shot cleared

RECH: clearance

2.3. GOALKEEPERS' ACTIONS

Under the heading "Goalkeepers' actions" we group a number of categories of a defensive character performed only by the goalkeeper. They include saves from shots from different areas of the field of play, goals conceded and one-to-one situations facing a forward of the other team.

There are seven categories of "Goalkeepers' actions", as in the first study. They cover one-to-one counterattacks, saves from on-target shots by the other team, and goals conceded:

PAAR: Shot from inside the area, saved by the goalkeeper

PAPA: Shot from the sides, saved by the goalkeeper

PACE: Shot from the centre, saved by the goalkeeper

GOAR: Goal conceded from a shot inside the area

GOPA: Goal conceded from a shot from the sides

GOCE: Goal conceded from a shot from the centre

UVPO: One-to-one situation with forward

2.4. OTHER INCIDENTS

Under the heading "Other incidents" we define ten behaviors related in general to infringing the regulations, such as warnings from referees (in the form of red, blue and yellow cards), penalties, and direct free hits. Only substitutions are not associated with infringements, although one type of substitution is a consequence of non-compliance with the rules. For warnings (cards) we establish three categories, for penalties two, for free hits two and two also for substitutions:

TAAM: Yellow card shown by referee

TAAZ: Blue card shown by referee

TARO: Red card shown by referee

PERE: Penalty taken

PECO: Penalty scored

FDRE: Free hit taken

FDCO: Goal from a direct free hit

CAMJ: Change of player for tactical reasons

CAMP: Change of player due to accumulation of fouls

LESI: Injured player leaves field of play

3. Method

3.1. SUBJECTS

Initially, in order to analyze the quality of the data, the match was coded in three different situations. The behavior flow was coded by the observation team in two of the situations, and by a team of trained observers in the third. In all cases observers used *consensus agreement* (Anguera, 1990). The first analysis involved a sample comprising ten professional players from the premier division.

We then coded six premier division matches involving a total of six different teams. This second sample comprised sixty-six professional players from the Spanish premier division.

3.2. MATERIAL

The material used in coding the behavioral flow of the two samples and in the statistical and sequential analysis was: a VHS video recorder, a high definition multi-Syn television, a portable computer with an 80486SX microprocessor (33 Mz speed, 4 Mb RAM and 210 Mb on the hard disk), a laptop computer with an 80486DX microprocessor (66 Mz, 80386 mathematical coprocessor, 16 Mb RAM and 420 Mb on the hard disk), the SPSS statistical package version 6.1 for Windows, the "TRANSCRIPTOR" coding program, version 2.1, (Peralbo, Riso, Ramos & Hernández Mendo, 1991; Hernández Mendo, Ramos, Peralbo & Riso, 1992, 1993, 1994b; Hernández Mendo, 1994), the sequential analysis program SDIS-GSEQ (Bakeman & Quera, 1995) and the Exact Permutations Program, PSEQ (Bakeman, Robinson & Quera, 1996).

3.3. PROCEDURE

To analyze data quality three different temporal moments of a roller-hockey match were coded – two by one team of observers, and the third by another previously trained group. In all cases, observation was carried out using consensus agreement (Anguera, 1990). When coding was complete, the inter- and intra-observer concordance was calculated using the kappa index, a simple agreement-disagreement index and a study of the correlations.

To perform sequential analysis and to study the corresponding max lag, the same observer coded six matches. Subsequently, using the SDIS-GSEQ program (Bakeman & Quera, 1995) a study of the corresponding patterns was performed.

4. Results

4.1. ANALYSIS OF DATA QUALITY

To contrast the quality of data, the first half of a top level roller-hockey match (Novara, Italy, v. Dominicos, Spain) was coded. The behavioral flow was coded by two different teams of observers trained following the classic specifications for observer training (Johnson & Bolstad, 1973; Engram, 1976; Gladding, 1978; Schrier, Carver & Gibbons, 1979; Fiske, 1979; Mueller & Courtois, 1980; Anguera, 1990). Each team of observers used consensus concordance (Anguera, 1990). One team of observers coded this match twice.

The frequencies obtained in each of the codings, which were used subsequently to calculate the indices, were the following:

The three codings produced three files (N2, N3 and N4). Kappa, concordance and agreement indices were calculated on the basis of these files; the relationship between files N2 and N3 and N2 and N4 was used to calculate inter-observer concordance, and files N3 and N4 were used to calculate intra-observer concordance. The results are shown below:

The kappa indices were calculated over different time intervals. As the interval increases, so does the kappa index. However, from the 3' interval onwards the results begin to form in a band that can be considered acceptable. The results are therefore satisfactory.

The results obtained on the concordance index are similar to those of the kappa indices, and can also be considered satisfactory. The correlation indices are high, and satisfactory:

4.2. SEQUENTIAL ANALYSIS

According to Losada (1995), during the eighties considerable progress was made in systematizing and optimizing observational methodology data. The modalities of quantitative analysis that can be applied to observational data are very varied. Sackett, one of the leading authors in the field, distinguishes between sequential and non-sequential analysis (Sackett, 1978) and the same division is proposed by Sackett & Landesman-Dwyer (1982). The choice of analysis type depends on the objectives and hypotheses of the particular research project.

The term "sequential analysis" refers to a set of techniques which aim to highlight sequential relationships, associations or dependences between behavior units. It is the commonest form of microanalysis, since it consists in determining how the occurrence probabilities of certain conducts vary in relation to the prior occurrence of others; it therefore relates behavioral measurements obtained diachronically. It is not the only form of analysis in observational methodology, but it is the most important.

We can distinguish two forms of approaching sequential analysis; one is *modelling*, in which researchers formulate a theoretical model as a possible generator

Table 1. Frequencies obtained in each of the codings

	NOVARA2. Moda..	TRN(N2) REDI	NOVARA3.TRN(N3) REDI	NOVARA4.TRN(N4) REDI		
Total de Ocurrencias...		164	139	163		
	Rango...	32	28	32		
Cod	Descripción	Frec				
		N2	N3	N4		
REIN	Recuperación Indirecta. Es la acción indirecta de a	18	12	18		
PERD	PERDidas.Pérdida de la posesión	11	13	13		
REDI	Recuperación Directa. Es la acción individual de ap	32	28	32		
ASIS	ASIStencias. Pase a compañero con claras posibilid	1	0	0		
DIND	Defensa INDividual	25	28	26		
DZOC	Defensa ZONal en Cuadrado	0	0	0		
DZOR	Defensa ZONal en Rombo	0	1	0		
DMIX	Defensa MIXta	0	0	0		
DTRA	Defensa en TRAnsición. Defensa circunstancial en i	17	11	17		
DINF	Defensa circunstancial en INFerioridad numérica	1	0	1		
TAMO	Tiro desde el Área Mal Orientado	2	1	3		
TABO	Tiro desde el Área Bien Orientado	9	10	9		
TAGO	Tiro desde el Área GOI	0	1	1		
TPMO	Tiro desde Pasillos laterales Mal Orientado	3	1	0		
TPBO	Tiro desde Pasillos laterales Bien Orientado	4	8	5		
TPGO	Tiro desde Pasillos laterales GOI	0	0	0		
TCMO	Tiro desde pasillo Central Mal Orientado	7	5	3		
TCBO	Tiro desde pasillo Central Bien Orientado	2	3	8		
TCGO	Tiro desde pasillo Central GOI	0	0	0		
PAAR	acción de portero. PARada tiro de ÁREA	8	11	4		
PAPA	acción de portero. PARada tiro de PASillo lateral	3	4	6		
PACE	acción de portero.PARada tiro de pasillo CEntral	2	1	0		
GOAR	GOI encajado desde la zona del ÁREA	0	0	1		
GOPA	GOI encajado desde la zona de los PASillos lateral	1	0	0		
GOCE	GOI encajado desde la zona del pasillo CEntral	0	0	0		
UVPO	Uno contra portero	0	0	1		
TAAM	TARjeta AMarilla mostrada por el árbitro	1	0	0		
TAAZ	TARjeta AZul mostrada por el árbitro	0	0	1		
TARO	TARjeta ROja mostrada por el árbitro	0	0	0		
PERE	PEnalty REalizado	0	0	0		
PECO	PEnalty COnvertido	0	0	0		
FDRE	Falta Directa REalizada	0	0	0		
FDCE	Falta Directa COnvertida	0	0	0		
CAMJ	CAMBios. Cambio de jugadores realizados en el equi	3	0	0		
CAMP	CAMBio obligatorio por acumulación de Personales	0	0	0		
LESI	abandono de la pista por LESIón	0	0	0		
TIRE	Tiro REchazado	12	12	12		
RECH	RECHazo	2	1	2		

Table IV. Correlation coefficients

	N2-N3	N2-N4	N3-N4
PEARSON	0.96	0.97	0.95
KENDALL	0.80	0.70	0.78
SPEARMAN	0.87	0.78	0.85

of the behavior sequences they observe, and on this basis determine which hypothetical sequences would be observed if the model were true. Researchers then compare the sequences observed with those expected, and if the fit is reasonable, conclude that the model is valid. The other approach is *description*, in which researchers have no theoretical model for the sequences that they observe, and seek to identify the regularities that exist in them. Modelling is fundamentally a deductive procedure, and description an inductive one; description is more widely used in behavior observation, and is the one that we used in this project.

In the field of description, the lag technique is one of most frequently used. It was developed by Sackett (1978, 1980, 1987) on the basis of the work by Bakeman & Brown (1976) in which conditional probabilities in the first lag were used. By recording type I and type II data (either directly or by prior transformation) or events (in our case) (Bakeman & Quera, 1995) the measurements of autocontingency and heterocontingency between behaviors are obtained. The behavior pattern obtained is equivalent to a highly condensed extract of the information, and is of considerable use in establishing an objective view of the behavior studied and in analyzing its evolution, if desired. Detailed discussions of the process can be found in Allison & Liker (1982), Anguera (1983, 1990), Bakeman & Gottman (1986), Quera (1993), Escudero (1995). For this analysis we used the SDIS-GSEQ program (Bakeman & Quera, 1995, 1996).

Exact permutations analysis, used to contrast the probability of occurrence of the patterns established by means of sequential analysis, is a procedure based on the randomization of observations using a Montecarlo simulation model. It is used when the z scores do not follow normal distribution (as is the habitual assumption) when the transitions in a table are interconnected, or when working with very low frequencies (as is the case in some of the categories used in this study).

Exact permutations analysis makes it possible to optimize the sequential analysis, by applying asymptotic analytical techniques to assign significance. Sample distributions are constructed by randomizing the data observed. For this analysis we used the PSEQ software (Bakeman, Robinson & Quera, 1996).

For the sequential analysis, 6 roller-hockey matches from the Spanish premier league during the 1994–95 season were coded using the TRANSCRIPTOR program version 2.0 (Peralbo, Risso, Ramos & Hernández, 1991; Hernández, Ramos,

Peralbo & Risso, 1993, Ramos, Hernández, Peralbo & Risso, 1993; Hernández, 1994).

4.2.1. *Description of Results*

We now present the frequencies of the categories of each of the six observational sessions (six complete matches) which were coded for sequential analysis.

FIRST SESSION

The first session corresponded to an international match between Dominicos, from La Coruña, Spain, and Novara, Italy. In this first session Dominicos were coded, and the following frequencies were found:

SECOND SESSION

The second session was performed during the same match, and involved the coding of the behavior of the Italian team. The frequencies were as follows:

THIRD SESSION

The third session coded a Spanish premier division match between Igualada and Liceo Caixa Galicia. The third session recorded the behavior flow of the Igualada team; the frequencies obtained were:

FOURTH SESSION

The fourth session corresponded to the Igualada-Liceo Caixa Galicia match, and coded the Liceo Caixa Galicia team. The frequencies obtained were:

FIFTH SESSION

The fifth session covered a match between Reus and Voltreg., and recorded the behavior of the Reus team. The frequencies obtained were:

SIXTH SESSION

The sixth session covered the same match, and recorded the behavior of the Voltreg. team. The frequencies obtained were:

Table V. First session

TRANSCRIPTOR. © 1991 A.H.Mendo, M.Peralbo, R.Ramos, A.Risso
 File currently in use: DOMITOTA.TRN
 Analysis of frequencies for codes
 Subject observed ... EQAN Mode ... REDI
 Total occurrences ... 394 Range ... 75

Code	Description	Frec.	%
REIN:	indirect recovery	42	10.66
PERD:	loss of ball	35	8.88
REDI:	direct recovery	75	19.04
ASIS:	assist	1	0.25
DIND:	individual defence	72	18.27
DZOC:	square zonal defence	0	0.00
DZOR:	diamond zonal defence	0	0.00
DMIX:	mixed organized defence	0	0.00
DTRA:	transitional defence	31	7.87
DINF:	defence in numerical inferiority	4	1.02
TAMO:	Shot from inside the area, off-target	3	0.76
TABO:	Shot from inside the area, on-target	25	6.35
TAGO:	Shot from inside the area, goal	3	0.76
TPMO:	Shot from the side, off-target	4	1.02
TPBO:	Shot from the side, on-target	10	2.54
TPGO:	Shot from the side, goal	1	0.25
TCMO:	Shot from the centre, off-target	8	2.03
TCBO:	Shot from the centre, on-target	7	1.78
TCGO:	Shot from the centre, goal	0	0.00
PAAR:	Shot from inside the area, saved by the goalkeeper	15	3.81
PAPA:	Shot from the sides, saved by the goalkeeper	4	1.02
PACE:	Shot from the centre, saved by the goalkeeper	6	1.52
GOAR:	Goal conceded from a shot inside the area	4	1.02
GOPA:	Goal conceded from a shot from the sides	1	0.25
GOCE:	Goal conceded from a shot from the centre	0	0.00
UVPO:	One-to-one situation with forward	0	0.00
TAAM:	Yellow card shown by referee	3	0.76
TAAZ:	Blue card shown by referee	0	0.00
TARO:	Red card shown by referee	0	0.00
PERE:	Penalty taken	0	0.00
PECO:	Penalty scored	1	0.25
FDRE:	Free hit taken	0	0.00
FDCO:	Goal from a direct free hit	0	0.00
CAMJ:	Change of player for tactical reasons	3	0.76
CAMP:	Change of player due to accumulation of fouls	0	0.00
LESI:	Injured player leaves field of play	0	0.00
TIRE:	shot cleared	27	6.85
RECH:	clearance	9	2.28

Table VI. Second session

TRANSCRIPTOR. © 1991 A.H.Mendo, M.Peralbo, R.Ramos, A.Risso
File currently in use: DOMITOTA.TRN
Analysis of frequencies for codes
Subject observed ... EQAN Mode ... REDI
Total occurrences ... 326 Range ... 69

Code	Description	Frec.	%
REIN:	indirect recovery	40	12.27
PERD:	loss of ball	47	14.42
REDI:	direct recovery	69	21.17
ASIS:	assist	0	0.00
DIND:	individual defence	16	4.91
DZOC:	square zonal defence	6	1.84
DZOR:	diamond zonal defence	30	9.20
DMIX:	mixed organized defence	1	0.31
DTRA:	transitional defence	20	6.13
DINF:	defence in numerical inferiority	3	0.92
TAMO:	Shot from inside the area, off-target	1	0.31
TABO:	Shot from inside the area, on-target	24	7.36
TAGO:	Shot from inside the area, goal	2	0.61
TPMO:	Shot from the side, off-target	2	0.61
TPBO:	Shot from the side, on-target	6	1.84
TPGO:	Shot from the side, goal	0	0.00
TCMO:	Shot from the centre, off-target	0	0.00
TCBO:	Shot from the centre, on-target	4	1.23
TCGO:	Shot from the centre, goal	0	0.00
PAAR:	Shot from inside the area, saved by the goalkeeper	17	5.21
PAPA:	Shot from the sides, saved by the goalkeeper	4	1.23
PACE:	Shot from the centre, saved by the goalkeeper	10	3.07
GOAR:	Goal conceded from a shot inside the area	4	1.23
GOPA:	Goal conceded from a shot from the sides	0	0.00
GOCE:	Goal conceded from a shot from the centre	0	0.00
UVPO:	One-to-one situation with forward	2	0.61
TAAM:	Yellow card shown by referee	2	0.61
TAAZ:	Blue card shown by referee	0	0.00
TARO:	Red card shown by referee	0	0.00
PERE:	Penalty taken	0	0.00
PECO:	Penalty scored	0	0.00
FDRE:	Free hit taken	0	0.00
FDCO:	Goal from a direct free hit	0	0.00
CAMJ:	Change of player for tactical reasons	0	0.00
CAMP:	Change of player due to accumulation of fouls	0	0.00
LESI:	Injured player leaves field of play	0	0.00
TIRE:	shot cleared	8	2.45
RECH:	clearance	8	2.45

Table VII. Third session

TRANSCRIPTOR. © 1991 A.H.Mendo, M.Peralbo, R.Ramos, A.Risso
File currently in use: DOMITOTA.TRN
Analysis of frequencies for codes
Subject observed ... EQAN Mode ... REDI
Total occurrences ... 366 Range ... 73

Code	Description	Frec.	%
REIN:	indirect recovery	49	13.39
PERD:	loss of ball	45	12.30
REDI:	direct recovery	73	19.95
ASIS:	assist	0	0.00
DIND:	individual defence	70	19.13
DZOC:	square zonal defence	0	0.00
DZOR:	diamond zonal defence	0	0.00
DMIX:	mixed organized defence	0	0.00
DTRA:	transitional defence	18	4.92
DINF:	defence in numerical inferiority	8	2.19
TAMO:	Shot from inside the area, off-target	2	0.55
TABO:	Shot from inside the area, on-target	14	3.83
TAGO:	Shot from inside the area, goal	3	0.82
TPMO:	Shot from the side, off-target	2	0.55
TPBO:	Shot from the side, on-target	7	1.91
TPGO:	Shot from the side, goal	0	0.00
TCMO:	Shot from the centre, off-target	0	0.00
TCBO:	Shot from the centre, on-target	7	1.91
TCGO:	Shot from the centre, goal	1	0.27
PAAR:	Shot from inside the area, saved by the goalkeeper	15	4.10
PAPA:	Shot from the sides, saved by the goalkeeper	7	1.91
PACE:	Shot from the centre, saved by the goalkeeper	2	0.55
GOAR:	Goal conceded from a shot inside the area	2	0.55
GOPA:	Goal conceded from a shot from the sides	0	0.00
GOCE:	Goal conceded from a shot from the centre	0	0.00
UVPO:	One-to-one situation with forward	0	0.00
TAAM:	Yellow card shown by referee	2	0.55
TAAZ:	Blue card shown by referee	1	0.27
TARO:	Red card shown by referee	0	0.00
PERE:	Penalty taken	0	0.00
PECO:	Penalty scored	0	0.00
FDRE:	Free hit taken	1	0.27
FDCO:	Goal from a direct free hit	0	0.00
CAMJ:	Change of player for tactical reasons	4	1.09
CAMP:	Change of player due to accumulation of fouls	0	0.00
LESI:	Injured player leaves field of play	0	0.00
TIRE:	shot cleared	10	2.73
RECH:	clearance	23	6.28

Table VIII. Fourth session

TRANSCRIPTOR. © 1991 A.H.Mendo, M.Peralbo, R.Ramos, A.Risso
 File currently in use: DOMITOTA.TRN
 Analysis of frequencies for codes
 Subject observed ... EQAN Mode ... REDI
 Total occurrences ... 369 Range ... 70

Code	Description	Frec.	%
REIN:	indirect recovery	38	10.30
PERD:	loss of ball	30	8.13
REDI:	direct recovery	70	18.97
ASIS:	assist	0	0.00
DIND:	individual defence	22	5.96
DZOC:	square zonal defence	50	13.55
DZOR:	diamond zonal defence	3	0.81
DMIX:	mixed organized defence	2	0.54
DTRA:	transitional defence	31	8.40
DINF:	defence in numerical inferiority	1	0.27
TAMO:	Shot from inside the area, off-target	2	0.54
TABO:	Shot from inside the area, on-target	11	2.98
TAGO:	Shot from inside the area, goal	2	0.54
TPMO:	Shot from the side, off-target	6	1.63
TPBO:	Shot from the side, on-target	10	2.71
TPGO:	Shot from the side, goal	0	0.00
TCMO:	Shot from the centre, off-target	0	0.00
TCBO:	Shot from the centre, on-target	2	0.54
TCGO:	Shot from the centre, goal	0	0.00
PAAR:	Shot from inside the area, saved by the goalkeeper	16	4.34
PAPA:	Shot from the sides, saved by the goalkeeper	7	1.90
PACE:	Shot from the centre, saved by the goalkeeper	5	1.36
GOAR:	Goal conceded from a shot inside the area	2	0.54
GOPA:	Goal conceded from a shot from the sides	0	0.00
GOCE:	Goal conceded from a shot from the centre	2	0.54
UVPO:	One-to-one situation with forward	2	0.54
TAAM:	Yellow card shown by referee	4	1.08
TAAZ:	Blue card shown by referee	6	1.63
TARO:	Red card shown by referee	0	0.00
PERE:	Penalty taken	0	0.00
PECO:	Penalty scored	0	0.00
FDRE:	Free hit taken	2	0.54
FDCO:	Goal from a direct free hit	0	0.00
CAMJ:	Change of player for tactical reasons	2	0.54
CAMP:	Change of player due to accumulation of fouls	3	0.81
LESI:	Injured player leaves field of play	0	0.00
TIRE:	shot cleared	25	6.78
RECH:	clearance	13	3.52

Table IX. Fifth session

TRANSCRIPTOR. © 1991 A.H.Mendo, M.Peralbo, R.Ramos, A.Risso
File currently in use: DOMITOTA.TRN
Analysis of frequencies for codes
Subject observed ... EQAN Mode ... REDI
Total occurrences ... 352 Range ... 87

Code	Description	Frec.	%
REIN:	indirect recovery	34	9.66
PERD:	loss of ball	47	13.35
REDI:	direct recovery	87	24.72
ASIS:	assist	0	0.00
DIND:	individual defence	54	15.34
DZOC:	square zonal defence	0	0.00
DZOR:	diamond zonal defence	0	0.00
DMIX:	mixed organized defence	0	0.00
DTRA:	transitional defence	22	6.25
DINF:	defence in numerical inferiority	6	1.70
TAMO:	Shot from inside the area, off-target	7	1.99
TABO:	Shot from inside the area, on-target	22	6.25
TAGO:	Shot from inside the area, goal	4	1.14
TPMO:	Shot from the side, off-target	4	1.14
TPBO:	Shot from the side, on-target	8	2.27
TPGO:	Shot from the side, goal	0	0.00
TCMO:	Shot from the centre, off-target	1	0.28
TCBO:	Shot from the centre, on-target	5	1.42
TCGO:	Shot from the centre, goal	0	0.00
PAAR:	Shot from inside the area, saved by the goalkeeper	11	3.13
PAPA:	Shot from the sides, saved by the goalkeeper	5	1.42
PACE:	Shot from the centre, saved by the goalkeeper	4	1.14
GOAR:	Goal conceded from a shot inside the area	0	0.00
GOPA:	Goal conceded from a shot from the sides	1	0.28
GOCE:	Goal conceded from a shot from the centre	0	0.00
UVPO:	One-to-one situation with forward	4	1.14
TAAM:	Yellow card shown by referee	4	1.14
TAAZ:	Blue card shown by referee	2	0.57
TARO:	Red card shown by referee	0	0.00
PERE:	Penalty taken	0	0.00
PECO:	Penalty scored	0	0.00
FDRE:	Free hit taken	0	0.00
FDCO:	Goal from a direct free hit	0	0.00
CAMJ:	Change of player for tactical reasons	1	0.28
CAMP:	Change of player due to accumulation of fouls	1	0.28
LESI:	Injured player leaves field of play	0	0.00
TIRE:	shot cleared	12	3.41
RECH:	clearance	6	1.70

Table X. Sixth session

TRANSCRIPTOR. © 1991 A.H.Mendo, M.Peralbo, R.Ramos, A.Risso
File currently in use: DOMITOTA.TRN
Analysis of frequencies for codes
Subject observed ... EQAN Mode ... REDI
Total occurrences ... 375 Range ... 83

Code	Description	Frec.	%
REIN:	indirect recovery	30	8.00
PERD:	loss of ball	52	13.87
REDI:	direct recovery	66	17.60
ASIS:	assist	0	0.00
DIND:	individual defence	0	0.00
DZOC:	square zonal defence	83	22.13
DZOR:	diamond zonal defence	0	0.00
DMIX:	mixed organized defence	0	0.00
DTRA:	transitional defence	27	7.20
DINF:	defence in numerical inferiority	4	1.07
TAMO:	Shot from inside the area, off-target	0	0.00
TABO:	Shot from inside the area, on-target	6	1.60
TAGO:	Shot from inside the area, goal	1	0.27
TPMO:	Shot from the side, off-target	1	0.27
TPBO:	Shot from the side, on-target	5	1.33
TPGO:	Shot from the side, goal	1	0.27
TCMO:	Shot from the centre, off-target	1	0.27
TCBO:	Shot from the centre, on-target	4	1.07
TCGO:	Shot from the centre, goal	0	0.00
PAAR:	Shot from inside the area, saved by the goalkeeper	21	5.60
PAPA:	Shot from the sides, saved by the goalkeeper	7	1.87
PACE:	Shot from the centre, saved by the goalkeeper	7	1.87
GOAR:	Goal conceded from a shot inside the area	3	0.80
GOPA:	Goal conceded from a shot from the sides	0	0.00
GOCE:	Goal conceded from a shot from the centre	0	0.00
UVPO:	One-to-one situation with forward	2	0.53
TAAM:	Yellow card shown by referee	7	1.87
TAAZ:	Blue card shown by referee	4	1.07
TARO:	Red card shown by referee	1	0.27
PERE:	Penalty taken	0	0.00
PECO:	Penalty scored	0	0.00
FDRE:	Free hit taken	0	0.00
FDCO:	Goal from a direct free hit	0	0.00
CAMJ:	Change of player for tactical reasons	1	0.27
CAMP:	Change of player due to accumulation of fouls	4	1.07
LESI:	Injured player leaves field of play	0	0.00
TIRE:	shot cleared	9	2.40
RECH:	clearance	28	7.47

4.2.2. Results of Sequential Analysis

We used the lag method to study behavior patterns. As noted above, the lag method, developed by Sackett (1978, 1980, 1987) is, along with Markovian models and time series models, one of the three sequential analysis procedures. According to Anguera (1983), the lag method “*provides, if not the direct and exact identification of patterns of occurrence between behaviors, an approximate idea of it, and offers certain advantages over Markovian methods: a) it makes it possible to obtain measurements of contingency between behaviors far away from each other in order (sequential events) or in time (duration); b) it makes it possible to obtain direct measurements of cyclicity for a single conduct (self-contingency) or phase relationships between a range of conducts (lagged contingency)*” (p. 137).

For this analysis we used the SDIS-GSEQ program (Bakeman & Quera, 1995), constructing the data file from the codings obtained using the TRANSCRIPTOR program, version 2.0. We analyzed the criterion behaviors resulting from a first sequential analysis performed for each macrocategory defined; for each one lags 1 to 5 were calculated.

One of the restrictions of the PSEQ program is that it cannot analyze more than twenty categories. We therefore recategorized shots from the area, shots from the sides and from the centre, zonal defences, goalkeepers' actions and incidents associated with the rules of the game. Shots from inside the area (TAMO, TABO, and TAGO) were recategorized as TA. Shots from the sides (TPMO, TPBO, and TPGO) were recategorized as TP. Shots from the centre (TCMO, TCBO, and TCGO) were recategorized as TC. Cautions (TAAZ, TAAM, TARO) were recategorized as TAR; fouls (FDRE and FDCO) as FALT; Saves (PAAR, PAPA and PACE) as PARA. Goals conceded (GOAR, GOPA and GOCE) as GOLE. Zonal defences (DZOC and DZOR) as DZO.

The table below presents a summary of all the patterns found, and also contrasts the results with those of the exact permutations analysis:

We will now review each of the patterns obtained in each macrocategory.

A. In the Shooting actions category: taking different microcategories as criterion behavior, the following patterns were found:

1. With the criterion behavior TAGO (shot from inside the area, goal) two logical, conventional and easily interpretable patterns were found. There was a dyadic bifurcation at lag 0 and the two max lags were at lag 1. The tree structure associated three categories. There was no coincidence with the exact permutations analysis. The patterns obtained were:
 - a. TAGO-DIND
 - b. TAGO-DZOC

Shots from inside the area resulting in goal (TAGO) are followed by individual defence (DIND) or square zonal defence (DZOC). These patterns reflect a feature of the regulations, i.e., that after a goal play restarts in the centre of the playing area.

Table XI. Sequential analysis: Summary

Macrocategory	Criterion behavior	Max Lag	No. of links	Type of bifurcation	Coincidence with permutations	
Shooting actions	TAGO	DIND, DZOC	2	Dyadic	NO	
	TPBO	TABO, TPBO, REIN, PERD, FDRE, CAMJ	3	Hexadic	NO	
	TPGO	REDI, DZOC	3	Dyadic	NO	
	TCBO	TABO, DIND, DINF	2	Tryadic	NO	
	TCGO	REIN, DIND, PACE	3	Tryadic	NO	
Technical-tactical actions	REIN	TAMO, TABO, TPBO, REIN, PERD, FDRE, CAMJ, TIRE	2	Eightyadic	YES (TAMO, TABO, PERD) NO (the others)	
	PERD	DIND, DZOC, DZOR, DTRA, DINF, TAAM	2	Hexadic	YES (DTRA, DINF) NO (the others)	
	REDI	TABO, TAGO, TPMO, TPBO, TCBO, REIN, PERD, TIRE, UVPO, TAAZ, CAMJ	2	Eneadic (eleven way)	YES (TABO, TAGO, TPMO)	
	ASIS	REDI, DTRA	3	Dyadic	NO	
	DIND	REDI, DIND, PAPA, PACE	2	Tetradic	NO	
	DZOC	TCMO, REDI, ASIS, DZOC, TIRE, RECH	2	Hexadic	NO	
	DZOR	REIN, REDI, PACE, TCMO, REDI	2	Tryadic	NO	
	DTRA	DIND, DZOC, DZOR, DMIX, PAAR, GOAR, FDRE	2	Nine way	NO	
	DINF	TABO, DTRA	2	Dyadic	NO	
	TIRE	REDI, DTRA, TAAM	2	Tryadic	NO	
	RECH	REDI, DZOC, GOAR, PECO	2	Tetradic	YES (REDI) NO (the others)	
	Goalkeepers' actions	PAAR	REDI	2	Linear pattern	YES
		PAPA	TABO, DTRA, UVPO	3	Tryadic	NO
PACE		DIND, DZOC, DZOR, DTRA, DINF	3	Pentadic	NO	
GOAR		REIN	2	Linear pattern	YES	
GOPA		REIN	2	Linear pattern	YES	
	GOCE	REIN	2	Linear pattern	YES	

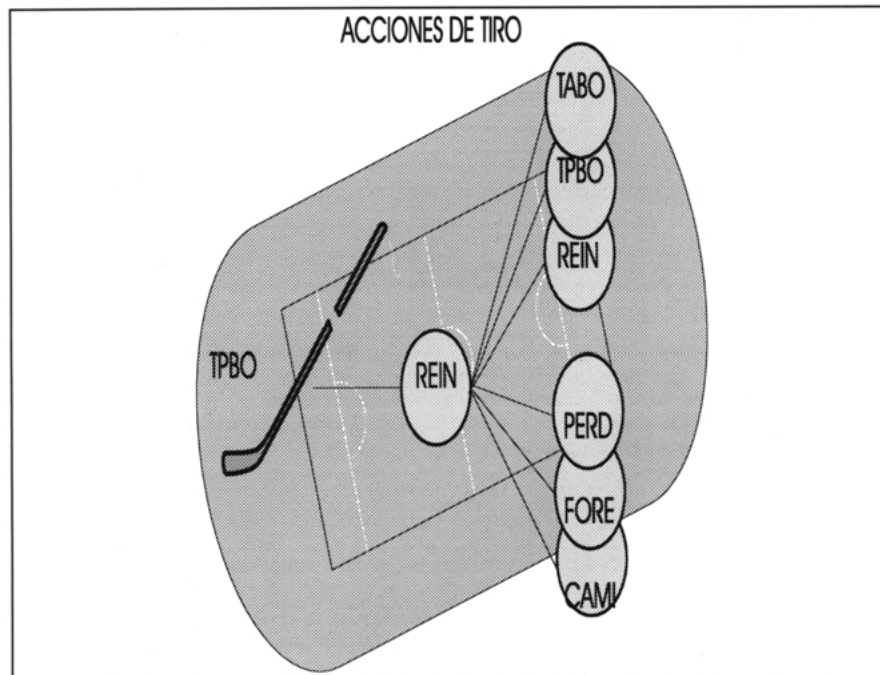


Figure 1. TPBO (shot from the side, on-target) as criterion behavior.

2. With the category TPBO (shot from the side, on-target) as lag 0 or criterion behavior, the following patterns were found. The tree structure associated eight categories, presenting a linear pattern until lag 1 (common to the six patterns); at lag 1 there was a hexadic bifurcation. The max lags were in the second lag. There was no coincidence with the exact permutations analysis. The patterns obtained were:
 - a. TPBO-REIN-TABO
 - b. TPBO-REIN-TPBO
 - c. TPBO-REIN-REIN
 - d. TPBO-REIN-PERD
 - e. TPBO-REIN-FDRE
 - f. TPBO-REIN-CAMJ

All the patterns obtained are logical or interpretable with the exception of the third, (c), in which there was an autocontingent transition; the difference between the conditioned and unconditioned probabilities indicated that it is a secondary behavior. In all patterns the TPBO criterion behavior was followed by an indirect recovery (REIN), followed in turn by (1) a TABO (shot from inside the area, on-target); (2) a TPBO (shot from the side, on-target); (3) a PERD (loss of ball); (4) an FDRE (free hit taken); or (5) a CAMJ (change of player for tactical reasons). The two first patterns (a and b) and the fifth (e) are expressions of the team's offensive efficiency, the fourth of offensive

inefficiency and the last (f) a move permitted by the rules, intended to increase offensive capacity by substituting a player.

3. Taking **TPGO** (shot from the side, goal) as criterion behavior) two patterns are obtained. The tree structure associated four categories, presenting a linear development until the first lag (which is common to both patterns) where there was a dyadic bifurcation in which the max lags were at the second lag. There was no coincidence with the exact permutations analysis. The patterns obtained were:
 - a. TPGO-DZOC-REDI
 - b. TPGO-DZOC-DZOC

The patterns obtained are logical, conventional and interpretable. A TPGO (shot from the side, goal) was followed by a DZOC (square zonal defence) followed in turn by (1) a REDI (direct recovery) or (2) square zonal defence. The first pattern can be interpreted as indicating effectiveness in defence. In the second pattern there is a autotransition which may be due to a break in the play.

4. Taking **TCBO** (shot from the centre, on-target) as criterion behavior) the following patterns were obtained. The tree structure showed two links with a triadic bifurcation in which the max lags were on the first lag. The patterns are logical, conventional and interpretable, although they do not coincide with the results of the exact permutations analysis. The criterion behavior or lag 0, TCBO, may be followed by (1) a TABO (shot from inside the area, on-target); (2) a DIND (individual defence) or a DINF (defence in numerical inferiority). The first pattern (a) may reflect the team's offensive capacity, and the two others may reflect an uninterrupted transition from attack to defence.
5. Taking **TCGO** (shot from the centre, goal) as criterion behavior three patterns were obtained, showing a five-category tree structure, in which the first stage was a linear transition between lags 0 and 1; at lag 1, there was a triadic bifurcation, in which the max lags occupied lag 2. Lag 1 was a link common to the three patterns. None of the patterns obtained coincided with the results of the permutations analysis. The patterns obtained were:
 - a. TCGO-DIND-REIN
 - b. TCGO-DIND-DIND
 - c. TCGO-DIND-PACE

All the patterns are logical, conventional and interpretable. The criterion behavior TCGO (shot from the centre, goal) is followed in all cases by a DIND (individual defence) followed in turn by (1) a REIN (indirect recovery), (2) another individual defence or (3) a PACE (goalkeeper's save, shot from the centre). The first pattern (a) may indicate moderately effective defensive action (moderate because the ball is recovered only indirectly). In the second pattern there is an autocontingent transition which may be due to a break in the play.

B. Technical-Tactical Actions: of all the categories in this macrocategory, eleven are considered as criterion behaviors:

1. Taking REIN (indirect recovery) as criterion behavior, eight patterns were generated, showing a highly mutable two-link tree structure. It had an octadic bifurcation in which the max lags were on the first lag. It also presented partial concordance with the results of the exact permutations analysis. The patterns were:
 - a. REIN-TAMO
 - b. REIN-TABO
 - c. REIN-TPBO
 - d. REIN-REIN
 - e. REIN-PERD
 - f. REIN-FDRE
 - g. REIN-CAMJ
 - h. REIN-TIRE

All the patterns are logical, conventional and easily interpretable. The criterion behavior REIN (indirect recovery) can be followed by (1) TAMO (shot from inside the area, off-target); (2) TABO (shot from inside the area, on-target); (3) TPBO (shot from the side, on-target); (4) REIN (indirect recovery); (5) PERD (loss of ball); (6) FDRE (free hit taken); (7) CAMJ (change of player for tactical reasons); (8) TIRE (shot cleared). The three first patterns (a, b and c), the sixth (f) and the eighth (h) reflect the team's offensive capacity. The fourth (d) is a self-transition; checking the difference between the conditioned and unconditioned probabilities shows it to be a secondary behavior. The fifth (e) can be considered as an inefficient behavior pattern, characteristic of a lack of definition in possession and probably of tactical awareness. The seventh pattern (g) presents a transition which was described above as a move permitted by the rules, possibly intended to increase offensive capacity by substituting a player. Overall, this group presents high mutability.

2. The patterns obtained from the criterion behavior PERD (loss of ball) showed a two-link tree structure, high mutability (though lower than in the previous case) with a hexadic bifurcation, with seven categories. The max lags were on the first lag; two of them (DTRA and DINF) coincided with the results of the exact permutations analysis. The patterns obtained were:
 - a. PERD-DIND
 - b. PERD-DZOC
 - c. PERD-DZOR
 - d. PERD-DTRA
 - e. PERD-DINF
 - f. PERD-TAAM

All the patterns are logical, conventional and easily interpretable. In all of them except the last, the criterion behavior PERD is associated with categories of a defensive nature (DIND, DZOC, DTRA AND DINF). The last pattern, (f),

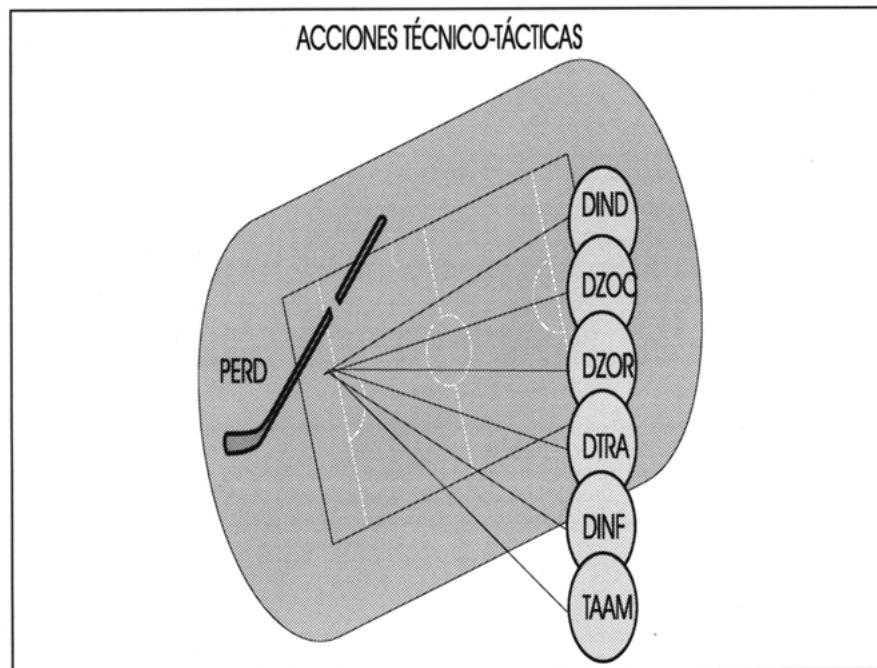


Figure 2. PERD (loss of ball) as criterion behavior.

present an association between the criterion behavior and a category related to the rules of the game – the referee shows a yellow card (TAAM).

3. Taking REDI (direct recovery) as criterion behavior, a highly mutable two-link tree structure was generated, associating eleven categories. It had an eleven-way polyadic bifurcation, in which the max lags were on the first lag. The patterns found were:
 - a. REDI-TABO
 - b. REDI-TAGO
 - c. REDI-TPMO
 - d. REDI-TPBO
 - e. REDI-TCBO
 - f. REDI-REIN
 - g. REDI-PERD
 - h. REDI-TIRE
 - i. REDI-UVPO
 - j. REDI-TAAZ
 - k. REDI-CAMJ

With the exception of the sixth (f), all the patterns are logical, conventional and easily interpretable. In all cases, a direct recovery (REDI) is associated with (1) a shot from inside the area, on-target (TABO); (2) a shot from inside the area resulting in goal (TAGO); (3) a shot from the side, off-target (TPMO);

(4) a shot from the side, on-target (TPBO); (5) a shot from the centre, on-target (TCBO); (6) an indirect recovery (REIN); (7) loss of ball (PERD); (8) a shot cleared (TIRE); (9) one-to-one situation between goalkeeper and forward (UVPO); (10) yellow card (TAAM); (11) change of player (CAMJ). Patterns a, b, c, d, e, h, and i reflect the team's offensive capacity. Patterns j and k are related to the rules of the game. The sixth pattern (f) is not logical, and the difference between the conditioned and unconditioned probability is very small.

4. Taking ASIS (assist) as criterion behavior, a three-link tree structure was found with a first linear stage from lag 1 to lag 2 (common to the two patterns). There was a dyadic bifurcation, in which the max lag categories were in the second lag. The structure in general was associated with four categories which did not coincide with the results of the exact permutations analysis. The patterns obtained were:

- a. ASIS-TABO-REDI
- b. ASIS-TABO-DTRA

The patterns are logical, conventional and easily interpretable. The criterion behavior ASIS is followed by a TABO (shot from inside the area, on-target), followed in turn by (1) a direct recovery (REDI) or (2) a transitional defence (DTRA). The first pattern can be considered as an expression of the team's offensive capacity, and the second as a transition from offensive to defensive activity.

5. The structure generated from the criterion behavior DIND (individual defence) was a two-link tree with a tetradic bifurcation with five categories, and in which the four categories in the max lag position were in lag 1. The results did not coincide with the exact permutations analysis. The patterns obtained were:

- a. DIND-REDI
- b. DIND-DIND
- c. DIND-PAPA
- d. DIND-PACE

The patterns are logical, conventional and easily interpretable. The criterion behavior DIND can be followed by (1) a direct recovery (REDI); (2) another individual defence (DIND); (3) a shot from the sides, saved by the goalkeeper (PAPA); (4) a shot from the centre, saved by the goalkeeper (PACE). We should note the autocontingent transition of the second pattern which, as in previous cases, may have been caused by a break in play. The two patterns reflect the team's defensive capacity and effectiveness.

6. The category DZOC (square zonal defence), a defensive behavior like the previous one, generated the following patterns. The structure was a two-link tree, presenting high mutability and possessing a six-way polyadic bifurcation in which the six categories occupying the max lag position were on the first lag. The patterns were:

- a. DZOC-TCMO

- b. DZOC-REDI
- c. DZOC-ASIS
- d. DZOC-DZOC
- e. DZOC-TIRE
- f. DZOC-RECH

Of these six patterns, three (a, c, and e) are not interpretable, since a defensive action cannot be followed by an offensive action unless the team first recovers the ball. The three other patterns (b, d, and f) report defensive actions; e.g., square zonal defence (DZOC) is followed by (1) a direct recovery (REDI), (2) a new square zonal defence (contingent self-transition) or (3) a clearance (RECH).

7. Taking category DZOC (Diamond Zonal Defence) as lag zero category, a triadic two-link tree was produced with four associated categories in which the max lags were on lag one. The results did not coincide with the exact permutations analysis. The patterns obtained were:
- a. DZOR-REIN
 - b. DZOR-REDI
 - c. DZOR-PACE

The patterns are logical, conventional and easily interpretable. The criterion behavior DZOR can be followed by (1) an indirect recovery (REIN); (2) another direct recovery (REDI); (3) a save from a shot coming from the centre. The three patterns reflect defensive action.

8. Taking category DTRA (Transitional Defence) as criterion behavior, a nine-way polyadic tree structure was produced, with ten associated categories, two links and the max lag categories on lag one. The results did not coincide with the exact permutations analysis. The patterns obtained were:
- a. DTRA-TCMO
 - b. DTRA-REDI
 - c. DTRA-DIND
 - d. DTRA-DZOC
 - e. DTRA-DZOR
 - f. DTRA-DMIX
 - g. DTRA-PAAR
 - h. DTRA-GOAR
 - i. DTRA-FDRE

The patterns are all (with the exception of a.) logical, conventional and easily interpretable. In pattern (a) the difference between the conditioned and unconditioned probability indicates that it is not a primary behavior. Transitional zonal defence (DTRA) is followed by *TCMO: shot from the centre, off-target* (1) a direct recovery (REDI); (2) individual defence (DIND); (3) square zonal defence (DZOC); (4) diamond zonal defence (DZOR); (5) mixed zonal defence (DMIX); (6) a save from a shot from inside the area (PAAR); (7) a goal conceded from a shot inside the area (GOAR); (8) a free hit (FDRE). Patterns

c, d, e and f reflect a transition from an unstable defence to a stable one. All the patterns reflect a range of defensive developments.

9. Taking category DINF (defence in numerical inferiority) as lag zero category, a dyadic two-link tree was produced, associating three categories; categories occupying the max lag position were on lag one. The results did not coincide with the exact permutations analysis. The patterns obtained were:
 - a. DINF-TABO
 - b. DINF-DTRA

Of the two patterns obtained, the first (a) is not interpretable since, although the association is significant, this heterocontingent transition between a defensive category and a shooting action is not possible unless the team first recovers the ball. The second pattern (b) reflects the transition from a defence in numerical inferiority (DINF) to a transitional defence (DTRA).

10. Taking category TIRE (shot cleared) as criterion behavior, a triadic two-link tree structure was produced, in which the three categories occupying the max lag position were on lag one. The structure was associated with four categories. The results did not coincide with the exact permutations analysis. The patterns obtained were:
 - a. TIRE-REDI
 - b. TIRE-DTRA
 - c. TIRE-TAAM

The patterns are logical and interpretable. A cleared shot (TIRE) can be followed by (1) a direct recovery (REDI); (2) a transitional defence (DTRA); (3) a yellow card (TAAM). The first pattern reflects an incident in the offensive action. The second, in contrast, indicates a transition from an offensive action to a defensive one.

11. Taking category RECH (clearance) as criterion behavior, a tetradic two-link tree structure was produced with five associated categories, where the categories occupying the max lag position were on lag one. There was partial coincidence with the exact permutations analysis, in the category REDI. The patterns obtained were:
 - a. RECH-REDI
 - b. RECH-DZOC
 - c. RECH-GOAR
 - d. RECH-PECO

All the patterns obtained are interpretable, although the fourth (d) presents some difficulty due to the heterotransition from a defensive category to an offensive one. The other patterns are logical and interpretable; a clearance (RECH) is followed by (1) a direct recovery (REDI); (2) a square zonal defence (DZOC); (3) a goal conceded from inside the area (GOAR) or (4) a penalty scored (PECO).

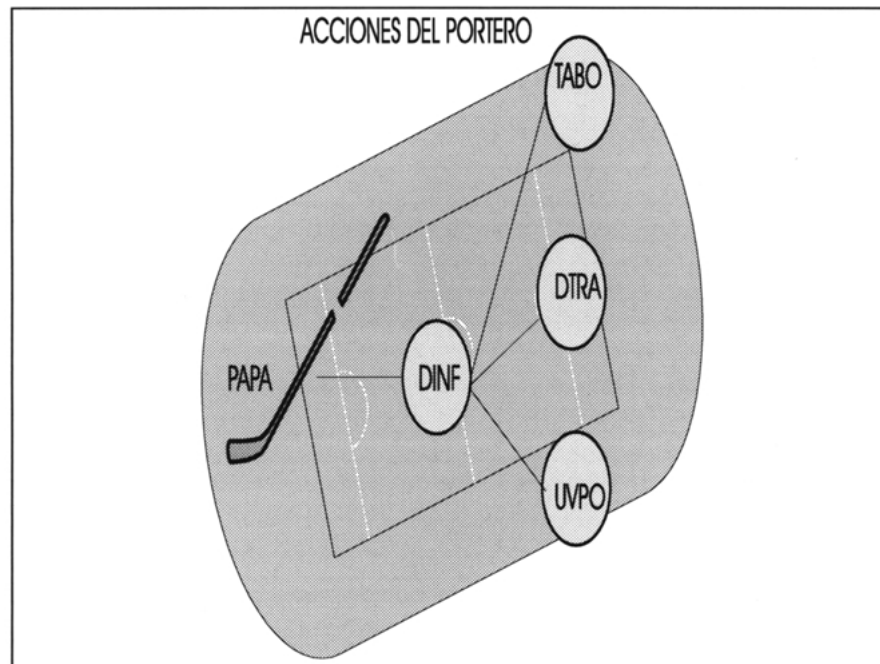


Figure 3. PAPA (shot from the sides, saved by the goalkeeper) as criterion behavior.

C. **Goalkeepers' actions:** for goalkeepers' actions six criterion behaviors were considered:

1. Category PAAR (a save from a shot from inside the area) generated a single linear two-link pattern, in which the category occupying the max lag position was on lag one. There was a coincidence with the exact permutations analysis. The pattern obtained was:
 - a. PAAR-REDI
2. Taking category PAPA (shot from the sides, saved by the goalkeeper) as criterion behavior generated a structure which was linear until lag one (common to all patterns), where a triadic bifurcation began. The categories occupying the max lag position were on lag two. The three patterns did not coincide with the exact permutations analysis. The patterns obtained were:
 - a. PAPA-DINF-TABO
 - b. PAPA-DINF-DTRA
 - c. PAPA-DINF-UVPO

The first pattern (a) is interpretable until the first lag; the heterotransition from lag one to lag two, though statistically significant, is not logical. The two other patterns are logical and interpretable; a shot from the sides, saved by the goalkeeper (PAPA) is followed by individual defence (DINF), which is followed

in turn by (1) a transitional defence (DTRA) or (2) a one-to-one situation between goalkeeper and forward. In general, the second and third patterns are both eminently defensive.

3. Taking category PACE (shot from the centre, saved by the goalkeeper) as criterion behavior generated a °three-link structure which was linear until lag one (common to all patterns), where a five-way polyadic bifurcation began. The five categories occupying the max lag position were on lag two. The patterns did not coincide with the results of the exact permutations analysis. The patterns obtained were:
 - a. PACE-PERD-DIND
 - b. PACE-PERD-DZOC
 - c. PACE-PERD-DZOR
 - d. PACE-PERD-DTRA
 - e. PACE-PERD-DINF

All the patterns are logical, conventional and easily interpretable. The criterion behavior PACE is followed by a PERD (loss of ball) and the loss in turn followed by (1) an individual defence (DIND); (2) a square zonal defence (DZOC); (3) a diamond zonal defence (DZOR); (4) a transitional defence (DTRA) or (5) a defence in numerical inferiority (DINF). All the patterns reflect ineffective defence.

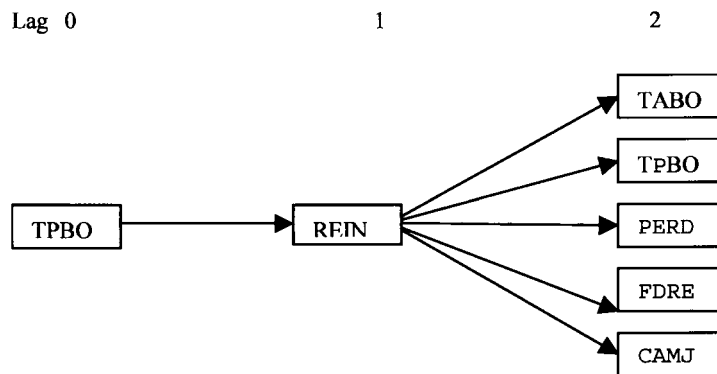
4. The three following patterns emerged from taking goals conceded (GOAR, GOPA, GOCE) as criterion behavior. Each of the three gave a single two-link linear pattern with a single max lag category on lag one. The patterns coincided with the results of the exact permutations analysis. The patterns obtained were:
 - a. GOAR-REIN
 - b. GOPA-REIN
 - c. GOCE-REIN

The three categories coincide in the max lag category. They are logical, although their fundamental characteristic is that they are conventional. A goal conceded (GOAR, GOPA, GOCE) is followed by an indirect recovery. These patterns are basically due to the rules of the game.

5. Conclusions

This category system, designed to observe and analyze the patterns of play in roller-hockey, has proved itself to be valid and the recordings reliable with regard both to intra- and inter-observer agreement, and to the agreement of patterns that emerge as part of the game. The category system also has implications for what Parlebas (1976a, b, c) termed **sociomotor semiotics**. We found that the macrocategories with the highest relevance or weight in terms of sociomotor semiotics (e.g., Technical and Tactical Actions) were involved in the longer patterns of play. In roller hockey there are no patterns of more than three links, and three-link patterns make

Table XII. Tree structure



up 24% of the total (21 out of 87 possible). In general, we consider that the larger the area of play (thinking of other sociomotor sports such as soccer) the longer and stronger the patterns of play; consequently the less mutable and less transient they are (Hernández Mendo, 1996). As the size of the area of play diminishes, so do the length and strength of the patterns, and the mutability and transience of the categories increases.

This category system and its results also have implications for the learning of motor skills associated with the techniques and tactics of roller hockey and of other sociomotor sports (Hernández Mendo, 1999). The process of learning motor sequences tends to follow a priori criteria, and/or tends to deal with aspects of motor complexity, without bearing in mind the behavioral patterns that emerge in real play. If we consider the behavioral patterns studied, we see how one could approach the process of learning motor sequences in terms of sociomotor complexity and communication, starting with the easier sequences and going on to progressively more difficult ones. Taking shooting as an example, the range of patterns described can be classified according to complexity, on the basis of the number of categories associated with each pattern:

- a. TAGO-DIND
- b. TAGO-DZOC
- c. TCBO-TABO
- d. TCBO-DIND
- e. TCBO-DINF
- f. TPGO-DZOC-REDI
- g. TPGO-DZOC-DZOC
- h. TCGO-DIND-REIN
- i. TCGO-DIND-DIND

Table XIII. Intervention proposals

Lag	Category	Aim	Intervention technique
0	TPBO	Improve effectiveness	<ul style="list-style-type: none"> – training in relaxation techniques – training in perceptive + segmentary coordination – training in self-efficacy and self-confidence
1	REIN	Increase no. of recoveries	<ul style="list-style-type: none"> – training in decision-making – training in group communication techniques – training in anticipation – training in self-efficacy and self-confidence – Biofeedback techniques
2	TABO	Improve effectiveness	<ul style="list-style-type: none"> – training in relaxation techniques – training in perceptive + segmentary coordination – training in self-efficacy and self-confidence
	TPBO	Improve effectiveness	<ul style="list-style-type: none"> – training in decision-making – reduction of anxiety – assertiveness training
	PERD	Reduce no. of losses	<ul style="list-style-type: none"> – training in decision-making – reduction of anxiety – assertiveness training
	FDRE	Improve effectiveness	<ul style="list-style-type: none"> – training in relaxation techniques – training in perceptive + segmentary coordination – training in self-efficacy and self-confidence
	CAMJ	IDEM	IDEM

- j. TCGO-DIND-PACE
- k. TPBO-REIN-REIN
- l. TPBO-REIN-TABO
- m. TPBO-REIN-TPBO

A classification of this kind, based on complexity of the patterns, could be of use to coaches. However, some of the patterns described and interpreted are not sufficiently specific, and cannot be applied in the learning of motor skills. The category PERD, losing the ball, is one of these. Finally, the description and interpretation of patterns of play also has implications for Psychosocial Intervention. The study of the patterns will shed light on the behavioral development of real play, and thus determine both the intervention at each link in the behavior chain and the consideration of intervention techniques or strategies suited to improving players' resources. As an example, consider the following tree structure (linear until the first lag, in which there is a six-way polyadic bifurcation, although for this proposal we will only include five of the max lags):

Although the study does not consider psychosocial variables, the description of patterns of play in roller-hockey that it provides makes it possible to formulate them; in turn, the patterns may contribute towards more efficient and effective psychosocial intervention.

References

- Allison, P. D. & Liker, J. K. (1982). Analyzing sequential categorical data on dyadic interaction: A comment on Gottman. *Psychological Bulletin* 93: 393–403.
- Anguera, M. T. (1983). *Manual de Prácticas de Observación*. México: Trillas.
- Anguera, M. T. (1990). Metodología observacional. En J. Arnau, M. T. Anguera y J. Gómez (eds), *Metodología de la Investigación en Ciencias del Comportamiento*. Murcia: Secretariado de Publicaciones de la Universidad de Murcia, pp. 125–236.
- Areces, A. (1987). *Libro de Táctica*. La Coruña: H.C. Liceo Caixa Galicia.
- Bakeman, R. & Brown, J. V. (1977). Behavioral dialogues: An approach to the assessment of mother-infant interaction. *Child Development* 48: 195–203.
- Bakeman, R., Robinson, B. & Quera, V. (1996). Testing sequential association: Estimating exact P values using sampled permutations. *Psychological Methods* 1.
- Bakeman, R. & Gottman, J. M. (1986). *Observing Interaction: An Introduction to Sequential Analysis*. New York: Cambridge University Press.
- Bakeman, R. & Quera, V. (1992). SDIS: a sequential data interchange standard. *Behavior Research Methods, Instruments & Computers* 24(4): 554–559.
- Bakeman, R. & Quera, V. (1995). *Analyzing Interaction: Sequential Analysis using SDIS and GSEQ*. New York: Cambridge University Press.
- Bakeman, R. & Quera, V. (1996). *Análisis de la Interacción. Análisis Secuencial con SDIS-GSEQ*. Madrid: Ra-Ma.
- Escudero, V. (1995). *Proyecto Docente*. La Coruña: Universidad de La Coruña (unpublished).
- Hernández Mendo, A. (1994). *Construcción de Herramientas Informáticas para Aplicación en Psicología del Deporte*. Santiago de Compostela: Unpublished Thesis.
- Hernández Mendo, A. (1999). Observación y Deporte. En M. T. Anguera (ed.), *Metodología Observacional en la Investigación psicológica*. Aplicaciones, vol. III. Barcelona: E.U.B., pp. 39–70.
- Hernández Mendo, A. (1996). *Observación y Análisis de Patrones de Juego en Deportes Socio-motores*. Doctoral Thesis. Santiago de Compostela: Servicio de Publicaciones e Intercambio Científico.
- Hernández Mendo, A. & Ramos, R. (1996a). *Introducción a la Informática Aplicada a la Psicología del Deporte. Herramientas Informáticas de uso en las Ciencias del Deporte*. Madrid: Ra-Ma.
- Hernández Mendo, A. & Ramos, R. (1996b). Tarea informática para evaluación y entrenamiento de la atención: Aplicación en el entrenamiento deportivo. *Anales de Psicología* 11(2): 183–191.
- Hernández Mendo, A., Areces, A., González Hernández, M. D. & Garea, J. (1994, July). Observación conductual en el hockey sobre patines. *I Congreso Internacional de Psicología Conductual/I International Congress of Behavioral Psychology*. La Coruña, Spain.
- Hernández Mendo, A. & Ramos, R. (1996). El uso de la informática aplicada a la evaluación y entrenamiento psicológico. En E. Perez Corobba & J. C. Caracuel (eds), *Actas del IV Congreso Nacional y IV Congreso Andaluz de Psicología de la Actividad Física y el Deporte*. Malaga: Instituto Andaluz del Deporte, pp. 114–128.
- Hernández Mendo, A., Ramos, R., Peralbo, M. & Risso, A. (1993). Un programa para el análisis observacional: Transcriptor v1.1., aplicación en psicología del deporte. *Revista de entrenamiento deportivo* 3(7): 18–25.

- Johnson, S. M. & Bolstad, O. D. (1973). Methodological issues in naturalistic observation: Some problems and solutions for field research. In L. A. Hamerlynck, L. C. Handy & E.J. Mash (eds) *Behavior change: Methodology, Concepts and Practice*. Champaign, Ill.: Research Press, pp. 7–67.
- Losada, J. L. (1995). *Proyecto docente*. Barcelona: Universidad de Barcelona (unpublished manuscript).
- Parlebas, P. (1976a). Les universaux du jeu collectif. Pour une semiologie du jeu sportif. *EPS* 140: 52–62.
- Parlebas, P. (1976b). Les universaux du jeu sportif collectif. Linguistique, semiologie et conduites motrices. *EPS* 142: 49–52.
- Parlebas, P. (1976c). Les universaux du jeu sportif collectif. La communication masquee. *EPS* 143: 69–72.
- Parlebas, P. (1977). Les universaux du jeu sportif collectif. Fonstion semiotrice et jeu sportif. *EPS* 144: 38–40.
- Parlebas, P. (1981). *Contribution à un Lexique Commenté en Science de l'Action Motrice*. Paris: INSEP.
- Parlebas, P. (1986). *Elementes de Sociologie du Sport*. Paris: PUF.
- Peralbo, M., Risso, A., Ramos, R. & Hernández Mendo, A. (1992). Programa informático para transcripción y análisis de datos observacionales. En C. Martin Vide (ed.), *Actas del VII Congreso de Lenguajes Naturales y Lenguajes Formales*. Barcelona: Universidad de Barcelona.
- Quera, V. (1993). Análisis secuencial. En M. T. Anguera (ed.), *Metodología Secuencial en la Investigación Psicológica*. Barcelona: P.P.U., vol. II, pp. 341–583.
- Ramos, R., Hernández Mendo, A., Peralbo, M. & Risso, A. (1994). Análisis Informático del Proceso de Observación. En C. Arce & G. Seoane (eds), *Actas III Symposium de Metodología de las Ciencias Sociales y Humanas*. Santiago de Compostela: Universidad de Santiago de Compostela, pp. 707–712.
- Sackett, G. P. (ed.) (1978). *Observing Behavior: Data Collection and Analysis Methods*. Baltimore: University Park Press, vol. II.
- Sackett, G. P. (1980). Lag sequential analysis as a data reduction technique in social interaction research. In D. B. Sawin, R. C. Hawkins, L. O. Walker & J. H. Penticuff (eds.), *Exceptional Infant. Psychosocial Risks in Infant-environment Transactions*. New York: Brunner/Mazel, pp. 300–340.
- Sackett, G. P. (1987). Analysis of sequential social interaction data: Some issues, recent developments, and a causal inference model. In J. D. Osofsky (ed.), *Handbook of Infant Development*. New York: Wiley, pp. 855–878.
- Sackett, G. P. & Landesman-Dwyer, S. (1982). Data analysis: Methods and problems. in D. P. Hartmann (ed.), *Using Observers to Study Behavior*. San Francisco: Jossey-Bass, pp. 81–99.