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# OBSERVATIONAL METHODOLOGY IN SPORT SCIENCES

## *La metodología observacional en el ámbito del deporte*

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## Abstract

This paper reviews the conceptual framework, the key literature and the methods (observation tools, such as category systems and field formats, and coding software, etc.) that should be followed when conducting research from the perspective of observational methodology. The observational designs used by the authors' research group over the last twenty years are discussed, and the procedures for analysing data and assessing their quality are described. Mention is also made of the latest methodological trends in this field, such as the use of mixed methods.

**Key words**: observation, observational methodology, observational designs, category systems, field formats, data quality.

## Resumen

En este trabajo se realiza una revisión del concepto, de los principales trabajos y del protocolo metodológico (herramientas de observación –sistemas de categorías y formatos de campo- y programas de codificación, etc.) que debe seguir una investigación desarrollada desde la perspectiva de la Metodología Observacional. Recoge uno de los aspectos novedosos dentro de esta metodología, los diseños observacional donde el grupo de investigación de los autores ha trabajado en los últimos veinte años. Se recoge el procedimiento de análisis de calidad del dato y de análisis de datos. Quedan apuntadas las últimas tendencias metodológicas en esta área como los *Mixed Methods.*

**Palabras Clave:** metodología observacional, diseños observacionales, sistemas de categorías, formatos de campo, calidad del dato

## 1. Introduction

Over the last decade, researchers in the field of sport have shown an increasing interest in the application of observational methodology, whose influence can now be seen in both the qualitative and quantitative domains. On the one hand the use of observational methods has opened up the field of qualitative investigation, which had previously focused more on other methodological options such as the quasi-experimental or selective approaches, and to a lesser extent on the use of case or biographical studies. As regards quantitative research, observational methodology has now been used in relation to a wide range of sports (including soccer, basketball, handball, tennis, swimming, athletics, judo and polo), as well as to study different kinds of activity (competition, training, etc.), different levels of performance (professionals and amateurs) and different age categories (from junior level to the third age). This has led not only to a considerable number of scientific publications, but also to methodological developments that offer new procedural resources to researchers and professionals in the field of sport and physical activity. It should be noted, however, that there are certain restrictions regarding the sphere of application of observational methodology, although as a methodological approach it also offers enormous flexibility, provided that the requirements of the scientific method are met.

In the field of sport, observation is important from both the procedural and substantive points of view. In terms of procedure, it is the only scientific approach that is capable of gathering data directly from participants (athletes, coaches, trainers, etc.) in both the training and competitive contexts without eliciting a response from them. This is achieved through the direct capture of perceivable information (mainly visual, although it may also be auditory), in other words, the information that is available to our sense organs. The observation process can be facilitated by recording the observed events, and the whole task has become much easier as a result of the technological resources that are now available. Note, however, that from a methodological point of view the investigator needs to pay attention to different stages of the research process: (i) defining the problem and proposing an observational design; (ii) gathering, managing and optimizing the data; (iii) data analysis; and (iv) interpretation of results.

From the substantive perspective, or in terms of content, observational methodology can serve a wide range of purposes, which are listed below in generic form. Importantly, however, it can also be adapted and optimized to meet the specific needs of researchers working on any type of sporting activity. In general terms, observational methods may be applied in relation to the following objectives:

a. Supporting and developing knowledge in general, and in the field of sport in particular.
b. Obtaining and analysing objective data, whether in relation to competitive play or the training context (e.g. the drills used and their outcomes).
c. Objective evaluation of the effectiveness of training regimes in the context of competitive performance.
d. Assessing the effectiveness of a competitive rival.
e. Comparing the effectiveness of a team’s tactical approach per se with its effectiveness in relation to an opponent.
f. Quantitative and qualitative monitoring of technical and tactical errors made by players, both as individuals and as members of a team.
g. Assessing the effectiveness of different tactical approaches.
h. Formulating new functional models for analysing different sports.
i. Studying the implementation of new systems of play or training regimes.
j. Assessing the extent to which young athletes acquire certain motor skills through teaching programmes.
k. Assessing the outcomes of low-intensity exercise programmes with different groups of users.

## 2. The profile of observational methodology

Observational methodology can make an enormous contribution to the study of human behaviour (Anguera, 2010) and, therefore, to our understanding of its many forms of expression within the sporting context (Anguera, 2009). Furthermore, its potential to meet the challenges of today continues to grow at a time when there are increasing demands regarding the publication of scientific knowledge and where large databases will, as a result of more widespread open access policies, come to play a key role in research over the coming years, not least as this will enable data to be managed and processed in different ways depending on the objectives being sought. Changes are also being made to the application of ethical standards, in that although the literal wording may not have been modified, there is now an acknowledgement that we live in an image culture, that the public broadcasting of numerous sporting events means that researchers can dispense with informed consent (Belmont Report, 1978; APA, 2010, Articles 4.03 and 8.05), and that the widespread adoption of open access policies by the governing bodies of the world's most prestigious universities has rendered redundant the APA guideline (1992, Article 6.12) stating that participants should be informed before any personally identifiable data are shared or used for another purpose.

Many in the scientific community are now aware that observational methodology is applied in naturalistic or habitual contexts and that it is a scientific procedure which, in line with the established objectives, serves to reveal the occurrence of perceivable behaviour that is then systematically registered by means of a specially designed instrument and through the use of suitable parameters. Having ensured that the data are of sufficient quality the necessary analyses (qualitative and quantitative) are then performed in order to identify various kinds of relationships between the different dimensions and their respective categories or codes. For the different stages of this process (especially the creation of the observational register, the control of data quality and data analysis) there are now numerous software applications (see below) that make the researcher's job much easier. Furthermore, there are three aspects of observational methodology that help to ensure that the behaviour which one is attempting to observe will yield all the elements required for adequate detection (Anguera, 2003), including the acquisition by observers of the necessary skills (Anguera, Blanco-Villaseñor, Losada & Sánchez-Algarra, 1999). These factors are the enormous flexibility of the observational procedure, the possibility of varying the extent to which one considers a given behaviour as a whole or focuses on discrete aspects of it (molarity vs. molecularity), and the spontaneous or habitual nature of the behaviour being observed.

For many situations in sport, observational methodology will be the most suitable or perhaps the only approach possible. Table 1 lists various examples of studies that have been carried out since 1999, and as such it highlights the extent to which this line of research has developed in recent years.

Tabla 1. Utilización de la metodología observacional en el ámbito del deporte (y afines).

| Substantive area | Year | Authors | Purpose/Focus |
|---|---|---|---|
| ***Physical activity*** | 2012 | Fernández, Sánchez, Jiménez, Navarro, & Anguera | Promoting inclusion in physical education |
| ***Basketball (adults)*** | 2009 | Fernández, Camerino, Anguera, & Jonsson | Development of attacking play |
| | 2009 | Sautu, Garay, & Hernández Mendo | Analysis of indirect interactions |
| | 2010 | Fernández, Camerino, & Anguera | Development of attacking play |
| | 2010 | Sautu | Analysis of play |
| ***Basketball (children)*** | 2011 | Garzón, Lapresa, Anguera, & Arana | Free throws |
| | 2013 | Lapresa, Anguera, Alsasua, Arana, & Garzón | Detection of T-patterns |
| ***Handball*** | 2004 | Prudente, Garganta, & Anguera | Validation of an instrument |
| | 2009 | Santos, Fernandez, Oliveira, Leitão, Anguera, & Campaniço | Detecting patterns |
| | 2013 | Montoya, Moras, & Anguera | Analysis of attempts on goal |
| | 2012 | Gutiérrez-Santiago, Prieto, Camerino, & Anguera | Effectiveness of attacking systems |
| ***Communication*** | 2003 | Hernández-Mendo & Garay | Models of communication |
| ***Paraverbal communication*** | 2009 | Castañer, Miguel, & Anguera | Construction of an instrument |
| ***Dance*** | 2008 | Castañer, Torrents, Dinušová, & Anguera | Detection of T-patterns |
| | 2009 | Castañer, Torrents, Anguera, & Dinušová | Construction of instruments |
| | 2009 | Castañer, Torrents, Anguera, Dinušová, & Jonsson | Analysis of motor responses |
| | 2009 | Castañer, Torrents, Dinušová, & Anguera | Construction of instruments |
| | 2011a | Torrents, Castañer, & Anguera | Motor creativity |
| | 2011b | Torrents, Castañer, & Anguera | Emerging patterns |
| | In press | Castañer, Torrents, Dinušová, & Anguera | Task restrictions in creative dance |
| | 2012 | Torrents, Castañer, Dinušová, & Anguera | Interaction with partners |
| | In press | Torrents, Castañer, Dinušová, & Anguera | Influence of the partner |
| ***Combat sports*** | 2010 | Iglesias, Gasset, González, & Anguera | Competitive interaction |
| ***Teaching physical education*** | 1999 | Castañer | Non-verbal kinesic communication of teachers |
| | 2001 | Oliveira, Campaniço, & Anguera | Swimming instruction |
| | 2008 | Planchuelo | Moral development in physical education classes |
| | 2010 | Castañer, Camerino, Anguera, & Jonsson | Study of paraverbal communication |
| | 2010 | Hernández-Mendo, Díaz Martínez, & Morales Sánchez | Prosocial behaviour in physical education classes |
| | 2011 | Torrents, Castañer, & Anguera | A teaching model |
| | 2012 | Hernández-Mendo, Olmedo, & Planchuelo | Moral development in physical education classes |
| | 2012 | Hernández-Mendo & Planchuelo | Construction of instruments |
| | 2013 | Castañer, Camerino, Anguera, & Jonsson | Kinesics and proxemic communication |
| | In press | Ramos & Hernández-Mendo | Gender discrimination in the classroom |
| ***Entertainment events involving motor behaviour*** | 2010 | Mateu | Expression of motor behaviour on stage |
| ***Evaluation of sport and exercise programmes*** | 1999 | Ordóñez | Physical education in the school context |
| | 2001 | Hernández-Mendo & Anguera | Analysis of the temporal dimension |
| | 2003 | Soler Vila | Psychological and social intervention with the elderly |
| | 2013 | Carreras | Old age, physical activity and dependency |
| ***Fitness*** | 2013 | Franco, da Costa, Castañer, Fernandes, & Anguera | Triangulation of trainers' behaviour |
| ***Soccer (adults)*** | 2000 | Blanco, Castellano, & Hernández-Mendo | Generalizability of observations of play |
| | 2000 | Castellano | Patterns of play |
| | 2000 | Castellano & Hernández-Mendo | Sequential analysis |
| | 2000 | Castellano, Hernández-Mendo, Gómez de Segura, Fontetxa, & Bueno | Analysis of play |
| | 2001 | Hernández-Mendo & Anguera | Structure of behaviour |
| | 2002 | Castellano & Hernández-Mendo | Observation and analysis of play |
| | 2002 | Castellano, Hernández-Mendo, & Haro Romero | Socio-behavioural maps |

| Substantive area | Year | Authors | Purpose/Focus |
|---|---|---|---|
| | 2002 | Lago & Anguera | Interaction between players |
| | 2003 | Castellano & Hernández-Mendo | Polar coordinates analysis |
| | 2003 | Lago & Anguera | Interaction between players |
| | 2004 | Arda, Casal, & Anguera | Attempts on goal in elite soccer |
| | 2005 | Silva, Sánchez Bañuelos, Garganta, & Anguera | Detection of patterns |
| | 2006 | Jonsson, Anguera, Blanco-Villaseñor, Losada, Hernández-Mendo, Ardá, Camerino, & Castellano | Detection of T-patterns |
| | 2007 | Castellano, Hernández-Mendo, Morales-Sánchez, & Anguera | Analysis of play |
| | 2008 | Perea | Analysis of team play |
| | 2009 | Castellano, Hernández-Mendo, & Morales Sánchez | Study of cohesion |
| | 2009 | Sarmento, Leitão, Anguera, & Campaniço | Developing an instrument |
| | 2010 | Chaverri, Camerino, Anguera, Blanco-Villaseñor, & Losada | Detection of T-patterns |
| | 2010 | Sarmento, Anguera, Campaniço, & Leitão | Notational system |
| | 2011 | Sarmento, Barbosa, Campaniço, Anguera, & Leitão | Detection of T-patterns |
| | 2011 | Sarmento, Marques, Martins, Anguera, Campaniço, & Leitão | Analysis of tactics |
| | 2012 | Camerino, Chaverri, Anguera, & Jonsson | Detection of T-patterns |
| | 2012 | Reina-Gómez | Analysis of factors related to performance |
| | 2013 | Barreira, Garganta, & Anguera | Elite soccer |
| | 2013 | Barreira, Garganta, Machado, & Anguera | Ball recovery in elite soccer |
| | 2013 | Lapresa, Arana, Anguera, & Garzón | Analysis of sequential patterns |
| | 2013 | Sarmento, Anguera, Campaniço, & Leitao | Analysis of play |
| ***Soccer (children)*** | 2000 | Ardá & Anguera | Prospective analysis in 7-a-side soccer training |
| | 2002 | Arda, Casal, & Anguera | Analysing successful attacks in 11-a-side soccer |
| | 2009 | Reina-Gómez, Hernández-Mendo, & Fernández-García | Analysis of play |
| | 2013 | Arana, Lapresa, Anguera, & Garzón | Adapting soccer to children |
| ***Roller hockey*** | 2000 | Hernández-Mendo & Anguera | Structure of behaviour |
| | 2002 | Hernández-Mendo & Anguera | Structure of behaviour |
| ***Judo*** | 2011a | Gutiérrez-Santiago, Prieto, Camerino, & Anguera | Temporal structure of judo |
| | 2011b | Gutiérrez-Santiago, Prieto, Camerino, & Anguera | Learning judo |
| | 2013 | Gutiérrez-Santiago, Prieto, Camerino, & Anguera | Sequences of errors |
| | 2013 | Prieto, Gutiérrez-Santiago, Camerino, & Anguera | Analysis of errors |
| ***Swimming*** | 2010 | Louro, Silva, Anguera, Marinho, Oliveira, & Campaniço | Patterns of behaviour |
| ***Doubles tennis*** | 2003 | Garay | Analysis of play |
| | 2006 | Garay, Hernández-Mendo, Morales Sánchez, | Coding system and analysis of data quality |
| | 2007 | Garay, Hernández-Mendo, & Morales Sánchez | Estimating patterns of play |
| ***Singles tennis*** | 2005 | Gorospe, Hernández Mendo, Anguera, & Martínez de Santos | Estimating patterns of play |
| ***Violence*** | 2004 | Molina Macias & Hernández-Mendo. | Content analysis |
| | 2006 | Molina Macias & Hernández-Mendo | Contribution of variability analysis to the analysis of content |
| ***Volleyball*** | 2008 | Salas, Molina, & Anguera | Front row defence |
| | 2012 | Hernández-Mendo, Montoro Escaño, Reina Gómez, & Fernández García | Analysis of play |

## 3. Defining the problem

According to the logic of the scientific method the first step in any research process is to define the problem. However, we would like to make a number of specific points that may help readers in relation to the correct application of observational methodology; as such these points can be considered as guidelines for good practice.

a. With respect to behaviour in sport there will be a knowledge area of particular interest, one that will be considered to be relevant or of strategic importance. This knowledge area may be opportunistic (e.g., a championship that is taking place), may not have been sufficiently studied, or may be one in which the findings are partially or completely inconsistent.

b. This knowledge area is what in scientific language would be called a *research topic* and it is the starting point for the definition of various problems, each of which is a branch of the core topic.

c. The problem must be discrete enough to enable it to be described in a comprehensive statement and to be fully addressed in the study that is being proposed.

d. A scientific problem always requires the specification of one or several general objectives, although it may also be useful to break these down into specific objectives, as required.

e. In observational methodology the defined problem requires the study of behaviour and/or contexts, which in turn implies the study of directly perceivable information (Van Deventer, 2009).

f. Each of the specified objectives will require an adequate observational design, in other words, a flexible structure that guides and directs the whole of the empirical part of the process.

g. Recent years have seen enormous progress being made in terms of methodological complementarity, a development that we regard as positive in that it has made room for the study of hidden behaviours, as well as enabling convergence with other methodologies.

h. A key feature of the last decade has been the emergence of mixed methods (Anguera, Camerino & Castañer, 2012), an approach that has contributed enormously to greater interplay between qualitative and quantitative data. Observational methodology has, however, yet to achieve a significant presence within this emerging tradition, and addressing this is one of the challenges we aim to meet in the immediate future.

## 4. Observational designs

The design is a strategy that sets out how the study will be conducted empirically, organizing the data according to the established objectives and guiding the investigator towards appropriate analyses. Observational designs are highly flexible and, therefore, they serve as useful guidelines regarding what data should be gathered and how they should be subsequently organized and analysed.

A wide range of criteria can be applied in drawing up a map of possible designs. One initial proposal that has been developed over the last decade or so combines three dichotomous axes: *idiographic (singularity)/nomothetic (plurality)*, *single observation point/follow-up*, which helps to separate the basic ways of analysing observational data (Anguera, 1995c; Anguera, 1999; Anguera, Blanco, Losada &

Hernández Mendo, 2000), and *unidimensional/multidimensional*, the latter being closely linked to the observation instrument that will be constructed for a given study. This framework for understanding observational designs has been described in several publications (Anguera, Blanco & Losada, 2001; Anguera, 2003, 2010; Anguera, Blanco-Villaseñor, Hernández-Mendo & Losada, 2011; Losada & Anguera, 2013).

This proposal yields eight zones spread across four quadrants that correspond to eight different designs which are defined by the vertical axis, the horizontal axis and the concentric circles shown in Figure 1.

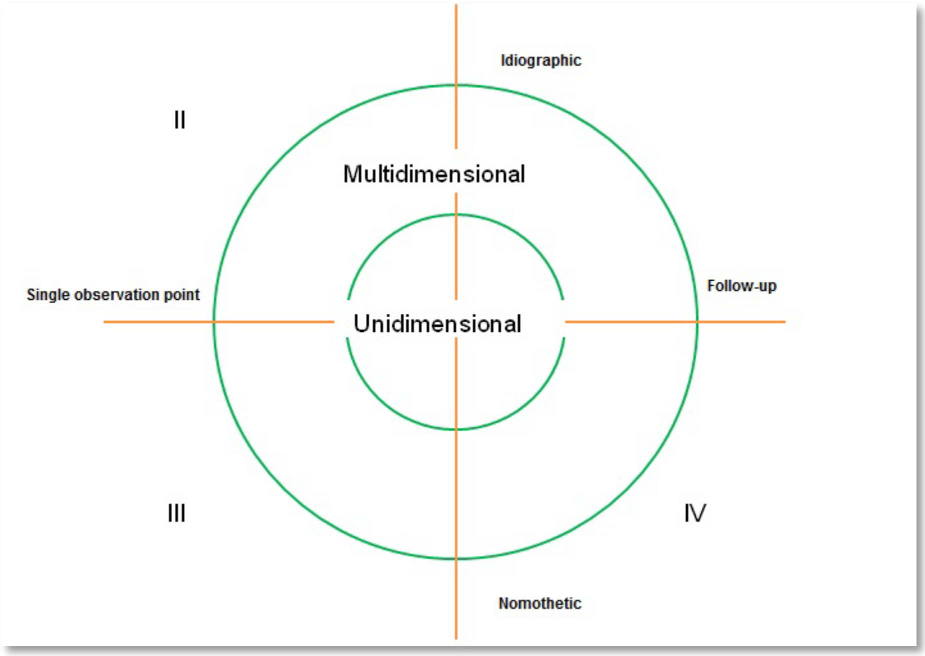


**Figura 1.** Graphical representation of eight possible observational designs, derived by superimposing the three criteria: *Units of study* (represented by the vertical axis), *Temporality* (represented by the horizontal axis) and *Dimensionality* (represented by the concentric circles). This yields eight zones corresponding to eight observational designs (Anguera, Blanco-Villaseñor & Losada, 2001; Anguera, Blanco-Villaseñor, Hernández-Mendo & Losada, 2011).

The vertical axis refers to the units that must be considered in accordance with the study objective (e.g. coach, group of players with a common role, such as defenders, or a team characterized by a given strategy, etc.), the horizontal axis refers to the temporal aspect of the observation (a single session or several sessions over a period of time), and the concentric circles refer to dimensionality (which depends on the criteria of the observation instrument). We are aware, however, that this framework requires further development, and it is likely that the next step will concern an update with respect to the use of observational methodology in multiple case studies (Stake, 2006). At present, doubts may arise in relation to the idiographic/nomothetic axis in those situations where participants are selected according to criteria of homogeneity and the researcher wishes to detect potential regularities among them; studies currently underway have brought this controversy to light, and our recommendation is to consider them as particular cases of idiographic studies.

The upper pole of the vertical axis refers to an *idiographic* study (i.e. single units), one, for example, that considers a coach, a player returning to competition or a team that adopts a particular strategy devised by their coach. The lower pole refers to a *nomothetic* study (i.e. multiple units), such as the case where all the defenders taking part in a soccer match are studied separately.

The left pole of the horizontal axis refers to a single observation point (i.e. one session), for example, one half of a competitive match or an uninterrupted period of training. It is important to note, however, that during this single observation session the researcher may or may not carry out within-session follow-up. The right pole of the horizontal axis refers to *follow-up* over a period to time and, therefore, will involve more than one observation session (where a session corresponds to an uninterrupted period of data recording). Once again, the researcher may opt to carry out within-session follow-up in any of these sessions. The decision as to whether or not within-session follow-up will be conducted in one or more sessions is an important one as it will influence the nature of the primary parameters that feature in the register. As illustrated in Figures 2 and 3, between-session follow-up produces a data register based on the frequency of observed events, whereas within-session follow-up complements this parameter with additional information based on the order of events.


**Figure 2**. Example of between-session follow-up (only the frequency or occurrence of behaviours is recorded).

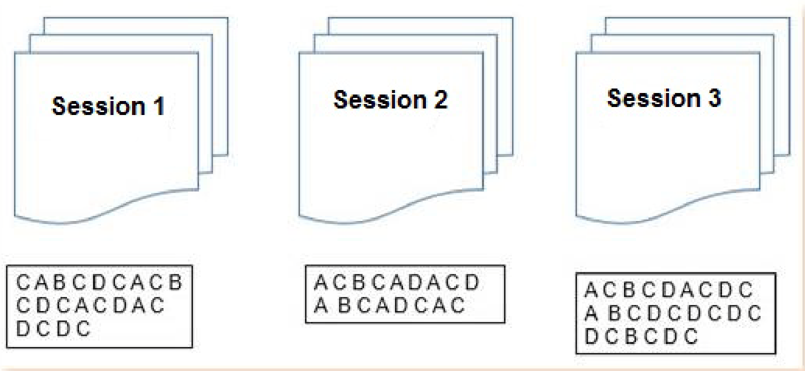


**Figure 3**. Example of within-session follow-up. Here the order or sequence of occurrence of behaviours is recorded in addition to their frequency, which is obtained merely by counting them.

En la Figura 1, las circunferencias concéntricas representan el tercer criterio rector de los diseños observacionales, relativo a la dimensionalidad. En metodología observacional, una dimensión se refiere a un aspecto o faceta del comportamiento (podría considerarse como un paralelismo incompleto de la "variable" en los diseños cuasiexperimentales), sobre cuya puntualización existen referencias ya desde la época clásica del nacimiento de la metodología observacional (Weick, 1968, 1985). Con la experiencia de más de tres décadas, recomendamos apoyarnos, siempre que sea posible, en literatura científica existente, pero, si no existe en el subámbito correspondiente, se puede hacer una propuesta de dimensiones *ex novo*, documentada a partir de estudios empíricos siempre que sea posible; como ejemplo, ver Figura 4. La circunferencia de radio menor correspondería a estudios en los cuales solamente interesa un único nivel de respuesta (unidimensional), mientras que la de radio mayor a estudios que requieren la consideración de varios niveles de respuesta (multidimensional). Es frecuente que en un estudio la unidimensionalidad planteada en un momento inicial devenga en un desplegamiento posterior de la que en sus comienzos era una única dimensión. Pueden efectuarse tantos desplegamientos (nivel 1, nivel 2, …, nivel n) como sea necesario, en función de los objetivos planteados.

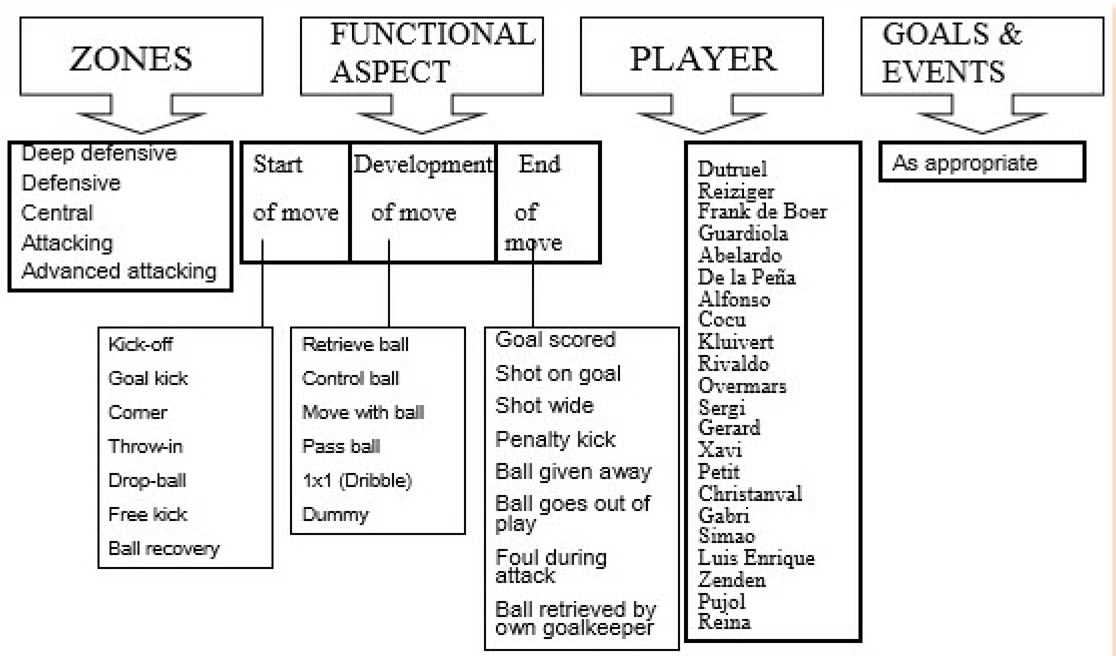


**Figure 4**. Example of dimensions and sub-dimensions proposed *ex novo* on the basis of studies carried out as part of the research agreement between the Group for Research on Observational Designs (University of Barcelona) and FC Barcelona (Anguera, Blanco, Losada, Ardá, Camerino, Castellano & Hernández-Mendo, 2004).

# 5. Gathering, managing and optimizing data

In terms of the scientific method this is the most extensive stage of the process and there are several aspects that need to be considered here, notably the restrictions to bear in mind, the decisions made regarding observational sampling and the way in which the data register will be created (which nowadays almost always involves computerized coding, data management and control of data quality).

### *5.1. Restrictions to bear in mind*

Prior to recording any data it is important to establish some *initial restrictions* that can help ensure the procedure is followed correctly and prevent errors from being made (Anguera, Blanco, Losada & Hernández Mendo, 2000). The main points to consider are as follows:

5.1.1. *Maintaining constancy between sessions*: In order to ensure a maximum degree of homogeneity across the different observation sessions it is essential to draw up a list of minimum requirements that these sessions should fulfil in accordance with the established objectives. The criteria used may vary, provided they are adequate (days, place, time, activity, characteristics of the setting, absence of outside interruptions, etc.). For example, one might decide to observe all the away matches played by a given basketball team.

5.1.2. *Maintaining constancy within sessions*: Constancy within a single session may be affected by an unforeseen event or circumstance that leads to the observed activity being interrupted (the action stops). In the above example of a basketball match this could be the result of a player being injured.

5.1.3. *Dealing with temporal disruptions*: Temporal disruptions occur when an unforeseen event or circumstance interrupts the observation session but without the action itself stopping. This temporary lack of observability generally results from one of two things: the observed participant is momentarily outside the field of observation (e.g. a player moves out of camera shot), or there is a technical issue (e.g. part or all of the field of observation is out of camera shot, poor camera orientation at a given moment, etc.).

5.1.4. *Labelling the observation session*: In addition to identifiers such as date and time it is important to include information regarding four basic aspects of all contexts: a) physical environment (surface area, lighting, implements, etc.); b) type of activity (training session, competitive match etc.); c) social data regarding the observed participant(s); and d) information of an institutional or organizational nature (start and duration of activities in their habitual context).

### *5.2. Observational sampling plan*

The sampling plan tells us when we need to observe in order to obtain the desired register. Ideally, one would generate a continuous register that covers the whole of the activity that we wish to study. However, this is often not possible, or would be too costly. Hence it is useful to establish two levels of sampling, between and within sessions, the nature of which will depend on a series of decisions that have to be made (Anguera, 2003). Specifically, the between-session level of sampling is established on the basis of decisions regarding the following aspects:

a. Period of observation: for example, the pre-season matches of a given soccer team.
b. Periodicity of sessions: for example, training matches prior to the competitive season.
c. Minimum number of observation sessions: for example, ten.
d. Criterion to establish the start of the session: for example, the referee blows a whistle to indicate that the match is underway.
e. Criterion to establish the end of the session: for example, the referee blows a whistle to indicate the end of a period (first or second half, etc.).

The within-session (or second) level of sampling refers to the information that is gathered during each session. The different options are:

a. Continuous register of the whole session. In this case there is effectively no within-session sampling as all the information that is relevant to the study objective will be registered; for example, all the movements by a team's line of defence.
b. Sampling of events. Here only certain types of behaviour or elements are registered, for example, the movements (including throws) of the pivot in handball.
c. Temporal sampling. In this case, information is selected according to a real period of time, and there are various options here: sampling of specific instants or points in time, sampling of complete intervals or sampling of partial intervals. For example, in a training session on a small pitch, one could sample certain players every 30 s in order to see whether they maintain task intensity.
d. Focal sampling. When several participants are to be observed, the session duration can be divided up into equal parts so that each target participant is observed in successive rounds. For example, when observing a training session one could focus for five minutes on each participant in succession, and when they have all been observed the round would begin again.

### *5.3. Developing the observation instrument*

The extraordinary diversity of situations that may be systematically observed for evaluation purposes means that we cannot rely on standard instruments but must, instead, dedicate as much time as is necessary to develop an instrument ad hoc in each case (Bakeman & Gottman, 1989; Anguera, 2003; Anguera & Blanco, 2003, 2006; Anguera, Magnusson & Jonsson, 2007). The basic instruments of observational methodology are category systems, field formats, the combination of the two, and, to a lesser extent, rating scales. The strength of category systems is their basis in theory, whereas field formats offer greater flexibility, especially in highly complex empirical situations.

*5.3.1. Category systems:* Category systems provide the observer with a kind of receptacle or mould (in the figurative sense) that is derived both from the nature of the situation (the observed subjects, episodes, activities or contexts) and a theoretical framework (which may, in the case of sport, be the rules of the game), such that the observed behaviours can then be assigned to one of the categories included in the system. Note, however, that attention should be paid not only to the individual nature of each category but also to the structure of the system as a whole.

The process of creating a category system involves moving back and forth between the situation to be observed and the theoretical framework (Anguera, 2003; Anguera & Blanco, 2003, 2006; Anguera, Magnusson & Jonsson, 2007). It is advisable to start by drawing up a *repertoire* or list of the different behaviours that may be encountered (the observable reality). For example, if the aim is to observe children's motor behaviour in a school gym and to categorize the movements they make, then the repertoire might include the following categories: walks, runs, goes down the slide, climbs up the climbing wall, sits astride the vaulting horse, performs somersaults, moves around with feet together, walks the tightrope, etc. When constructing the instrument it is important to ensure that the categories chosen are *exhaustive*. To this end one will need to conduct a suitable number of observation sessions and also to establish how many successive sessions must pass without the emergence of any new behaviour not featured in the repertoire list. It is advisable for this to be at least three sessions. Thus, in the above example of children's motor behaviour we would ensure that at least three observation sessions occurred without any non-listed behaviours being observed.

The next step consists in proposing, on the basis of the conceptual framework, a set of criteria that allow specific behaviours to be grouped together according to their similarity, and to give a provisional label to these groupings. One would then conduct further observation sessions of the activity in question and attempt to assign the behaviours of interest to these provisional groups. It is at this point that, with reference to the theoretical framework, one will analyse and check whether there is an adequate degree of homogeneity among the registered behaviours, such that, where necessary, the groups can be further broken down or modified, etc. Having made these changes, new sessions would then be observed and the newly proposed categories would be tested, and so on in an iterative fashion until all the categories constitute an exhaustive system in relation to the observed situation or area. Note that each of the dimensions or levels of the final category system must also be mutually exclusive (for more details on these aspects, see Anguera, 2003). These two aspects of a category system, exhaustiveness and mutual exclusivity, are referred to using the notation E/ME. In practice, *exhaustiveness* means that any behaviour regarded as an object of study (i.e. a behaviour that will have been selected and sampled from the behavioural repertoire of the subject) may be assigned to one of the categories. *Mutual exclusivity* refers to the fact that there is no overlap between the categories included in the system, such that a given behaviour can only be assigned to one category.

The universal way of notating a category system is {A,B,C,D,E}, where A, B, C, D and E are the codes corresponding to the respective categories. This notation symbolizes the fact that the different categories are exhaustive and mutually exclusive. There is no limit to the minimum or maximum number of categories which may be included, although it is worth remembering that too few categories will mean that the instrument has poor discriminatory capacity, whereas an excessive number of categories may lead to errors of commission (confusion among categories).

The categories must be carefully defined so that they cover all possible nuances of the behaviour they are supposed to represent, and it is advisable to include examples and counterexamples (perhaps in the form of graphics, photographs or images) so as to increase their specificity (Anguera, 1991). Each category will have a *core feature* that captures its essence, as well as a *degree of plasticity or openness*, which refers to the full range of external manifestations of the behaviours that may be assigned to the same category. For example, if the category is '*passes ball*', the degree of plasticity would refer to the various possible behaviours that might be covered by this description, for example, with the foot, with the head, a pass by the goalkeeper, etc.

Any behaviour that is featured in a category system but which does not occur is indicated by the formal category symbol Ø (*empty set*), or simply by leaving the category blank.

It is important to note that more than one category system is likely to be possible in any one situation, and the system chosen will depend partly on the person who has developed it. However, the category systems developed in relation to a given situation or set of behaviours can be regarded as *equivalent* (although not identical) if, during the process of categorization, the same criteria have been adopted, although this equivalence refers to the system as a whole rather than to the individual categories. Consequently it is possible to compare two or more systems, and this may give rise to interesting topics of investigation (e.g. different versions of an instrument).

A final point to bear in mind concerns the possibility of structuring the category system hierarchically into different levels of detail, which we refer to as the degree of molarity and molecularity. Let us imagine, for example, that we are observing play in soccer and the categories are {Start of move, Development of move, End of move}. In this case, each one of these categories could be broken down further and this would give rise to a new more 'molecular' category system; for example, the category *Start of move* could yield a new category system as follows: {Kick-off, Goal kick, Corner, Throw-in, Drop ball, Free kick, Ball recovery}.

Formally, the register created on the basis of a category system will comprise a column of codes (which can, if one wishes, be regarded as a matrix of codes with a single column).

*5.3.2. Field formats:* Field formats have their origins in an old data registry technique (Weick, 1968) that began to be used once again around two decades ago, and which is now regarded as a form of observation instrument, once it has been suitably optimized (Anguera, 2003; Anguera & Blanco, 2003, 2006; Anguera, Magnusson & Jonsson, 2007; Losada & Anguera, 2013). The use of field formats has increased enormously in recent years. The creation of an observation instrument based on field formats involves the following steps:

1) Establishing the criteria or axes of the instrument, the nature of which will depend on the study objectives. For example, with respect to learning to swim the 11 possible criteria would be zones, entering the water, submersion, balance, independent arm and leg propulsion, gliding, rotations in all axes, basic skills, diving, control of breathing, and deep immersions (Oliveira, Campaniço & Anguera, 2001). One or more of these criteria could be broken down hierarchically into others. The proposed criteria should be derived from a theoretical framework (as in the above example), but if no such framework is available they can be based on the knowledge gained through empirical studies.

2) Drawing up a list of behaviours/situations (open list, referred to as the *catalogue*) corresponding to each of the criteria, and noted down as a result of the information provided by the exploratory stage of the study. For example, based on the criterion *entering the water* the list of behaviours could be: involuntary entry, feet-first entry with help, entry from sitting position on the edge of the pool without support, standing upright with both feet on the entry ladder and falling either forwards or backwards into the water, jumping into the water from the edge of the pool without support, feet-first entry without help, head-first entry without help, etc. (the 'etc.' refers precisely to the fact that more behaviours could be added, as the list is not a closed one).
3) Assigning a decimal coding system to all the behaviours/situations derived from the criteria, which also means that, if appropriate, any one of them can be broken down into a lower-order hierarchical system. Depending on the complexity of the case or the desired degree of molecularity, these systems may have two, three or more codes. For example, the codes for the swimming criteria would be 1 (zone), 2 (entering the water), 3 (submersion), etc. However, 2 could be broken down into 21 (involuntary entry), 22 (feet-first entry with help), etc., and 22 could be broken down further into 221, 222, 223, and so on in succession, depending on the degree of molecularity required in each case.
4) Drawing up a list of configurations. A configuration is the basic unit in the field format register and consists of a chain of codes corresponding to simultaneous or concurrent behaviours. This enables an exhaustive register of the flow of behaviour to be created, and helps enormously when it comes to the subsequent analysis of data. For example:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 24 | 321 | 42 | 53 | 61 | 75 | 84 | 96 | 102 | 113 |
| 14 | 24 | 325 | 42 | 54 | 68 | | 84 | 95 | | 114 |
| 14 | 22 | 31 | 44 | 54 | 61 | 75 | 82 | 95 | | 114 |
| 11 | | | | | | | | | | |
| 13 | 22 | 32 | | 54 | 62 | 72 | 84 | 95 | 102 | 113 |
| Etc. | | | | | | | | | | |

In other words, the register obtained by means of field formats will always take the form of a matrix of codes in which the columns correspond to the criteria/sub-criteria established in the instrument (there being 11 in the above example) and the rows correspond to each one of the successive co-occurrences of behaviour (when coded, each of these co-occurrences is transformed into a chain of codes that corresponds to the simultaneously produced behaviours that are represented by the different criteria/sub-criteria). If, in a given configuration, one or more codes are not registered, the corresponding space is left blank. Consequently, each row of the matrix will contain at least one code, while the maximum number will be the same as the number of criteria/sub-criteria that have been established in the instrument.

Table 2 (Anguera, 2003) shows the main differences between the two types of instruments, category systems (CS) and field formats (FF).

**Table 2.** Comparison of category systems and field formats (Anguera, 2003).

| ***Criteria*** | ***Category system*** | ***Field format*** | ***Advantage lies with ...*** |
|---|---|---|---|
| Structure | Closed system | Open system | FF |
| Relationship to theory | Theoretical framework essential | Theoretical framework advisable but not essential | CS |
| Dimensionality | Unidimensional | Multidimensional | FF |
| Coding | Single codes | Multiple codes | FF |
| Flexibility | Rigid system | Self-regulating system | FF |

*5.3.3. Combining field formats and category systems:* The purpose of combining the two instruments would be to take advantage of the strengths of each (consistency of CS, and the multidimensionality and self-regulatory nature of FF), at the same time as compensating for their weaknesses (the unidimensionality of CS and their inability to function in changing situations, and the limited consistency of FF in the absence of a theoretical framework).

The combined approach can be used when the following two conditions are fulfilled for one or more of the criteria/sub-criteria of a field format: (i) a theoretical framework is available for them; and (ii) they are atemporal. In this case, a category system can be developed on the basis of the corresponding criterion/sub-criterion. As in the case of the original field format, the format of the resulting register will be a matrix of codes, the difference being that one or more of these codes will have the status of a category.

This combined use of field formats and category systems can be found in the majority of observation instruments that have been constructed in the field of sport (see Table 1), since this is a context which is inherently multidimensional and for which the equivalent of a theoretical framework is available (i.e. the rules of a given sport).

*5.3.4. Rating scales:* This kind of observation instrument, which constitutes a dimensional system for recording data, is less widely used since it requires the ordering of a given attribute or dimension, something which is not always easy or even possible. Furthermore, even if each of the points on a rating scale is clearly defined there remains an important risk of subjective bias in the majority of cases, and hence extreme caution must be exercised when using such instruments. For example, if our aim were to assess the performance of a motor skill in a given kind of physical activity, a rating scale might include the following levels: Poor, Average, Good. However, each of these levels would need to be clearly operationalized, and the distance between them would have to be held constant. As these aspects are difficult to achieve in many cases, rating scales are not widely used as observation instruments.

### *5.4. Data registry and coding*

Registering data involves two steps: capturing them from a real-life situation (Anguera, 2003), which must be a suitable context in which the aspects of interest have been clearly specified, and storing them in a given support medium (nowadays always computerized) by means of the appropriate software.

Full systematization of data is achieved through a system of codes (iconic, literal, numerical, mixed, chromatic, etc.) whose structure may be that of a chain, module or cascade, etc. (Saldaña, 2013). Obviously, coding may be binary (present/absent, which may be notated as 1/0), focus on just one kind of element (for example, verbal interactions between players on the same team), or involve the *simultaneous coding of several concurrent aspects*. Consequently, it is possible to develop a *complete syntax for any observed situation* that achieves the maximum degree of systematization without resorting to any descriptive terms (Anguera & Blanco, 2003). In this case, it is advisable to draw up a *set of rules for applying the codes*, on which basis one could break down the codes and end up with the corresponding descriptive register in its initial, non-systematized form.

The different kinds of data register that have been, or which could be created are too many to count, not least because of the various levels of detail that may be opted for along the continuum between molarity and molecularity (Thompson, Felce & Symons, 2000). The choice of approach must take into account the study objectives and the context in which the observation will take place; for example, a study of shots at the basket in basketball may opt for a triple register involving the frontal, lateral and zenithal planes, with data being recorded simultaneously in all three (Garzón, Lapresa, Anguera & Arana, 2011). Nowadays, almost all observation sessions can be recorded, such that the process of registering data actually involves three steps, the recording, viewing and, on the basis of the recording, the registering of data.

It should be noted that the systematization of the data register and the construction of the observation instrument are two stages whose order is interchangeable (i.e. one may start by developing the instrument and then systematize the register, or vice-versa).

Technological advances in recent years have led to the development of numerous software applications that enable any perceivable behaviour to be registered. Furthermore, these applications can register the duration of behaviour and are able to produce the matrices of codes that we referred to in the previous section on the observation instrument (matrices in the case of field formats or the combination of field formats and category systems, or a single-column matrix in the case of category systems). Some of the most widely used software applications in Spain are *Codex*[1] (Hernández-Mendo, Anguera & Bermúdez-Rivera, 2000; Hernández Mendo, Bermúdez Rivera, Anguera & Losada, 2000), *HOISAN*[2] (Hernández-Mendo, López-López, Castellano, Morales-Sánchez & Pastrana, 2012), LINCE[3] (Gabín, Camerino, Anguera & Castañer, 2012), *MOTS*[4] (Castellano, Perea, Alday & Hernández Mendo, *2008*), *SDIS-GSEQ*[5] (Bakeman & Quera, 1996), the *Observer*[6] (1993), and *Themecoder*[7] (Anguera & Jonsson, 2002).

[1] Free download available at *http://www.efdeportes.com/efd18/codex.htm* [CHECK]
[2] Free download available at *http://www.menpas.com*
[3] Free download available at http://observesport.com/
[4] Free download available at http://menpas.com y en http://observesport.com
[5] Free download available at http://www.ub.es/comporta/coporta.htm
[6] This commercial software can be purchased at http://www.noldus.nl
[7] This program is designed to export data to THEME, and it is open use software

A broad scope project aimed at improving the connectivity between these different software applications is already underway and beginning to make progress.

### *5.5. Data management*

The purpose of data management is to link the observational design on which each research objective is based to both the nature of the data (primary parameter) and the needs/restrictions that apply in each case.

The different possible types of data were established by Bakeman (1978), with his initial proposal being subsequently adapted in conjunction with other authors (Bakeman & Gottman, 1989; Bakeman & Quera, 1996, 2011). All existing software applications, whether explicitly or otherwise, are able to register both state data and event with time data, at least (although not event data, interval data or multi-event data), and these kinds of data obey the primary parameters of frequency, order and duration (Anguera, 2003).

Given the possible transformations among different types of data (from state to event, and from event with time to multi-event), and given, too, the correspondence between observational designs and observation instruments (Anguera, Blanco, Hernández-Mendo & Losada, 2011), as well as between observational designs and types of data (Anguera, Blanco, Hernández-Mendo & Losada, 2011), researchers in the field of exercise and sport, and professionals in general, should have no problem in accessing appropriate and free software that enables them to create a suitable, clean database and to manage their data in accordance with the study objectives.

Depending on the objectives it may be useful to prepare combined registers of several observation sessions, or across different seasons or from different teams. Alternatively, one may wish to place successive episodes of interest (e.g. attacking moves in soccer that end in a goal) into a single file, or, conversely, it may be helpful to divide up a file into distinct sections. None of these ways of managing data poses the slightest difficulty nowadays. What we do recommend, however, is to create as extensive a database as is feasible (some software applications explicitly require a minimum of 30 data items), and also to register the data in the form of smaller units (e.g. episodes or parts of a match), from which they can subsequently be organized into broader units (e.g. matches, home matches during a season, several seasons, matches played by all participating teams in a championship, etc.).

### *5. 6. Control of data quality*

Once the data have been gathered the observer must then ensure that they are of sufficient quality (Anguera, 2003), the most basic requirement being what has traditionally been referred to as the reliability of the observational register.

Another concept closely linked to reliability is *validity*, which involves determining whether we are actually measuring what we set out to measure. It has generally been assumed that agreement between independent observers offers the type of consistency that a direct observation system needs in order to be valid. However, this is not necessarily the case, since different observers may agree on the basis of making the same error. Given that an instrument is valid if it measures what it is supposed to measure, it has been argued that data registers derived from direct observation are obviously valid, as opposed to other kinds of register that are strongly influenced by interpretation, for example, the self-reports of a professional who is responsible for making critical decisions in the field of fostering and adoption.

An observation instrument is reliable if it contains few measurement errors, and if it shows stability, consistency and dependency in the individual scores awarded to the assessed characteristics.

Another concept associated with the reliability of registers is their precision. A measure is precise if it fully represents a given behavioural trait, with precision being measured according to the degree of concordance between an observer and an established standard.

Among the numerous aspects involved in any evaluation there are obviously many factors that can have a range of different effects on the actions being taken, and hence we have to ask whether the observed data are worthy of interpretation or whether, on the contrary, they are the result of random fluctuations introduced by the observation instrument that is being used (Blanco, 1989, 1993; Tójar, 1994; Blanco & Anguera, 2000; Blanco & Anguera, 2003). In this regard, there are two basic quantitative approaches for determining the reliability of observational data: a) coefficients of concordance between two observers who independently code behaviours using the same observation instrument; and b) coefficients of agreement, which are based on correlation. It is also possible to apply generalizability theory, notably when one wishes to integrate different sources of variation (different observers, distinct measurement occasions, various instruments, different types of register, etc.) into a global structure (Blanco, 1991, 1992, 1993, 2001).

There are numerous coefficients that can be calculated in order to control data quality in a wide range of situations, and they can be organized according to the basic categories shown in Table 3. Note that in addition to the quantitative approaches to data quality the table also makes reference to concordance by consensus (Anguera, 1990, 2003), an approach that is becoming increasingly popular. The aim here is that observers reach an agreement before producing the register (rather than afterwards, as in the case of the various coefficients associated with the quantitative approaches), and this will be possible provided that the observation session has been recorded. The observers then discuss and decide together the category or field format code to which each of the observed actions should be assigned. There are obvious advantages to this approach, not only because a single register is produced but also because the observation instrument is greatly strengthened by the fact that its definitions are more clearly set out, including any fine adjustments that are required. Conversely, a potential disadvantage of the consensus approach is that an observer may assign a behaviour to a given category or field format code as a result of trusting in the supposed better judgement or prestige of another observer, whose proposal is the one that is accepted; alternatively, problems may arise in terms of social dynamics, such that observers find it difficult to reach a consensus.

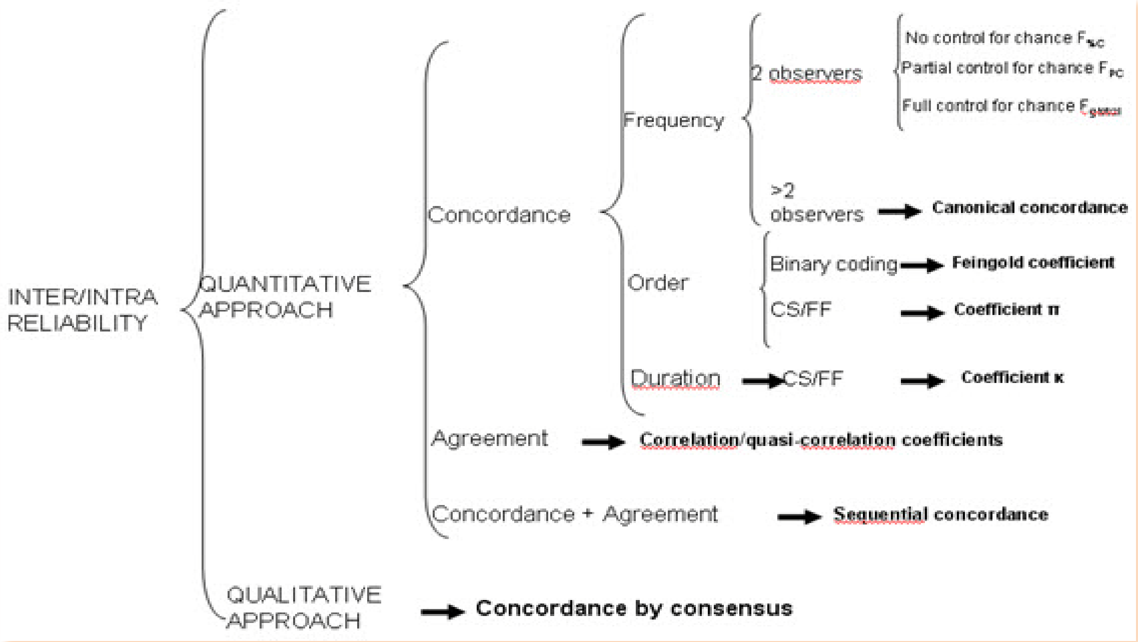


**Figure 5**. Basic coefficients of inter-observer and intra-observer agreement (Anguera, 2003).

## 6. Data analysis

On many occasions we have addressed the nature of data and the repercussions this has in terms of the subsequent analysis, as well as the problems that reductionism would imply (Anguera, 1995a, 1995b, 1995c, 2000; Anguera & Izquierdo, 2008; Sánchez-Algarra & Anguera, 2013). The first issue to consider in this regard concerns the choice between qualitative or quantitative analysis, or whether one will use a combination of the two through a mixed methods approach.

Textual data require a qualitative analysis of the information that has been gathered (Gibbs, 2012). The CAQDAS platform now includes numerous software applications that are suitable for this purpose (ATLAS.TI, ELAN, HYPERBAS, NUDIST, NVIVO, THE ETNOGRAPH, TRANSANA, etc.), and all of them, with obvious variations, are able to produce matrices of codes that can subsequently be adapted for quantitative analysis, in accordance with the different aspects and objectives we discussed in the section above on observation instruments. In our view, this is likely to be one of the lines along which mixed methods research will develop in the future, although there are obviously others.

The quantitative analysis of data depends on the observational design that has been proposed. Earlier in this paper it was stated that the observational design enables the study to be organized empirically, from the initial proposal of objectives right through to the analytic stage. Once the coded register has been obtained and the quality of the data has been checked, the data obtained must then be analysed.

Observational methodology occupies a privileged position in that it bridges the qualitative and quantitative approaches to research. On the one hand it is capable of capturing a rich variety of information from a given situation through the development of an ad hoc observation instrument and the adequate registering and coding of data. At the same time, however, it also makes use of analytic techniques that help to bring maximum rigor to the results.

In terms of the eight observational designs we described earlier, each one of them, in accordance with its defining characteristics, will suggest particular ways of analysing data, although this does not have to be a limiting feature (Anguera, Blanco & Losada, 2001; Blanco, Losada & Anguera, 2003; Anguera, 2003) (Table 4). Indeed, observational designs are characterized by both their flexibility and the precision that derives from the observational method.

**Table 4**. How data may be analysed according to the type of observational design [Adapted from Anguera, Blanco & Losada (2001, pp. 154-155)].

| **Single point / Idiographic / Unidimensional** | **Single point / Nomothetic / Unidimensional** | **Follow-up / Idiographic / Unidimensional** | **Follow-up / Nomothetic / Unidimensional** |
|---|---|---|---|
| Descriptive statistics<br>Ordinal correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Polar coordinate analysis | Descriptive statistics<br>Ordinal correlation<br>Linear correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Polar coordinate analysis | Descriptive statistics<br>Ordinal correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Between-sessions sequential analysis<br>Polar coordinate analysis<br>Intra-class correlation<br>Logistic regression<br>Panel analysis<br>Trend analysis<br>Time series<br>Analysis of variance<br>Analysis of variance for categorical data | Descriptive statistics<br>Ordinal correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Between-sessions sequential analysis<br>Polar coordinate analysis<br>Intra-class correlation<br>Logistic regression<br>Panel analysis<br>Trend analysis<br>Time series<br>Multiple time series<br>Analysis of variance<br>Analysis of variance for categorical data |
| **Single point/Idiographic / Multidimensional** | **Single point / Nomothetic / Multidimensional** | **Follow-up / Idiographic / Multidimensional** | **Follow-up / Nomothetic / Multidimensional** |
| Descriptive statistics<br>Ordinal correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Polar coordinate analysis<br>Log-linear analysis<br>Intra-class correlation<br>Logistic regression | Descriptive statistics<br>Ordinal correlation<br>Linear correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Polar coordinate analysis<br>Log-linear analysis<br>Intra-class correlation<br>Logistic regression | Descriptive statistics<br>Ordinal correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Between-sessions sequential analysis<br>Polar coordinate analysis<br>Multiple correlation<br>Logistic regression<br>Panel analysis<br>Trend analysis<br>Multiple time series<br>Multivariate analysis of variance<br>Multidimensional scaling | Descriptive statistics<br>Ordinal correlation<br>Chi-squared<br>First-order Markov chains<br>Within-session sequential analysis<br>Between-sessions sequential analysis<br>Polar coordinate analysis<br>Log-linear analysis<br>Multiple correlation<br>Logistic regression<br>Panel analysis<br>Trend analysis<br>Time series<br>Multiple time series<br>Multivariate analysis of variance<br>Multidimensional scaling |

A final point to make is that the data analysis obviously leads to a set of results, which must then be linked not only to the study objectives but also to the relevant literature so that they can be adequately interpreted.

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