3.2 Feedback

3.2.1 Introductory Concepts

The topic of feedback is one of the most fascinating subjects, with major teaching consequences. Its first use is to facilitate understanding the processes of monitoring and regulating motor act: the way in which reafferent information is used to correct, either the same movement before it finishes, or the next movement. The second use refers to the correction of errors and understanding its special teaching method in order to improve learning and increase motivation. The concept of feedback is closely related to neurocybernetics, which, let's recall, stems from **information processing theory** (channeling capacity) as an alternative to Gestalt and behaviorism, both dominant until the middle of the XX century.
The importance of feedback has to do with the following:

- There is an indispensable condition for learning in and of itself, and with this help, we can evaluate both the process and the result of the movement.
- It does not appear to be a crucial condition for the execution of already learned and automatic movements.
- It is not just important to understand and know how to provide feedback as an instructor, but also, and above all, to teach it to the athlete.
- It is important to teach the athlete to pay attention to it, recognize it and use it appropriately for self-correction.
- For Soviet authors, specialists in the study of movement, the human being needs to understand the effect and usefulness of his actions, that is, recognize results. Recognizing results is fundamental for motor learning and technique training.

Ruíz Pérez (1994) summarized the function of understanding results in order to strengthen the following:

- Inform.
- Provide incentives.
- Reinforce.

The concept of an examined life is ancient. Many philosophers promoted it as fundamental in athletic life just as in any of life's other aspects.

Understanding the results of one's own actions is incredibly important. Socrates said: "An unexamined life is not worth living".
We will begin with three major classifications, presented by three excellent authors:

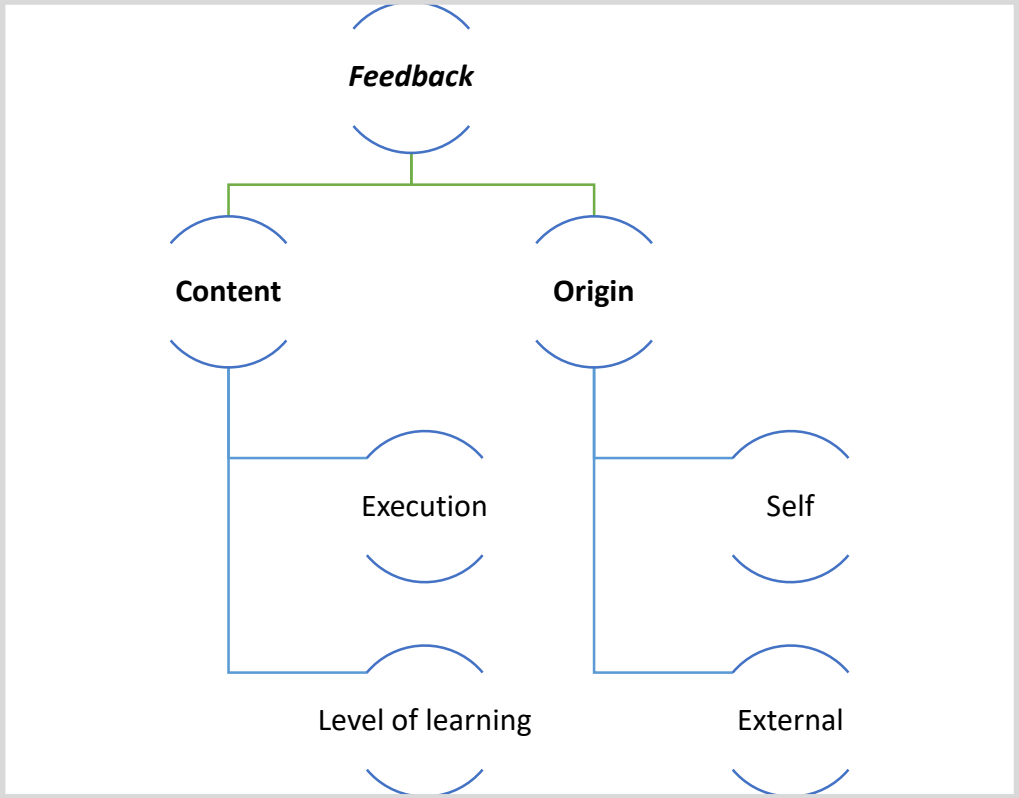
- Jacques Corraze (1988): author of *Las Bases Neuropsicológicas del Movimiento Humano [Neuropsychological Foundations of Movement]* raises an ideal analysis.
- Rigal (1987): the concepts drawn from his books *Motricidad Humana [Human Motor Function]* and *Motricidad: aproximación neurofisiológica [Motor Function: neurophysiological approximation]* are crucial.
- Grosser (1988): he considers the topic in detail in his two books related to training athletic technique.

The first classification belongs to Jacques Coraze (1988), in his book *Las bases neuropsicologías del movimiento [Neuropsychological Foundations of Movement]*, dividing feedback and its practice in two:

    - Terminal Feedback: is that which is based on the reafferences that end the movement.
    - Simultaneous feedback: is directed towards the reafferences that are present throughout the entire movement.
    - The second classification is by Robert Rigal (1987), which stems from comparisons of human movements:
    - Control in closed loop: is based in the use of feedback or reafferences. The movement is corrected as it is developed (for example: the system of controlling the temperature of a house by means of a thermostat).
    - Control in open loop: this is based on programming prior to the action, where the necessary instructions are programmed before triggering said action, which is executed independently from simultaneous effects (example: an automatic washing machine).

The third classification comes from Grosser and Neumaier (1988). This classification by Manfred Grosser and August Neumaier (*technik training*) allows an initial approach to the possibilities of feedback in the universe of motor learning and technique training (Grosser, 1988).
We can see this in figure 1.

Figure 1: *Feedback*



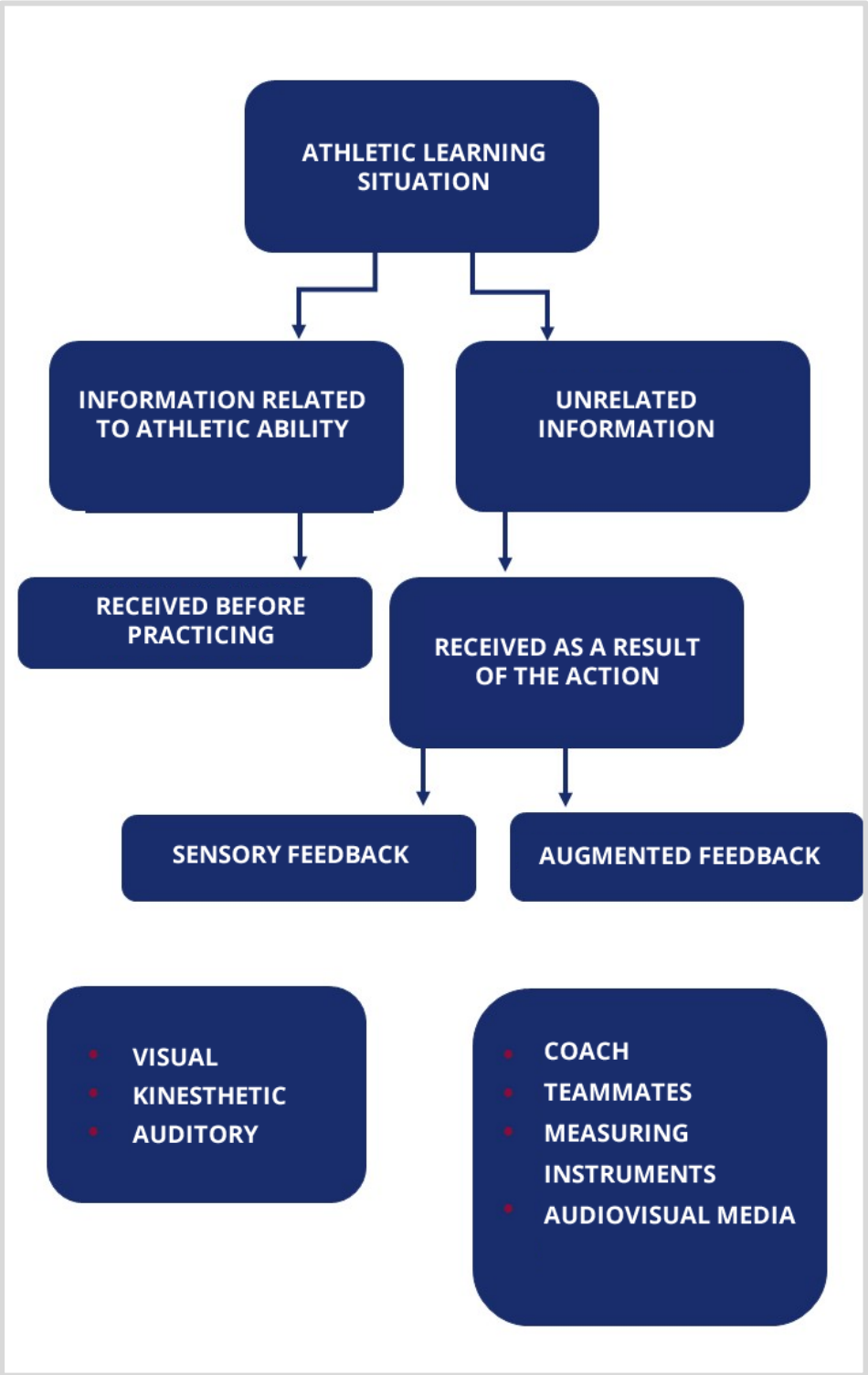
Source: Prepared by the author.

3.2.2 Neurocybernetics and Feedback

In the learning process, the athlete needs to understand the results. Among the tasks that the coach or teacher should carry out, we highlight the information that he should provide to the student regarding what he is achieving and how he is doing it.

In the learning process, the athlete, by experiencing different practices, obtains diverse sensory information regarding his own performance, which will be stored in his memory and can be used to progress in his learning (Pérez, 1994).

Figure 2: Situation of sports learning



Source: Adapted from Schmidt, 1982, cited in Pérez, 1994, p. 226.

According to Pérez, (1994), who based his work on diverse studies, it is necessary to take into account various aspects when transmitting an understanding of results to our students. Below, we mention the following:

Precision of information regarding results

In the entire learning process, providing information regarding results is essential for correcting errors.
In the initial phase, providing too detailed information regarding motor executions can make the process more clumsy; thus, the information should be more general and not so analytical. To provide knowledge regarding results, we have to take into account the person who is learning and his capacity for analyzing and processing information.
As the student gains experience, the amount of information that he can process will also increase.

Amount of information and knowledge regarding results

Often, those responsible for providing information are tempted to give extensive discourses to their students. These long talks during practice can be counterproductive for student attention levels and memory because they are trying to retain so much information.
A few corrections regarding relevant aspects are what will actually have a significant influence on learning. We need to avoid giving information on every aspect of the implementation of a determined ability or physical situation; on the contrary, we have to pay attention to what is really important. In the same way, giving scant feedback on the results also impedes learning.

Ideal moment to provide information regarding results

"Pôlhman (1979) has shown that feedback given within a span of less than 5 minutes can have negative effects. Its instantaneous nature does not allow the student to even minimally assess his own action (sensory feedback)" (Pérez, 1994, p. 230). However, we cannot allow too much time to go by before providing this information, in order to ensure that the student still has the traces of the motor program fresh in his mind.

Frequency of information regarding results

Is it necessary to give feedback regarding results at every moment of practice? This depends on the subject's understanding of the demands of the motor task (Pérez, 1994). Providing information regarding results during all of the practical activities could overload the student's information channels and impede his ability to use this information to improve his motor skills (Pérez, 1994).

Function of information regarding results

Understanding results gives the student information on the activities that he is doing and how he is doing them. Descriptions, assessments or prescriptions are constantly communicated to individuals in athletic teaching sessions. The objective of this is that the student be able to understand the effects of his actions and, thus, be able to know what to do in subsequent sessions. Understanding results motivates the student by providing him with sufficient encouragement to keep practicing until he achieves the objective. This reinforces the subject's response (Pérez, 1994).

3.2.3 Types of Feedback

Another concept that Corraze (1998) talks to us about is related to **ballistic movement**. A ballistic movement is one in which, due to its speed, cannot be corrected by feedback until it has finished. This does not mean that there is no feedback, as there can be no movement without it. The question is whether the feedback corrects the movement before it ends or not. We consider that, sometimes, a centrally programmed movement should be independent from afferences when it is being developed, but the central program itself contains emergency plans for a variety of different afferences. The question is: how long can a motor program control a movement without taking afferences into account? Ballistic movements, evidently, do not have to be extremely quick.

Some movements that are free from any retroactive control are not the only ones programmed and are not necessarily fast (like the trajectory of a projectile, which cannot be modified retroactively after it has been launched). Some authors even object that no matter how quick a movement is, it can still be corrected.

- Corraze (1988) presents us with the idea of supplementary or artificial feedback:

    - **Supplementary:** adding supplementary reafferences to the task can have a negative effect, that is, subtractive and not additive. Thus, it leads to a deterioration of performance. These effects are clearly explained in specific cases. Providing additional information, whether or not it is redundant, can create an information overload that exceeds the processing capacity of the nervous system. In other cases, the presence of visual reafferences has a negative effect on the others due to what is called capture or predominance (Corraze, 1988).
    - **Artificial:** a context where artificial feedback can be verified is when reafferences are outside of the field of vision. For many motor learning processes, a large part of the activity escapes our sight. Experiments in this field use recordings. Logically, they should present, in the first place, a visual model of the movement to be learned, executed by a well-trained subject, and, during the course of the learning process, show the subjects a film of their own movements (Corraze, 1988).

The **bio-feedback technique** consists of making it possible to monitor a physiological variable by providing information regarding its effects. Given that under ordinary conditions the central nervous system does not perceive these effects, they have to be provided through artificial means. For example, giving the subjects visual or audible information when they execute a movement is providing them with artificial feedback. This last type of effect has been used to reduce neuromuscular handicaps (Coraze 1988).

A great number of the functions of our body are inaccessible to our consciousness: blood pressure, blood sugar levels, cholesterol, infections or cognitive processes themselves. Bio-feedback gives us access to much of the information that our consciousness cannot access in any other way: its objective is preventive. We ask ourselves: Why is so little accessible to our consciousness? Could this be an advantage? What do we have the best chances of gaining access without the help of auxiliary equipment.

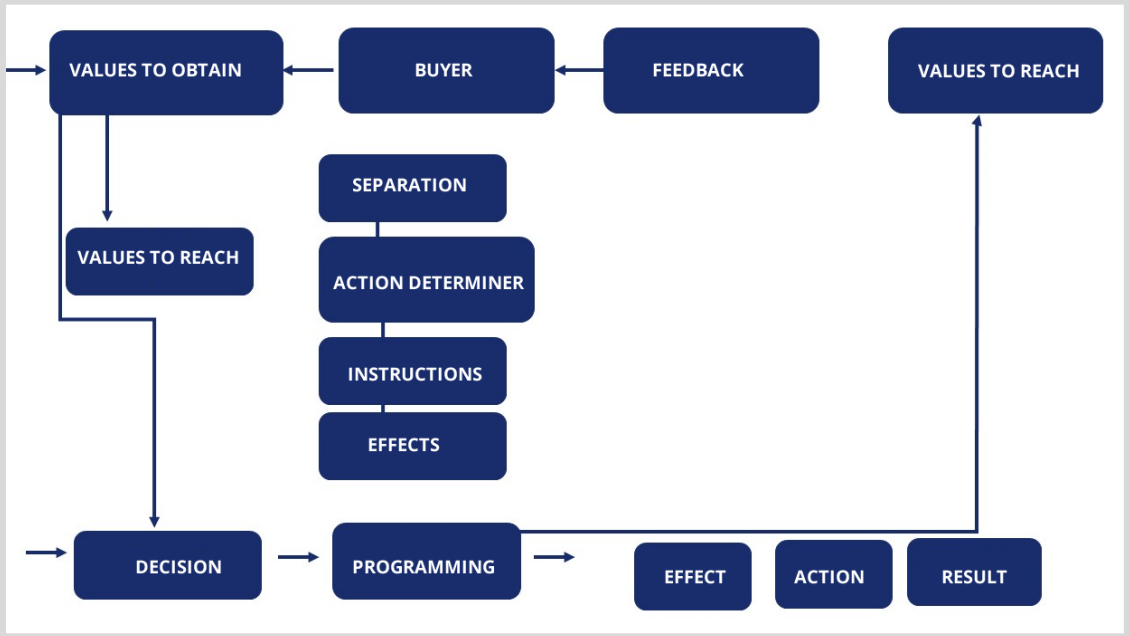
- Rigal's classification (1987): the majority of movement executed with a precise objective in mind is subject to control in one form or another. Generally, the effect of a movement can be used to prepare or modify the next movement, or the required movements could be independent from each other when each one has been programmed in advance and developed without correction (Rigal, 1987).

    - **Closed loop:** The closed loop system is based on the use of feedback or reafferences coming from different pathways such as, for example, proprioceptive, auditory or kinesthetic sensations that provide feedback, on the basis of which a movement can be corrected while it develops. This corresponds to the detection of a difference or an error, and the feedback that instructs the control system in regard to the similarity or difference between the intention and the action. Thus, while executing a movement, the proprioceptive, visual, auditory or kinesthetic intentions provide feedback or reafference regarding its development, on the basis of which it is possible to correct or modify the movement (Rigal, 1987, p. 307). In general, feedback tends to be negative, as it is characterized by trying to bring the value achieved closer to the desired value in an attempt to provide the system with stability. Positive feedback, in contrast, increases separation and destabilizes the system (Rigal 1983, p. 307). Taking Rigal's example (1987) to explain this phenomenon, we refer to the panicked behavior of a crowd, where, the more people start to panic, the more they also lose control, which aggravates the situation (Rigal, 1987). The closed loop model predominates in slow or progressive

actions, where there is sufficient time to receive reafferences and carry out adjustments as necessary.

- **Open loop:** the control system for an open loop is based on programming prior to the action. The necessary instructions are programmed prior to triggering the action that is executed independently of the simultaneous effects. It is not reafferences or retro-actions anymore, but rather efferences or pre-actions that regulate the development of the movement. When we decide to execute a movement, an efferent copy (or a corollary discharge) of the motor order, this decision reaches an encephalic nervous structure where the correct movement models are stored (Rigal, 1987).

Figure 3: Open loop model



Source: Rigal, 1987, p. 306.

3.2.4 Consequences for Teaching

The proposals based on information processing could be:

- **Direct**: the athlete should learn where to direct his attention, which requires that he be provided with prior information.
- **Limit**: the athlete can only assimilate information in a limited framework, so it is important not to overload him.
- **Distinguish**: in order to accomplish this, the coach should distinguish relevant information from irrelevant information and give concrete instructions.
- **Restrict**: information and instructions from the coach should be restricted to a few important points.

Perspectives and discussions

It is necessary to continue expanding the general teaching method on error correction in order to develop new methodological consequences.

Teach how to self-detect and self-correct through the following:

- Hierarchical control.
- Cybernetics.
- Dynamic systems (Di Santo, 2015)

Feedback for maintaining motivation is based on the following:

- Abilities.
- Pain.
- Activities in everyday life.
- Technique.

In turn, this feedback is related to the sources of feedback:

- Self: the sooner we have our own information, the greater chances we have of creating a consistent image of movement and improving our programming and motor control. The possibility of achieving complete self-information is not so simple. There are areas of the body that are inaccessible to our vision and other analytical tools.

Some clarifications regarding self-feedback

Self-information is rarely complete:

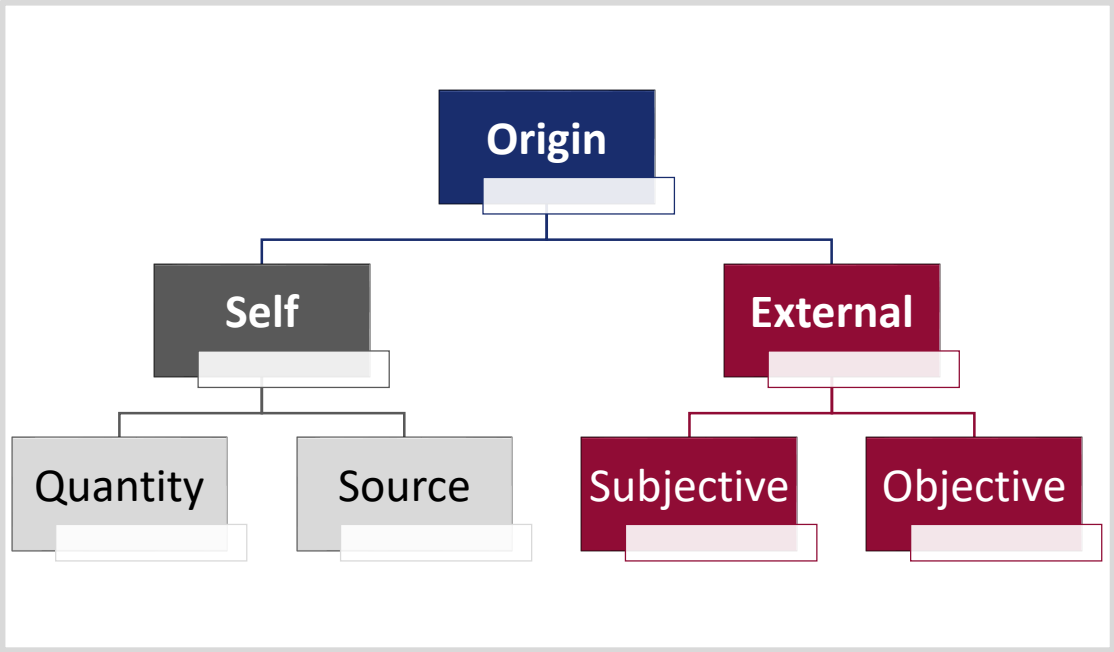
- **Visual:** consists of what I can see of my body and is inevitably, with regard to self-information, partial (never complete) and, all the same, very important.
- **Auditory:** consists of what I can hear from my body, and, although often very obliquely, it is very important for injury prevention when lifting weights.
- **Touch:** in relation to proprioceptive information, this makes us aware of haptic sensitivity, which is key in motor control processes.

Self-provided information: repeat without repeating

Concentrating on specific sources of information is crucial for one's awareness and production, depending on the athlete's capacity for paying attention and his level of mastery:

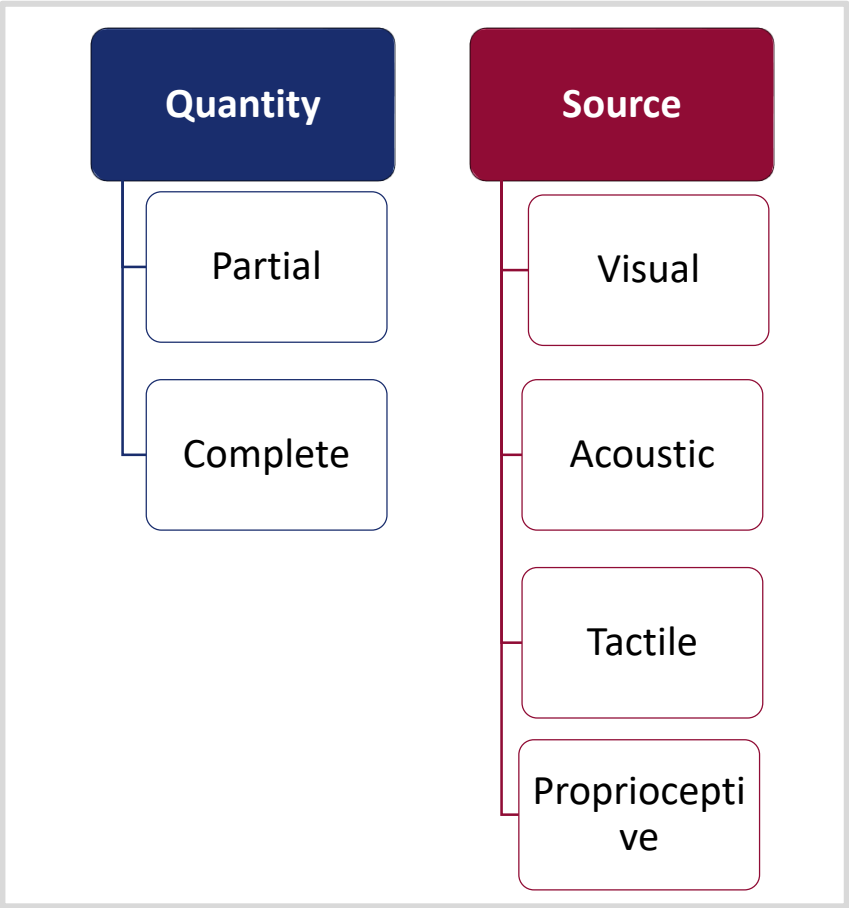
- Consciously assimilating information from oneself has a decisive importance in training technique (much more than external information).
- Subjective external feedback is not sufficient, and it is useful to have objective information on one's execution (videos) as soon as possible.
- The athlete needs to learn where to direct his attention to avoid focusing on irrelevant data and to discard information that is not applicable.

Figure 5: Consequences for teaching



Source: Prepared by the author.

Figure 6: Quantity and source



Source: Prepared by the author.

- External: this is information not generated by the subject himself, but rather provided by outside sources. All information is important (Di Santo, 2015).

In regard to external information:

- Information provided by the athlete himself is often imprecise, incomplete and full or errors.
- The experienced coach often records more data than the athlete himself.
- For this reason, assimilating self-provided information along with external and complementary information, accelerates learning.
- This external information could be both subjective and objective, but it acquires its real value when it is combined with information from the athlete himself.

In regard to subjective external information:

- Subjective information offers an emotional component that objective information does not possess.
- A face or expression can provide more information than words or videos.
- It is key from the motivational perspective.
- It should be taken into account without discarding objective information (combine them).
- No matter how rich the objective information is, without the subjective information, it is difficult.
  It would be like learning from manuals.

In regard to verbal comments:

- This is provided by the coach, and comes in different types. Good teachers often combine the different types of verbal comments equally:
  - Perceptual.
  - Biomechanical.
  - Motivational.
  - Energetic.

Consider also:

- Voice quality.
- Voice rhythm.
- Inflexions.
- Resonance.
- Tone of voice (Pérez, 1994).

In regard to non-verbal comments:

- A look often has more power than a word. It is useful to combine both verbal comments and non-verbal comments with objective external information and, in turn, accompany verbal comments with facial and body gestures.

Conditions of the teacher:

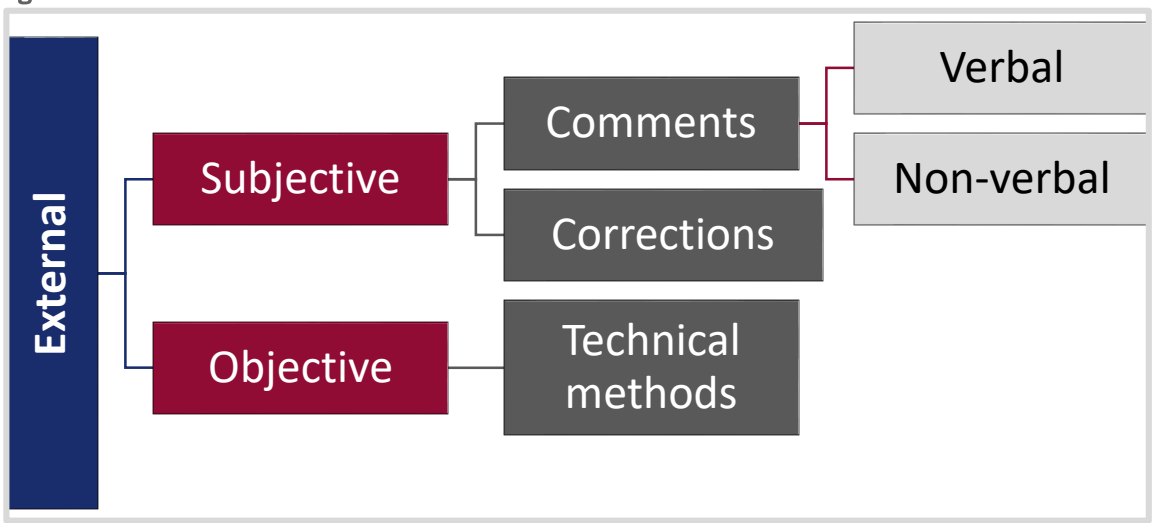
- Concentration to observe.
- Determining which subjects will be observed.
- Speed of observation.
- Organization of the session.
- Location of the session.

- Understanding the technique (Pérez, 1994).

In regard to objective external information:

- Photos and stills.
- Videos and special programs.
- Better in the context of training.
- Execute, observe, interact and correct (Pérez, 1994).

Figure 7: External information



Source: Prepared by the author.

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