



The Functional Understanding of Human Movement

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Abstract

Jaded for the excess of wealth (information, food..., and even money), accustomed to poverty and not adapted to affluence, we delay in adapting to abundance and understanding the difference between a wealthy live (a rich live) and “a live that is rich”. Abundance led people to trivialize things. So, for instance, the human movement, something that we constantly contact with, is banalized. We will show succinctly how the human movement is not “just” about activating one or several muscles. A movement requires a global action by the human body that must maintain the necessary balances, regarding objectives and intentionalities. We present a simple model, in a somewhat rudimentary way, highlighting the importance of muscles, joints and the center of mass / support base relation, to better understand and explain the functionality of the human movement. A complex process that is possible to control, learn, and train, presenting simple examples in sport activities operationalizing the presented model and emphasizing the importance of understanding and explaining this whole process in order to understand its effects on sport, health or education.

Keywords: Human Movement; Model; Functional Understanding; Sport; Health

Introduction

It is already a banality, but data are nowadays numerous and its access is extremely easy. In the most diverse areas, data abounds as a result of tools development (essentially materials) and technologies that have significantly reduced the costs of collecting and disseminating them [1]. What was a rarity turned into abundance and saturation.

This abundance has led people to become accustomed to trivializing even the most important things. The accessory is easily confused with the relevant in the permanent race for novelty, for something different [2]. As with the child with an excess of toys which misprize them quickly passing from one to another without even playing.

Life became superficial

- Food abundance was transformed into obesity.
- The abundance of information in the inability to deepen the themes.
- The ease of moving into running around.
- Access to strong stimuli in indifference because television, communication in general, fell into the trap of privileging emotion to information, the immediate to the profound.

- Policy was reverted into speech and manifestation, instead of the public affairs management debate.
- The pleasure of studying and investigating turned into the need of publishing the useless.
- Live well was forgotten and given priority to looking good.
- Moved from the useful tool to the gadget that is astounding and immediate.

Natural changes in those who suddenly passes from “poverty” to an abundance for which they were not prepared. But the transition has its adaptation times and demands. Exaggerating has costs that may not be acceptable [3].

Data is accessible, with lower costs (temporal, financial, even human,...), more rigorous and precise [4], but the understanding of its functioning has not changed significantly (see in this regard how the major decisions that have been taken in the face of the Covid-19 pandemic that the world is going through has not changed significantly compared to the Spanish Flu over 100 years old).

In the event of a pandemic, we are forced to slow down (or even stop), which we use to think deeply.

We will focus on a human action that is also trivialized and to which most do not care. The functioning of the human movement, with which we are permanently in contact.

Human movement and a functional model

Any movement of Man, however simple it may seem, is complex. It is not “just” to activate one or several muscles. A movement always calls for a global action by the human body that has to maintain the necessary balances, the indispensable coordination not only for the realization of the movement, but also for the indispensable homeostasis to the movement, its objectives, internationalities and transformations caused (or causing). In addition to being a privileged form of connection to the context, to the world in which we live [2].

And when we talk about coordination’s, we cannot ignore the importance of kinetic chains. Kinetic chains are sets of joints and body segments that work in a coordinated way for a given objective (conscious or unconscious), with a strategy, multiple decision making.

And for kinetic chains to work muscle action is essential. But the action of several muscles that during the movement vary the value of the useful forces they produce is the determining aspect since what must be considered are those resulting from the useful forces. Therefore, changing only the direction of the force exerted is enough for the resulting force to increase, as can be seen in the following figure:

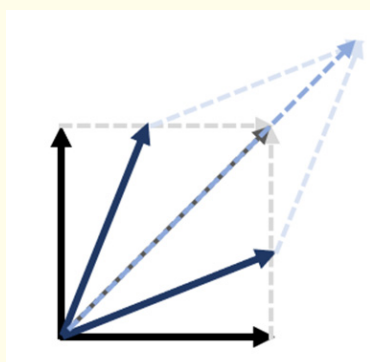


Figure 1: Implications of changing the direction of the force on the resulting one.

Recalling that this is an extremely complex process, we will simplify, in a somewhat rudimentary way, to better understand and explain the functionality of the human movement, presenting a simple model highlighting the action in joint and the center of mass/support base relation.

The joint

A joint does not normally work on the basis of a single muscle. In a simplified way, several muscle groups are necessary for the movement of any joint, with origin and insertion in different segments, and the muscles can contract (agonists) or relax (antagonists). We feel it when we have an injury and try to move a segment, sometimes distant from the injury, and the pain reminds us that we are a group, a globality in which it is difficult to isolate some parts.

Of course, we cannot ignore that we do not only have the movement of a joint when we mention human movement (any action, how simple it may seem), but of a set of joints that move simultaneously which makes this whole an even more complex process (for example, if we want to “just” bring the forearm closer to the arm (flex the upper limb) we cannot do it without “blocking” the shoulder joint (an absence of movement (at least at naked eye) that also implies an extremely complex set of coordination of muscle contractions and essential for the stabilization of the kinetic chain that allows flexion of the upper limb (not to mention the effects of resistance (such as grabbing a weight))).

Let’s see more in details.

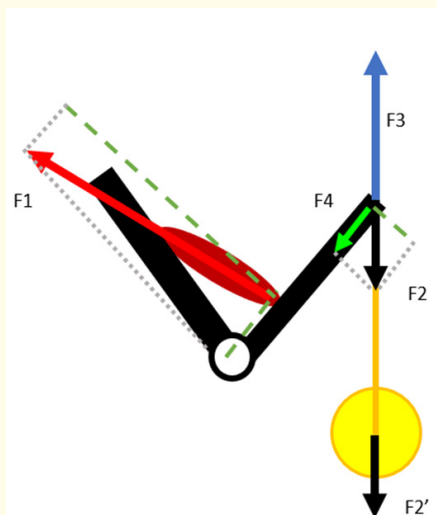


Figure 2: Example of decomposition of forces in the action of the upper limb.

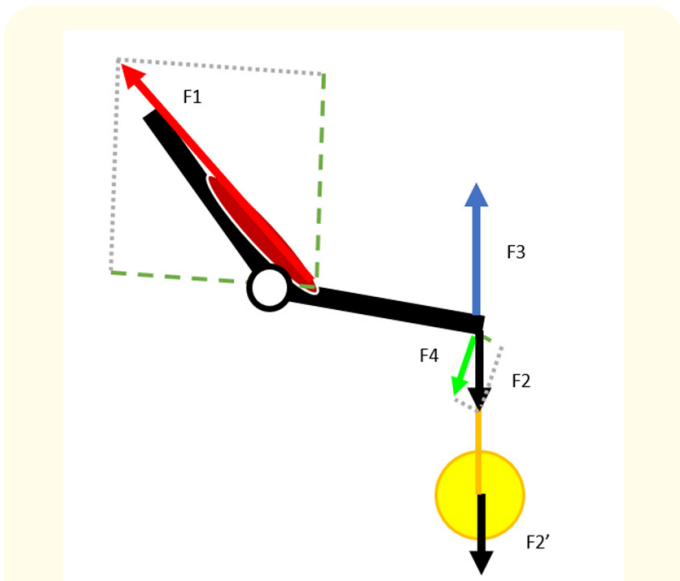


Figure 3: Example of decomposition of forces in the action of the upper limb.

Considering these previous examples

- If $F2 \times BF = F3 \times BF \rightarrow$ There is no movement (the forearm is still).
- If $F2 \times BF > F3 \times BF \rightarrow$ The weight makes the forearm go down.
- If $F2 \times BF < F3 \times BF \rightarrow$ The forearm rises the weight.

F4 implies a compression of the elbow in figure 2 while in figure 3 it means a traction.

Whenever there is a change in the angle of the elbow, there must be a change in the force F1 so that there can be the same relationship between the arm force x force in power and resistance. When we have precise movements (object launching, shooting, walking, etc.) this relationship is essential. This relationship implies adjusting the objective to the way of achieving it, to the strategy.

There are, thus, several aspects that must be considered in the movement of the joints

- Several muscle groups are necessary for the movement of any joint, with origin and insertion in different segments through tendon and ligamentous structures.
- The movement does not result only from the contraction of the muscle (muscle group, as we've mentioned being more rigorous), but simultaneously from the relaxation of the opposite muscle (muscle group) considered the antagonist of the movement [5].

- Coordination between agonist and antagonist muscles (groups) is essential for controlling joint movement.
- The capacity to exert force (to contract) of the muscle is not always the same in different joint amplitudes (the concepts of arm of strength and arm of resistance cannot be ignored).
- Forces are needed to “block” the joints preventing them from moving in unintended directions, so the muscles also have an essential function here as well as the tendon and ligament structures.

But joints don't work independently. The forces exerted must be supported on different segments of the human body or on external supports, so it is essential to consider the relative position of the Center of Mass (CM) and the Support Base (BA). This relation is essential to exert force on the outside as well as to move [6].

The center of mass/support base relation

The ability to exert force on the outside depends on the point of support and to use our weight to compensate the reaction force through the position of the CM in relation to the BA. Let's see the following illustration.

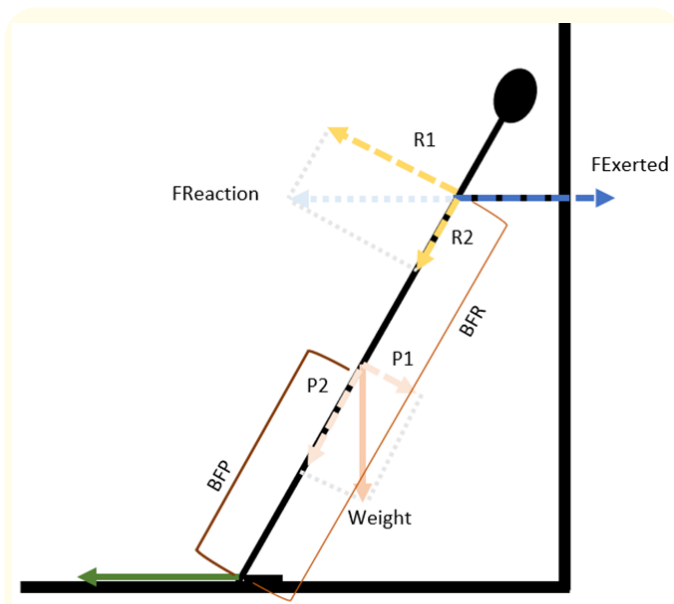


Figure 4: Decomposition of forces exerting a force on the outside.

Thus, and as we've mentioned in another publication [7], to exert a force on the outside we have to solve two problems: 1- compensate the reaction force to the force exerted; 2- have friction at the level of the support (soil) so that we do not slip due to the force of reaction of the exerted force:

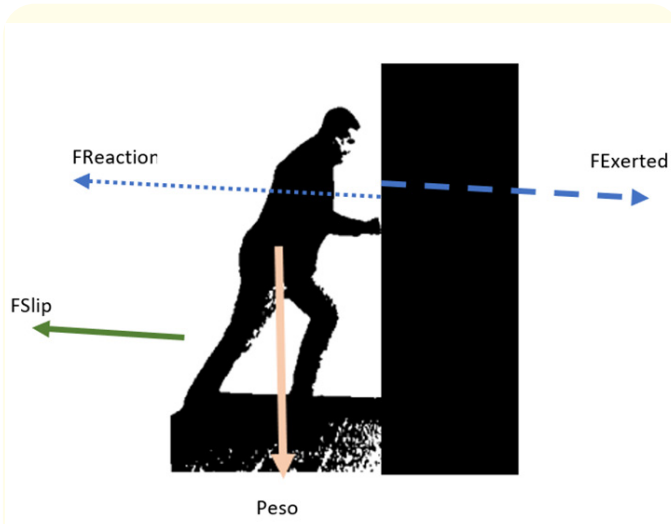


Figure 5: Exerting force on the outside.

The integration in the context has its costs but the individual is never an isolated system (except, of course, for the study of some particular aspects, when isolation, even if only imagined, has its advantages)

Some examples in sport

In this way, we already have some instruments to understand the human movement. A complex process, but that is possible to control, learn, and train. Notice how, from the earliest ages, learning to control the body, walking, running, jumping, are essential in terms of movement control. An apprenticeship that can be much more refined and meticulous the greater the need to control the body, to control the movements (or its absence).

But the same is true with high-level sportsmen who can only be so because they reveal extremely accurate control of their body [9], of a set of joints that allows them to perform precise movements in order to achieve unique performances in the most diverse activities.

In Football (Soccer)

For example, the adjustments that the best footballers can make in fields with different types of grass, with wet or dry grass, where it is necessary.

- Adjusting the coordination of the joints and segments used in a given movement so that they can maintain an extremely high and effective movement accuracy.
- To coordinate the center of mass/support base relation in order to be able to exert the desired force (with direction, intensity and time of acting) according to the objective and ball's trajectory.

Or when taking a direct free kick in front of the opponent's goal, considering that the ball must be placed where the foul was committed and not in a previously defined place (except for the penalty) needing

- To coordinate joints and muscles to be able to accumulate kinetic energy over a short run, being able to transmit it to the ball.
- To adjust the center of mass/support base relation in order to exert the required force on the ball so that it has a trajectory that allows it to reach the goal without being intercepted.

Because the players have to make these coordinations and movements are a sequence, it is thus possible to collect important information about the movement of the others (teammates and the other team players) that allow them to anticipate their actions (or "reading the game" as usually it is said), also gaining an advantage in the times of actions, particularly if we consider the concept of reaction time and the need to collect, interpret and process data aiming at decision making and consequent action [10]. Everything has its advantages and disadvantages and improving performance leads to situations that the opponent can also take advantage of - it is a dialogue of communications and relationships with which everyone wins.

In Tennis

Although the dimensions of the tennis courts are the same, it is naturally different to play on grass or clay. The ball's trajectory will undergo the corresponding changes depending on the type of floor (ignoring other factors such as air resistance or wind, for example) which will imply that the best players are able to

- Adjust the kinetic chains that will have to master, exercising the necessary muscle control to the resulting forces desired in the racket.
- Control the center of mass/support base relation in order to move in times that allow them to intervene on the ball and, simultaneously, exert the desired force on it with the racket adjusted to each circumstance.

In Athletics

Also in athletics, for example, it is recognized that the state of the track (simplified elasticity) is altered by temperature (more or less hot), which will require:

- Different readjustments in the forces that must be exerted by sprinters.
- Control of the different kinetic chains aiming the necessary coordination for such adjustments in the intended resultant forces.

- Permanent adjustments in the center of mass/support base relation that allows running adjusting to the reaction forces suffered.

In other daily activities

But the same happens if we are dealing with everyday situations such as driving a car. When we always drive the same car and one day we have to lend it to someone who changes the seat position, we are well aware of the discomfort we feel until we find “our” seat position again, the position in which we feel comfortable with, the one we had adapted and automated the kinetic chain in the necessary movements for our “natural” driving of the vehicle.

In these simple examples we seek to focus on the operationalization of the model previously presented without resorting to much data. But as mentioned at the beginning, data today abounds. Currently, many of those who go out for small runs (whether for reasons of health, leisure, socialization, etc.) no longer dispense equipment that allows them to access their data on such a race. Data such as distances covered, speeds, accelerations, unevenness, stops or routes are made available in real time and recorded for future access [11]. But although these data may even be interesting and important, what conclusions will be drawn by whoever holds them? Without models that allow a functional understanding of phenomena it is not possible to integrate data and improve performance, movement and its effects.

As previously mentioned on another publication [12] understanding man, his characteristics and limits, as well as the features he presents are parameters that underlie many areas of knowledge, areas that naturally focus in different phenomenon and characteristics. Looking at man from different perspectives is a wealth to share and should not be a factor of separation and isolation [13].

Conclusion

The development of material tools that made the access to data extremely easy was not properly accompanied by the creation and development of conceptual tools that allow the treatment of data, its interpretation and lessons based on it.

It is not enough to have more data about man, about the human movement to understand, explain and intervene. A functional model is increasingly an indispensable tool in this context. Even more when we have the capacity to access and collect data, when we have the possibility to interpret, analyze and deepen it.

The movement and its adaptations have effects on man. We must understand its effects on sport, health, education. The importance of understanding and explaining this whole process in order to understand how to manage it efficiently and not only through trial and error is essential.

It is time to deepen knowledge, the ability to go further in interpreting the available data without losing sight of the phenomena as a whole. Science itself has lost track of functionality, which for a time was necessary to simplify its understanding, but it is urgent to overcome it by making knowledge again have a purpose, to be useful.

The pedagogical process is also of particular importance since the world for which young generations are trained is no longer the 20th century or even the beginning of this 21st century. The functional understanding and explanation of the phenomena should guide the intervention of professionals with responsibilities in this area (the media cannot fail to also assume its role in this regard educating people and opening visions instead of clinging to “tics” and flashy representations with a lot of noise and meaningless screams).

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