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SENSORY-MOTOR RESPONSES IN FENCING

A tennis player may have highly efficient techniques but may lack skill in tennis because he does not perceive the right moment to use those techniques. A skilled footballer, or any other games player, must take action which is appropriate and therefore the skill involves interpreting the needs of the situation and making the right decision, as well as carrying out the necessary movements. In games, decision making is a vital part of the skill.

Barbara Knapp

Key words: tactics and psychology in fencing, components of sensory-motor responses, perception and choice of action in fencing bouts.

ABSTRACT

All branches of sport share many common traits and also feature many different characteristics. Some sports feature only one closed (intrinsic) sensory-motor skill (weightlifting, field-and-track events), no direct opponent and no tactics. Other sports involve many closed (intrinsic) sensory-motor skills (figure skating, artistic gymnastics), no direct opponent and no tactics. The accuracy and beauty of predicted movements in those sports are assessed by the judges. Fencing and other combat sports, sports games and team games differ considerably in the above respect in having many open (extrinsic) sensory-motor skills, facing directly the opponent, and great importance of tactics. In fencing, it is not only important how to execute a given fencing action (sensory-motor skill), but also how to apply a chosen action in a bout. Technical-tactical and tactical abilities are of immense significance here. In fencing, sensory-motor skills, i.e. various fencing actions (offensive, defensive, and counter-offensive), are mostly applied in a bout as different types of sensory-motor responses: simple, choice, differential, sensory-motor responses to a pre-signal, sensory-motor response to a moving object, switch-over responses (changes of decision while executing a foreseen action) and intuitive responses.

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INTRODUCTION

At every instant the motor activity must be related by, and appropriate to the external situation. . . what is learned is not a series of individual acts. . . what we learn at tennis is not a set of strokes but how to make strokes appropriate to the moment.

Barbara Knapp

Many physical exercises, movements, strokes and actions, which are the form and content of various sport disciplines, display certain traits characteristic of conscious, voluntary activity. Such activity occurs in the form of sensory-motor skills, which are often applied as sensory-motor responses. This is especially important in sports with many open sensory-motor skills and tactical abilities, such as fencing and other combat sports, games and team games.

Simple sensory-motor response is a reply in which one knows or foresees a stimulus which is about to occur and, for which, one can prepare an adequate action in a specific way in advance. Take, for example, the sprinter's start. The athlete knows the aim of his movements, he knows the way of executing them, and he knows the stimulus. He is waiting for the stimulus/signal – the firing of the starter's gun. To this signal, the athlete responds with a well-known, well-learned, and often practiced movement – the start. Another example of simple sensory-motor response could be a sabre lesson, during which the fencing master commands: "On my opening – change of position from quinte to seconde and execute a direct cut to head". The beginning of the fencing master's movement is then a signal for the execution of the cut to head.

The structure of a sensory-motor response consists of:

1. Receiving a recognized stimulus (signal).
2. Realisation of the stimulus and preparation of the counter-action programme.
3. Execution of the appropriate movements.

Three periods of a sensory-motor response can be distinguished:

1. Preparatory period, i.e. waiting for the stimulus.
2. Latent or central period (also called "reaction period").
3. Executory or final period, in which a chosen action is executed.

The preparatory period lasts from the appearance of the stimulus to the beginning of the action. It takes a very short time, but it influences

greatly the speed and the way of execution of a chosen movement or action. Although the athlete remains immobile, highly dynamic and important processes take place in his brain cortex.

The latent period may be divided into:

1. Sensory part – reception of the stimulus (signal).
2. Associative part – realisation that *this* is the stimulus for action.
3. Motor part – excitation of the motor area of the cortex and a flow of motor impulses along the nerves to the appropriate muscles.

The executory (or final) period is the time from the beginning of the movement (action) to its completion. It is visible and thus may appear to a casual observer to be the most important phase. It should be understood, however, that the actual movement is prepared by, and depends on, the first and second periods of the sensory-motor response.

A sensory-motor response is a sensory-motor skill (motor habit pattern), executed and applied as a sensory-motor response to a stimulus. Figure 1 depicts a simple model of sensory-motor response.

Preparatory Period	Latent Period	Executory Period (execution of a given stroke)
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The preparatory period lasts from the signal, "attention" (or situation which causes an increase of attention), to the appearance of the stimulus. The latent period lasts from the appearance of a stimulus to the beginning of movement. The executory period lasts from the beginning of movement to its completion. The term "reaction time" signifies the time of the latent period. The time of motor response comprises the latent period and the time of the movement execution.

Figure 1. A general model of a sensory-motor response

Many authors only distinguish between simple and compound (choice) sensory-motor responses (SMR). In my view there are multiple varieties of sensory-motor responses: simple SMR, choice SMR, differential SMR, SMR to a moving object, switch-over SMR, SMR to a pre-signal and intuitive SMR. All these varieties play a key role in fencing and other combat sports, as well as in sports games and team games. In fencing, they form the basis of various technical-tactical capabilities such as distance assessment and choice of footwork; recognition of the threatened line;

choice between a parry and a stop-hit; choice of the appropriate parry; intuitive choice of an action; the ability to change one's intention during a foreseen action as a reply to the opponent's unexpected movement, etc.

In competition, apart from physical abilities, coordination abilities, sensory-motor skills and responses, extremely significant are also tactics, aspects of attention, perception, level of arousal, and achievement motivation and competitor's self-confidence. As I often say to my pupils: Nothing is as simple as it may superficially appear. In discussing sensory-motor responses it is important to mention that a fencer responds differently to different stimuli, with the fastest reaction to kinesthetic stimuli (internal) followed by auditory stimuli, tactile stimuli and, lastly, visual stimuli. In fencing, the combination of visual and tactile stimuli plays a significant role.

SIMPLE SENSORY-MOTOR RESPONSE

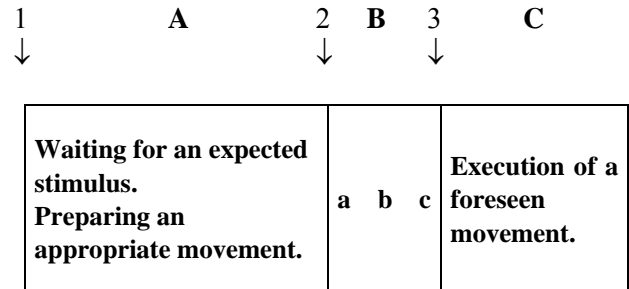
Once a fencer has learned the mechanisms of basic fencing movements, the activity loses its primary, total physical requirements and becomes more of a mental exercise. Concentration, self-control, and quick decision command muscles and reflexes for successful scoring.

Michel Alaux

The essence of a simple sensory-motor response is a known, foreseen stimulus followed by a known, foreseen response. For example, in a laboratory, on the appearance of a red light, you must press a button; in a fencing lesson, when the coach announces "On my step forward [known expected stimulus], you execute a direct attack with lunge [foreseen response]"; in a fencing bout, when one expects or provokes a given movement by the opponent and reacts to it with a previously foreseen and planned action. Figure 2 shows the structure of a simple sensory-motor response.

In a simple motor response, the process of reaction is not very complicated. There is only one well-known stimulus – signal – to which one replies with one well-known foreseen movement. In the preparatory part of simple response, two important psychological processes occur:

- a) waiting for the expected stimulus (signal),
- b) preparing the response, i.e. motor programme of a foreseen action.



1 – Signal or change of external situation which causes higher demand of attention

2 – Appearance of the stimulus

3 – Beginning of the movement/action

A – Preparatory period

B – Latent (central) period

C – Executory (final) period

a – Sensory part of the latent period (noticing the stimulus)

b – Associative part of a latent period (recognizing the expected stimulus)

c – Motor part of the latent period (sending executory motor impulses to the muscles)

Figure 2. A model of simple sensory-motor response

Careful observation and laboratory experiments yield three main types of simple sensory-motor responses, based on the differences in the preparatory period, which have an impact on the latent and executory periods of sensory-motor response and – above all – on the duration of the latent period.

Sensory type

The athlete concentrates, above all, on perceiving the signal (e.g., a sprinter waiting for the starter's gun shot or a fencer waiting for the expected movement of his opponent's blade). Waiting for the signal stimulates parts of the brain cortex responsible for analysis of auditory stimuli (sprinter) or visual and tactile stimuli (fencer). Other areas of the cortex – including the motor areas – are faintly active or slightly inhibited. The athlete, concentrating all his attention on the waiting for the signal, is not well prepared for a speedy, energetic and well-co-ordinated execution of a given action since, as stated above, the motor areas of his brain cortex are slightly inhibited.

Motor type

In the motor type of sensory-motor response, the athlete's (fencer's, boxer's) total attention during the preparatory period is concentrated on preparing the execution of the foreseen action. The excitation which occurs in the auditory or visual receptors is quickly transmitted to the part of the brain responsible for analysis, and from there it proceeds to the association centres. When it comes to the motor area of the brain cortex (the motor programme already well-prepared), the impulses are sent quickly to the effector organs in the muscles. These types of sensory-motor responses, however, have a certain drawback as they, not infrequently, may involve errors. The athlete, by mistake, can take another stimulus for the one he is awaiting. That is why a premature start, or premature actions of the blade can occur. For example, a fencer who is waiting for his opponent's attack and has prepared a parry-riposte (anticipated defensive action), mistakes a slight movement of his opponent's blade for the commencement of the attack and prematurely reacts with a parry.

Intermediate type

The intermediate type of sensory-motor response occurs, when there is certain equilibrium of excitatory and inhibitory processes in the sensory and motor parts of the cortex. The fencer divides his attention between carefully watching for the appearance of the stimulus and preparing the motor programme of the expected action. The latent period of such types of sensory-motor responses takes from 140 to 150 thousandths of a second. This is the best variety of simple sensory-motor skill.

Examples of simple sensory-motor responses:

- During practice: a) the coach says: On my step forward, execute a direct attack with lunge; b) on my attempt to take your blade, derobe; c) on my direct attack, parry and riposte.
- During a bout: a) a fencer notices and expects certain movements of his opponent's and reacts accordingly, e.g. on the opponent's expected step forward he executes a direct attack; b) when the opponent extends his arm (weapon in line), the fencer executes a beat and direct thrust; c) on the opponent's attempt to bind his blade the fencer derobes (attack by disengagement).

CHOICE SENSORY-MOTOR RESPONSE

Choice sensory-motor responses are those which involve the possibility of multiple varied stimuli and many, or at least several, varied replies, i.e. we do not know which of the stimuli will act nor with which reply (which action) we should react to a given stimulus, because to each stimulus there may be a varied number of sensory-motor responses. As I explain to my students, "We know all the answers – we just don't know which question will be asked".

Choice sensory-motor responses are very important and they occur in all combat sports (e.g. fencing, boxing, judo, wrestling) and sports games (e.g. tennis, badminton, basketball, soccer, volleyball).

A fencer acquires a vast repertoire of various sensory-motor skills (motor habits patterns) of different fencing actions – offensive, defensive, and counter-offensive – and, meeting his opponent on the piste, he usually knows what he should use, what style of fighting he should prepare against his opponent. A fencer will base his general plan of action on his experience of previous fights against his opponent, or by observing his style of fencing. But what he does not know, and cannot know, is which action at a given moment his opponent will apply. He, therefore, must observe his opponent's movements, maintaining general preparedness (very important) for action, and must be ready for a quick, precise and adequate response to his opponent's movements. This is why choice sensory-motor responses should not resemble the motor type of simple sensory-motor responses. One should not concentrate on preparing a motor programme of a given action because one does not know what the opponent will do – to every movement of the opponent, one must respond with a different counter-action. The difference between the two types can be illustrated by the following example: A fencer notices that his opponent, as a preparatory movement, frequently uses a reverse (circular) beat. He resolves to derobe by counter-disengagement on the next beat (simple sensory-motor response used in a bout – a known stimulus with one foreseen reply).

While preparing a defensive action, a fencer resolves: "If my opponent attacks by a simple movement, I will parry. If he attacks using a compound attack, I will stop-hit" (choice sensory-motor response). If the fencer has no idea what his

opponent will do and, on the opponent's action, he chooses the appropriate counter-action, it is also a choice sensory-motor response. A great amount of unpremeditated and unforeseen movements in a bout and multiple training exercises requiring the selection of a stroke by the pupil, are examples of choice sensory-motor responses.

The structure of a choice sensory-motor response is more complicated as it differs considerably from a simple sensory-motor response, in both the preparatory and latent periods. In a simple sensory-motor response, a fencer already knows in the preparatory period what action he will execute in the executory period; in a choice sensory-motor response, the fencer chooses his reply, only after the appearance of the signal (stimulus), and only then, in the latent period, does he choose the appropriate motor programme.

In the preparatory period of choice sensory-motor response, there are two important processes: a) a high level of attention and perception, trying to assess the development of the tactical situation and, above all, the opponent's movements; and b) general readiness for action (not just waiting for a foreseen signal, like in a simple sensory-motor response, but trying to be prepared for any situation).

In the latent period of choice sensory-motor response, the following parts can be distinguished:

- Sensory part: noticing the (unforeseen) stimulus.
- Selecting the stimulus from others, while acting at the same time: i.e., a fencer receives a constant stream of stimuli – watching his opponent's legs, weapon action, movement and general behaviour and, to some degree, various external factors in his environment – and yet selects one particular movement important to him as a signal for sensory-motor response.
- Recognising the selected signal (closely connected with the previous part): the fencer classifies the selected signal as belonging to a certain group of actions, which is usually connected with the secondary signalling system and formulates it in internal speech. This, of course, is not expressed in words but it is rather a split-second realisation of his opponent's intention (perception on a higher, conceptual-

functional, level; not only seeing, feeling, etc., but understanding what is going on¹).

- Differentiating stimuli and selecting the motor programme of a chosen action: the fencer has to distinguish one given signal from among others, sometimes similar, while acting at the same time. This is very important for understanding a tactical situation and the opponent's intention, his plans and, above all, for choosing an adequate stroke. After recognising the opponent's movement, the fencer chooses the appropriate counter-action and selects, from a long-time memory store, the appropriate motor programme.
- Motor part of the latent period of choice sensory-motor response: mobilisation and activation of the motor area of the brain cortex and sending of appropriate motor impulses to the effector organs, i.e. muscles.

Figure 3 presents a model of choice sensory-motor response.

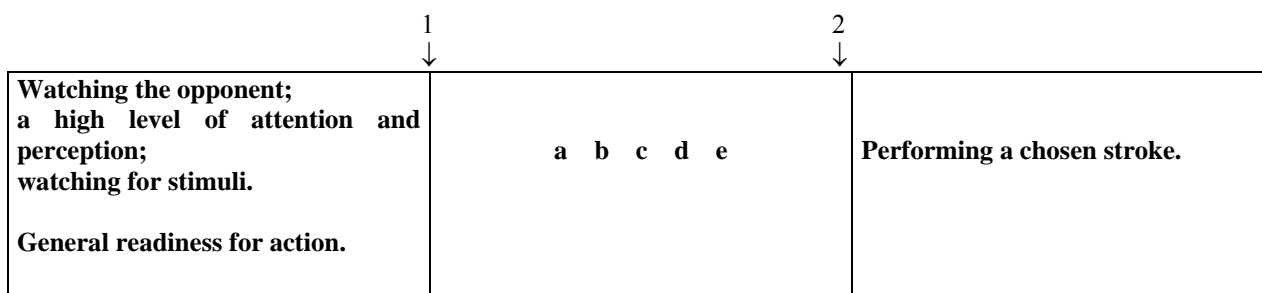
In short, the latent period of choice sensory-motor response features the following parts:

- sensory part,
- selection of stimulus,
- recognition of stimulus,
- choice of stroke,
- motor part of latent period of sensory-motor response.

Due to the more complicated structure of the latent period of choice sensory-motor response, its time increases and is usually slightly more than 300 thousandth of a second. In a well-known activity, a choice sensory-motor response lasts a comparatively short time and, in elite fencers the latent period of the choice sensory-motor response is very short, and often nearly as short as the sensory type of simple sensory-motor response.

It is worth remembering that simple sensory-motor responses and choice sensory-motor responses vary in different individuals. There are fencers with very fast simple sensory-motor responses and slow compound sensory-motor responses, and vice versa. There are also fencers with both slow simple and choice sensory-motor responses.

¹ Perceiving on a lower – sensory-motor – level means that we see, for example, a line of Hebrew script, or hear a foreign language but do not understand. A higher, conceptual-functional, level of perception means that we do not only see, hear, and feel something, but that we understand it, can explain it, and give a name to it.



- 1 – The appearance of an important stimulus (signal).
- 2 – The beginning of the execution of a chosen stroke.

- a – Sensory part of choice sensory-motor response – reception of the stimulus.
- b – Isolating the stimulus from among others, while acting at the same time.
- c – Identification of the stimulus, classifying it to a given group of actions.
- d – Perception of a given stimulus, in connection with other stimuli, acting at the same time; assessment of the situation and understanding the opponent’s intentions; choice of appropriate action; programming execution of the action.
- e – Motor part of choice sensory-motor response – sending motor impulses from the brain to the muscles.

Figure 3. A model of choice sensory-motor response

Of course, an ideal fencer should possess fast simple and choice sensory-motor responses like, for instance, Polish sabre fencer Jerzy Pawłowski, a multiple Olympic and World Championship medalist, who in his brilliant bouts, he took advantage of simple, choice, and other varieties of motor responses. However, one can achieve top results, indeed, with average simple and high choice sensory-motor responses – provided one can adapt one’s fencing style and tactics as the occasion requires. A very good example of a fencer whose great assets in fencing were highly developed choice sensory-motor responses was Jacob Rilsky of the USSR, a three-time world sabre champion. Also, one may be very successful with fast simple sensory-motor responses and average choice sensory-motor responses, e.g. Polish foilist Witold Woyda, who won two gold medals at the Olympic Games in Munich and won many World Championship and Olympic medals, based his tactics, to a large extent, on extreme speed of simple sensory-motor response and of movement (in other words, on a very short time of simple motor responses).

Simple and choice responses must be carefully distinguished from simple and compound actions. A compound action may be a simple sensory-motor response – for example, when a fencer executes a compound attack on a signal

which he was expecting, such as a “one-two” (attack by feint of disengagement-disengagement) executed on his opponent’s expected pressure on the blade. A choice sensory-motor response may result in a simple action selected from several possible movements in answer to an unforeseen stimulus.

Fencing masters stressing the importance of speed in fencing often use the expression “speed of reaction”, “speed of execution” or “speed of movement”. It is obvious that by “speed of reaction”, they really mean the latent period, and by “speed of execution” the executory period of the sensory-motor response.

OTHER VARIETIES OF SENSORY MOTOR RESPONSES

As mentioned above, there are other varieties of sensory-motor responses, apart from simple and choice responses, which are very important in fencing bouts, forming the basis of fencers’ technical-tactical abilities. The other types include:

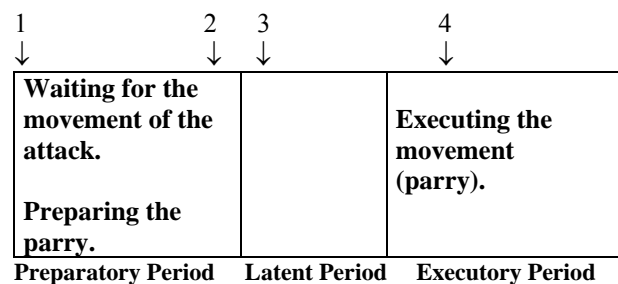
- differential sensory-motor response, in which one has to differentiate and act accordingly between stimuli very similar to each other. For example, when a sabreur executes correctly a cut to head, one has to parry. If he executes an

- attack incorrectly, by exposing his forearm, one has to execute a stop-hit to arm.
- Sensory-motor response to a moving object (surprisingly enough not only important in tennis, soccer, volleyball, etc., but also in fencing) in which one assesses the trajectory and speed of a given object – soccer ball, tennis ball, epee, etc. – and reacts at the right appropriate moment – not too early, not too late. This is why, in fencing, changes of rhythm and, especially, acceleration of the final part of an attack are so important and constitute a significant factor of taking the opponent by surprise (timing, à propos).
 - Switch-over sensory-motor response – change of a preconceived action, during its execution, as a reaction to the opponent’s unexpected movement. For example, an epee fencer begins his attack trying to hit the opponent’s leg when suddenly he notices his opponent’s stop-hit. He changes his action and executes a counter-time (parrying stop-hit and riposting).
 - Sensory-motor response to a pre-signal, i.e. reacting not to the opponent’s final movement but to a “pre-signal” – a certain gesture or change of position made by the opponent betraying his intention.
 - Intuitive sensory-motor response – a sensory-motor response based on “statistical intuition”. It is strange but even most experienced fencers choose their actions intuitively (without analysis) and their choice is based on hundreds of similar situations in training and competition.

Figure 4 presents the essence of a sensory-motor response to a pre-signal. All varieties of sensory-motor responses are concisely presented in Table 1.

Being surprised is a privilege of children. Yet – in spite of my advanced age – it never ceases to astonish me that many coaches, in individual lessons and other exercises, pay attention to, and teach, only how to quickly and correctly execute a given fencing stroke. They are completely oblivious to the fact that the speed, accuracy, and success of a fencing action depends, not only on the executory period, but also – and to a large extent – on the preparatory and latent periods of sensory-motor responses. A very accurate, fast, and well-chosen fencing action is not good and not effective if it is started too late (bad perception, long latent period of sensory-motor response). A fast and accurate

movement, started early, but inappropriately chosen, is also to no avail. If, for example, my opponent executes an attack – a cut to head with a lunge – and I take, very early, quickly, and beautifully, parry two (wrong choice of action), I will, of course, be hit. A well-chosen and early-started action – even if it is slightly slow – may be successful (fast reaction – short period of latent period).



1. Signal, “attention”, or change of situation, which stimulates the fencer’s attention and vigilance.
2. Appearance of a pre-signal (change of position, unwitting betrayal of opponent’s own intention).
3. Appearance of the “proper” stimulus (in this case, the opponent’s attack).
4. Beginning of movement; the fencer – sometimes not fully consciously – begins to parry, as a sensory-motor response to the pre-signal, before his opponent really starts the attacking movement.

It is obvious that when a fencer reacts to a pre-signal, he starts his movement earlier than it would have been, had he reacted to the “real” stimulus. It should be noted that the beginning of the movement is earlier, though the latent period takes the same time, because the latent period starts sooner – before the “real” signal.

Figure 4. A model of sensory-motor response to a pre-signal

It is therefore obvious (and obvious things – as I use to say – are often the most difficult to notice) that the fencing master and the pupil should pay attention to all three periods of sensory-motor responses, i.e., early and correct perception of stimulus, fast choice of the appropriate action, and early, fast and correct execution of the action.

Table 1. Typology of sensory-motor responses

Sensory-motor response type	Essence	Situation in a lesson	Situation in a bout
Simple sensory-motor response	Known signal/stimulus – known response: known and foreseen action as a reply to the opponent’s expected movement.	Execution of a given stroke, as a response to the coach’s previously announced movement.	The fencer expects certain movements from the opponent, and waits for it, having a prepared motor programme of the response.
Choice sensory-motor response	Unknown signal – response in accordance with the signal meaning: the pupil does not know what signal/stimulus will appear and, to each one, he replies appropriately (“We know all the answers, but we don’t know which question will be asked”).	Choosing from previously announced and previously unannounced actions.	The fencer responds with different actions, in reply to the opponent’s unexpected offensive movements. He adapts the movement of his offensive actions to the opponent’s defensive actions; foreseen and partly foreseen actions.
Differential sensory-motor response	Differentiating between very similar stimuli.	For example: false preparatory attack, the pupil disregards – real attack, he parries; correctly executed cut to head, he parries – to cut to head with elevated hand, he replies with stop-cut.	The fencer assesses whether an attack is real or false, simple or compound, whether the cut is executed correctly or with exposed arm.
Sensory-motor response to a moving object	Perceiving and anticipating the trajectory and speed of a moving object (in fencing, the opponent’s moving weapon).	Learning and perfecting spatiotemporal orientation.	The fencer foresees the path of the opponent’s weapon and reacts in the appropriate time; for example, parry or beat – not too early and not too late.
Switch-over sensory-motor response	Change of original intention while executing a foreseen – first or second intention – action, in reply to the opponent’s unexpected movement.	The pupil practises foreseen attacks (or other actions) and the coach, from time to time, changes his predicted movement; the pupil must then alter his action in response to the unexpected movement.	For example: the fencer wants to hit the opponent with feint attack, but the opponent – contrary to expectations – instead of parry, executes a stop-hit; the fencer then changes his original intention and applies counter-time.
Sensory-motor response to a pre-signal	The pupil does not react to a “real” signal/stimulus, but to a pre-signal (e.g., preliminary movement, change of position, unwitting betrayal of the opponent’s own intention).	For example: attack on the coach’s “careless” movement, betraying the desire to start an attack.	For example: the fencer executes a fast attack at the moment when his opponent, by an unnecessary movement, betrays his own intention of launching an attack.
Intuitive sensory-motor response	A response based on “statistical intuition”.	Exercises “lottery à la Borsodyi”.	The fencer takes decisions, not so much based on observation or very penetrative perception of the opponent’s movement, but based on not-fully conscious intuitive mental-emotional processes, shaped by hundreds of similar situations in practice and competition.