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Lecture 11. The phases of the formation of mental actions

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I will start with a quick overview of what I was talking about in my previous lecture. I said that we would begin the study of the formation of mental actions with the development of ideal actions because it is the ideal actions that form the basis of all mental processes. I also said that in this endeavour, we would take Marx's statement as a starting point that the ideal is nothing other than the material, “transferred” into the human mind, and transformed there. In this lecture, we are going to trace this process.

To start with, we need to find out how actions are first formed as external actions with objects, and then transferred to the ideal plane. As a result of this transfer, external actions undergo changes, which make them totally unrecognisable and they begin to look like mental processes.

We will examine the formation of an action by starting with some pre-defined indicators. Such an approach will allow us to establish a causal relationship between the properties of the action and the conditions that lead to the formation of these properties. The whole of school practice, and life in a broader sense demand that some actions should be performed not physically, but ideally. For instance, when you cross the road, you estimate the distance and the speed of vehicles and evaluate whether you are able to move faster than the approaching vehicles and cross the road safely. In doing so, you perform an ideal action in the field of perceptions, and very often life teaches us how to perform these ideal actions in the surrounding environment. If we do not set ourselves the task of creating an (ideal) action with certain properties, but instead go about it in the usual way, (for example, first the action is explained, then it has to be learnt, and then it is checked or tested), then different people under different circumstances, perform this action in totally different ways and correspondingly get different results. This way of working makes it very difficult to understand why and how the results achieved by learners are so different.

To avoid such a situation, we need to define in advance the properties we would like an ideal action to have. We should also choose the system of conditions that will ensure the formation of these desired properties. This system of conditions is divided into three subsystems. I'll name them first, and then we will look at each of them in detail.

The first subsystem contains the conditions necessary to construct a specific action or create a scheme of the orienting basis of the action.

The second subsystem ensures the acquisition of the desired properties of the action. The same action can be performed with different indicators that may serve as a measure for evaluation of the action: e.g. speed, the degree of dependency on certain conditions, etc.

The third subsystem transfers the original external action with objects to the ideal plane of the subject and transforms this action into a new psychological process.

In my previous lecture, when talking about the first subsystem, I said that it comprised the conditions the subject should take into account when creating a totally new action and learning how to perform this new action. First of all, you should specify a so-called “model” of the action. To achieve this, we have to visualise the future action – how it should be performed. An action, as you remember, is characterised primarily by what it produces - its outcome.[1] Therefore, you should also specify the outcome to be achieved with its particular characteristics and the action that creates this outcome. Such an approach represents a clear idea of what needs to be achieved (outcome) and how this can be achieved (process - action). However, since any process happens in time and the desired outcome cannot be achieved immediately, then the outcome should be divided into elements, which are presented in the

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[1] An outcome can be also understood as a learning outcome.

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order of their execution. This may not be the order in which these elements appear in the final outcome, but this is the sequence in which the elements, that constitute the final outcome, should be produced. So, we divide the desired outcome into elements in the order in which they have to be created and correspondingly we divide the action into individual units in the order of their performance. We should specify in advance the properties of each of these individual units of an action and their intermediate outcomes. I have previously emphasised that we should distinguish between a unit of an action and a step that a learner is able to perform which can, in fact, differ from the unit of the action (in this case the unit should be divided into steps that are manageable for the learner). What usually happens in the process of the formation of an action is that these units eventually become combined into one single step and the action is performed as a single, continuous, indivisible process. It is therefore important for us to separate the objective units of an action from the ability of a learner to perform these units (either in smaller steps, or in the steps of the size of the actual unit, or perhaps in larger steps).

The next point to be taken into account is the properties of the initial material that the action "deals with". Such material is always present, even when it is not visible and, as I have already told you, it is present even in the movements of free gymnastics: it is the ability of a person to perform the physical movements, their muscles and how well they can use them. So, the level of a person's physical development when learning these free movements is the initial material he is going to work with. In this case, it may seem that no initial material exists in the external field; however, in other cases such initial material can be recognised. In physical labour the initial material is the "raw" material we begin to work with. In mental work the initial material is the numerous sources we collect in order to do the work, for example, examining a problem and drawing a conclusion. So, there is always some type of initial material.

It is also very important to organise the initial material beforehand and not, as often happens, move immediately into the action without forethought. Organising the initial material ahead of acting is a very big task. Firstly, we need to verify whether the initial material is sufficient and suitable for the main purpose of the action. However, even if the initial material turns out to be suitable, it is still necessary to organise it in such a way that it can be used by learners in the corresponding individual units of the future action.

Then there are the tools of an action. Here we must clarify something I have been confused about myself for a long time. You see, tools can be used in the executive and in the orienting parts of an action and these tools are different. The tools of the executive part are quite obvious – these are tools used in an action as an external objective process. I will elaborate in detail on the tools of the orienting part a bit later.

Tools can be divided into groups: primary tools, auxiliary tools and control tools. This is a very important point, because you know how hard it is for a person undertaking intellectual labour to be in the position of controlling what he has done. Sometimes, it is necessary "to leave" the product for a while and to distance oneself from it. This distancing may involve a long wait time, which is not always possible. Therefore, it is very important to have some objective tools of control, especially in intellectual, mental forms of activity, where control has to be particularly precise and sensitive. Nevertheless, generally speaking, this type of control is not different from control in any other types of activity.

Control, although it may seem to be quite straightforward, should also be organised. Organisation of control comprises the identification of some of the points of control, because you cannot control absolutely everything. You can control an action as a process, and its outcome, in relation to some of the critically important indicators, which together with the means of control may serve as criteria of control. These criteria can be of any nature, but they should be objective. We also have to describe how these criteria will be used. So control, as you can see – is quite a complicated matter.

What follows after control (and this also should be planned in advance in the scheme of the orienting basis of an action) is the correction that may be necessary if some deviations (in the outcome or the process) have been identified.

Finally, in my previous lecture, I made a point about presenting a complete generalised scheme of an action. However, you may wonder what is "a complete generalised scheme of an action"? I have always considered this complete generalised scheme important as it highlights the difference between a human and a machine. A significant part of work (if it is very complex) could and should be transferred to a machine. However, there is something that cannot be transferred to a machine and this is the point we are discussing. A machine does not need to have an overview of an action as a whole. It operates according to some selected indicators: it reads the indicator and performs the operation. A machine does not require anything else because it, actually, cannot think. That is why, as you know, a mathematical algorithm that contains instructions or prescriptions can be performed without understanding, but when we deal with a human, a learner, this is another matter. In addition to ensuring that each instruction can be understood by the learner, we have to create an understanding of the complete generalised orienting scheme of the action as a whole.

Therefore, the last point in the scheme of the orienting basis of an action is, strictly speaking, a complete generalised scheme, presenting an action as a whole, or, as we have come to call it in recent years, an *operational scheme of thinking*. This scheme may be of various types: it can be, for example, quite specific, as it was in the analysis of the structure of church buildings mentioned in the previous lecture. However, back in I960, L.F. Obukhova used a similar scheme for solving problems in a physics course in secondary schools, such as the problems of the pressure of solid objects, and indicated that this scheme could be applied to a whole range of tasks. We did not recognise the significance of the operational scheme of thinking at the time; we thought it was only an auxiliary tool of low importance. It turned out that this scheme was of very high importance for human actions.

Imagine, for example, a carriage with four wheels (Fig. 11A). It is loaded with boxes; each of which has a certain weight. Your task is to calculate the pressure exerted by these boxes together with the carriage and the wheels on the rails. You know the bearing surface area of each wheel on the rails. What do we have to do? Firstly, we have to calculate the weight of all the bodies that exert pressure, and secondly, we need to calculate all the bearing areas. Then we divide the total weight by the total area.

It turned out (this is also interesting), that if you present a finished diagram to learners that depicts this problem, it does not provide any help: a child needs to see how you draw these lines, how you highlight and add all the parts that make the total weight, and the areas of support of each wheel. It is a very peculiar thing that a wide variety of problems can be solved in a similar way, with

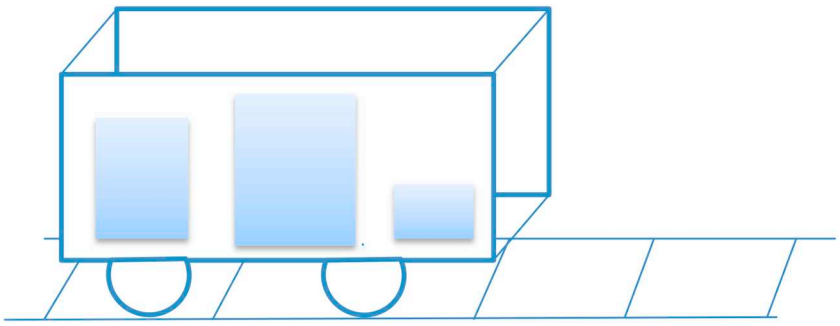

Fig. 11A. A carriage with four wheels and loaded with boxes.

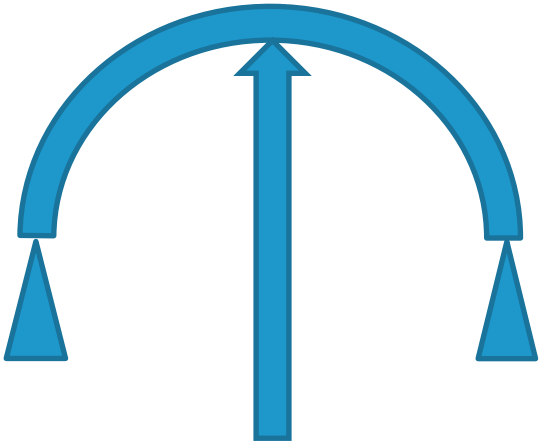

Fig. 11B. The scales with two cups.

a very complex arrangement of the bodies in relation to their bearing area.

Imagine the scales (Fig. 11B).

Here the weight of the cups is combined with the weight of the yoke and the bearing area is, in fact, the pointing part of the beam. As you can imagine, various combinations can be very difficult. It is very important that in these different combinations the scheme becomes very similar: there is the mass of the bodies, which exerts pressure, which means there is a pressing force P, and the total mass exerts its pressure on the area S (Fig. 11C).

This is, in fact, a scheme that can be used for solving any problem about the pressure of solid objects. But this - its final form, and the original form – are the lines that connect all the bodies, exerting the pressure and all the bearing points where the pressure is exerted. So, this is a generalised operational scheme of thinking, the scheme that can be applied for a range of problems.

Together with L. F. Obukhova we analysed the differences that occur in children's thinking in the transition from a happy preschool age to an early school age, when the school “drill” starts. It turns out that a child's thinking undergoes very significant changes. In its happy preschool age, a child believes that the things are the way he[2] sees them. This is the age when a child does not want to know anything about measuring, adjusting, etc. A child sees these things and believes that they are the way he sees them: such a naive egocentric position. In addition, a child usually thinks that all the properties of a thing are equivalent to the very thing itself. In philosophical terms, this means: a thing has its essence, and because the essence is singular - it makes a single entity with the thing which is expressed by its different properties. Moreover, all of these properties are equivalent expressions of this single entity. Therefore, a child can easily make judgements about some of the properties of a thing from the perspective of other properties. Well, with a skilful experimenter a child always misses the mark.

There are the wonderful experiments of Piaget used by L. F. Obukhova, in which a child is presented with two bottles filled with coloured water (Fig. 11D).

The child is asked if there is more water in one of the bottles. When both bottles are next to each other, he says that the amount of water is the same in both bottles. Sometimes a child (children, you know are terrible quibblers) says: “No, there's a little bit less here”. Then, we add a drop of water, and he says: “Now it's the same.” We have to compromise, and we agree that now the amount of water is the same. After that we immediately turn one bottle upside down (Fig. 11F).

[2] Child (noun) is masculine in Russian.

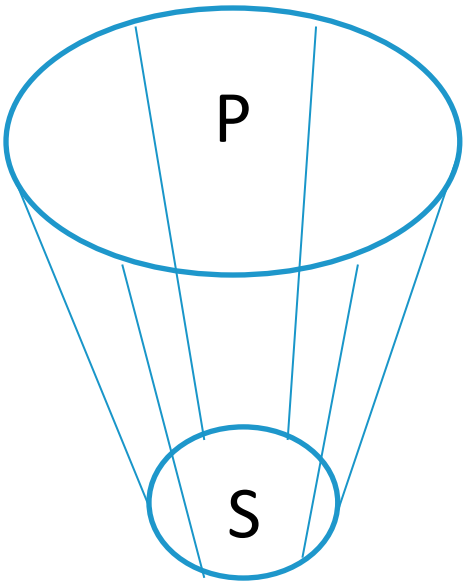

Fig. 11C. A pressing force P exerts its pressure on the area S.

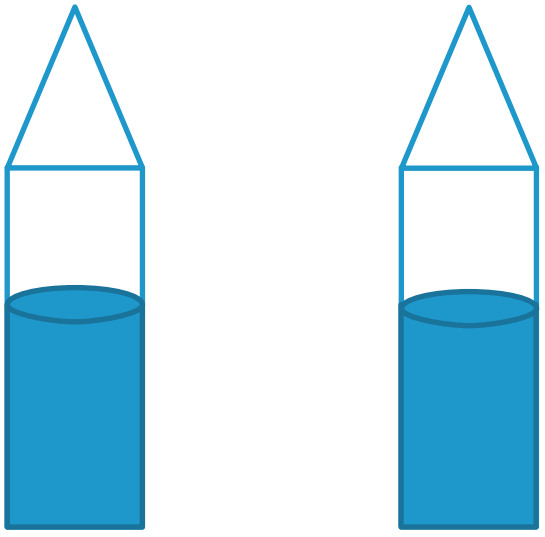

Fig. 11D. Two bottles filled with coloured water. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The water fills the narrow part and it seems that there is more water in one of the bottles. And when the child is asked: “Well, now where is more water?” He replies without hesitation: “Here” (pointing to the upside down bottle). We say to him: “How did it happen? We did not do anything”. He replies: “You turned it upside down, so there was more water”. It is difficult to prove that the child is wrong as he does not even want to measure. He just sees more water in the upside down bottle and that is all.

When a child becomes older he begins to recognise all sorts of difficulties in life, then he begins to evaluate things not on the basis of how they seem, but on the basis of how they really are, which means by measuring: a fundamentally different position in terms of an objective method. Importantly in this transition, from pre-scientific to the first proper scientific thinking in children, what happens is not so much a shift in knowledge, but a shift in a generalised operational scheme of thinking.

An interesting point is that you can teach a child how to measure, and he will measure and will get results, but these results will have no impact on the child's thinking at all. Let's say you showed a child how to measure, and when the bottles were next to each other, he measured the amount of water in the bottles with the help of, for example, a cup and found that there were four cups of water in each bottle (the child could also see that the amount of water in the bottles was the same). However, when you turned one bottle upside down, there came the contradiction. We asked the child: “Well, now how many cups are in this bottle?” He replied: “Now there are seven cups.” - “Why seven if we didn't add more water?” - “You turned it upside down, so it became seven instead of

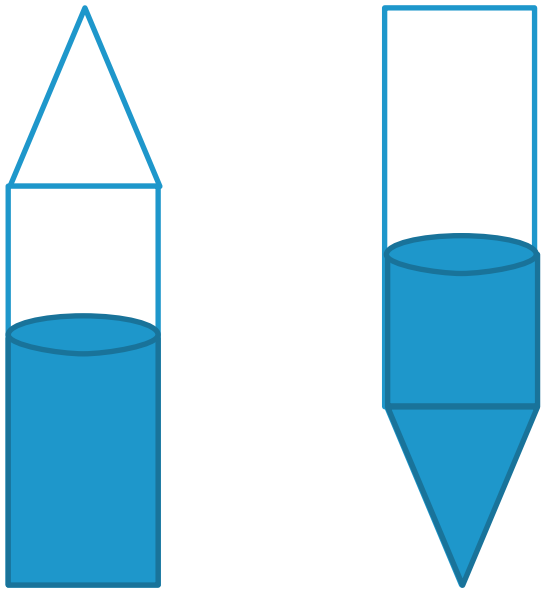

Fig. 11F. One of the bottles is turned upside down.

four". You have taught arithmetic and measuring, but still his understanding of the situation is subjected to his perception of things. Since the child sees that there is more water, then there are not four cups of water, but seven. You have taught him how to measure using technical tools but his understanding of the phenomenon remained the same. Therefore, it is important not only to teach some knowledge, but to facilitate a general change in the ways of thinking, from pre-scientific, naïve, egocentric thinking to scientific thinking itself.

In scientific thinking too there are a number of schemes, which include, for example, a shift from the naively egocentric position to the objective position of identifying the essence of a phenomenon by using pre-defined criteria. It is important to remember that these operational schemes of thinking may be of different types: they can be applicable for particular cases, or may cover an area of knowledge (as regional schemes). They may relate to the sciences as a whole, or to knowledge about specific physical phenomena. Even younger children, when they make the transition to initial scientific thinking, start evaluating things on the basis of measurements, from the perspective of an objective position. However, when young learners are presented with a problem from an area of, for instance, moral categories (again there are fascinating experiments by Piaget), they again demonstrate their original naivety. One example describes the situation when a boy, who was at home alone, without permission opened a cupboard to get some jam and dropped a cup, which unfortunately smashed. And another boy, in contrast, while helping his mother to put the clean dishes into a cupboard dropped three cups, which also smashed. The question is: "Which boy carried out the bigger offence?" The child usually answers: "The boy who smashed three cups." However, from the moral perspective the response should be the opposite. The first boy disobeyed and consciously committed a moral offence. And the second boy did it accidentally. This is not a moral offence, but, so to speak, a physical one; but the child judges only by the amount of damage, the physical damage. As you see, in the area of morality the learner is still lacking the true criteria, he still thinks very naively, but at the same time the same learner can demonstrate some elements of scientific thinking when dealing with physical phenomena.

Operational schemes of a philosophical type are also worth mentioning. You know that there are great scientists who have very peculiar views in areas that are not relevant to their field of competence. Let me give you an example of a big physiologist, the professor of Leningrad University, who died recently. He was a very clever scientist and had made a number of important discoveries in the physiology of nerve conductivity; but he was always interested in psychology. He, in fact, tried to transfer schemes suitable for the analysis of neural processes to a completely different area – the field of psychology. So he organised the Laboratory of Parapsychology at Leningrad University to study psychological phenomena. However, the direct transfer of schemes applied in one field to another field does not always work. Schemes of scientific thinking, applied for real material objects, are not suitable for the explanation of social or psychological phenomena. The scheme of thinking and analysis used, for instance, in the study of the struggle for survival in the animal world cannot be transferred and used for the analysis of human social relations. Why is it not suitable for the analysis of human social relations? This is mainly because of the nature of the laws applied in these sciences, which are completely different. Correspondingly, I believe that the schemes suitable in one area cannot be transferred to another area. This is a very important point, but we are not going to dwell on it for long. The important thing is that the operational scheme of thinking is always present, even in the smallest activities, either collective or individual. A person must be given not only a system of rigid instructions about what to do, but the whole perspective, the overview of the action. The operational scheme of thinking constitutes the last and a very important item of the orienting basis for an action.

This last point ends, as far as we know at the moment, the first subsystem of conditions necessary for the construction of an action that is new for the learner, who simply cannot perform the action without these conditions.

You now may be wondering how a person, using the first subsystem of conditions, can construct an action and perform it with the pre-determined and desired properties? In an attempt to answer this question, we need to turn to *the second subsystem of conditions*. We need first to consider what properties we actually want the action to have. To start with, I believe that we need to identify the maximum amount of properties and find the conditions to achieve these properties and later, if we would like to, we can easily reduce the amount of desired properties. I am sure you understand, we cannot work the other way round. If we do not know all the circumstances and conditions of the acquisition of the action and its desired properties, we cannot be sure that the action will acquire the desired properties, for example, if the conditions are randomly selected.

But what are these properties? First I will list all the properties, and then I will explain the meaning of each of them. First of all, we would like the action to be performed *rationally*. Next the action would need to be able to be *generalised* to a certain extent and applicable to *a range of circumstances* in which the action can be performed successfully. It is also desirable that the action is *performed consciously (with awareness)*. The action also needs *to be critical* (we will talk about this later). And finally, we need *a certain degree of mastery of the action*. This includes, for example, free and fast execution, performance with the minimum of attention – employing automatism, etc.

These are the main properties that we would like an action to have. Since we need to teach these properties, we have to define how we understand them, otherwise risky naïve ideas may quickly arise. It can happen that we think we understand something, and then it turns out that this is not what we mean or what others understand. Let us therefore define each of the properties of the action in detail.

Rationality of the action means that the subject (the learner) focuses on identifying the action's objective and significant relationships. There are many relationships between phenomena and the circumstances that constitute an action. Consequently the learner should be able to identify those, among all possible relationships, which are essential to perform the action.

Now the second property is usually called *generalisation*. This is also a very important aspect, because an action does not always occur under similar conditions. It can be performed under conditions that vary and sometimes are actually quite disruptive. Therefore, the idea of generalised action means that the acting subject (the learner) is able to identify the significant conditions for the particular action among the variety of conditions in which he operates. This is very important because some actions can be performed under very few conditions. Therefore, a learner has to demonstrate stability, a degree of insensitivity to any interference, and be able to identify the significant conditions needed to perform the action.

Consciousness of the action. We are not going to talk about what c*onsciousness* is in general, because there are ten thousand opinions on this point. Let us just agree about what we call *consciousness* of an action – it is a person's ability to give a verbal report of the action.

Criticality is a comparison or verification of the defined criteria for an assessment of the action in relation to reality. This is not just an application of the selected criteria to the action; it is an assessment of these criteria. Let us say I select some characteristics for the assessment of the action. Criticality means that I understand the reasons for selecting these characteristics as criteria. I need to understand whether these characteristics are the only characteristics available, or whether they are the most decisive and, in a broader sense, whether they correspond to reality, or whether I have imagined them myself and therefore decided that they were the most important criteria. Therefore, criticality of the action comprises the critical assessment of the criteria selected to assess the action.

Finally, *the measure of the mastery of the action*. This is an extremely important aspect. It is characterised, above all, by whether the action can only be performed by the learner using the initial material resources, or whether it can also be performed verbally, or in a symbolic form, or whether it can be performed mentally and how fast it can be performed, etc.

Clearly, when we plan these properties, we want the measure of mastery to be of maximum value. We want the learner to be able to perform the action at the maximum speed, consciously, and able to give an account of the action in many different ways: with material resources, without material resources, in writing, verbally or mentally, etc. Accordingly, we ask ourselves: how can these properties of the action be ensured? In order to answer this question, first of all, we have to analyse the constituent components of these properties and what initial material we need to transform to obtain these properties. We need to consider the desirable properties as derivative, secondary ones. These are the properties we want to form, but they may not be actually present in every case. Therefore, we should consider the initial existing properties of the action and form the desired properties from these initial ones by using some techniques.

We have listed all the final desired properties, but what are the primary properties of any action? These primary properties are as follows. *First*, I would say, it is *the nature of the objects with which the action is performed*. These objects can be either material, or verbal: represented in words or derivatives of words (e.g. all sorts of symbols). Ultimately, there might be actions with representations containing visual images of objects, or representations of various concepts. The differences between the objects with which the action is performed can be described as levels of the action, bearing in mind the following. The starting level - is material and is followed by the intermediate level. The intermediate level is a very special one, present only in humans: the level of speech, because speech has material basis. Marx used to say that the “curse of matter” gravitates onto speech. Language and speech in general always have a material basis, however meaning is ideal. And finally, we come to the next level - the mental level (in the sense that I told you earlier). These main levels are like gateways through which we raise the action from the material level to the level of speech and to the level of acting mentally. That's why we call them levels. These levels begin in the material world and through speech lead to the mental plane.

We have explored the first property of an action - the nature of the material, verbal and ideal objects with which we perform the action - which necessarily happens at the levels mentioned above, that is why this property is so important.

Now *the second property*, which is also always mandatory - is the initial completeness of the units of the action. Sometimes we can perform an action by skipping some of the intermediate units or by skipping all of the units, as it happens, for example, in

mathematics when doing calculations with formulae. However, what is a formula? You have the initial conditions/components, the operational sign and the final result. By using the formula, we omit the whole action and we perform calculations according to this formula. This is an example of a maximum reduced action. An action is always performed with a certain degree of completeness: it can be deployed to a greater or lesser degree, deployed differently in its different units, but the original completeness of these units is a mandatory primary property of an action.

Now, *the third property* – is a measure of differentiation, separating the essential from the non-essential. This is useful both for the ability to generalise and for the development of the ability, mentioned above, to resist interferences. Just keep in mind two main aspects: 1) the separation of the essential from the non-essential; and 2) a resistance to what is obviously inessential, yet nevertheless, may interfere in the action.

The fourth property - are timely parameters of the action: the tempo and the rhythm. These, as you know, are not the same things, because you may have a certain rhythm at a different tempo.

And finally, *the fifth property* – is the power characteristics of an action, the size and the distribution of effort of the subject (e.g. the learner) engaged in the action.

No action, including mental, can exist without some indicators for each of the five main primary properties. These five properties may have different values at different levels of action (material, verbal or mental), however, greater or lesser differentiation, the varying tempo, rhythm and effort – are always present in any action, and mental actions are no exception.

Consequently, since these five properties may have different values, we can call them the parameters of the action.

We should also note that we consider an action to be both an objective and a subjective process. As an objective process, it can perhaps have only the properties of time and power, as a person has to learn to perform an action with a certain tempo, rhythm and with a predetermined speed. Other properties discussed above are the properties of an action of a human subject.

The next question is - how to form the desired properties from these basic parameters, the initial properties we have identified in the action? We will explore this in the next lecture.