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METHODS FOR INVESTIGATING CONCEPTS

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The article was based on a talk which Sakharov presented at the Pedological Congress in Moscow on 1 January 1928. On 10 May 1928, Sakharov died under unknown circumstances. Leonid Solomonovich Sakharov (1900-1928) worked with Vygotsky at the Experimental Institute of Psychology, headed by Kornilov, and soon started co-operating with Vygotsky.

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Method of definition and its role in the study of children's concepts

One of the problems that has contributed to a refinement of the 'functional procedure of double stimulation' in experiments is the problem of concept formation in children. To form an idea of the significance of this experimental method for the study of children's concepts, it must be viewed against the background of other methods that have been used to deal with the same problem. The psychology of children's concepts not only is of tremendous theoretical interest but also undoubtedly has applied psychological importance since the accumulation of concepts, their nature and the way they are used are unquestionably correlated with a child's level of intellectual development and are, to some extent, indicators of that level. It is therefore not surprising that tests on concepts occupy an honoured place among existing systems of tests, and their diagnostic value has earned widespread recognition.

The *method of definition* is the best known of the various methods for studying children's concepts. It has also found its way into numerous different systems of tests for measuring intellectual aptitude. The following techniques for studying children's concepts are modifications of the method of definition: the experimenter enumerates attributes that are part of the content of a concept and asks the child to name the concept or concepts, or the child must produce a generic concept uniting them all. In both the first and the second case, the inductive method is chosen – from attributes to object, from species to genus. However, the deductive method is also used: a generic concept is given, and the child is required to name the species that are part of it; the child is offered a generic concept and an identifying attribute (*differentia specifica*) and asked to name the corresponding species; he is asked what differences exist among species of the same genus, or between the genus and the species. All these procedures complement the method of definition. Since they make fewer demands on the child, they are used with more success than direct definition in some cases – when, for example, a child has obvious difficulties in verbal expression.

The method of definition has been used not only as a test for measuring intellectual aptitude (Binet, Bobertag and other authors of versions of a metric scale, Gregor,

Roloff, etc.) but also in experimental studies devoted particularly to children's concepts (Pelman, Erg). What place does the method of definition and all techniques similar to it occupy among methods for studying children's concepts? They are, so to speak, indirect methods for studying concepts (Moede).[1]

Indirect methods focus on the store of concepts a child already possesses. The nature of this store is studied. The purpose of the investigation is not the process of genesis of new concepts in the child, but the qualitative characteristics of already existing concepts. But even these qualitative characteristics have by no means been thoroughly studied – perhaps not even their most important aspect. The method of definition cannot tell us how the child uses concepts in solving different life tasks. Indeed, an index of the qualitative characteristics of a concept is, in the particular case, not the child's practical use of this concept in his responses to objects in the world around him, but the verbal description of the content or the scope of the concept. We obtain this description under experimental or test conditions. However, this index is not only incomplete: it is not even clear.

The same definition of a concept may have a fundamentally different meaning for two different children. In the one case, it may be a mechanical reproduction of a formula that has been imprinted, but not worked through. The child simply repeats what he has heard from memory. In another case, the definition may be the result of actual activity and persevering, logical work. This is why the German psychologists speak about *Scheinbegriffe* and *echte Begriffe* (quasi concepts and genuine concepts). Varied advice has been given on how to combat the ambiguity of the results of the method of definition. Thus, it has been said that the questions asked should not presume any special knowledge, for then we shall often find ourselves dealing with rote repetition of what is written in books.

However, everyone knows how difficult it is to avoid this point. A special differential attribute of the active nature of definitional activity has further been pointed out, namely the consternation and confusion of the child after he has received the assignment. However, even if it were possible to find a relevant criterion that would be sufficiently objective and practical, the difficulties would not end there. Further, the results of logical work are communicated through language. The formula for definition consists of a series of words that should stand for the particular concepts. We also know that as a child learns a language, he absorbs a multitude of words, but the content of those words he usually learns in extremely imperfect, rudimentary form. The meaning of a word sometimes remains hidden for him, or at least somewhat indeterminate. All this is, of course, capable merely of intensifying the ambiguity of the experimental results. What does a child put into the words out of which he has fashioned the definition of a concept? This question still remains open. For example, Lindworsky considered it necessary for the experimenter to work individually with each child and to determine by means of special questions how the child understands the words he uses to define the concept. 'Mass tests are of little help', says Lindworsky,

'if the significance and the value of each individual case are not established'.[2] Need we mention that in the mass studies that have been carried out thus far using the method of definition, [Lindworsky's injunction) has, for the most part, not been complied with?

Experimental study of processes of abstraction in children

Thus, the main flaws in the method of definition are that it fails completely to take into account the process of concept generation in children and works only with finished concepts; that even the latter are studied in terms of only one aspect, and not the most

important one at that; and that the studies are carried out under conditions that cast doubt on the unequivocal nature of the results obtained. The reason for these shortcomings lies in the conditions of any experiment using a method of definition.

The stimuli eliciting behaviour from a child in an experiment are words that express corresponding concepts, i.e. they represent definite groups of attributes, common to different objects and abstracted from them. These objects themselves do not serve as stimuli in the experiment. The child's reaction is again limited to 'vocal representation' of the corresponding attributes. But the scope of the generalised response to stimuli in the surrounding world and, especially, the problem of the genesis of this response are at the centre of psychology's interest in the study of concepts, particularly children's concepts.[3] How do conditional responses to discrete situations result in the elaboration of a typical concept-like reaction to several situations similar to one another in terms of one attribute? What factors play a role; what psycho-physiological processes are taking place here? Finally, if a concept-like response by the child has already been elaborated, what are its characteristics in action? These are questions of cardinal importance that are almost never touched upon by the method of definition. Hence, the second group of methods is of much greater interest, i.e. direct methods of investigating concepts and studying directly processes that underlie concept formation.

In the first place, there are experimental methods of studying processes of abstraction in children. Since our report concerns only methods of investigation, we shall omit anything that has to do with the definition of abstractions, with existing theories on this question, etc. In experiments on abstraction, the subject is presented with a set of impressions, either simultaneously or successively. Some elements of this set are repeated. The subject selects from the total number of impressions those elements that are similar, either on instruction or without instructions, and positively abstracts them. The speed and accuracy in following the instructions serve as indicators of the level of development of processes of abstraction in the subject. Experiments that study processes of abstraction fall into two groups depending on what general recurrent impressions must be abstracted positively by the subject. In one case, they may be comparatively independent objects; in the other, independent attributes common to a number of objects, e.g. colour, shape. Examples of studies of this type are those by Koch, Habrich and von Kuenburg, with normal children, and by Heffler with deaf mutes. These four authors have introduced into child psychology a method of investigating abstraction that was first used with adults by Grunbaum.[4] In its general features, the method consists of the following. The child is presented with a group of meaningless figures separated by a line into two groups; either a projection light or a slide projector is used. In the easiest case, each sub-group contains two figures; there are also sub-groups of three, four, five or six figures each. One figure is repeated in both sub-groups; all the others are different. The time of presentation is 3 seconds. The child's task is to find the identical figure in the two sub-groups, point out, on an empty chart, the place that it occupied and then seek it on a control sheet among 20-25 figures. These experiments have shown that the child's capacity for abstraction increases with age, and is correlated with intelligence. Moreover, the more difficult the task, i.e. the larger the number of figures in a group, the greater is the influence of the superiority of gifted children.

Eliasberg, in a study of the psychology and pathology of abstraction, offers serious criticism of the Koch, Habrich and von Kuenburg method.[5] He points out that these experiments require of the children, in addition to processes of abstraction, completion

of a number of operations of a secondary order, e.g. seeking two similar figures, remembering them, recognizing them in a series of many others, locating them in a specific place on a sheet of paper, etc. Successful or unsuccessful accomplishment of these operations has an essential influence on the outcome of the experiment, and so the results obtained are not sufficiently indicative of processes of abstraction. Heffler, on the other hand, proved that, in these experiments, children with a visual type of imagination had a considerable advantage and ultimately did better than more intelligent children who had another kind of imagination. From the standpoint of studying the process of concept formation in children, the most serious shortcoming of this method lies elsewhere. However, this shortcoming is also inherent in other methods of studying abstraction in children. Therefore, let us dwell briefly on them.

An example of experiments in which it is independent attributes of objects, colour, form, etc. that are abstracted instead of comparatively independent objects (e.g. individual figures) are those by Katz.[6] Katz showed pre-school children a simple geometric figure, e.g. a red triangle, and had them select from a group of figures lying on a table exactly the same figure as that in the model. The task could clearly not be accomplished since among the figures on the table there were some that were similar to the model in shape, but were different colours, while others were identical in colour, but different in shape. Katz set up his experiment to see whether pre-school children could abstract positively at all, i.e. to determine a stable positive response to any attribute existing in combination with other attributes. The instructions in Katz's experiments required the child to respond to total similarity. However, this response was impossible under the experimental conditions. What would a child do? Would he act completely at random, or would he display a constant response to one specific attribute? To which one, colour or shape? Thus, the principal characteristic of Katz's method was that the child himself was required to select the criterion of abstraction, if he was capable of abstraction at all. It was found that in most instances the children chose figures of the same colour as the model. For example, if the experimenter displayed a red triangle and there were three red circles and three white triangles on the table, the children would almost invariably choose the red circles. Katz therefore concluded that pre-school children had the capacity to single out a specific attribute common to a number of objects and to react to it (and that colour had a greater impact than shape on children between the ages of two years, nine months, and five years). In experiments in which competing colours were eliminated, the children positively abstracted shape.

Because Katz's experiments aroused some doubts, Tobie tested his method in 1924 in a mass study involving about a thousand children.[7] Tobie established three phases in a child's development. The first phase, up to three years, eight months, is characterized by the fact that an orientation toward colour or shape depends on the saliency (*Aufdringlichkeit*) of one or the other of these attributes in the particular situation, not on general conditions. This he calls the zone of suggestibility (*Zone der Suggestibilität*). Then follows a colour zone (from three years, nine months, to five years old), when the child is orientated toward colour by virtue of constitutional factors. In the last months of this zone, the child makes the transition to an orientation toward shape. At the age of five years, two months, a new zone begins in which orientation toward shape dominates; but later, the capacity to abstract positively in both directions appears.

We may mention one other type of method for studying processes of abstraction in children. This is the method of Eliasberg, who used it mainly in experiments with pre-

school children. The experiments may be described as follows. Sheets of thin cardboard 4 × 10 cm, in diameter and of different colours (green, red, blue and yellow) are prepared. These sheets are bent in an arc, and small paper sticks are attached on the inside half of the sheets of a particular colour. It is impossible to see which of the sheets the sticks are attached to merely by looking at them from the top from the outside; to see this they have to be turned over. Sheets of two colours are used in each experiment. The sheets of one colour have the sticks attached; those of the other colour do not. For example, five yellow sheets with sticks and five blue sheets without them are placed in random order on the table.

The experimenter gives the child two extra sheets, one yellow with a stick, the other blue without it, and asks him to turn both of them over. Then he takes them away from the child and hides them. Now the experimenter points to the sheets lying on the table and says: 'Now look there'. The child begins to play with the sheets, turning them over and rearranging them from place to place, uttering his thoughts and asking questions. Finally, he indicates that he has nothing else to do. If there are some children who from the very beginning do not know what they are to do and show no sign of activeness, the experimenter lets them know that they should put the sheets of paper with the sticks aside. Then the child is taken aside, and during this time, some of the paper sheets or all of them are replaced by others. For example, the blue sheets without the sticks are replaced with sheets of a new colour, also without the sticks. The positive colour remains the same (yellow), and the negative colour (blue) is replaced by a new one. In another case, the positive colour is changed. In still other cases, the positive and negative colours change places; and in a fourth case, one pair of colours is completely replaced by another pair, etc. One of the most interesting modifications is for one or two sheets of a positive colour to be replaced by one or two sheets of the same colour but without sticks. This is a disruptive experiment, as it is called, which violates the law linking two attributes (the colour and the presence of sticks). When one of the above modifications has been made, the child is again taken to the table and given the freedom to play with the sheets, and the experimenter records all of his actions and words as he does so. Then a pause is made again, a new modification made, etc. Thus we see that in Eliasberg's experiments the subject's behaviour has nothing to do with carrying out a specific task. Eliasberg studies natural, spontaneous processes of abstraction in children. The only instruction the child receives from the experimenter or from the entire situation is to seek out the sheets with the sticks. Eliasberg is interested in how fast and in what way the child arrives at an understanding of the connection between the colour of the sheets and the presence or absence of sticks under them. All the modifications made in the material during the experiment serve to develop in the child a purely abstract understanding of this connection, namely, 'that of two colours, only one has the given attribute (stick)'.

Eliasberg points out that, in all preceding studies of abstraction in children, abstraction proved to be too closely related to and limited by the sensory nature of the material. Abstraction did not go beyond the limits of the concrete. In the final analysis, Koch, Habrich, von Kuenburg and Katz required of the child that he perceive relations of similarity among concrete attributes of objects undifferentiated in terms of sensory context. Eliasberg's studies for the first time posed the question of whether processes of abstraction that lead to the development of common generalised reactions not only to known, mutually similar sensory stimuli but also to a wholly formal relation among any stimuli, regardless of their sensory nature, take place in the natural behaviour of pre-school children.

We have examined the basic methods for studying processes of abstraction in children. Anyone who approaches these methods from the standpoint of the problem of concept formation cannot help but notice one property common to them all: that processes of abstraction are studied in experimental situations that are essentially alien to the natural conditions in which these same processes lead to concept formation. In [natural] concept formation, abstraction is directed and guided by words. The products of abstraction therefore enter into a close relation with language, and a concept is born: the meaning of a word. But the procedures of Koch, Habrich, von Kuenburg, Katz and Eliasberg differ in that processes of abstraction are studied in a situation that precludes taking into account the functional role of words, the most important factor in concept formation. Actually, in all these experiments, the role of words, as a factor that organises and guides the processes of abstraction, is reduced to a minimum. In Eliasberg's method, words do not even determine the ultimate objective toward which the child should strive, for in general there are no such objectives in these experiments. One of Katz's principal conclusions is that, regardless of whether the child is given the task of finding figures exactly like the models, or vice versa, i.e. completely different figures, he will behave in exactly the same way and choose figures similar in colour. Thus, because of the as yet insufficient development in the child of an understanding of speech, the instructions, so to speak, only set the process in motion, without determining either its direction or its individual stages. The child's behaviour is stimulated exclusively by a series of stimulus objects. Verbal stimuli are either completely absent or at least have no direct influence on the child's relations to the objective stimuli. In the experiments of Koch, Habrich and von Kuenburg, the direction of abstraction is determined by the instructions, namely to seek similar figures; but it is determined precisely as in any experiment in which the subject is set some task by means of instructions. Through words, the subject receives the actual task of abstracting from a given set of similar elements; but as soon as he begins to carry out this task, his actions are determined exclusively by the objective world with which he is dealing. Divergences from this logic serve as indicators of the defectiveness and unsuccessfulness of the psychological operations. Words do not guide the psychological operations; hence, the obtained product does not form a concept. We do not even mention the fact that Grünbaum's method, which these three authors used, is based on the abstraction of comparatively independent elements of a set, not interdependent attributes common to a number of objects. This also deprives it of any value for the study of processes of concept formation, since concepts also include interdependent attributes.

Thus, whereas the method of definition goes no farther than the words that participate in the process of concept formation, the method of investigating abstraction is limited exclusively to objects on the basis of which a concept is formed, without taking into account that a concept arises only if the child's psychological operations directed toward the objects are guided by words, i.e. if the child uses words as a means to guide the process of abstraction in one direction or another. 'Words without sensory material, or sensory material without words': that, in a nutshell, is the contrast between the method of definition and the method of studying abstractions.

It is all the more interesting that all the above-enumerated studies of processes of abstraction in children ran up against the fact that the level of development of processes of abstraction and the role of speech in the child's behaviour depend on the extent of his verbal resources. Data on the pace of development of processes of abstraction in relation to age for normal and deaf mute children are interesting in this

respect (Habrich, Heffler). In normal children the process is especially intensive during the first half of the school period, and considerably slower in the second half.

For deaf mutes, the contrary is the case: at first deaf mutes lag considerably behind normal children, but then they catch up considerably. According to Lindner's data, the backwardness of young deaf mutes in processes of abstraction is combined with a clear superiority over normal children in terms of recognising people; and, with regard to remembering meaningless figures, they barely lag behind normal children at all. The same is true of their memory of *Schriftbilder*.[8] On the other hand, in every case in which the processing of data of sense experience, singling out what is essential, perceiving and utilising relations, or abstracting is the task rather than simple remembering, the deaf mute child is quite a bit behind his normal peer. This seems clearly to be a question of retarded development of the corresponding functions because of deafness and lack of speech, as evidenced by the fact that by the third to fourth year of schooling, when deaf mute children learn to speak, their capacity for abstraction begins to increase sharply, and the gap between them and normal children narrows considerably. As Heffler says, an intellectual revolution takes place in a deaf child who at this time learns speech in a school for deaf mutes; this revolution is similar to what takes place in three-to-six-year-old children who can hear. In both cases, the discovery of the significance of language and of its function of naming is the source of a fundamental change in the child's behaviour. Spontaneous questions about the names of objects and about the purposes and the causes of things and processes are proof that, at this point, the young child who can hear and the deaf mute schoolchild begins to carry out differentiations and ordering in the infinite diversity surrounding them; they begin to recognise relations and systems of relations, and thus grow into the world of concepts of the adult human being. Interesting data about the role of language in the process of abstracting are provided by Descoeudres and Beckmann.[9] These authors observed that normal children between the ages of six and eight found it much easier to imagine a corresponding number of objects on the basis of a numeral given to them than to name the number of objects presented to them. This means that the speech abstraction of a symbol, used repeatedly and in many ways, furthers the process of abstraction from infinite sets of objects of counting to the concept of number. Language propels our thought along the path of abstraction, says Lindner. We encounter similar findings in Eliasberg. In his study, discussed above, Eliasberg demonstrated different results depending on which of three types the subject belonged to. The first group consisted of children with good general development and speech development. The second group was composed of children of normal development who were a bit retarded in speech. The third group of children consisted of those who were poorly and weakly developed in general and very retarded in speech. It was found that children of the second group, those who had developed normally, but were retarded in speech, had more difficulty than children of the first group in abstracting from sensory experience, and were more bound to concrete sensory situations.

Thus, the educationally stimulating role of words in processes of abstraction is beyond a doubt. Study of processes of abstraction as they take place under the direct guidance of words is therefore all the more interesting. The above analysed experimental methods, however, do not allow us to study them.

Methods of experimental study of the process of concept formation in children

We have outlined in general contours the immediate environment in which the method of double stimulation was born and was gradually developed for use in studying

children's concepts. A brief schematic history of it reduces roughly to the following. We have found the sources of it in old experimental psychology. In 1912, a study by the English subjectivist psychologist Aveling was published entitled *On the Consciousness of the Universal and the Individual.* The author himself called his work a 'contribution to the phenomenology of the thought processes'. And in fact, its purpose was to study, from a phenomenological perspective, processes of thought.

'What is discoverable in our consciousness when we think about the general or the individual, when we think "man"? Is it "this man" of "all men"?' asks the author.[10] The question was similarly posed in empirical psychology long before Aveling. One of the first was Ribot with his 'Inquiry into general ideas'.[11] Just before Aveling, psychologists of the Würzburg school, using the method of self-observation, attempted to give a phenomenological characterisation of the processes of thought and, in particular, the processes of subjective experiencing of the meaning of words, judgements, inferences, etc. But Aveling made a substantial change in the experimental method. He proposed studying the subjective experience of concepts associated not with words of one's native language, but with artificial words created experimentally. Aveling showed his subjects a series of pictures. Each series contained five pictures portraying some objects that were similar to one another, e.g. five different fruits, five different flowers, five different musical instruments, five birds of different species, etc. A meaningless word was under each picture, the same for all pictures in each series. For example, all flowers had the inscription 'Kumic'; all birds, 'Tuben'; and all fruits, 'Digep'. Over a period of several days, the subjects learned by heart the meaning of the nonsense words and created associations between these words and the pictures corresponding to them. This was done as follows. The subjects were presented, in random order, with pictures from the different series. They had to read aloud the meaningless words and look at the corresponding picture attentively for 10-15 seconds. In the second half of each session, after a ten-minute pause, the experimenter would name the nonsense words the subjects had been studying and begin the rehearsal session. The subject had to listen attentively and answer with the word 'yes' as soon as the meaning of the experimental word he heard arose in his consciousness. Then the subject would give a detailed description of his experiences based on self-observation. After 20 sessions, after the associations between the nonsense words and the corresponding objects were more or less firmly entrenched, Aveling carried out some test involving the 'Completion of Part judgements'.

Aveling would say some incomplete sentences in which the experimental words were the subjects and the subject had to give a suitable adjective. The experimental words had now an individual and then a general meaning. For example, the experimenter would begin as follows: 'All Digep are …', and the subject would have to finish the sentence. Or 'No Kumic is …', 'The first Sorab is …'. After completing the sentence, the subjects would communicate what they had observed in self-observation. What was unique about Aveling's procedure? The old studies of the problem of the subjective experience of the meaning of words by psychologists of the empirical school used the same method. The experimenter would present the subject with a stimulus word, and the subject had to respond to it with some other word, or not respond to it at all, and then, at a given signal, describe experiences elicited by the stimulus word. Aveling remained wholly on the foundation of self-observation.

What made him decide not to use native language words as stimuli? Solely interests of self-observation. He hoped in this way to avoid the difficulties self-observation constantly encountered. These were difficulties in distinguishing the subjective

experiences of the meaning of a word from the subjective experiences associated with the perception of the word itself as an auditory or visual stimulus. We are unable to hear any word of our native language without its meaning surging up into our beads, so closely are they related. Aveling wanted in some way to slow this process of transition from the subjective experience of the verbal form to experience of the meaning of the word, and so introduced new words that were not so tightly fused with the corresponding concepts. Hence, it is quite clear that Aveling did not study the process of concept formation, but only processes of the subjective experience of what had already been completed, of the concepts the subjects already possessed, e.g. the concepts of fruit, musical instruments, etc.

But the inclusion in the experiment, together with pictures of the objects, of words related to these objects and the use of special experimental words – this was the part of Aveling's procedure that had a future in the study of processes of concept formation – of course, with rejection of Aveling's purely phenomenological, subjective position. A study by Ach, the founder of the school of 'Determinations-psychologie', marked a decisive advance. His study was published in the book *Über die Begriffsbildung,* which came out in 1921.[12] Ach conducted experiments not only with adults but also with children. His method of studying concepts, the socalled search method [*Suchmethode*], was based on the following theoretical postulates, the formulation of which was doubtless one of Ach's merits.

1. One cannot be limited to the study of ready made concepts; the process of formation of new concepts is important.

2. The method of experimental investigation should be genetic-synthetic; during the course of the experiment, the subject must gradually arrive at the construction of a new concept – hence the need to create experimental concepts with an artificial grouping of attributes that belong to them.

3. It is necessary to study the process by which words acquire significance, the process of transformation of a word into a symbol and a representation of an object or of a group of similar objects – hence the necessity of using artificial experimental words that are initially nonsense to the subject, but acquire meaning for him during the course of the experiment.

4. Concepts cannot be regarded as closed, self-sufficient structures, and they cannot be abstracted from the function they serve in the sequence of mental processes. The processes of the objective conditions, i.e. a set of objects possessing common properties, is not sufficient for concept formation. A human being cannot be visualised as a passive photographic plate on which images of objects fall, reinforcing one another in their similar parts and forming a concept, like Galton's collective photograph. Concept formation also has subjective preconditions and requires the presence of a definite (psychological) need, which it is the function of the concept to satisfy. In thought and action, the development of a concept plays the role of an instrument for achieving certain ends. This functional aspect must be taken into account in an investigatory procedure; a concept must be studied in its functional context. We must pursue the path taken by Koehler, who in his study of the intelligence of anthropoids would put them in situations that could be resolved only by using certain tools, so that the functional use of those tools became an indicator of the level of the animal's intellectual behaviour.[13] Similarly, in an experiment, the subject must be confronted with tasks that can be accomplished only if the subject develops certain concepts. The development of those concepts will require the use of a series of nonsense verbal signs

to solve the problem, and as a result those signs will acquire a specific sense for the subject.

These are the main postulates on which Ach based his search method.[14] Let us now go on to a concrete description of the procedure as it was used with children.

The experimental material was a collection of geometric figures made of cardboard, 48 in all: 12 red, 12 blue, 12 yellow and 12 green. The 12 figures of each colour were separated by size, weight and shape. Six figures of each colour were large, and six were small. The six large items were divided by shape into two cubes, two pyramids and two cylinders, the pairs being outwardly identical. One cube, pyramid and cylinder were filled, and were heavy, whereas its partner was light. The same division was made for the six small units of each colour: two cubes, two pyramids and two cylinders, one of each shape being heavy and the other light. The units of each colour thus consisted of three large heavy and three large light items and three small heavy and three small light items.

We see that the collection of figures was strictly symmetrical. The experiments were carried out in three phases. The first was a practice period (*eine Übungsperiode*); the second, a period of search (*Suchperiode*); and the third, a period of testing (*Prüfungsperiode*). Each session began with a period of teaching/learning and practising. The figures were arranged in front of the child. Pieces of paper were attached to them on which experimental words were written. To all the large heavy figures, labels with the word 'Gazun' were attached; the large light objects bore labels with the word 'Ras'; the small heavy objects, the word 'taro'; and the small light ones, the word 'fal'. At first the subject had to deal with only a small number of figures. Then, in each new session, the number of figures increased until it reached 48. On the first day of the experiments, the children began with only six large blue figures. They were arranged in a *standard order*. The heavy figures with the label 'Gazun' were placed closest to the subject in a first row. To the left was a cube, followed by a pyramid and, finally, a cylinder. The light figures with the inscription 'Ras' were added in a second row. These were arranged in the same order so that the light cube stood behind the heavy cube, etc. The figures in the second row appeared no different to the eye than the figures standing in front of them. To determine the differences, they had to be picked up. The experimenter gave the child the instruction to lift a figure slightly and to say aloud what was written on it. Initially he lifted the large heavy cube to the side of the subject, and then the light cube behind it, then the heavy pyramid, followed by the light pyramid, etc. This procedure was usually repeated three times. Then the child was turned around while the pairs of figures were rearranged: a heavy figure of any shape, together with its inscription, was shifted to the second row in the place of the light object, and the latter was placed in the first row where the heavy one had stood. As a result, the 'normal order' (*normale Ordnung*) was replaced by an 'exchanged order' (*vertauschte Ordnung*). The child again lifted the figures in the same sequence and read what was written on them.

After three rehearsals, the figures were again rearranged. Now they were without any spatial pattern, in complete disorder (the so-called *bunte Ordnung*). Three new exercises were performed, then there was a four minute pause, during which the experimenter removed the inscriptions from the figures, hid them and shifted the figures into a new order without any pattern at all, as before. The practice period, which consisted of a normal, an exchanged and a random order, ended, and a search period (*Suchperiode*) began. The child received the instructions: 'Find and put to the side all figures on which a piece of paper with the word "Gazun" was once written. You should

pick them up'. When this task was completed, in whatever way, the child was asked why he thought that 'Gazun' had been written on the figures put aside. The time elapsed in completing the assignment, the order of placement of the figures and the explanation given by the child were recorded. If the task was performed incorrectly, the experimenter would say, 'You were wrong', without indicating what the mistake was.

The first task was followed by a second, third and fourth. The child had to tell what remained and what was written on the figures that remained. If he worked incorrectly or hesitantly, the practice period was repeated, after a five minute pause, with the same figures, and the child had to solve the same problems.

The child then moved on to practice and perform the tasks with the six small figures, 'taro' and 'fal'. Everything was done in the same order. At the end of this session, or in the next session on the following day, 12 blue figures arranged in normal order were immediately presented to the subject, the large ones to the left, and the small ones to the right. After three practice sessions, the figures were rearranged in altered order, and then in random order. In the search period the child had to perform not two, but four tasks, namely: to select figures on which the words 'Gazun', 'taro' and 'Ras' had been written and to say what remained. In the following sessions, the subject was presented with 24, 36 and 48 figures immediately after preliminary practice and had to perform the same tasks. The solution of each task required setting out six figures rather than three when there were figures of two colours, and their total number was 24, nine figures when there were figures of three colours, and 12 when figures of four colours were presented. In fact, when there were 48 figures on the table, there were 12 large, heavy 'Gazuns', three blue, three red, three green and three yellow.

After five to seven sessions, a normal child in most cases will have fully mastered the tasks required of him, will abstract from the colour, form and shape of the figures, and will begin to justify his choice of the same two attributes of the figures that were part of the concepts, namely heaviness and colour. The time spent in performing the task becomes considerably shorter, and in selecting the necessary figure the child ceases to act at random and does not make superfluous movements. To some degree or another, he begins to follow a certain order, based on, for example, the principle of colour or shape, etc., and seeks what is useful to him, first among figures of the same colour, then among figures of another colour, etc.; or else he begins with cubes, then selects from the pyramids and finally from among the cylinders. Counting is used to check on the thoroughness of completion of the task (whether everything has been selected). After becoming acquainted with the structure of the collection, the child is now able to solve the tasks by reasoning. Thus, for example, if the big light figures are 'Ras' and have already been selected, then when the child receives the task of selecting 'Gazun' figures, he may put aside all the remaining large figures without weighing them, since in the collection there are only two kinds of large figures, and if 'Ras' has already been selected, only 'Gazun' remain. Of course, not all children are equally able to develop such helping techniques for work with concepts. There are different levels of intelligence, and a broad range of age as well. Finally, the experiment enters its last phase, the testing phase. This period is necessary to establish whether the previous nonsense words 'Gazun', 'Ras', 'taro' and 'fal' have acquired some meaning for the child because of their functional utilization (*Prüfungsperiode*). The experimenter asks a number of questions: 'How do "Gazun" differ from "Ras"?' 'Are "Gazun" bigger than "taro"?' 'Are "taro" heavier or lighter than "fal"?'. 'What is "Ras"? ' 'What is "taro"?' etc. The child answers the questions without looking at the figures, and his answers and the time required to answer are recorded. Then a Maselonovsky sentence formation

experiment begins. For example, a child is asked to compile a sentence in which the words ‘Ras’ and ‘Gazun’ appear. This ends the experiments.

Thus we see that during the testing period, Ach used a method of definition and techniques similar to it with regard to newly formed concepts. This requires either the definition of new concepts or indications of differences between them. If we now examine carefully the overall course of the experiments from beginning to end, it is not difficult to see that the experiments pass through two stages in terms of the number of attributes that must be positively abstracted and associated with the experimental words. The first stage (*Stufe der Grundeigenschaft*) involves work with only six blue figures – first, with large ones, and then with small ones. At this stage the experimental word induces the subject to make a positive abstraction of only one attribute, weight. To be able to select ‘Gazun’ or ‘Ras’ figures from among the large figures the child must know that ‘Gazun’ is written on the heavy figures. To resolve the same tasks with the small figures, the child must again take into account only the fact that ‘taro’ is written on the labels on the heavy objects and ‘fal’, on the light ones. When the child has 12 figures directly before him, the experiments enter the second stage, the stage of primary differentiation. The combination of two pairs of signs, ‘Gazun’ and ‘Ras’, and ‘taro’ and ‘fal’ in one verbal series impels the subject to make a positive abstraction of one more attribute, size. For completion of the task, the subject now has to associate two attributes, weight and size, with each experimental word: ‘Gazun’ are large and heavy, ‘taro’ are small and heavy, etc. This becomes the final content of the experimental concepts. However, after the first series of experiments was ended, Ach usually did a second series using the same procedure, as a continuation of the first. The only difference from the first was that the concept included one more attribute, colour, and later, also a fourth attribute, shape. In place of the four concepts ‘Gazun’, ‘Ras’, ‘taro’ and ‘fal’, there were now 16: ‘bu-Gazun’ (large heavy blue), ‘ge-Gazun’ (large heavy yellow), ‘ro-Gazun’ (large heavy red) and ‘nu-Gazun’ (large heavy green); then ‘bu-Ras’ (large light blue), ‘ge-Ras’ (large light yellow), etc. Following the same principle, instead of just ‘taro’, we now have ‘bu-taro’, ‘ge-taro’, ‘ro-taro’ and ‘nu-taro’; and in place of ‘fal’, we have ‘bu-fal’, ‘ge-fal’, ‘ro-fal’ and ‘nu-fal’. Retaining the same series of objects, but enriching and differentiating the series of signs, Ach observed a new aspect of the abstraction process as well as new concepts.

Ach calls this stage of the experiment the stage of secondary differentiation. Primary differentiation took place in the first series, when the attribute of size was added to the attribute of weight. The experiments were completed with a third stage of differentiation when each of the 16 concepts elaborated in the preceding stage was differentiated into three new concepts with respect to the attribute of shape. The experimental words were now no longer ‘bu-Gazun’, ‘ro-Gazun’, etc., but ‘bu-Gazun-I’ (which means large heavy blue cube), ‘bu-Gazun-II’ (large heavy blue pyramid), ‘bu-Gazun-III’ (large heavy blue cylinder), ‘ro-Gazun-I’, ‘ro-Gazun-II’, ‘ro-Gazun-II’, etc. Each concept now contained the attribute of size, weight, colour and shape; and since in Ach’s collection of figures there were no two figures with the same combination of these four attributes, the product of the third stage of differentiation was 48 individual concepts. The content of a concept increased from stage to stage, but the scope diminished steadily, until it reached unity.

Such was Ach’s procedure. Ach [1921, p. 33] described it briefly as follows:

The subject receives assignments he cannot complete without the help of some initially meaningless signs ... These tasks can be correctly performed only on the basis of attentive prior observation of the words and of attributes (written on the labels) of

objects assigned to these words ... The signs (words) are means by which the subject can achieve a specific end, namely, to solve the problems posed by the experimenter; and because they are given such use, they acquire an unequivocal meaning. They begin to be vehicles of concepts for the subject. The subject can use these signs, now full of meaning, to make statements about the state of things, and these statements will be understood by the experimenter.

Perhaps it should be stressed, in connection with this description, that the analogy that naturally suggests itself between Ach's experimental words and Ebbinghaus's nonsense words for the study of memory is correct in only one respect: in both cases the reason for using the nonsense syllables or words was the desire to achieve unequivocal results in experiments and to work with material that would be independent of the subject's past individual experience. However, everything else appears totally different. The nonsense syllables for studying memory continued to remain lifeless, meaningless syllables during the course of the experiments. But in Ach's experiments (owing to the influence Köhlers experiments had on his method), the meaninglessness of the words plays the role of something that must be eliminated; the entire design of the experiment, and all the efforts of the subject, are directed against it, and the process of the experiment is at the same time one of transforming a meaningless sign into a meaningful word.

Ach set up his experiments almost exclusively for adults. To test the applicability of his *Suchmethode* to children, he also included four children aged five, six, seven and eight. The five-year-old and six-year-old were unable to read, and so they would pick up their figures and repeat the corresponding words after the experimenter. The procedure was found to be fully applicable to children. They formed concepts only after considerably more exercises and searches compared with adults. But whereas the seven-year-old and eight-year-old not only finally learned correctly to choose figures but also began to present two essential attributes forming a concept to justify their choice, the younger children did not yet have the ability to provide an adequate justification for what they did. They continued even in the stage of primary differentiation to give explanations suitable only for the first stage (*Stufe der Grundeigenschaft*), i.e. they would point out a specific attribute of the figures, e.g. weight.

The systematic nature of the actions and the use of inferences and conclusions were at a much lower level in the children than in the adults, as was to be expected. Ach observed considerable qualitative differences among his four subjects in this respect; in addition to a total absence of a definite form of behaviour, the children were unable to carry it out to completion, or to use it rationally.

Ach's method was later put to a much broader use by Rimat and Bacher with, however, certain modifications.[16] Rimat used Ach's method to study intelligence. It was his view that intelligence could not be reduced to purely passive discernment (*Einsicht*) of objective relations in the surrounding world; a factor of no less importance for characterising intelligence was the voluntary factor, i.e. the strength of determining tendencies. This factor is important first and foremost because it will serve different ends for the person. The character and level of intelligence are expressed most distinctly in the process of creating and using the different means necessary to solve problems and achieve life objectives. For example, in tests and experiments we encounter such problems as drawing a conclusion from two premises. But life perhaps never confronts us with premises in such an open and pristine form, nor requires us to draw conclusions from them. It usually presents us with veiled, masked problems; and

it is our task to create and use this or that means to resolve them. Hence, even in intelligence tests, a child should not be directly required to accomplish specific psychological operations: he must be given tasks to which such psychological operations serve as a means of access. The problem is then to determine whether the child is able to carry out these psychological operations and use them as means for solving problems. According to Rimat it is wrong, and moreover essentially futile, to attempt to study specific functions in isolation and to combine the results of discrete analytic tests in order to obtain a general picture of the subject's intelligence. Such mosaics leave out of account the unity: '*die Einheit der Leistung'*. When we are required to accomplish something in some life situation, we always not only activate some isolated mental function but use every way and means suitable to achieve our end, and the failure of one function may be compensated for by increased utilization of other functions.

Since, according to Rimat, intelligence is primarily a capacity to use one's own intellectual processes as means to achieve different goals, the symptomatic value of a test for rating intelligence will be greater the richer and more diversified the psychological operations that must be called upon for doing the test. It is just this property that distinguishes Ach's search method. What is more, in most existing intelligence tests, it is impossible to eliminate the role of knowledge acquired in school and the influence of the environment. Often test performance depends on reproduction, not on new creations. Thus, for example, tests of concept definition depend largely on school knowledge, not on intelligence. A precondition for the usability of tests of concept definition, as well as of intelligence tests, is that all the children must have had the same experience, which happens very rarely. Differences in the performance of many tests depend also on differences in the degree of mastery of a language. According to Rimat, Ach's method has none of these flaws when it is used as a test: the child is given a task, and he is forced to employ a range of means and techniques to accomplish it. The final result will then depend largely on the extent to which the child's behaviour is determined by the task, whether it links together the child's actions into a single integral process. Ach's method enables us to determine whether a child is capable of using his own psychological operations of abstraction, concept formation, judgement and inference to solve a problem, linking all these operations together in a single sequence directed toward the contemplated end. Differences in school knowledge and in the richness of children's experience cannot reflect on the solution of the task because the only aspect of experience relevant to solving Ach's test is that created during the experiments themselves.

Then, as Ach himself pointed out, we are able in such a case to meet the requirement of parallel tests set by Karstadt [17] for it permits the most varied modifications of the test in terms of selecting objects, varying the test words, varying the relations between the objects and the series of words (by new combinations of the attributes making up the experimental concepts, e.g. substituting shape + size for size + weight, colour + weight for shape + weight, etc.). It also permits broad possibilities for introducing different gradations of difficulty into the tasks. For example, the number of attributes making up the concepts can be increased, or the normal and modified order can be eliminated from the training period so that the practice sessions use exclusively figures arranged in random order. This, of course, makes the work considerably more difficult since the subject is no longer able to obtain help from complex perception, which facilitates concept formation.

Finally, there is one more advantage in using the *Suchmethode* as a test: we obtain an indication of not only theoretical but also practical intelligence. In the search periods

(*Suchperiode*), problem solving requires a certain practical activity, which may take place in the most varied ways. On the other hand, the processes of abstraction and concept formation that underlie this practical activity, and then the children's justification for their actions, their answers to questions about what remained and to questions during the testing period (*Prüfungsperiode*), characterise theoretical intelligence.

In the light of these considerations, Rimat did some investigatory work necessary for transforming the search method into a system of tests. He created a number of intermediate experimental set-ups in which he varied in the most diverse ways both the nature of the problems and the conditions of their presentation and tested the practical value of each variant. After finding that for children between the ages of 10 and 11 experiments done with a straightforward Ach-procedure were too easy and provided no means of distinguishing the more intelligent children from among those of average intelligence, Rimat made the problem solving more difficult: the tests began immediately with 12 figures instead of six, and training was done in hodgepodge order; the normal and the altered order were totally discarded. Then, to obtain a uniform assessment and grading of the solution of all the tests, Rimat introduced some substantial changes in the search period. For example, the experimenter gave the child the problem of pulling out figures with the inscription 'Gazun'. The child would do so. However, before assigning the next task, the experimenter returned the withdrawn figures so that in his new searches the child had to work with the same number of figures as before.

Then, to facilitate the processing of results, the experimenter evaluated not the solutions of the entire task, as Ach did, but the withdrawal of each individual figure: if the subject mistakenly withdrew some figure, the experimenter immediately called attention to the mistake. This enabled Rimat to distinguish five groups on the basis of their task performance: the first group-tasks accomplished by the subjects correctly without any help; second group – slight help (e.g. at first, not all the figures were set out, it was necessary to remember, etc.); the third group – the task was performed with one mistake; fourth group – the task was performed with several mistakes; and the fifth group – unsuccessful accomplishment of the task. By substituting the numbers of these groups in place of the tasks, Rimat obtained a numerical series characterising the process of variation in the performance level of problem solving, beginning with the first and ending with the last.

As for the reasons the children gave for their actions, Rimat only ascertained in which task a child would begin to include the two attributes that characterised the content of the experimental concepts in his reasons explaining his action, i.e. at what point it was possible to say with absolute certainty that concept formation had set in. A comparison of these data with data on problem solving is interesting from the standpoint of the relationships between theoretical and practical intelligence. Rimat arranged the children in a rank order on the basis of the average number of mistakes made on a task, i.e. on the basis of the relation of the total number of erroneously withdrawn figures to the total number of tasks. Rimat totally discarded the testing period in view of the difficulties of describing it quantitatively.

On the other hand, preliminary exercises were introduced before the beginning of the experiments with each child, since it was found that the comparability of the test results was endangered because of the influence of differences in the speed at which the children became accustomed to the experiment, and also because of differences in the children's disposition at the beginning of the experiments, when they would pick up

the figures and read what was written on them without understanding why this was done. This risk was eliminated if, before the beginning of the experiments, the child went through a series of preliminary trials, i.e. a number of practice exercises and problem solving sessions with the same figures, but with other experimental words and other concepts.

If, for example, a child had the words 'vushir', 'gak', 'zubi' and 'dipu' in the main experiments and attributes of shape and colour were included in the content of the concepts that they designated, in the preliminary exercises the child would meet 'Gazun', 'Ras', 'taro' and 'fal' and also another combination of attributes making up the content of the concepts, i.e. weight and size. In special experiments Rimat also showed that preliminary trials made it possible to compare results obtained from children who were being acquainted with the search method for the first time and children who had worked with it earlier.

It was found that during the preliminary experiments, children familiar with the search method had better results than beginners; but in the main experiments, this advantage disappeared and the principal factor determining test performance was the child's intelligence.

By placing his subjects in a rank order on the basis of the average number of mistakes made on a problem, Rimat obtained a high correlation with school ratings of the children's intelligence.

Because Rimat's individual test requires three days of work (one and a half hours each day) with each child, it is very difficult to use it to study patient groups. Hence, Rimat also devised a weighted test. In a mass test, Rimat had to discard the search period, which he replaced with a testing period that in the individual test played no role at all. The test was done as follows: the children were seated in a specific way, and individual figures were given to them with notes attached. Each child would read the inscription to himself, look attentively at the figure and then pass it on to his neighbour, and would himself receive a new figure from his other neighbour. The figures were presented in random order. After a series of repetitions, the number of which depended on the child's age and the nature of the problem, the learning period ended and the check began. Each child received a sheet of paper and wrote on it his answers to questions written on the blackboard: 'How do you recognise all the figures on which the word "Gazun" or "Ras" is written?' etc. Then more exercises followed; the errors made by the subjects in answering the questions, their lack of confidence and even their inability to answer the questions led, in the new exercises, to a fundamental reorganisation of attention, which was now directed toward the connection between the words and the objects. Thus, the role of the search period, which was completely left out, was taken over by the questions in the testing period. Throughout the test, which lasted three days (an hour every day), six groups of concepts with four concepts in each group were developed. The first preliminary experiments and the two groups of concepts formed on that day (heaviness + size, size + shape) were not taken into account in the evaluation and in determining the children's rank position. The subjects' responses to the questions divided them into five groups. The first group contained children with completely correct answers; they were given a score of four; the third group gave answers in which only one correct attribute in the composition of the concept was indicated, and scored two. The fifth group gave completely wrong answers or no answers: score zero. The rank position of the subject was established by adding together all the points of each subject.

In doing his mass test with several groups of school children between the ages of 11 and 14, Rimat found that the lower limit of applicability of the test was about age 12. After the age of 12 years, a considerable advance is noted in children's capacity for independent formation of new concepts. But concept formation and thought freed of sensory ingredients make demands that, as a rule, exceed the capacity of children under the age of 12. This was Rimat's basic conclusion.

The functional method of double stimulation and study of concept formation in children

Now let us characterise the last stage in the development of the procedure for the experimental study of concept formation in children, the stage in which the method of double stimulation acquired a new use under the influence of Vygotsky's idea of the development of higher forms of behaviour. Aveling, a psychologist of the era when the Würzburg school was in the ascendancy, used double stimulation not as a method for creating the principal conditions of the process of concept formation in order to analyse that process, but as a technical means for phenomenological description of the inner experience of the meaning of fully formed concepts. For psychologists of the school of *Determinationspsychologie*, i.e. Ach, Bacher[18] and Rimat, double stimulation plays the role of an environment outside of which it is impossible to study the process of concept formation. But it must be said that the problem of double stimulation, the problem of forms of behaviour and thought with regard to which external stimuli fall into two series, each with a different functional significance, is a problem the proponents of *Determinationspsychologie* had not yet posed. Ach understood that for concept formation it was necessary to have a number of objects under whose influence concepts could form, and a number of words requisite for their formation; but his attention was not centred on the question of the specific role of each of these nor, in particular, on the question of the fundamental role of the verbal series. In accordance with the basic idea of *Determinationspsychologie*, Ach thought it important to show that, in processes of concept formation and in other thought processes, we are dealing with phenomena that are not so much regulated by the laws of association and reproduction of ideas as by 'determining tendencies'. As Ach himself pointed out, the essential feature of this concept is 'regulation of mental processes in accordance with the meaning (sense) of goal conception (*Zielvorstellung*)'.

These special influences, which are directed toward the *Bezugvorstellung* and derive from goal conception, determine the course of mental processes in accordance with the image of the goal; Ach therefore called them 'determining tendencies deriving from goal perception'. A number of specific characteristics of Ach's procedure for studying concepts are derived from this theoretical proposition (which we cannot undertake to criticize here). The principal task is to show that the presence of a series of objects and words and the mechanical accumulations of associations between them is insufficient for the formation of a concept. The preconditions for concept formation are present only when the subject has a goal conception, a task. Under the influence of a task and the determining tendencies deriving from it, mental processes undergo an abrupt change.

A re-ordering of the entire plane of consciousness takes place: what had earlier been in the forefront now recedes into the background, and vice versa. Attention, which has previously been centred on the correctness of the arrangement of objects, is now directed toward the connection between signs and objects: some sets are replaced by others, and signs begin to be used as means of orientation in the series of objects. A specific order of completely repetitive psychological operations, the operations of

setting out the objects, etc., occurs. But all these processes are linked together in a single organic whole directed toward solving the problem.

It is only if the task is able to consolidate itself in the subject with sufficient force, if the determining influences coming from it are sufficiently powerful to steer psychological operations in a new direction and to use their, as means for accomplishing the task, that concept formation is possible. An idea of the level of a child's intelligence may be gathered from how the process of concept formation takes place. This points up a number of distinctive characteristics of Ach's method. The experiments begin with a mechanical association of individual objects with individual signs. The subject does not know why he is doing this, he does not have a 'task'. The grouping of the figures, by virtue of its symmetry, diverts his attention from the conditional connections forming between the objects and the verbal signs, leading to the formation of new connections, namely, connections among the objects themselves. As a result, the mechanism of association (even when the first exercise period is deliberately prolonged to several dozen repetitions) becomes impotent: a concept is not formed. Though having received a task, the subject is unable to resolve it. However, now a decisive turning point occurs: a task and a goal conception have appeared; all processes are gradually re-ordered, the mechanism of association acquires a new use and, after one or several attempts, the task of selecting a group of figures is resolved on the basis of a concept formed with the aid of words. That is the substance of Ach's method.

We approached the process of concept formation from another angle; hence, a criticism and an objective psychological interpretation of Ach's results are totally superfluous here. We were interested not in the determining role of the task, but in the special functional significance of the verbal signs that, in the particular case, organize the subject's reactions that are directed toward objective stimuli, the material. In our laboratory we term verbal stimuli that play this role 'instrumental' stimuli, to refer to their use in the subject's behaviour. On the request of the laboratory, I made an attempt to develop a new method in which principal attention would be directed toward the role of words in concept formation in children. In the summer and autumn of 1927, I conducted an experimental study using Ach's procedure and involving ten normal children and five mentally retarded children between the ages of six and 17. I shall focus here only on the procedural aspect and the results of this study. We found that the distinctive features that were justified under Ach's conditions were in our case not only superfluous but also directly harmful. The main flaw in the procedure was that the psychological operations in which we were interested were not sufficiently brought to the surface in the child, they were not outwardly manifested. During the practice period, the child's behaviour seemed outwardly to be confined to the framework of a stereotyped operation, namely picking up the figures in a specific order and reading the inscriptions on them. This outward, monotonous behaviour concealed the active internal processes of the subjects' responses to double stimulation. Although the internal processes were in a state of continuous development during the exercise period for the five to ten days of the experiments, this was in no way outwardly expressed.

Hence, Ach's description of the stages traversed by the process of concept formation is based mainly on self-observation of his adult subjects, which of course is totally inapplicable to an objective psychological procedure. The period in which the subject undergoes double stimulation is the exercise period.

While this was going on, it was very important to bring out the subject's free reaction in order to assess the role verbal and object stimuli play in its genesis. Ach's procedure

imposes upon the subject (in the interests of solving the problem: association and the determining tendency) a specific, stereotyped reaction, whose symptomatic value is equal to zero. The dynamics of development of an experimental concept in a child and the stages it undergoes may be clarified only by observing it during the search period – not to mention the fact that certain intermediate stages are beyond the investigator's purview, and that the nature of the response to double stimulation, i.e. the nature of the child's use of language, is totally beyond it. The fundamental flaw in Ach's method from the standpoint of the objectives we were pursuing was the way it organised the series of objects. We are dealing with an artificially, symmetrically constructed microworld that enables us to discover quite efficiently phenomena that are very important from the standpoint of *Determinationspsychologie*, i.e. the succession of complexes under the influence of determining tendencies, the emergence of a certain number of principles of ordering (*Ordnungsprinzipien*), the use of interferences, counting (*Hilfskriterien*). All these phenomena are specially organised by Ach's experimental design to show that not only the process of concept formation but also the use of fully formed concepts are under the influence of goal conceptions, as a result of which a set of auxiliary techniques to economise effort is developed with their assistance. By contrast, in natural processes of concept formation, objects are never grouped into such a smooth symmetrical system. However, the flaw of the procedure is not simply its artificiality, but the fact that this artificiality contributes to obscuring the interaction that takes place between reactions to verbal stimuli and reactions to object stimuli, with which our experiments are most concerned. To determine the contribution made by words to a child's reaction to the objective world, it is most expedient to present this objective world as a motley, unorganised diversity, so that it can be mastered only by using words. But the relationship between the series of objects and the series of words should be such that any reaction of the child will typify the extent and the originality of this [word] use. On the basis of these considerations, a procedure was developed under Vygotsky's leadership, the main principles of which I shall now present to conclude this essay.[19]

On a game board divided up into fields, about 20-30 wooden figures resembling draughtsmen are placed in one field. These figures are differentiated as follows: (1) by colour (yellow, red, green, black, white), (2) by shape (triangle, pyramid, rectangle, parallelepiped, cylinder), (3) by height (short and tall), (4) by planar dimensions (small and large). A test word is written on the bottom of each figure. There are four different test words: 'bat' written on all the figures small and short, regardless of their colour and shape; 'dek', small and tall; 'rots', large and short; 'mup', large and tall. The figures are arranged in random order. The number of figures of each colour, shape and of each of the other attributes varies. The experimenter turns over one figure – a red, small, short parallelepiped – and asks the child to read the word 'bat' written on its exposed underside. Then the figure is placed in a special field on the board. The experimenter tells the child that he has before him toys that belong to children from some foreign country. Some toys are called 'bat' in the language of this people, for example, the upturned figure; others have a different name. There are other toys on the board that are also called 'bat'. If the child guesses after thinking carefully where there are other toys called 'bat' and picks them up and places them on a special field of the board, he receives the prize lying on this field. The prize may be a sweet, a pencil, etc. The toys cannot be turned upside down to read what is written on them. The child must work without hurrying, as well as possible, so as not to pick up any toy that has another name and so as not to leave any toy in place that should be taken away. The child rehearses the conditions of the game and removes a group of figures. The time and the order in

which the child removes the figures are recorded. The most varied types of responses are observed: test reactions without any reasons, choice on the basis of a set (e.g. forming a collection), choices on the basis of maximum similarity, on the basis of similarity with regard to one attribute, etc. The experimenter asks why the child picks up these toys and what toys were called 'bat' in the language of the foreign people. Then he has the child turn over one of the figures not removed and finds that 'bat' is written on it. 'Here, you see, you made a mistake; the prize isn't yours yet'. For example, if the child picks up all the parallelepipeds regardless of their colour and size on the basis of the fact that the model is a parallelepiped, the experimenter has him expose the unremoved small short red circle 'bat' similar to the model in colour. The overturned figure is placed with the inscription up alongside the recumbent model, the figures removed by the child are taken back, and he is asked again to try to win the prize by picking all the 'bat' toys on the basis of the two toys known to him. One child will remove all red figures; another, all parallelepipeds and cylinders; a third will select a collection of figures of different shapes; still others will repeat their preceding response; a fifth will make a completely arbitrary choice of figures, etc. The game continues until the child picks up all the figures correctly and gives a correct definition of the concept 'bat'. Thus, the basic principle of our procedure is that the series of objects is given in complete form at the very beginning of the game, but the verbal series is gradually augmented; all the new items of this series gradually enter into the game one by one. After each change in the verbal series, i.e. after each change in the nature of the double stimulation, the child gives us his free reaction, on the basis of which we can evaluate the degree of functional utilisation of the items in the verbal series and the child's psychological reactions to the series of objects.

We did a preliminary study of the process of concept formation in adults using a similar method, and at present are completing an analogous study of children.

The basic features of the procedure we developed amount to the following. There is a collection of figures of different shapes, colours, height and planar dimensions. Unlike Ach's set of figures, this collection is a motley, unorganised whole: it is irregular and unsymmetric. Different attributes occur an unequal number of times. The collection is based on four experimental concepts associated with test words, which are written on the bottoms of the figures, not visible to the child. Each concept contains two attributes, e.g. height and planar dimensions. One concept embraces all tall and large figures; the other, all tall and small; the third, all short and small; and the fourth, all short and large. The experiment is done as a game. The figures are arranged on a game board at random, without any pattern. These are toys of a foreign nation. One of them is turned upside down, and its name in the language of this people is read aloud. According to the rules of the game, the child must remove all the toys that have the same name as the up-ended model and place them in a special field on the board without turning them over and looking at the inscription. He obtains in exchange for these toys a sweet, a pencil or something else of the sort from the experimenter as a prize. The entire game consists of the child's attempts to place correctly all the figures with the same inscription as the model. After each such attempt, the experimenter turns over the new figure, revealing the child's mistake, which is either that among the removed figures there is one figure with a different name from that which is on the model, or that among the figures not removed there is one with the same name as the model and hence belongs to the field. Since after each placement of the figures the child discovers the name of a new figure (which the experimenter has up-ended), every new attempt of the child to solve the problem is done on the basis of a larger number of models.

Thus, the principle of the experiment is that the series of objects is given to the child immediately as a whole but the series of words is given gradually, and the nature of the double stimulation continually varies. After each such change we obtain the child's free response, which enables us to assess the changes that have taken place in the child's psychological operations as a consequence of the fact that the series of objects now contains a new element from the verbal series. This enables us to assess the degree to which a child makes use of words. Of course, the task can be accomplished correctly only if the experimental concepts that underlie the test words have been formed. In a similar procedure, we carried out a study of concept formation in adults and ascertained its productiveness. We are now completing a study of concept formation in schoolchildren and are beginning to work with pre-school children, for whom verbal signs are replaced by arbitrary colour tokens. We are also in the process of developing and testing a new test.[20]

An illustration of the nature of the data that can be obtained on the basis of this procedure can be seen in the fact that a word in our experiments passes through three stages that are present in outline in the ontogeny of children's concepts. Initially, it is an individual sign with its own name; then it becomes a family sign with its own name associated with a series of concrete objects (complex concept); finally, it becomes a general abstraction. Some children pass through all these three stages; others remain at the middle stage. Thus, we have an experimentally organised picture of the ontogeny of concepts and are able to carry out analytical studies of the functional role of words in all stages of this ontogeny.