

Problems of Method

In general, any fundamentally new approach to a scientific problem inevitably leads to new methods of investigation and analysis. The invention of new methods that are adequate to the new ways in which problems are posed requires far more than a simple modification of previously accepted methods. Contemporary psychological experimentation is no exception in this respect; its methods have always reflected the ways in which fundamental psychological problems were viewed and solved. Therefore, our criticism of current views concerning the essential nature and development of psychological processes must inevitably result in a reexamination of methods of research.

◆ Despite great diversity in procedural details, virtually all psychological experiments rely on what we shall term a stimulus-response framework.

By this we mean that no matter what psychological process is under discussion, the psychologist seeks to confront the subject with some kind of stimulus situation designed to influence him in a particular way, and then the psychologist examines and analyzes the response(s) elicited by that stimulating situation. After all, the very essence of experimentation is to evoke the phenomenon under study in an artificial (and thereby controllable) way and to study the variations in response that occur in conjunction with various changes in the stimulus.

◆ On the surface may appear that various schools of psychology could not possibly agree on this methodology.

The objective psychology of Watson, Bekhterev, and others, for example, was constructed in opposition to the subjective theories of Wundt and the Würzburg school. But closer examination of the differences between schools of psychology reveals that those differences arise out of the theoretical interpretation

psychologists want to assign to the consequences of various stimulating environments and not out of variations in the general methodological approach within which observations are made.

◆ **Reliance on a stimulus-response framework is an obvious feature of those schools of psychology whose theories as well as experiments are based on stimulus-response interpretations of behavior.**

• *Pavlovian theory, for example, has utilized the notion of cortical excitation incited by various stimuli to explain how connections are formed in the brain that enable the organism to learn to respond to hitherto neutral stimuli.*

It may be less obvious that exactly the same framework applies to introspective psychology as well, since the framework and the theory do not seem to coincide. However, taking Wundt as an example, we find that the stimulus-response framework provided the context within which the experimenter-theorist could obtain descriptions of the processes presumed to have been elicited by the stimulus.

◆ **The adoption of a stimulus-response framework by introspective psychology in the 1880's was a revolutionary step forward for psychology because it brought psychology closer to the method and spirit of the natural sciences and prepared the way for the objective psychological approaches that followed.**

• *But to claim that both introspective and objective psychology share a common methodological framework does not in any way imply that there are not important differences between them.*

I am emphasizing their common methodological framework because its recognition helps us to appreciate the fact that introspective psychology was rooted in the firm soil of natural sciences and that psychological processes have long been understood within a reactive context.

◆ **It is also important to realize that the experimental method was first formulated by introspective psychologists in that area of psychophysics and psychophysiology that dealt with the simplest psychological phenomena, phenomena that could plausibly be interpreted as directly and uniquely linked to external agents.**

Wundt, for example, saw the very essence of psychological method as the systematic alteration of the stimuli that generate a change in the psychological process linked to them. He sought the maximally objective way to record the external manifestations of these internal processes, which is what he believed the subject's introspective reports to be.

At the same time, it is important to keep in mind that for Wundt the stimulus and response functioned only to set up the framework within which the important events, psychological processes, could be studied in a reliable and controlled way. Introspective reports of these processes remained the paramount evidence concerning their nature—an interpretation not shared by later investigators.

◆ **Our description of the basic framework of psychological experimentation as practiced by Wundt imply limitations on its applications: such experimentation was considered adequate only to the study of elementary processes of a psychophysiological character. The higher psychological functions did not allow study in this form and thus remained a closed book as far as experimental psychology was concerned.**

If we recall the kinds of experimentation on the cognitive development of children that characterized the research reviewed in earlier chapters of this book, we can easily understand why previous investigators concentrated on elementary psychological functions: this limitation is a built-in feature of the experimental method as it was generally accepted in psychology. Wundt understood and accepted this fact which is why he eschewed *experimental* studies of higher psychological functions.

◆ **From the forgoing it should be clear that a stimulus-response framework for constructing experimental observations *cannot* serve as the basis for the adequate study of the higher, specifically human forms of behavior. At best it can only help us to record the existence of the lower, subordinated forms, which do not capture the essence of the higher forms.**

Using current methods, we can only determine quantitative variation in the complexity of stimuli and in the responses of different animals and humans at different stages of development.

◆ **It is my belief, based upon a dialectical materialist approach to the analysis of human history, that human behavior differs qualitatively from animal behavior to the same extent that the adaptability and historical development of humans differ from the adaptability and development of animals.**

The psychological development of humans is part of the historical development of our species and must be so understood.

Acceptance of this proposition means that we must find a new methodology for psychological experimentation.

THE KEystone OF THE NEW METHODOLOGY FOR PSYCHOLOGICAL EXPERIMENTATION

The keystone of our method, which I will try to describe analytically in the following sections, follows directly from the contrast Engels drew between naturalistic and dialectical approaches to the understanding of human history.

◆ **Naturalistic approach to the understanding of human history.**

• *Naturalism in historical analysis, according to Engels, manifests itself in the assumption that only nature affects human beings and only natural conditions determine historical development.*

◆ **Dialectical approach to the understanding of human history.**

• *The dialectical approach, while admitting the influence of nature on man, asserts that man, in turn, affects nature and creates through his changes in nature new natural conditions for his existence.*

This position is the keystone of our approach to the study and interpretation of man's higher psychological functions and serves as the basis for the new methods of experimentation and analysis that we advocate.

◆ **All stimulus-response methods share the inadequacy that Engels ascribes to naturalistic approaches to history. Both see the relation between human behavior and nature as unidirectionally reactive.**

• *My collaborators and I, however, believe that human behavior comes to have that “transforming reaction on nature” which Engels attributed to tools.*

We must, then, seek methods adequate to our conception. In conjunction with new methods, we also need a new analytic framework.

I have emphasized that a basic goal of our research is to provide an analysis of the higher forms of behavior, but the situation in contemporary psychology is such that the problem of analysis itself must be discussed if our approach is to be generalized beyond the specific examples presented.

► **Dialectical Approach to the Study and Interpretation of Higher Psychological Functions of Man**

• Three principles form the basis of our approach to the higher psychological functions: *Analyzing process, not objects; explanations vs description, and the problem of “fossilized behavior.”*

ANALYZING PROCESSES, NOT OBJECTS

This principle leads us to distinguish between the analysis of an object and of a process.

◆ **As Koffka put it, psychological analysis has almost always treated the processes it analyzes as stable, fixed objects. The task of analysis consisted in breaking these forms down into their components.**

• *Psychological analysis of objects should be contrasted with the analysis of processes, which requires a dynamic display of the main points making up the processes’ history.*

Consequently, developmental psychology, not experimental psychology, provides the new approach to analysis that we need. Like Werner, we are advocating the developmental approach as an essential addition to experimental psychology.

• *Any psychological process, whether the development of thought or voluntary behavior, is a process undergoing changes right before one’s eyes.*

The development in question can be limited to only a few seconds, or even fractions of seconds (as is the case in normal perception). It can also (as in the case of complex mental processes) last many days and even weeks. Under certain conditions it becomes possible to trace this development. *Werner’s work furnishes one example of how a developmental viewpoint may be applied to experimental research. Using such an approach, one can, under laboratory conditions, provoke development.*

◆ **Our method may be called experimental-developmental in the sense that it artificially provokes or creates a process of psychological development.**

• *This approach is equally appropriate to the basic aim of dynamic analysis.*

If we replaced object analysis by process analysis, then the basic task of research obviously becomes a reconstruction of each stage in the development of the process: the process must be turned back to its initial stages.

EXPLANATIONS VS DESCRIPTION

In associationistic and introspective psychology, analysis is essentially description and not explanation as we understand it. Mere description does not reveal the actual causal dynamic relations that underlie phenomena.

◆ **K. Lewin contrasts phenomenological analysis, which is based on external features (phenotypes), with what he calls genotypic analysis, wherein a phenomenon is explained on the basis of its origin rather than their outer appearance.**

• *The difference between these two points of view can be elucidated by any biological example.*

A whale, from the point of view of its outer appearance, stands closer to the fish family than to the mammals, but in its biological nature it is closer to a cow or a deer than to pike or a shark. Following Lewin, we can apply this distinction between the phenotypic (descriptive) and genotypic (explanatory) viewpoints to psychology. By a developmental study of a problem, I mean the disclosure of its genesis, its causal dynamic basis. By phenotypic I mean the analysis that begins directly with an object's current features and manifestations. It is possible to furnish many examples from psychology where serious errors have been committed because these viewpoints have been confused. In our study of the development of speech, we have emphasized importance of the distinction between phenotypic and genotypic similarities.

◆ **In their external, descriptive aspects, the first manifestation of speech in the one-and-half-year-old child are similar to adult speech.**

On the basis of this similarity, such serious researchers as Stern come to the conclusion that in essence the eighteen-month-old child is already conscious of the relation between the sign and meaning. In other words, he classes together phenomena that have absolutely nothing in common from the developmental point of view. On the other hand, egocentric speech—which in its outer manifestations differs from internal speech in essential ways—must be classed together with internal speech from the developmental point of view.

◆ **Our research on young children's speech brings us to the basic principle formulated by Lewin:**

• *Two phenotypically identical or similar processes may be radically different from each other in their causal dynamic aspects and vice versa; two processes that are very close in their causal dynamic nature may be very different phenotypically.*

I have said that

◆ **The phenotypic approach categorizes processes according to their external similarities.**

Marx commented on the phenotypic approach in a most general form when he stated that "if the essence of objects coincided with the form of their outer manifestations, then every science would be superfluous"—an extremely reasonable observation. If every object was phenotypically and genotypically equivalent (that is, if the true principles of its construction and operation were

expressed by its outer manifestation), then everyday experience would fully suffice to replace scientific analysis. Everything we saw would be the subject of our scientific knowledge.

◆ **In reality, psychology teaches us at every step that though two types of activity can have the same external manifestation, whether in origin or essence, their nature may differ most profoundly.**

• *In such cases special means of scientific analysis are necessary in order to lay bare internal differences that are hidden by external similarities. It is the task of analysis to reveal these relations.* In that sense, real scientific analysis differs radically from subjective, introspective analysis, which by its very nature cannot hope to go beyond pure descriptions. The kind of objective analysis we advocate seeks to lay bare the essence rather than the perceived characteristics of psychological phenomena.

For example, we are not interested in a description of the immediate experience elicited by a flashing light as it is revealed to us by introspective analysis; rather we seek to understand the real links between the external stimuli and internal responses that underlie the higher form of behavior named by introspective descriptions. Thus, psychological analysis in our sense rejects nominal description and seeks instead to determine causal-dynamic relations. However, such explanation would also be impossible if we ignored the external manifestations of things. By necessity, objective analysis includes a scientific explanation of both external manifestations and the process under study. Analysis is not limited to a developmental perspective. It does not repudiate the explanation of current phenotypical idiosyncrasies, but rather subordinates them to the discovery of their actual origin.

THE PROBLEM OF “FOSSILIZED BEHAVIOR”

◆ **The third principle underlying our analytic approach is based on the fact that in psychology we often meet with processes that have already died away, that is, processes that have gone through a very long stage of historical development and have become fossilized.**

These fossilized forms of behavior are most easily found in the so-called automated or mechanized psychological processes which, owing to their ancient origins, are now being repeated for the millionth time and have become mechanized. They have lost their original appearance, and their outer appearance tells us nothing whatsoever about their internal nature. Their automatic character creates great difficulties for psychological analysis.

◆ **The processes that have traditionally been referred to as voluntary and involuntary attention provides an elementary example that demonstrates how essentially different processes acquire outer similarity as a result of this automation. Developmentally speaking, these two processes differ very profoundly.**

• *But in experimental psychology it is considered a fact, as formulated by Titchener, that voluntary attention, once established, functions just like involuntary attention.*

In Titchener's terms, “secondary” attention constantly changes into “primary” attention. Having described and contrasted the two types of attention, Titchener then says, “there exists, however, a third stage in the development of attention, and it consists in nothing less than a return to the first stage.” The last and highest stage in development of any process may demonstrate a purely phenotypic similarity with the first or primary stages, and if we take a phenotypic approach, it is impossible to distinguish between higher and lower forms of this

process. The only way to study this third and highest stage in the development attention is to understand it in all its idiosyncrasies and differences. *In short, we need to understand that we need to concentrate not on the product of development but on the very process by which higher forms are established. To do so the researcher is often forced to alter the automatic, mechanized, fossilized character of the higher form of behavior and to turn it back to its source through the experiment. This is the aim of dynamic analysis.*

◆ **The fossilized form is the end of the thread that ties the present to the past, the higher stages of the development to the primary ones.**

• *Inactive, rudimentary functions stand not as the living remnants of biological evolution but as those of the historical development of behavior.*

Consequently, the study of rudimentary functions must be the point of departure for evolving a historical perspective in psychological experiments. It is here that the past and the present are fused and the present is seen in the light of history.

Here we find ourselves simultaneously in two planes: that which is and that which was. The fossilized form is the end of the thread that ties the present to the past, the higher stages of the development to the primary ones.

◆ **To study something historically means to study it in the process of change; that is the dialectical method's basic demand. Thus, the historical study of behavior is not an auxiliary aspect of theoretical study, rather forms its very base. As P.P. Blosky has stated, "Behavior can be understood only as the history of behavior."**

• *The concept of a historical based psychology is misunderstood by most researchers who study child development.*

For them, to study something historically means, by definition, to study some past event. Hence, they naively imagine an insurmountable barrier between historic study and the study of present-day behavioral forms. *To study something historically means to study it in the process of change; that is the dialectical method's basic demand. To encompass in research, the process of a given thing's development in all its phases and changes—from birth to death—fundamentally means to discover its nature, its essence, for "it is only in movement that a body shows what it is."* Thus, the historical study of behavior is not an auxiliary aspect of theoretical study, rather forms its very base. As P.P. Blosky has stated, "Behavior can be understood only as the history of behavior."

◆ **The search for method becomes one of the most important problem of the entire enterprise of understanding the uniquely human forms of psychological activity. In this case, the method is simultaneously prerequisite and product, the tool and the result of the study.**

• *In summary, then, the aim of psychological analysis and its essential factors are as follows:*

- (1) process analysis as opposed to object analysis;
- (2) analysis that reveals real, causal or dynamic relations as opposed to enumeration of a process's outer features, that is, explanatory, not descriptive, analysis; and
- (3) developmental analysis that returns to the source and reconstructs all the points in the development of a given structure.

◆ **The result of the development will be a qualitatively new form that appears in the process of development.**

The result of the development will be neither a purely psychological structure such as descriptive psychology considers the result to be, nor a simple sum of elementary processes such as associationistic psychology saw it, but a qualitatively new form that appears in the process of development.

▶ **The Psychology of Complex Choice Responses**

◆ **In order to illustrate contrasting approaches to psychological analysis, I will discuss in some detail two different analysis of one task.**

• *In the task I have chosen, the subject is presented one or more stimuli (visually or auditorily as a rule). The required response differs according to the number of stimuli and the interest of the investigator:*

Some approaches seek to break the reaction down into a series of elementary processes whose durations can be added and subtracted to establish the laws of their combination; others seek to describe the emotional reaction of the subject as he responds to the stimulus. In either case, the subject's introspective analyses of their responses are used as basic data. In these experiments the inadequacies of prior formulations provide useful illustrations of our basic analytic principles.

◆ **It is also characteristic of this analyses that complex and simple responses are distinguished primarily by quantitative complexity of the stimuli: a simple reaction is said to occur when a single stimulus is presented, and the complexity of response is said to increase with an increasing number of stimuli.**

An essential presumption in this line of thinking is that the complexity of the task is identical to complexity of the subject's internal response.

This identity is clearly expressed in the algebraic formulas commonly used in the analysis of responses to such tasks. If we present a single stimulus, we can write an equation in which the complex reaction is equivalent to a reaction (sensory recognition): $R_t = R_s$ where R_t is the response time for the total, complex reaction and R_s is the response time for a single recognition reaction. If we present two or more stimuli, from which the subject must select one, this equation becomes: $R_t = R_s + D$, where D is the time taken to discriminate between the target stimulus and the remainder. Using these two equations, we could establish the time required both for a simple reaction and for the discriminative reaction. If we complicate the task by requiring the subject to chose a different response for each stimulus (for example, press the left-hand key for stimulus A and the write-hand key for stimulus B), we obtain the classical choice reaction formula: $R_t = R_s + D + C$, where C is the time required to chose the correct movement, for example, to press the key corresponding to the stimulus presented.

◆ **A verbal description of the theory underlying this set of formulas would be the following:**

• *The discrimination response is a simple reaction plus discrimination; the choice reaction is a simple reaction plus discrimination plus choice. The higher, more complex response is seen as the arithmetic sum of its elementary components.*

Proponents of this analytic approach apply it quite widely. Thus, for example, Cattle believes that subtracting the time needed to comprehend and name a word

from the time needed to comprehend, translate a word into another language, and name it, we can obtain a pure measure of the translation process. In short, even higher processes such as speech comprehension and production can be analyzed by these methods.

◆ **A more mechanical notion of the complex, higher forms of behavior would be hard to imagine.**

However, this analytic approach has been shown to lead to a variety of difficulties. The most basic, empirical observation that contradicts this theory comes from Titchener, who pointed out that the time to execute a carefully prepared choice reaction may be equal to the reaction time for a simple, sensory response. By the logic of the analysis summarized in the equations given above, this state of affairs is impossible.

◆ **In our view, the basic premise underlying this entire line of analysis is incorrect.**

- *It is not true that a complex reaction consists of a chain of separate processes which may be arbitrarily added and subtracted. Any such reaction reflects processes that depend upon the entire process of learning at every level of practice.*

- *This mechanical analysis substitutes relations existing between stimuli for the real relations underlying the process of choosing.*

This kind of substitution reflects a general intellectualism in psychology which seeks to understand psychological processes in the manipulations that make up the experiment itself; experimental procedures become surrogates for psychological processes.

While various scholars have demonstrated the inadequacy of psychological analysis based upon a mechanical decomposition of responses into their elements, these critics face the problem that their introspective analyses of complex reactions must be restricted to description: the description of external responses is replaced by the description of internal feelings. In either case, we are restricted to phenotypical psychological analysis.

◆ **Introspective analysis in which highly trained observers are instructed to note every aspect of their own conscious experience cannot carry us very far.**

- *A curious result of this work, as Ach put it in discussing choice reaction studies, has been the discovery that there are no conscious feelings of choice in the choice reaction.*

Titchener emphasized that one must keep in mind the fact that the names given to a complex or simple reaction (for example, “differentiation” or “choice”) refer to the external conditions of the task. We do not differentiate in the differentiation reaction and we do not choose in the choice reaction.

◆ **This kind of analysis broke the identity between experimental procedures and psychological processes.**

Process names like “choosing” and “differentiating” were treated as leftover from a previous era of psychology when experimentation was still unknown:

introspective observers were trained to make a clear distinction between process names and their conscious experience in order to circumvent this problem.

♦ **It should be clear that introspective analysis cannot provide a real causal or dynamic explanation of the process; for that to occur, we must give up reliance on phenotypic appearances and move to a developmental viewpoint.**

These introspective studies resulted in the conclusion that a situation which seems to require choice process furnishes no grounds for speaking of a psychological choice response; talks of such responses was replaced by a description of the subjects' feelings during the experiment. But no one could provide evidence that these feelings were an integral part of the particular response process. It seems more likely that they are only one of its components, and require explanation themselves; we are led to conclude that introspection is often unable to provide an accurate description, let alone a correct explanation, for even the subjective aspect of the response. For the same reasons, the frequent discrepancies among the introspective descriptions of various observers which plague this area of research might be expected. It should be clear that introspective analysis cannot provide a real causal or dynamic explanation of the process; for that to occur, we must give up reliance on phenotypic appearances and move to a developmental viewpoint.

♦ **Research in complex reactions also illustrates psychological's reliance on the analysis of processes only after they have become fossilized.**

- *It might be said that complex reactions have been studied postmortem.*

This point was noted by Titchener, who remarked that researchers have concentrated on the reaction time of the responses they study, not on the learning processes or the content of the reaction itself. This same conclusion is seen clearly in the standard practice of discarding the data from early sessions when the response is being established. Uniformity was sought, so that it was never possible to grasp in flight; instead, researchers routinely discarded the critical time when a reaction appears and when its functional links are established and adjusted. Such practices lead us to characterize the responses as "fossilized." This reflects the fact that these psychologists were not interested in complex reactions as a process of development. This approach is also a major cause of the confusions which arose concerning complex and simple reactions that have surface similarities. It might be said that complex reactions have been studied postmortem.

♦ **Another perspective on this issue can be gained from comparing complex reactions with reflexes, which are psychological different in many respects. One point of comparison will suffice for purposes of illustration.**

It is well known that the latent period for a complex reaction is longer than the latent period for a reflex. But Wundt long ago established that the latent period for a complex reaction decreases with practice. As a result, the latency of the complex reaction and the simple reflex become equivalent. The most important differences between a complex reaction and a reflex are usually most apparent when the reaction is in its early stages; as practice proceeds, the differences become more and more obscured. Therefore, the differences between these two forms of behavior should be sought in the analysis of their development. But instead of increasing the discernible differences between them, investigations of well-practiced choice reactions and reflexes hide these differences. The preparatory trials demanded by standard experimental methods often last for several long sessions.

When these data are then discarded or ignored, the researcher is left with an automatized reaction that has lost its developmental difference from a reflex and has acquired a surface or ignored, the researcher is left with an automatized reaction that has lost its developmental difference from a reflex and has acquired a surface, phenotypical similarity to it. These factors have led to our assertion that previous researchers have studied reactions in psychological experiments only after they have become fossilized.

This discussion of traditional analyses of complex reaction defines, albeit negatively, the basic tasks confronting us. In order to obtain the kind of causal-dynamic analysis we have been advocating, we will have to shift the focus of our research.

▶ **A causal-dynamic study of choice reactions**

◆ **Through an objective study of the entire history of the reaction, we can obtain an integrated explanation of both its internal and surface manifestations.**

Obviously, the early sessions during which a reaction is formed are of crucial concern because only data from this period will reveal the reaction's true origin and its links to other processes. Through an objective study of the entire history of the reaction, we can obtain an integrated explanation of both its internal and surface manifestations. Thus, we will want to study the reaction as it appears initially, as it takes shape, and after it is firmly formed, constantly keeping in mind the dynamic flow of the entire process of its development.

◆ **From my previous discussion another part of the task is clear: the complex reaction must be studied as a living process, not as an object. We must transform the reaction back to its source if we encounter it in automatized form.**

• *When we examine the experimental procedures used in complex reactions, we find that all are restricted to meaningless connections between stimuli and responses.*

The subject is presented several stimuli to which he must respond in different ways: neither the relations between the stimuli and the required responses nor the sequence in which the stimuli are presented have any significance from the subject's point of view. When a motor response, such as a key press, is required, subjects may make the movement in any way they like. These conventions render the relations among the elements of the problem mechanical in principle and place the procedures on a plane with the research on memory that uses nonsense stimuli.

◆ **This analogy between choice reaction and memory studies can be extended by considering the similarity of the role of repetition in the two tasks. Although no one has dwelt on a study of the practice trials in choice reaction studies, it is safe to conclude that if reaction is formed through repeated training (or training plus written or oral instruction), it has been learned by rote, just as learning the connection between two nonsense syllables in a rote process.**

If simple reactions were involved and the subject was given extensive explanation ahead of time so that the relation between stimulus and response were meaningful (for example, push key number 1 when I say "one," push key number 2 when I say "two"), we would be dealing with already existing links. In neither case

could we study the process of organizing the reaction, during which its underlying links would be discoverable.

◆ **To make all of this clear, let us trace the stages through which the choice reaction moves, first in experiments with adults and then with children.**

If we set up a relatively simple choice reaction, say, pressing a button with the left hand when a red stimulus is shown and pressing with the right hand when a green stimulus is shown, adults quickly acquire a stable response. Suppose, however, we increase the number of stimuli and responses to five or six and diversify the responses so that the subject has to respond not only with both hands, but sometimes pressing a button and sometimes simply by moving a finger. With this larger number of stimulus-response pairings, the task is considerably more difficult. Suppose further that instead of a lengthy pretraining period in which the subject is allowed to learn the stimulus-response relations, we give only minimal instructions. Faced with this situation, adults often refused even to attempt to deal with the problem, objecting that they could not remember what to do. Even after the session started, they kept repeating the instructions to themselves, asked about aspects of the task they had forgotten, and generally sought to master the entire system of relations as a whole before they settled down to the task as it is usually conceived.

However, if we placed additional stimuli on the response buttons and keys in a manner analogous to the procedures in previously described memory studies, the adults immediately used these auxiliary means to remember the necessary stimulus-response relations.

Among young children, a different picture emerged. We first presented the problem as we did with adults, by asking the child to make a number of different responses to different stimuli. Unlike the adults, children six to eight years of age often started right into the task after listening to the instructions and attempted to follow them without the slightest hesitation. As soon as the experiment began, most children found themselves in great difficulty. If a child recalled one or two of the required relations and responded correctly to those stimuli, he would naively ask about the remaining stimuli, treating each of them in isolation from each other. This behavior contrasted with that of the adults who generally failed to deal effectively with the individual stimuli until all the necessary relations were mastered. We view this behavior on the part of the children as evidence that they are in the stage of responding to the task in a natural or primitive manner because they rely on unmediated memory for the task elements. The fact that children would unhesitatingly accept the challenge of establishing a complex choice response to as many as ten stimuli suggests that they do not yet know their own capacities and limitations. They operate with complex tasks in the same way they operate with simple ones.

The child's behavior also differs from adult behavior when we introduce auxiliary stimuli, although we can discern the beginnings of the restructuring that characterize the adult.

First, we introduce auxiliary stimuli that bear a clear relation to the primary stimuli with which we began. For example, if the primary stimulus was a horse, in response to which the child was supposed to press a key with his left index finger, we pasted a picture of a sleigh on that key. On the key corresponding to a loaf of bread we pasted a picture of a knife. In this case, the child understands that sleigh goes with horse, the knife with bread, and so on. Choice reactions are smoothly established from the outset. Furthermore, it does not matter how many stimuli and responses are involved; the qualitative features of responding remain the same. The

child quickly works out a rule for the problem's solution and makes his choice on the basis of this rule.

It would be incorrect, however, to assume that the child has mastered a mediated system of behavior in its full, adult form. We need only to change the relations among the primary and auxiliary stimuli to discover the limits of the child's response system. If pair the stimuli in a different way (say, horse with knife, bread with sleigh) the child will no longer use the auxiliary stimuli in a proper way. The child recalls only that horse helped to find sleigh in some way. He reveals by his responses that he had been using the conventional association of horse and sleigh to guide the choice, but had not mastered the internal logic of using one stimulus to mediate the response to another.

If we continue our experiment long enough, we will begin to see changes in the way the child responds. In the first stage of responding to arbitrarily related stimuli, the child has insufficient experience with the task to organize his behavior effectively. He uses experience naively. But in the course of the experiment, he gains experience necessary for restructuring his behavior. Just as naïve physical knowledge is acquired as the child operates with objects, knowledge of psychological operations is acquired as the child strives to carry out the choice reaction task. As he attempts to recall which stimuli are linked to which responses, the child begins to learn what remembering in this situation consists of and begins to use one or another of the auxiliary stimuli effectively. The child begins to realize that certain relations among the stimuli and auxiliary pictures produce correct choice responses, while others do not. He soon begins to object to the arrangement of pictures, asking that the pictures on the key be arranged to fit the primary stimuli that are associated with the key. When told to press the bread key in response to the horse picture, the child answers "No, I want the sleigh key." This shows that the child is accumulating experience which is changing the structure of his own memorizing.

Having naively comprehended what the memorizing operations require, the child moves to the following stage. If presented with primary and auxiliary stimuli in an arrangement that seems haphazard, the child will ask to put them in special order, thus personally establishing a specific relation between them. At this point the child is showing that he knows that certain signs will help to achieve certain operations. In short, he is beginning to memorize through the use of signs.

Once this happens, the child no longer experiences difficulties in creating relations and using them. Given some pairing of primary and auxiliary stimuli, the child is no longer restricted to using already available relations (such as horse-sleigh) but can create relations of his own. **This may be called the stage of external sign use.** It is characterized by the independent formation of new relations in the child's internal operations using externally presented signs. Now the child is organizing externally stimuli to carry out its responses. **This fundamental stage is then followed by the stage at which the child begins to organize stimuli of an internal nature.**

These changes are manifested in the course of the choice reaction experiment. After considerable practice in the choice experiment, the reaction time begins to grow shorter and shorter. If the reaction time in a particular stimulus had been 500 milliseconds or more, it reduces to a mere 200 milliseconds. The longer reaction time reflected the fact that the child was using external means to carry out the operations of remembering which key to push. **Gradually, the child casts off the external stimuli, no longer paying attention to them.** The response to the external auxiliary stimuli is replaced by a response to internally produced stimuli. **In its most developed form, this internal operation consists of the child grasping the very structure of the process, learning to**

understand the laws according to which external signs must be used. When this stage is reached, the child will say, “I don’t need pictures anymore. I’ll do it myself.”

► Characteristics of the New Method

◆ I have attempted to demonstrate that the course of child development is characterized by a radical alteration in its very structure of behavior; at each new stage the child changes not only her response but carries out that response in new ways, drawing on new “instruments” of behavior and replacing one psychological function by another.

• *Psychological operations that were achieved through direct forms of adaptation at early stages are later accomplished through indirect means.*

The growing complexity of children’s behavior is reflected in the changed means they used to fulfill new tasks and the corresponding reconstruction of their psychological processes.

◆ Our concept of development implies a rejection of the frequently held view that cognitive development results from the gradual accumulation of separate changes.

• *We believe that child development is a complex dialectical process characterized by periodicity, unevenness in the development of different functions, metamorphosis or qualitative transformation of one form into another, intertwining of external and internal factors, and adaptive processes which overcomes impediments that the child encounters.*

Steeped in the notion of evolutionary change, most workers in child psychology ignore those turning points, those spasmodic and revolutionary changes that are so frequent in the history of child development. To the naïve mind, revolution and evolution seem incompatible and historic development continues only so long as it follows a straight line. Where upheavals occur, where the historical fabric is ruptured, the naïve mind sees only catastrophe, gaps, and discontinuity. History seems to stop death, until it once again takes the direct, linear path of development.

Scientific thought, on the contrary, sees revolution and evolution as two forms of development that are mutually related and mutually presuppose each other. Leaps in the child’s development are seen by the scientific mind as no more than a moment in the general line of development.

◆ As I have repeatedly emphasized, an essential mechanism of the reconstructive processes that takes place during a child’s development is the creation and use of a number of artificial stimuli.

• *These play an auxiliary role that permits human beings to master their own behavior, at first by external means and later by more complex inner operations.*

Our approach to the study of cognitive functioning does not require the experimenter to furnish subjects with ready-made, external or artificial means in order to that they may successfully complete the given task. The experiment is equally valid if, instead of giving children artificial means, the experimenter waits

until they spontaneously apply some new auxiliary method or symbol that they then incorporate into their operations.

The specific area to which we apply this approach is not important. We might study the development of memorizing in children by making available to them new means for solving the given task and then observing the degree and character of their problem-solving efforts. We might use this method to study how children organize their active attention with the aid of external means. We might trace the development of arithmetic skills in young children by making them manipulate objects and apply methods either suggested to them or “invented” by them. What is crucial is that in all these cases we must adhere to one principle. We study *not only the final effect of the operation, but its specific psychological structure*. In all these cases, the psychological structure of the development appears with much greater richness and variety than in the classic method of the simple stimulus-response experiment. Although stimulus-response methodology makes it extremely easy to ascertain subjects’ responses, it proves useless when our objective is to discover the means and the methods that subjects use to organize their own behavior.

Our approach to the study of these processes is to use what we call *the functional method of double stimulation*. The task facing the child in the experimental context is, as a rule, beyond his present capabilities and cannot be solved by existing skills. In such cases a neutral object is placed near the child, and frequently we are able to observe how the neutral stimulus is drawn into the situation and takes on the function of a sign. Thus, the child actively incorporates these neutral objects into the task of problem solving. We might say that when difficulties arise, neutral stimuli take on the function of a sign and from that point on the operation’s structure assumes an essentially different character.

By using this approach, we do not limit ourselves to the usual method of offering the subject simple stimuli to which we expect a direct response. Rather, we simultaneously offer a *second series of stimuli* that have a special function. In this way, we are able to study the *process of accomplishing a task by the aid of specific auxiliary means*; thus we are also able to discover the inner structure and development of the higher psychological processes.

The method of double stimulation elicits manifestations of the crucial processes in the behavior of people of all ages. Tying a knot as a reminder, in both children and adults, is but one example of a pervasive regulatory principle of human behavior, that of *signification*, wherein people create temporary links and give significance to previously neutral stimuli in the context of their problem-solving efforts.

◆ **We regard our method as important because it helps to *objectify* inner psychological processes; stimulus-response methods are objective, but they are limited to the study of external responses that are usually in the subject’s repertoire to begin with.**

- *We believe that our approach to objectifying inner psychological processes is much more adequate, where the goals of psychological research are concerned, than the method of studying preexisting, objective responses.*

- *Only the objectification of the inner process guarantees access to specific forms of higher behavior as opposed to subordinate forms.*

REVIEW

In general, any fundamentally new approach to a scientific problem inevitably leads to new methods of investigation and analysis. The invention of new methods that are adequate to the new ways in which problems are posed requires far more than a simple modification of previously accepted methods.

Contemporary psychological experimentation is no exception in this respect; its methods have always reflected the ways in which fundamental psychological problems were viewed and solved. Therefore, our criticism of current views concerning the essential nature and development of psychological processes must inevitably result in a reexamination of methods of research.

Despite great diversity in procedural details, virtually all psychological experiments rely on what we shall term a stimulus-response *framework*. By this we mean that no matter what psychological process is under discussion, the psychologist seeks to confront the subject with some kind of stimulus situation designed to influence him in a particular way, and then the psychologist examines and analyzes the response(s) elicited by that stimulating situation.

Reliance on a stimulus-response framework is an obvious feature of those schools of psychology whose theories as well as experiments are based on stimulus-response interpretations of behavior.

The adoption of a stimulus-response framework by introspective psychology in the 1880's was a revolutionary step forward for psychology because it brought psychology closer to the method and spirit of the natural sciences and prepared the way for the objective psychological approaches that followed.

The adoption of a stimulus-response framework in the psychological experimentation is adequate only to the study of elementary processes of a psychophysiological character; but it is not adequate to study the higher psychological functions. This limitation is a built-in feature of the experimental method in psychology.

From the forgoing it should be clear that a stimulus-response framework for constructing experimental observations *cannot* serve as the basis for the adequate study of the higher, specifically human forms of behavior. At best it can only help us to record the existence of the lower, subordinated forms, which do not capture the essence of the higher forms.

It is my belief, based upon a dialectical materialist approach to the analysis of human history, that human behavior differs qualitatively from animal behavior to the same extent that the adaptability and historical development of humans differ from the adaptability and development of animals. The psychological development of humans is part of the historical development of our species and must be so understood.

Acceptance of this proposition means that we must find a new methodology for psychological experimentation.

THE KEYSTONE OF THE NEW METHODOLOGY FOR PSYCHOLOGICAL EXPERIMENTATION

The keystone of our method, which I will try to describe analytically in the following sections, follows directly from the contrast Engels drew between naturalistic and dialectical approaches to the understanding of human history.

Naturalistic approach to the understanding of human history: Naturalism in historical analysis, according to Engels, manifests itself in the assumption that only nature affects human beings and only natural conditions determine historical development.

Dialectical approach to the understanding of human history: The dialectical approach, while admitting the influence of nature on man, asserts that man, in turn, affects nature and creates through his changes in nature new natural conditions for his existence.

This position is the keystone of our approach to the study and interpretation of man's higher psychological functions and serves as the basis for the new methods of experimentation and analysis that we advocate.

All stimulus-response methods share the inadequacy that Engels ascribes to naturalistic approaches to history. Both see the relation between human behavior and nature as unidirectionally reactive. My collaborators and I, however, believe that human behavior comes to have that "transforming reaction on nature" which Engels attributed to tools.

Dialectical Approach to the Study and Interpretation of Higher Psychological Functions of Man

Three principles form the basis of our approach to the higher psychological functions: *Analyzing process, not objects; explanations vs description, and the problem of "fossilized behavior."*

ANALYZING PROCESSES, NOT OBJECTS

This principle leads us to distinguish between the analysis of an object and of a process.

As Koffka put it, psychological analysis has almost always treated the processes it analyzes as stable, fixed objects. The task of analysis consisted in breaking these forms down into their components. Psychological analysis of objects should be contrasted with the analysis of processes, which requires a dynamic display of the main points making up the processes' history. Any psychological process, whether the development of thought or voluntary behavior, is a process undergoing changes right before one's eyes. Werner's work furnishes one example of how a developmental viewpoint may be applied to experimental research. Using such an approach, one can, under laboratory conditions, provoke development.

Our method may be called experimental-developmental in the sense that it artificially provokes or creates a process of psychological development. This approach is equally appropriate to the basic aim of dynamic analysis.

EXPLANATIONS VS DESCRIPTION

In associationistic and introspective psychology, analysis is essentially description and not explanation as we understand it. Mere description does not reveal the actual causal dynamic relations that underlie phenomena.

K. Lewin contrasts phenomenological analysis, which is based on external features (phenotypes), with what he calls genotypic analysis, wherein a phenomenon is explained on the basis of its origin rather than their outer appearance. The difference between these two points of view can be elucidated by any biological example.

A whale, from the point of view of its outer appearance, stands closer to the fish family than to the mammals, but in its biological nature it is closer to a cow or a deer than to pike or a shark. Following Lewin, we can apply this distinction between the phenotypic (descriptive) and genotypic (explanatory) viewpoints to psychology. By a developmental study of a problem, I mean the disclosure of its genesis, its causal dynamic basis. By phenotypic I mean the analysis that begins directly with an object's current features and manifestations.

Our research on young children's speech brings us to the basic principle formulated by Lewin:

Two phenotypically identical or similar processes may be radically different from each other in their causal dynamic aspects and vice versa; two processes that are very close in their causal dynamic nature may be very different phenotypically. I have said that the phenotypic approach categorizes processes according to their external similarities.

In reality, psychology teaches us at every step that though two types of activity can have the same external manifestation, whether in origin or essence, their nature may differ most profoundly. In such cases special means of scientific analysis are necessary in order to lay bare internal differences that are hidden by external similarities. It is the task of analysis to reveal these relations.

In that case, real scientific analysis differs radically from subjective, introspective analysis, which by its very nature cannot hope to go beyond pure descriptions. The kind of objective analysis we advocate seeks to lay bare the essence rather than the perceived characteristics of psychological phenomena.

THE PROBLEM OF "FOSSILIZED BEHAVIOR"

The third principle underlying our analytic approach is based on the fact that in psychology we often meet with processes that have already died away, that is, processes that have gone through a very long stage of historical development and have become fossilized. These fossilized forms of behavior are most easily found in the so-called automated or mechanized psychological processes which, owing to their ancient origins, are now being repeated for the millionth time and have become mechanized.

They have lost their original appearance, and their outer appearance tells us nothing whatsoever about their internal nature. Their automatic character creates great difficulties for psychological analysis.

The processes that have traditionally been referred to as voluntary and involuntary attention provides an elementary example that demonstrates how essentially different processes acquire outer similarity as a result of this automation. Developmentally speaking, these two processes differ very profoundly. But in experimental psychology it is considered a fact, as formulated by Titchener, that voluntary attention, once established, functions just like involuntary attention.

The last and highest stage in development of any process may demonstrate a purely phenotypic similarity with the first or primary stages, and if we take a phenotypic approach, it is impossible to distinguish between higher and lower forms of this process.

The only way to study this third and highest stage in the development attention is to understand it in all its idiosyncrasies and differences. In short, we need to understand that we need to concentrate not on the *product* of development but on the very process by which higher forms are established. To do so the researcher is often forced to alter the automatic, mechanized, fossilized character of the higher form of behavior and to turn it back to its source through the experiment. This is the aim of dynamic analysis.

The fossilized form is the end of the thread that ties the present to the past, the higher stages of the development to the primary ones. Inactive, rudimentary functions stand not as the living remnants of biological evolution but as those of the historical development of behavior. Consequently, the study of rudimentary functions must be the point of departure for evolving a historical perspective in psychological experiments. It is here that the past and the present are fused and the present is seen in the light of history.

To study something historically means to study it in the process of change. Thus, the historical study of behavior is not an auxiliary aspect of theoretical study, rather forms its very base. As P.P. Blosky has stated, "Behavior can be understood only as the history of behavior."

The concept of a historical based psychology is misunderstood by most researchers who study child development. For them, to study something historically means, by definition, to study some past event. Hence, they naively imagine an insurmountable barrier between historic study and the study of present-day behavioral forms. *To study something historically means to study it in the process of change*; that is the dialectical method's basic demand. To encompass in research, the process of a given thing's development in all its phases and changes—from birth to death—fundamentally means to discover its nature, its essence, for "it is only in movement that a body shows what it is."

The search for method becomes one of the most important problem of the entire enterprise of understanding the uniquely human forms of psychological activity. In this case, the method is simultaneously prerequisite and product, the tool and the result of the study.

In summary, then, the aim of psychological analysis and its essential factors are as follows:

- (1) process analysis as opposed to object analysis;
- (2) analysis that reveals real, causal or dynamic relations as opposed to enumeration of a process's outer features, that is, explanatory, not descriptive, analysis; and
- (3) developmental analysis that returns to the source and reconstructs all the points in the development of a given structure.

The result of the development will be neither a purely psychological structure such as descriptive psychology considers the result to be, nor a simple sum of elementary processes such as associationistic psychology saw it, but a qualitatively new form that appears in the process of development.

The Psychology of Complex Choice Responses

In order to illustrate contrasting approaches to psychological analysis, I will discuss in some detail two different analysis of one task. In the task I have chosen, the subject is presented one or more stimuli (visually or auditorily as a rule). The required response differs according to the number of stimuli and the interest of the investigator.

It is also characteristic of this analyses that complex and simple responses are distinguished primarily by quantitative complexity of the stimuli: a simple reaction is said to occur when a single stimulus is presented, and the complexity of response is said to increase with an increasing number of stimuli. An essential presumption in this line of thinking is that the complexity of the task is identical to complexity of the subject's internal response. The identity is clearly expressed in the algebraic formulas commonly used in the analysis of responses to such tasks.

A verbal description of the theory underlying this set of formulas would be the following: the discrimination response is a simple reaction plus discrimination; the choice reaction is a simple reaction plus discrimination plus choice. The higher, more complex response is seen as the arithmetic sum of its elementary components.

A more mechanical notion of the complex, higher forms of behavior would be hard to imagine. However, this analytic approach has been shown to lead to a variety of difficulties. The most basic, empirical observation that contradicts this theory comes from Titchener, who pointed out that the time to execute a carefully prepared choice reaction may be equal to the reaction time for a simple, sensory response.

In our view, the basic premise underlying this entire line of analysis is incorrect. It is not true that a complex reaction consists of a chain of separate processes which may be arbitrarily added and subtracted. Any such reaction reflects processes that depend upon the entire process of learning at every level of practice.

This mechanical analysis substitutes relations existing between stimuli for the real relations underlying the process of choosing. This kind of substitution reflects a general intellectualism in psychology which seeks to understand psychological processes in the manipulations that make up the experiment itself; experimental procedures become surrogates for psychological processes.

While various scholars have demonstrated the inadequacy of psychological analysis based upon a mechanical decomposition of responses into their elements, these critics face the problem that their introspective analyses of complex reactions must be restricted to description: the description of external responses is replaced by the description of internal feelings. In either case, we are restricted to phenotypical psychological analysis.

This kind of analysis broke the identity between experimental procedures and psychological processes. Process names like "choosing" and "differentiating" were treated as leftover from a previous era of psychology when experimentation was still unknown: introspective observers were trained to make a clear distinction between process names and their conscious experience in order to circumvent this problem.

It should be clear that introspective analysis cannot provide a real causal or dynamic explanation of the process; for that to occur, we must give up reliance on phenotypic appearances and move to a developmental viewpoint.

These introspective studies resulted in the conclusion that a situation which seems to require choice process furnishes no grounds for speaking of a psychological choice response; talks of such responses was replaced by a description of the subjects' feelings during the experiment. But no one could provide evidence that these feelings were an integral part of the particular response process. It seems more likely that they are only one of its components, and require explanation themselves; we are led to conclude that introspection is often unable to provide an accurate description, let alone a correct explanation, for even the subjective aspect of the response. For the same reasons, the frequent discrepancies among the introspective descriptions of various observers which plague this area of research might be expected. It should be clear that introspective analysis cannot provide a real causal or dynamic explanation of the process; for that to occur, we must give up reliance on phenotypic appearances and move to a developmental viewpoint.

Research in complex reactions also illustrates psychological's reliance on the analysis of processes only after they have become fossilized. It might be said that complex reactions have been studied postmortem. Previous researchers have studied reactions in psychological experiments only after they have become fossilized.

A causal-dynamic study of choice reactions

Through an objective study of the entire history of the reaction, we can obtain an integrated explanation of both its internal and surface manifestations.

From my previous discussion another part of the task is clear: the complex reaction must be studied as a living process, not as an object. We must transform the reaction back to its source if we encounter it in automatized form. When we examine the experimental procedures used in complex reactions, we find that all are restricted to meaningless connections between stimuli and responses.

The subject is presented several stimuli to which he must respond in different ways: neither the relations between the stimuli and the required responses nor the sequence in which the stimuli are presented have any significance from the subject's point of view. When a motor response, such as a key press, is required, subjects may make the movement in any way they like. These conventions render the relations among the elements of the problem mechanical in principle and place the procedures on a plane with the research on memory that uses nonsense stimuli.

◆ This analogy between choice reaction and memory studies can be extended by considering the similarity of the role of repetition in the two tasks. Although no one has dwelt on a study of the practice trials in choice reaction studies, it is safe to conclude that if reaction is formed through repeated training (or training plus written or oral instruction), it has been learned by rote, just as learning the connection between two nonsense syllables in a rote process.

If simple reactions were involved and the subject was given extensive explanation ahead of time so that the relation between stimulus and response were meaningful (for example, push key number 1 when I say "one," push key number 2 when I say "two"), we would be dealing with already existing links. In neither case

could we study the process of organizing the reaction, during which its underlying links would be discoverable.

To make all of this clear, let us trace the stages through which the choice reaction moves, first in experiments with adults and then with children.

If we set up a relatively simple choice reaction, say, pressing a button with the left hand when a red stimulus is shown and pressing with the right hand when a green stimulus is shown, adults quickly acquire a stable response. Suppose, however, we increase the number of stimuli and responses to five or six and diversify the responses so that the subject has to respond not only with both hands, but sometimes pressing a button and sometimes simply by moving a finger. With this larger number of stimulus-response pairings, the task is considerably more difficult. Suppose further that instead of a lengthy pretraining period in which the subject is allowed to learn the stimulus-response relations, we give only minimal instructions. Faced with this situation, adults often refused even to attempt to deal with the problem, objecting that they could not remember what to do. Even after the session started, they kept repeating the instructions to themselves, asked about aspects of the task they had forgotten, and generally sought to master the entire system of relations as a whole before they settled down to the task as it is usually conceived.

However, if we placed additional stimuli on the response buttons and keys in a manner analogous to the procedures in previously described memory studies, the adults immediately used these auxiliary means to remember the necessary stimulus-response relations.

Among young children, a different picture emerged. We first presented the problem as we did with adults, by asking the child to make a number of different responses to different stimuli. Unlike the adults, children six to eight years of age often started right into the task after listening to the instructions and attempted to follow them without the slightest hesitation. As soon as the experiment began, most children found themselves in great difficulty. If a child recalled one or two of the required relations and responded correctly to those stimuli, he would naively ask about the remaining stimuli, treating each of them in isolation from each other. This behavior contrasted with that of the adults who generally failed to deal effectively with the individual stimuli until all the necessary relations were mastered. We view this behavior on the part of the children as evidence that they are in the stage of responding to the task in a natural or primitive manner because they rely on unmediated memory for the task elements. The fact that children would unhesitatingly accept the challenge of establishing a complex choice response to as many as ten stimuli suggests that they do not yet know their own capacities and limitations. They operate with complex tasks in the same way they operate with simple ones.

The child's behavior also differs from adult behavior when we introduce auxiliary stimuli, although we can discern the beginnings of the restructuring that characterize the adult.

First, we introduce auxiliary stimuli that bear a clear relation to the primary stimuli with which we began. For example, if the primary stimulus was a horse, in response to which the child was supposed to press a key with his left index finger, we pasted a picture of a sleigh on that key. On the key corresponding to a loaf of bread we pasted a picture of a knife. In this case, the child understands that sleigh goes with horse, the knife with bread, and so on. Choice reactions are smoothly established from the outset. Furthermore, it does not matter how many stimuli and responses are involved; the qualitative features of responding remain the same.

The child quickly works out a rule for the problem's solution and makes his choice on the basis of this rule.

It would be incorrect, however, to assume that the child has mastered a mediated system of behavior in its full, adult form. We need only to change the relations among the primary and auxiliary stimuli to discover the limits of the child's response system. If pair the stimuli in a different way (say, horse with knife, bread with sleigh) the child will no longer use the auxiliary stimuli in a proper way. The child recalls only that horse helped to find sleigh in some way. He reveals by his responses that he had been using the conventional association of horse and sleigh to guide the choice, but had not mastered the internal logic of using one stimulus to mediate the response to another.

If we continue our experiment long enough, we will begin to see changes in the way the child responds. In the first stage of responding to arbitrarily related stimuli, the child has insufficient experience with the task to organize his behavior effectively. He uses experience naively. But in the course of the experiment, he gains experience necessary for restructuring his behavior. Just as naïve physical knowledge is acquired as the child operates with objects, knowledge of psychological operations is acquired as the child strives to carry out the choice reaction task. As he attempts to recall which stimuli are linked to which responses, the child begins to learn what remembering in this situation consists of and begins to use one or another of the auxiliary stimuli effectively. The child begins to realize that certain relations among the stimuli and auxiliary pictures produce correct choice responses, while others do not. He soon begins to object to the arrangement of pictures, asking that the pictures on the key be arranged to fit the primary stimuli that are associated with the key. When told to press the bread key in response to the horse picture, the child answers "No, I want the sleigh key." This shows that the child is accumulating experience which is changing the structure of his own memorizing.

Having naively comprehended what the memorizing operations require, the child moves to the following stage. If presented with primary and auxiliary stimuli in an arrangement that seems haphazard, the child will ask to put them in special order, thus personally establishing a specific relation between them. At this point the child is showing that he knows that certain signs will help to achieve certain operations. In short, he is beginning to memorize through the use of signs.

Once this happens, the child no longer experiences difficulties in creating relations and using them. Given some pairing of primary and auxiliary stimuli, the child is no longer restricted to using already available relations (such as horse-sleigh) but can create relations of his own. This may be called the stage of external sign use. It is characterized by the independent formation of new relations in the child's internal operations using externally presented signs. Now the child is organizing externally stimuli to carry out its responses. This fundamental stage is then followed by the stage at which the child begins to organize stimuli of an internal nature.

These changes are manifested in the course of the choice reaction experiment. After considerable practice in the choice experiment, the reaction time begins to grow shorter and shorter. If the reaction time in a particular stimulus had been 500 milliseconds or more, it reduces to a mere 200 milliseconds. The longer reaction time reflected the fact that the child was using external means to carry out the operations of remembering which key to push. Gradually, the child casts off the external stimuli, no longer paying attention to them. The response to the external auxiliary stimuli is replaced by a response to internally produced stimuli. In its most developed form, this internal operation consists of the child grasping the very structure of the process, learning to understand the laws according to which

external signs must be used. When this stage is reached, the child will say, "I don't need pictures anymore. I'll do it myself."

Characteristics of the New Method

I have attempted to demonstrate that the course of child development is characterized by a radical alteration in its very structure of behavior; at each new stage the child changes not only her response but carries out that response in new ways, drawing on new "instruments" of behavior and replacing one psychological function by another. Psychological operations that were achieved through direct forms of adaptation at early stages are later accomplished through indirect means.

Our concept of development implies a rejection of the frequently held view that cognitive development results from the gradual accumulation of separate changes. We believe that child development is a complex dialectical process characterized by periodicity, unevenness in the development of different functions, metamorphosis or qualitative transformation of one form into another, intertwining of external and internal factors, and adaptive processes which overcomes impediments that the child encounters.

As I have repeatedly emphasized, an essential mechanism of the reconstructive processes that takes place during a child's development is the creation and use of a number of artificial stimuli. These play an auxiliary role that permits human beings to master their own behavior, at first by external means and later by more complex inner operations.

Our approach to the study of these processes is to use what we call *the functional method of double stimulation*. The task facing the child in the experimental context is, as a rule, beyond his present capabilities and cannot be solved by existing skills. In such cases a neutral object is placed near the child, and frequently we are able to observe how the neutral stimulus is drawn into the situation and takes on the function of a sign. Thus, the child actively incorporates these neutral objects into the task of problem solving. We might say that when difficulties arise, neutral stimuli take on the function of a sign and from that point on the operation's structure assumes an essentially different character.

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objectification of the inner process guarantees access to specific forms of higher behavior as opposed to subordinate forms.

