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PERCEPTION IN SOVIET PSYCHOLOGY

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The relation between experimental work in perception in the Soviet Union and the orthodox philosophy of the Soviet state is discussed. It is pointed out that both the philosophy derived from Lenin and Marx and the needs of the state exert an influence on the nature of the problems studied and the type of theory developed. Studies in the areas of tactual, auditory, and visual perception are reviewed. These are considered against the background of Leont'ev's motor-copy theory of perception, currently the most systematic Soviet approach to perception. Certain other studies in visual perception conducted in the context of Uznadze's theory of set, as well as some mathematical approaches to perception not fitting into any general theoretical frame, are also briefly reviewed.

Three prominent issues are apparent in Soviet work in the field of perception: an epistemological concern, an emphasis on response processes, and a pragmatic interest. It is the purpose of the present review to describe several areas of research pursued by Soviet psychologists interested in perception. The discussion will attempt to point out the manifestations of these trends and at the same time to be detailed enough to present some essence and perhaps more flavor of the research.

The epistemological current in Soviet psychology derives from the accepted state philosophy, Marxist materialism—in this particular case Lenin's elaboration of Marx as it is applied to sensation and perception. In brief the Soviet philosophical position might be characterized as follows: The materialist position argues for the existence of the real world and the primacy of matter against any kind of idealist philosophy. Further, Lenin in an emotional polemic claims that we know the real world as it actually exists. This knowledge is obtained through our sense organs and our brain mirrors the world (Lenin, 1927). Lenin's theory of the reflection of the real world has been termed by some a copy theory and is discussed in detail by Wetter (1958).

The Soviet psychologists' assumption that perception mirrors the real world leads them to be concerned with images and their formation in consciousness. When one examines the procedure by which the existence and qualities of an image are determined, it is sometimes easily translated into operations. For example, in a study of the role of eye movements in young children's perception (Zinchenko, Chzhi-tsin, & Tarakanov, 1962), the authors mention the "adequacy" of the image of an object but they use a multiple-choice recognition procedure and error score to measure this.

One implication of the copy theory is that we do not have to add anything to the information obtained via sense organs. Central addition to sensory information in order to obtain true knowledge smacks of idealism and is rejected. Idealism (as opposed to materialism)

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here refers to any possible sense in which ideas define or determine reality. The concept that association or integration is imposed on stimulation by the central nervous system might lead to the possibility that ideas define reality. On the other hand, kinesthetic feedback and other combined sensory inputs from several modalities are emphasized by Soviet psychologists (Leont'ev, 1959b). This fact suggests that basically the Soviet psychologists may be rejecting successive association and Gestalt organization for simultaneous association.

The importance of kinesthetic feedback or response-produced stimulation in Soviet theory seems to derive from a happy coincidence of certain philosophical points in Marx and Engels and some theoretical ideas of Sechinov and Pavlov. Marx in his *Theses on Feuerbach* implied that truth is determined in activity, in particular, that sensory activity and practice, not passive contemplation, determine reality (Aikin, 1956, p. 193).

The theoretical ideas of Sechinov come from his observations of behavior and subsequent speculations (cf. Leont'ev, 1959a) to the effect that sense organs, exemplified by the hand, obtain information by actively exploring the objects in the environment. These suggestions are further reinforced by Pavlov's interest in the orienting response and in the kinesthetic analyzer.

The very real requirements of a rapidly industrializing country and the emphasis on action as exemplified by Marx's *Theses on Feuerbach* (Aikin, 1956, p. 195) give to Soviet psychology quite a pragmatic cast.

The considerations outlined above, the materialist assumptions and the response emphasis, are embodied in the most important current Soviet theory of perception—one developed by Leont'ev (1959a). In this theory the organism is considered to make a reflex response to a stimulus. The combination of receptor stimulation and the reflex feedback form the basis of the perception. In one case (Leont'ev, 1959b), the stimulus is conceived as evoking an orienting response to which the organism is initially insensitive. Then by a classical conditioning procedure the attention of the subject is attracted to the reflex state itself and, in this mediated way, the subject is able to respond to the original stimulus. An example of this is the stimulation by a light of the skin of a blindfolded subject. Light with appropriate heat filters had been shown to elicit a physiological skin reaction to which subjects ordinarily do not respond. When the light is consistently followed by an electric shock, subjects slowly come to be able to anticipate the shock although they do not know the basis of the anticipation. In another case, tactual stimulation and kinesthetic feedback combine to yield the perception of specific objects in active touch (Anan'ev, Vekker, Lomov, & Yarmolenko, 1959). Here, it seems that the physical object constrains the hand to reproduce the contour of the object, and feedback from this motion forms the basis of perception of the object. The initial interaction of the hand and object with its correlative tactual stimulation forms the basis of the perception of such qualities as temperature, hardness, elasticity, etc. But even these depend to a certain extent on feedback from the hand movement.

In the first of the above cases (the stimulation of the skin by a light), Leont'ev's idea was that a reflex response is made to a stimulus and the subject becomes sensitive to this response and not to the conditioned stimulus. Leont'ev employs this type of process to explain "sensation." In the second case, the response that we are perceiving is a reproduction (by our own movements) of the physical stimulus. This general process forms the basis of Leont'ev's theory of perception. We in some sense reproduce the physical object by our movements. The combination of kinesthetic feedback and initial stimulation serve as the basis of our perception. This is a motor theory of perception, but a motor theory which involves copying the physical stimulus.

It is easy to point out difficulties for the theory, the same difficulties with which our motor theorists of cognition and perception have been faced. Instead, let us consider three sets of investigations which have been instigated by this view of perception. One set is on tactual perception, the second on the development of visual and tactual perception, and the third on auditory-pitch perception.

The studies of tactual perception (Anan'ev et al., 1959) generally involved asking a blindfolded subject to explore an object by hand and then either to make a drawing of it or to recognize it among several objects. Particular attention was paid in many of their investigations to the manner in which the subject explored. This, of course, is a manifestation of the interest in response processes described above. The question of how the movements of the hand provide the basic information for perception of the object is important here.

Very often time-motion analyses of the hand movements of the subjects exploring the objects were made. From motion picture films a "tsiklogram" was constructed consisting of a plot over time of the positions of the hands and fingers. From this the speed of movements along the contour could easily be analyzed. Such analyses carried out for the separate fingers, exploring an object bimanually, indicated that the different fingers explored at different rates and stopped at different times. Pauses typically occurred at corners. A sample (Anan'ev et al., 1959) of the results of such an analysis of a subject, who has been asked to explore a shoelike cutout form, indicated that all the fingers of the right hand were in motion more of the time than they were at rest during the exploration, while for the left hand the index finger and fourth finger were at rest more than they were moving. These relations changed somewhat upon repeated exploration of the same object. In spite of such methods which easily lend themselves to quantification, the investigators presented very little quantitative data and appeared to be more interested in a qualitative analysis of the process of tactual exploration.

The picture presented (Anan'ev et al., 1959) of the bimanual exploration of an object (under directions to the subject to reach behind a screen and explore an object so that he will be able to make a drawing of it) starts with movements of both hands in the air or on a table along the sagittal axis of the body until contact with the object is made. The hands then slide lightly over the surface of the object to the upper edge. These movements are said to be regulated mainly by stimulation from the middle finger. When the hands get to the far point of the object, they stop for a moment. All of these movements are said to be orienting in nature. Reproductions made after this initial exploration are poor in detail but good in general form although often elongated along the vertical axis. It is noted that such reproductions are made in the order that the exploration occurred and subjects have great difficulty in changing the order of reproduction.

The subsequent exploring motions consist of both gross hand and finger movements and micro finger movements of a millimeter or two, the purpose of the latter being interpreted as maintenance of sensitivity. The function of the gross movements is said to be synthesis of the multitude of cues being perceived. The basis of this interpretation is that the subject having made these movements is then able to draw a picture of the object starting from any point of the contour. The authors suggest that the spatial-temporal image has developed into a spatial image.

The form of the gross exploring movements is more or less determined by the shape of the object. The trajectory of the movements corresponds in general to the shape. The optimal speed is between 5 and 10 centimeters per second. The movements are not even, but broken into a series of small sections. The pauses occur at apex angles and changes of direction of movement. The two hands move and pause at the same time when exploring symmetric objects. But if one hand reaches a stopping point it pauses until the other catches up. If the object is not bilaterally symmetric the movements of the hands become asynchronous and alternating—one hand moving and the other acting as a reference point for the exploration.

In a fashion as descriptive as the above, many aspects of touch were analyzed: monomanual touch, touch with various fingers immobilized, passive touch, touch with instruments including artificial limbs, touch in the physically handicapped, touch in the process of manual labor, etc.

One hypothesis presented in this monograph, namely, that the nature of the interaction between receptor and object determines the properties of the perception, has been further investigated by Vekker and Lope (1961). These experimenters moved geometric forms with sides of various compositions across a subject's passive finger. They report a curvilinear relation between the roughness and estimated length. The smoothest and very roughest lengths were estimated as longer than similar lengths of intermediate roughness. The same results were obtained with active touch using a single finger. Duration of movement is positively correlated with estimated length of object; if the duration is doubled, estimated length is increased by 50%.

Another aspect of the use of information from moving stimuli reported in the same paper is that adequacy of perception of stimuli moving on a particular part of the skin is positively correlated with the absolute threshold of that part of the skin. In this connection it should also be mentioned that Mileryan and Tkachenko (1961) reported some work in the tradition of classical threshold psychophysics. They gave subjects 12 days of practice in spatial discrimination of tactual stimuli. Their report indicates that thresholds decreased markedly for the practiced section of skin and the increased sensitivity generalized to neighboring areas decreasing as the areas became more remote. There was, however, complete bilateral transfer of improved discrimination.

Anan'ev and his colleagues suggested that tactual perception is more primitive ontogenetically than visual perception. They repeat rather often the assertion that touch teaches vision. No evidence is presented for this assertion, but the following investigations of Zinchenko are concerned with the development of tactual and visual perception and with cross-modal perception.

Zinchenko (1957; Zinchenko, Lomov, & Ruzskaya, 1959) was struck by the obvious fact that gross eye movements are not necessary for perception of objects by adults. This posed an immediate problem for a motor theory of perception. Moreover he observed that although the hand was the organ par excellence for the motor-copy theory, it could also, under unusual conditions, perceive while remaining quite passive.

Reviewing results of other investigators (both Soviet and Western) Zinchenko (1957) concluded that: (*a*) Young children (3 years old) do not initially visually differentiate geometric forms presented to them. They orient towards the forms tactually and only when the hand movements around the contour of the objects become orderly do the eyes begin to track the hands. Tactual differentiation precedes visual differentiation. (*b*) Tactual identification of unfamiliar objects by adults is quite slow, requiring much preliminary exploration. It becomes almost instantaneous as the object becomes very familiar. (*c*) Visual inspection of new objects also involves many large movements initially. With repeated inspection these movements become more abbreviated and conform more closely to the contour of the object, finally dropping out completely. On the basis of such analyses of previous work, Zinchenko felt that visual and tactual perception were not as different as had been previously considered.

These considerations inspired an additional series of studies on the comparative development of touch and vision (Chzhi-tsin, Zinchenko, & Ruzskaya, 1961; Lavrent'eva & Ruzskaya, 1960; Tarakanov & Zinchenko, 1960; Zinchenko, 1960; Zinchenko, Chzhi-tsin, & Tarakanov, 1962; Zinchenko & Ruzskaya, 1960a, 1960b).

The majority of these experiments were concerned with the perception of forms both within one sense modality and cross modally. The forms used were rather amorphous two-dimensional cutouts adapted from those used by Gaydos (1956). The stimulus was presented to the subject visually or tactually and required the subject to recognize it when presented either visually or tactually along with two other forms. The subjects were preschool children aged 3 to 7. Quantitative observations included percentage of errors in recognition and amount of time spent in the recognition part of the task. Qualitative observations were made of the type of exploratory movements, both hand and eye, which occurred as the children performed the task.

In general, errors decreased with age. Wherever big improvement in error score occurred it was interpreted in light of the changes in hand and/or eye movements which occurred along with it. Thus eye movements of 3–4 year olds in the visual-visual combination did not follow the contour of the form, but consisted of saccadic movements almost entirely inside the contour. These children made approximately 50% errors. The 4–5 year olds made 28.5% errors and their eye movements conformed much more closely to the contour.

These experiments while quite interesting in principle are somewhat disappointing in execution. Control for order and practice effects appears to be lacking. Sometimes much is made of small differences in percentage of errors which probably would not be significant if statistical analyses were made. The results are suggestive nevertheless and the percentage of errors for the different tasks is shown in Table 1.

The next experiments in the series were designed to study procedures for improving performance on this type of task. Lavrent'eva and Ruzskaya (1960) tried to improve cross-modal matching in children by making the task one of simultaneous matching rather than successive, on the supposition that the poor performance of the younger children might be due to the memory requirements of the successive situation. Children were shown one stimulus in one sense modality and asked to recognize it simultaneously from a group of

TABLE 1

PERCENTAGE OF ERRORS IN RECOGNITION OF PERCEIVED FIGURES

Condition of initial perception	Condition of recognition	Percentage of errors at age: 3–4	4–5	5–6	6–7
Visual	Visual	50.0	28.5	0	2.5
Visual	Tactual	—[a]	73.0	34.0	23.2
Tactual	Tactual	47.7	42.3	25.0	23.1
Tactual	Visual	70.5	42.3	38.5	40.4

[a] Subjects unable to respond meaningfully to this task.

three through the other modality. To the surprise of the investigators, performance was worse on this simultaneous task than on the previous successive tasks, particularly for the younger children. The relative failure of the younger children is attributed to their tendency to orient towards the recognition stimuli and not towards the single stimulus to be matched. This conclusion is supported by data of exploratory time spent with the different stimuli. The children who spend practically no time examining the stimulus to be matched can hardly develop an image of it. The older children do spend as much as one third of their total time exploring the single stimulus and consequently do relatively better.

The second procedure used to improve performance was reported by Tarakanov and Zinchenko (1960). They had one group of children examine a stimulus tactually and visually for 10 seconds, then recognize it from among three, tactually by one subgroup and visually by another. A second group was required to fit the initial stimulus form into one of three holes which matched it in size and shape. In this case, the second group was markedly superior to the first group on both visual and tactual recognition tasks. The superiority of the second group is attributed to the fact that the practical task required of the subjects insured that the proper aspects of the stimuli were attended to. The authors suggest that generally children of this age learn more when performing a practical activity than when instructed to remember something for subsequent use.

Finally, a straightforward attempt to train children to perform such a matching task was made by Chzhi-Tsin, Zinchenko, and Ruzskaya (1961). Children were given three successive stages of training. In the first stage the subject was asked to follow, by eye, the movement of a pointer with which the experimenter traced around the contour of the stimulus form. In the second stage the subject was shown how to grope (with his fingers) around the contours of the forms presented tactually. In the third stage the subject was asked to move his own finger around the contour of the original single stimulus and to follow his own movements by eye. Error scores indicated that performance improved at each training stage but the biggest improvement occurred at the first stage. The authors concluded that requiring the subject to visually follow the experimenter's pointer moving around the contour, is the most effective procedure and it remains effective longest. However, no controls were included for order and practice effects of the successive stages of training so the conclusions must be accepted with extreme caution.

In reviewing the results of several of these experiments, Zinchenko and Ruzskaya (1960b) noted that, under various conditions, visual perception proceeds sooner and more accurately than tactual, and that tactual perception interferes in some cases with visual. These results forced them to reject their initial formula that the hand teaches the eye.

The experiments considered so far have all involved receptor systems in which the receptor organs and the organ "copying" the stimulus were one and the same, the eye or the hand. A more critical demonstration of the generality of their motor-copy theory would be in a modality of perception for which such correspondence was not the case. Leont'ev and his colleagues have conducted a series of experiments on pitch perception with just such an aim in view. The ear, of course, is the receptor organ for auditory stimuli, but if any motor system is involved in copying the physical stimulus it would be the voice musculature. Leont'ev approached the study of pitch perception by trying to isolate it from its dependence on timbre.

The initial experiment was the determination of the difference threshold for pitch, first in the classical manner, that is, with pure tones, and again with the pitch-timbre correspondence distorted by adding specific harmonics to a base tone (Gippenreiter, 1957, 1960). Both threshold determinations involved presentation to the subject of a series of pairs of tones. Subjects were asked to judge which of the two tones was higher in pitch.

The thresholds determined in the classical manner ranged from 5 to 135 musical cents. The timbre-distorted thresholds (tdt) showed a sharp increase in most cases over the classical thresholds. Three groups of subjects were distinguished: a small minority (13%) whose thresholds did not change; a second group (57%) whose thresholds deteriorated moderately, for example, by a factor of three or four; and a third group (30%) whose thresholds for all intents and purposes deteriorated so as to be unmeasurable (specifically being greater than 1,200 musical cents). There also appeared to be little correlation between threshold for pure pitch and tdt's. This fact is interpreted as supporting a hypothesis that there are two separate systems involving the perception of pitch.

The next step, in investigating this problem, involved application of the motor-copy theory by studying the relation between ability to vocalize tones and ability to discriminate pitch. Three small studies were conducted (Gippenreiter, 1958, 1960). The first began with a replication of the tdt determinations with a new group of subjects, then tdt values were obtained requiring the subject to vocalize the tones before making the judgments as to which tone was of higher pitch. This vocalizing procedure resulted in a sharp decrease in threshold over the values obtained without vocalization. Some subjects were retested under instructions to remain silent. Their thresholds reverted to the initial high values. The second study was a determination of tdt's for people who had narrow ranges of accurate vocalization. For tones within this range these subjects had very small difference thresholds. Finally in the third small study it was determined that the overall correlation between accuracy of vocalization and tdt was .83. Such data provide correlational evidence of a close association between vocalization and discrimination but they do not demonstrate the nature of this association.

Further support for this association was adduced on the basis of experiments in which thresholds were determined while the subject was asked to intonate a different note from the one presented (Ovchinnikova, 1958, 1960b).

Subjects with both small and large tdt's were tested in this manner. They were required to sing a given note while tdt determinations were made at a different range on the scale. Subjects with large tdt's were not much affected by singing. Their pitch thresholds were so bad to start with under these timbre-distorted conditions that they could not get worse. Of the 18 subjects in the groups with small tdt's, 12 showed a marked increase in threshold when the determination was made while intonating a note. The other 6 showed little change in threshold. Upon questioning, 4 of these latter reported having had a good deal of experience singing in choruses. The inference from these results, that motor involvement causes the deterioration of threshold, is weakened by the possibility that the sound generated by the subject himself interfered with the task of discrimination. In addition it could be argued that the subject has to attend to two tasks and becomes less efficient. The interference criticism is eliminated in a purer experiment described below. The present experiment along with the other evidence accumulated is certainly supportive of the hypothesis of vocal-motor involvement in pitch perception.

On the basis of the data, Leont'ev and his colleagues hypothesized that there are indeed two functional systems for auditory perception (Gippenreiter, 1960; Leont'ev & Gippenreiter, 1959). They suggested that these perceptual systems develop early ontogenetically and independently—the one depending on speech training, the other on musical training. In some cases the system depending on speech training develops normally and replaces or suppresses the other system in which pure pitch discriminations are important. In languages such as Vietnamese where the pitch itself carries meaning, there should be no chance for such replacement or suppression. With these considerations in mind the original pure tone and tdt experiments were carried out on a group of 20 Vietnamese college students. Table 2 abstracted from Leont'ev and Gippenreiter (1959) presents a comparison of the results obtained from Russians and Vietnamese.

Having gone about as far as possible to support the motor-copy theory on the basis of normative data, the next step was to try to experimentally manipulate the precision of perception of this timbre-distorted pitch—in short, training experiments. Two methods of training were tried (Ovchinnikova, 1959a, 1959b, 1960b). The first was a sensory training method consisting essentially of correcting the subject during the same psychophysical procedure that was used to test thresholds. Before and after this training, tdt's were determined as were thresholds for pure tones. This training, carried out on nine subjects, resulted in a decrease in threshold for the pure tones but no significant generalization to the timbre-distorted tones.

The second method involved motor training. Here subjects were presented with single pure tones and were asked to sing them. The experimenter verbally corrected the subject's performance,

TABLE 2

PERCENTAGE OF SUBJECTS WITH INDICATED CHANGE OF TDT

Group	Unchanged	Increased by a factor of 2	Increased by a factor 2–4	Increased by a factor of 5 or more
Vietnamese	50	25	25	0
Russian	26	20	13.5	40.5

coaching him on to the correct tone. All nine subjects given this motor training improved in their ability to intonate these tones accurately and all improved considerably in their tdt's. Those who improved most reported singing the notes to themselves. Those who improved least did not sing the notes. When the latter subjects were instructed to sing the notes aloud before making discriminative judgments, their tdt's dropped to a much lower level.

The authors interpreted this as suggesting that, on the basis of reinforcement, an association is established between the pitch of the sound and a particular activity of the vocal chords. This activity then serves as an indicator of the pitch. Such an interpretation implies a two-level theory of perception (which is, of course, implicit in the whole motor-copy hypothesis) in which an apparently lower-level reflex response occurs which forms the basis of the conscious discrimination of pitch.

Independently of these investigations, Chistovich and her colleagues working in the Pavlovian Institute in Leningrad have also studied the role of vocalization in auditory perception (Chistovich, Alyakrinskii, & Albul'yan, 1960; Chistovich, Klass, & Alekin, 1961). In general her approach has been to have subjects repeat (identify) or discriminate (same-different judgments) sounds presented to them. Accuracy of both repetition and discrimination are better for languagelike sounds than for random tones. Quantitative analysis of the results was carried out in terms of information transmitted.

To return to Leont'ev, his model, as it so far has been presented, can be considered to involve a stimulus exciting a receptor organ (sensory link) and a reflex response (motor link), the latter serving as a mediator. The final two experiments in the series replace the sensory link on the one hand (Leont'ev, 1960) and the motor link on the other hand (Ovchinnikova, 1960a).

The auditory sensory link was replaced as follows: Instead of sounding a note, a vibratory stimulus was applied to the skin of the subject. Vibratory stimulation, according to Leont'ev, has, like sound, two often confused parameters, specifically frequency and intensity. That is, increasing the intensity of the vibration typically results in a decrease of perceived frequency and conversely. A noiseless vibrator was applied to the index finger in this study. At first, frequency difference thresholds were obtained for vibrations of the same intensity, then with the intensity of one stimulus half that of the other. In the latter case the difference threshold was increased by a factor of three to five. The subjects were then trained to intonate notes of the same frequency as the vibratory stimuli. Slowly, on the basis of verbal reinforcement from the experimenter they became able to match the frequency of the stimuli with their voices. Difference thresholds were redetermined and differential sensitivity to these amplitude-distorted vibrations had increased.

In the experiment in which the motor link was replaced, the auditory system was utilized as in the earlier experiments on pitch. But here when a note was sounded instead of singing it as in the previous auditory motor training procedure, the subjects were asked to press a key with a pressure defined by an arbitrary scale which linearly related pressure to frequency. The experimenter verbally corrected the subject's pressure. The experiment was carried out with three subjects who initially had large tdt's. After numerous (25–33) training sessions the subjects learned this arbitrary scale. Their tdt's were then redetermined and showed large increases in sensitivity. Furthermore if the subject's hand was involved in some extraneous task his tdt's reverted back to the initial high levels.

These are rather clever experiments with which the series is ended, but the last experiment contradicts the motor-copy hypothesis. In particular, the subject does not have to produce a tone with his muscle pressure in order to differentiate pitch. Interestingly the apparatus was wired so that the subject's pressure produced a tone via an audio oscillator. However, the subject *did not hear the tone.* The experimenter monitored the pressure by watching the tone on an oscilloscope. It would seem as if the copy part of the motor-copy hypothesis has been shown to be unnecessary in this experiment.

There have been no other such systematic, theoretically integrated research programs carried out in auditory perception by Soviet psychologists although the work of Chistovich referred to briefly above approaches this in some respects and is of very high quality. Chistovich's colleague, Maruseva (1959a, 1959b), has extensively studied the functioning of the auditory system both in children and adults. This work has also been concerned with determination of sensitivity and with possible ways of increasing sensitivity but has been done from a more strictly classical psychophysiological point of view. There has been a recent attempt to relate individual differences in auditory perception to occupation (Kalikinskiĭ, 1961a, 1961b) and a study of the development of speech comprehension (Liamina, 1960), but such work seems to be sporadic and of questionable quality.

Some work on visual perception has been described in various connections but Soviet contributions in this area have generally not been systematic or profound. General discussions of perception such as Anan'ev's (1960) adopt a generally empirical approach to visual perception. Within this point of view some of the classical problems of space perception are interpreted from a Pavlovian model of learning. Thus some of the classical cues like convergence, accommodation, etc., become conditioned stimuli for the perception of depth. The Soviet interpretation would like, as usual, a reflex response to form the initial basis of depth discrimination. Such an argument can be made for convergence and accommodation. Anan'ev (1960) *finds it difficult in the* case of retinal disparity. But by a rather abstruse route he also attempts to put this on a reflex basis (pp. 154–160). He cites experiments conducted in his laboratory which indicate that eye dominance shifts with change of viewing distance. He then suggests that this shift of eye dominance is the conditioned reflex to a change of distance. Even granting this claim, it is not clear to this reviewer how the function of retinal disparity in depth perception is thereby explained.

The problem of constancy has been approached more or less systematically by Georgian psychologists. They have been working in the context of Uznadze's theory of set. Many psychological phenomona are interpreted as manifestations of established sets. A thorough exposition of this point of view is presented by Prangishvili and Khodzhava (1958). In fairness it should be stated that the proponents of this school are concerned both with how to establish a set and its subsequent effects. However, it appears to be a rather naive approach and does not offer very satisfying explanations. When the concept of set is applied to the problem of constancy, we find, for example, Natadze (1961) simply suggesting that all theories of constancy demand some sort of evaluation of the situation by the subject and since this goes on unconsciously it may be simply that the subject is set for a particular situation. The same author (Natadze, 1960) describes an apparatus similar to that of Holway and Boring (1941) for varying the amount of information (secondary spatial cues) available to the subject as to the distance at which he is making size judgments. When he is thus set for the actual distance, constancy is good. Working in the opposite direction, Adamashvili (1960) creates a false set and shows how this distorts size judgments. Part of his report concerns the way in which independent variation of size and distance of stimuli can effect the set established in the subject.

Bzhalava (1962) has applied the concept of set to figural aftereffects of the Köhler-Wallach and Gibson types. The line of reasoning as far as the Köhler-Wallach aftereffects are concerned is that fixation of the inspection figure induces a set to see a particular size figure in a particular part of the visual field. When a smaller or larger test figure is subsequently introduced, a contrast illusion results in the test figure looking even smaller or larger than it actually is. Experiments are reported in which such contrast effects are obtained when the inspection and test figures differ considerably in shape. The analysis is provocative, but all the variations of Köhler-Wallach aftereffects cannot be so simply handled, and a critical demonstration that a general set can handle these phenomena depends on a careful analysis of the precise shapes perceived upon presentation of the test figures. Such an analysis is not presented. Finally "set" so far has been too vaguely defined to constitute an explanatory concept.

There are isolated studies on other aspects of visual perception to be found in Soviet psychology. For example, Dymerskiĭ (1960) completed a dissertation on the perception of spatial-temporal relations. He was primarily interested in the cues used by pilots in landing airplanes. Using experimental studies of the perception of distance by moving observers, the practical experience of pilots, and mathematical analysis, he established a general relation between perceived distance and various components of angular acceleration. In addition, it was suggested that the optimum place a pilot should look in landing an airplane depends on the difference between the change of angular velocity due to changing altitude and the change in angular velocity due to change in direction of movement with respect to the ground surface.

Another example is the work of Fonarev (1959) who investigated the presence of conjugate eye movements in neonates. He found that in the absence of visual stimulation (very low uniform illumination) the majority of neonates' eye movements were conjugate. However, introduction of a stimulus inhibits this conjunction and the majority of eye movements become disjunctive.

An interest in eye movements is quite congruent with the motor-copy theory as suggested previously and there is a large amount of interest in eye movements but no systematic research programs. Luriya, Providina-vinarskaya, and Yarbus (1961) present an interesting study of a case of optic ataxia in which the patient could fixate and track a moving stimulus but was unable to shift point of fixation at will. Zinchenko (1957) was interested in the possibility of conditioning exploratory eye movements. He found that, under certain conditions of practice, eye movements anticipated the onset of a light stimulus if an appropriate signal preceded it. Khomskaya (1962) has studied eye movements from the point of view of determination of the necessary stimulus conditions for movement. She recorded eye movements by means of photoelectric cells activated by light reflected from the eye. Subjects were asked to perform four tasks: (*a*) to look back and forth between two points separated by a visual angle of 30 degrees, (*b*) to follow a moving light which moved back and forth at rates of .32–2.08 cycles per second, (*c*) to repeat Task *a* to see if fatigue effects occurred, and (*d*) to track a moving light by memory, that is, to continue tracking movements after the moving light was extinguished. In Task *a* saccadic movements occurred between the two points with short fixations at the two points. The frequency of the movements was very constant for each subject but large individual differences were noted. In Task *b* eye movements tracked the light quite closely at low frequencies but at high frequency movements became saccadic again. In Task *c* there were no differences from Task *a*. And in Task *d* as soon as the actual moving light was extinguished, the subject's eye movements became saccadic.

One final significant trend in the Soviet study of perception is the application of mathematical methods. The dominant figure in this work is E. N. Sokolov, better known for his work on the orienting reflex. Sokolov and Mikhalevskaya (1961a, 1962) have applied mathematical techniques to evaluation of the effectiveness of near-threshold stimuli. In one case they used Bayes theorem to estimate the conditional probability that the stimulus had occurred given that a particular EEG response was present. In another case, an investigation of sensitivity to light, they empirically determined the general relation between reaction time and intensity of light stimulus. After fixing confidence bounds for the function, they were able to estimate the probability that specific stimuli were above, at, or below threshold, given a particular reaction time, threshold being defined as that value of stimulus perceived a certain percentage of the time.

A few years ago Sokolov became concerned with scanning mechanisms which might be used for letter recognition. His approach (Arana, 1961; Sokolov, 1960) was to look at an ideally efficient form of scanning behavior (one which minimizes area scanned) and to compare this with actual behavior of subjects. Letters of the alphabet were to be individually scanned until recognition occurred. To make the experimental situation one of sequential scanning a tactual task was used with vision precluded.

A probability model for ideal scanning was constructed using successive application of Bayes theorem. That is, given that the *n*th square is filled, what is the probability that the letter is A, B, C . . . ? And given the new probabilities, what is ideally the next square to scan? Analyses of situations employing various numbers of letters and fuzziness of letters have been made. A subject's behavior in such situations show a gradual approach to the most efficient scanning behavior for the set of letters used. Using a large number of letters has the effect of increasing the number of superfluous scanning movements. But gradually increasing the number of letters after efficient scanning behavior has developed results in preservation of the scanning strategies developed by the subject.

In another approach, Sokolov and Mikhalevskaya (1961b) elaborated a probability and information analysis for discrimination situations, much like the analysis of Garner and Hake (1951). There is a lively interest in the application of information theory to psychology in the Soviet Union. There conceivably are difficulties in integrating an information-theory approach with Lenin's copy theory. An information-theory model for perception would not seem to require that a "copy" of the stimulus arrive in the head since obtaining information strictly speaking only involves reducing the uncertainty in designating which stimulus has occurred. The reviewer, however, has seen no Soviet commentaries on any such difficulty so perhaps it is not the problem he imagines.

This final area of Soviet research is apparently one in which Soviet philosophy and the needs of the state have not imposed their influence. But this is not usual and, in general, it has been suggested that the motor-copy theory and the resarch inspired by it have sanction, if not the enouragement of orthodox Soviet philosophy. The theory and research reflect as well the emphasis on response processes derived from the Russian physiological tradition. Several aspects of the research, in visual perception (aircraft landings), in auditory perception (occupational differences), and tactual perception (touch in manual labor) have a definite practical orientation. Soviet psychology is a relatively small enterprise in comparison with American psychology. It is to be hoped that as it increases in size and importance, and with a general liberalization in the Soviet Union, some of the constraints will evaporate and Soviet psychologists will apply their creativity and industriousness in many more directions.

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