THE ORGANISM AND THE CAUSAL TEXTURE OF THE ENVIRONMENT[1]

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Having found that our previous separate investigations had led us quite independently of one another to a common point of view as to the general nature of psychology, we decided upon this joint article.

I

Each of us has come to envisage psychology as primarily concerned with the methods of response of the organism to two characteristic features of the environment. The first of these features lies in the fact that the environment is a *causal texture* (*Kausalgefüge*) [2] in which different events are regularly dependent upon each other. And because of the presence of such *causal couplings* (*Kausalkoppelungen*), actually existing in their environments, organisms come to accept one event as a *local representative* (*Stellvertreter*) for another event. It is by the use of such acceptances or assertions of local representatives that organisms come to steer their ways through that complex network of events, stimuli and happenings, which surrounds them. By means of such *local representation* (*Stellvertretung*) the organism comes to operate in the presence of the local representative in a manner more or less appropriate to the

[1] This article was written during a relatively long stay of the one author, Tolman, in Vienna. A somewhat different version under the title "*Das Lebewesen im Kausalgefüge seiner Umgebung*" will, it is hoped, appear later in German. The authors have sought throughout to bring their two sets of terminologies into correspondence. The parallel German terms are presented here in parentheses.

[2] For the term "texture" as well as for advice on various other English terms we wish to express special indebtedness to Professor S. C. Pepper. (See also 29.)

fact of a more distant object or situation, i.e. the *entity represented* (*das Vertretene*).[3]

The second feature of the environment to which the organism also adjusts is the fact that such causal connections are probably always to some degree *equivocal* (*mehrdeutig*). Types of local representatives are, that is, not connected in simple one-one, *univocal* (*eindeutig*) fashion, with the types of entities represented. Any one type of local representative is found to be causally connected with differing frequencies with more than one kind of entity represented and vice-versa. And it is indeed, we would assert, this very *equivocality* (*Mehrdeutigkeit*) in the causal "representation"-strands in the environment which lend to the psychological activities of organisms many of their most outstanding characteristics.

It appears also that, whereas the one of us, Tolman (33), was led to emphasize these two facts of *local representation* and of *equivocality* (*Mehrdeutigkeit*) by a study of the relations of *means-objects* (*Mittelgegenstände*) to *ends* (*Zielgegenstände*) in the learning activities of rats, the other, Brunswik (2) was led to emphasize these same concepts as a result of an examination of the relations of *stimulus-cues* or *signs* (*Reize als Anzeichen*) to *Gegenstände*[4] as a result of a study of the relations in-

[3] The first modern psychologist to suggest the universal importance of this principle of "representation"—the scholastic "*aliquid stat pro aliquo*"—for *all* psychological phenomena was Karl Bühler (7). He has emphasized in particular the "sign" function of local representatives in their different forms, *i.e.* as "*signals*" for action and as "*Anzeichen*" in reception. He has made an especially important analysis of the sign function of "*symbols*" in his psychology of speech (8).

For another modern emphasis on the sign-function in perception and thought see Ogden and Richards (26).

[4] The word "*Gegenstand*" has been employed by Brunswik (2) and will herein be further employed to designate, not complete environmental objects or bodies in their concrete totalities, but single object-characters abstracted from such total bodies. Such abstracted characters are conceived and defined in completely objective fashion. They are discovered and identified by processes of measurement and computation as these latter are carried out either by physics or by the more ordinary procedures of practical life. And it appears thus that in any single total *behavior-object* (*Korper*, "*Ding*") there intersect numerous simple *Gegenstände*, such, for example, as: size, form, reflection-coefficient for light waves (*i.e.* physical "color"), hardness, weight, density, volume, chemical characteristics, etc. All these properties might at different occasions (in different life-contexts) become in different manner biologically important, or, to use the concept of Karl Bühler, become in different manner "*abstractively relevant*." From this standpoint the properties of a means-object, characterized pre-

volved in the "Konstanz"-phenomenon in human perception.[5]

We observe animals making and using tools, entering paths, ingesting food, avoiding dangerous objects, and the like. But in each such case the tools, the paths, the foods, the dangerous objects are behaved to only because of their role as means-objects. They are behaved to, that is, in their roles as the most probable "local representatives" whereby to reach or avoid such and such more ultimate, "represented" positive or negative, goals. For it is the reaching or avoiding of these more distant represented goals which are of final importance to the organism. And further, we also observe these same animals, responding selectively, (and perhaps in the ordinary case relatively correctly), to immediate entities (*e.g.*, the detailed structure of light-wave bundles, and the like) in their turn, as the most probable local representatives, *i.e.*, cues, for such tools, paths, foods, dangerous objects, etc. And here, also, it is the character of these more distant "represented" objects which have the greater determining significance for the organism. Light-wave bundles, and the like, are to be correctly selected as the most probable local representatives, *i.e.*, as cues, for such and such object-characters, just as the latter must themselves be correctly selected as the best local representatives (*i.e.*, as means-objects) for the finally to-be-reached or to-be-avoided goals. Without the ability to rely on these

viously by Tolman as *discriminanda, manipulanda, utilitanda,* are to be conceived as groups of *Gegenstände*, which are different with respect to their abstract relevancy for the organism. (Cf. 26, Chapter III.)

Further, because of its generality and abstractness this word *Gegenstand* can be used not only for the properties of *means*-objects but also for the *cue*-properties of peripheral stimulation-processes (*e.g.*, intensity, form, or size of the projection of an object at the retina, the visual angle, etc.) as well as for such internal events or states as goal-satiation, and the like,—in short for everything, which can be defined in terms of physics (or geometry, etc.) and which is therefore capable of objective measurement.

[5] It should also be noted that of the two of us it was primarily Brunswik (2, pp. 29 *f.*) who previously emphasized the importance of the feature of equivocality (*Mehrdeutigkeit*) in the environmental causal couplings. This sort of *Mehrdeutigkeit* is, of course, not to be confused with the possibility of a subjective "*Gestaltmehrdeutigkeit*," *i.e.*, with the fact—first emphasized by Benussi—that one and the same stimulus-configuration may on different occasions be responded to by quite different perceptual impressions.

two successive types of local representation no higher forms of organism could have developed and successfully survived.

Finally, it is to be pointed out that because of the equivocality (*Mehrdeutigkeit*) that always to some degree obtains in both such steps, *i.e.*, in the relations between cues and means-Gegenstände and in those between the latter and goals, the organism is led in both instances to the assertion of "hypotheses." That is, whether in the process of selecting the correct means-object (Gegenstand-complex) to reach a given goal or in that of selecting the correct cue-Gegenstände for perceptually identifying a means-Gegenstand, the organism is forced to venture an hypothesis.[6] We would here introduce, that is, the term hypothesis as not only appropriate and inevitable for the case of discursive thought, for which it was originally coined, but also for such simpler lower-order situations as are here involved in immediate perception and in the simpler sorts of means-end activities. Thus, whether the case be that of a father, who, as a result of his reading and previous experimentation, ventures a discursive verbalized hypothesis to the effect that the conditioned reflex is the fundamental principle of all learning and proceeds thereupon to try to make his children love Latin as a substitute-stimulus for chocolates; or whether it be that of a rat, who, from having been run through a discrimination-box and having found the lighted alley always open, tends "hypothetically" to choose this alley continuously for some time afterwards (whether or not the latter then still leads to food); or whether, finally, it be that of a monkey or a human being who, upon having projected upon his retina the characteristically fuzzy grading-off edge of a dark area, sees this dark area as a shadow and not as a separate spot with a blacker surface-quality; the essentials are the same. In each such case the organism behaves "as though." That is, he ventures an hypothesis. He may be right; but he may also be wrong. A fuzzy edge in the given case may surround not a shadow, but a spot with separate surface-color.[7]

[6] This use of the term "hypothesis" in a purely *objective* sense was first made by Krechevsky (23) and has since also received the approval of Claparède (9). The objective ear-mark for such hypotheses lies in the appearance of systematic rather than chance distributions of behavior.

[7] For all the various possibilities in this sort of situation see Kardos (21).

The lighted door in the given instance may lead, not to food, but to electric shock. The giving of Latin before chocolate may result not in the child's coming to love Latin, but merely in an unpleasant propensity to secrete saliva while studying Latin.

An hypothesis "asserts" that a given "*a*" is the local representative of a given "*b*." But the connections between types of local representative and types of entitites represented are, as we have said, practically never "one-one." Any given type of "*a*" is probably always capable of being in varying degrees the representative of a number of different types of "*b*." And any given type of "*b*" is probably always capable of being represented with different degrees of frequency by each of a number of different types of "*a*." Any particular hypothesis therefore that a given "*a*" on a given occasion means a given type of "*b*" will have only a certain probability of being valid. The degree to which such an hypothesis will tend to be valid or merely superficial and hasty will vary with the degree to which, "normally," the given type of cue-Gegenstand does tend to be coupled in "relatively one-one" *i.e.*, *univocal*, (*eindeutig*) fashion with the given type of to-be-perceived (*intendiert*) means-Gegenstand or upon the degree to which the latter does tend to be normally coupled in "relatively" one-one fashion with the given type of goal-Gegenstand.

As we have indicated, it is to be one of the main tasks of this essay to indicate the further significance for the psychologies of perception and of means-end action of just such lacks of complete *univocality*.

But first we wish to present a single simplified scheme for combining perception and means-end action into one picture (on the oversimple assumption of univocality).

II

Figure 1 is a diagram to represent the combined perceptual and means-end activities of an organism. This diagram involves the simple but incorrect assumption (to be corrected by later diagrams) of solely univocal, one-one (*eindeutig*) correspondences between goals and means-objects and between the latter and cues. In this figure the area above the v-shaped continuous line (*i.e.* a "v" with a curved bottom) represents the environment, whereas the area below this line represents the organism. Let us suppose that *b* indicates a

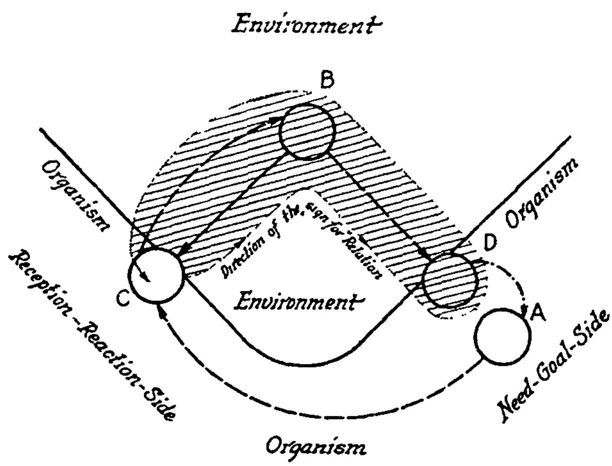

FIG. 1. Organism and behavior object—with assumption of univocal, one-one, couplings between cues, means-objects and goals. The cognitive lasso principle.

behavior-object (*Hantierbarerkörper*) *i.e.* a possible means-object in the visual field, *e.g.* food, which, as such, has the characteristic that it is an appropriate possible cause (with the cooperation of the organism) for resultant satiation, *d*. Independently of the organism this object *b* radiates causal trains, *e.g.* light-waves, in many directions. And part of these lead (continuous arrow *bc*) to the sensory surface of the organism. Let us assume, further, that other objects of the same variety as *b* have previously sent visual influences of this same sort to the organism. And let us also suppose that previous trial and error activities on the part of the organism have demonstrated the *behavior-manipulability* (*Hantierungstauglichkeit*) of these *b* sorts of object. And, finally, let us suppose that the outcome of such behavior-manipulations led in each past case to satiation *d*, *i.e.* let us suppose previous experience by the organism of the *utilitability* (*Erfolgstauglichkeit*) of things like *b.* The total organized experience resulting from all these previous causal currents means the present readiness of a system of "hypotheses" concerning the various different actual or possible causal chains connected with *b*,—that is, as to the probable suitability of any new *b* as a means for reaching, *i.e.*, as a cause for resulting *d* and also as to the fact that the given peripheral stimulus at *c* probably results from (has probably been caused by) a *b* sort of object.

If, now, as a result of some internal activity, say hunger *a*, there comes an influence from the *need-goal-side* (*Bedarf-Erfolgseite*) of the organism to the *reception-reaction-side* of the latter (broken arrow *ac*), resulting in an opening of sense-organs and in the activation of this hypothesis-system, this latter together with the peripheral stimulus-configuration coming from *b* will lead to a reactional event *c*. In this reactional event *c* the peripheral stimulus has assumed the function of a *sign*, *cue*, (*Anzeichen*) indicating an actual *b* and "transitively" through *b*, a possible final *d*. In this event *c* the total past and present causal complex—indicated in the diagram as surrounded by the dotted loop—is anticipatively *lassoed* (*Lassoprinzip*). *C* thus has the character of a *sign-gestalt* (*Zeichengestalt*).[8] It appears, therefore, further, that if the situation be one of univocal relations or, that is, if it be a situation in which the anticipatory achievement of the lasso will be in all cases of this type correct, then it can be said that the means-object and also the goal have been by means of this lasso or sign-gestalt, *intentionally attained* (*intentional erreicht*) (Brunswik, 2).[9]

[8] Previously (33, 34) Tolman used the term "sign-gestalt-expectation" for the organic event and the term sign-gestalt for the objective environmental complex corresponding (in the case of correct behavior) to this organic event. Here, however, it seems simpler for the term sign-gestalt-expectation to be omitted and to use the term sign-gestalt for the organic event alone. The environmental entity or entities (with reference to which the organic event—the sign-gestalt—occurs) are, as we are emphasizing throughout this article, to be conceived and described as simply some area within a total environmental causal texture. Such an area will contain as its most essential feature strands of "local representation."

[9] It should be pointed out that one of the important features of the type of psychology here being argued for is that it demands and makes possible a characterization of the fundamental capacities of the organism in terms of the types of object and goal which the given organism is capable of thus "intentionally attaining." It is this

We note next that broken arrows indicate those causal chains in which the activity of the organism itself is necessary. Thus the broken arrow *cb* (issuing from the sign-gestalt *c*) is intended to depict the actual manipulation of *b*, grasping, eating, etc. And the outcome of this manipulation of *b* is indicated by the broken arrow *bd*. This latter action is to be conceived as resulting out of such manipulation, that is, as occurring without further independent activity on the part of the organism and it brings about the final goal situation *d*. Finally, after the attainment of *d* there will occur (after some interval of time) as a result of physiological processes (which need not concern us here) a new appearance in the organism of the need *a* (broken line *da*). And thereupon the whole circular process will once again be set into action.

III

Figure 1 presented the scheme of an organism in its environment for a very simple case—namely, that in which one step only is involved both on the left-hand and on the right-hand sides of the diagram. But organisms often meet situations involving a succession of cues or a succession of means-objects or both. Figure 2 is therefore now presented to show types of further extension of the diagram which are necessary for cases involving more than one step between cue and behavior-object or between the latter and the final goal.

The nature and meaning of Fig. 2 will be understood most easily if you apply it to a concrete example. Let us suppose that the organism in question is a child in his crib and that the object *b* is a piece of chocolate. We shall suppose further, however, that the latter is beyond the child's own reach.[10]

feature which Brunswik had in mind when he called his a "*Gegenstand-psychology*" ("*Psychologie vom Gegenstand her.*"), that is, a psychology from the standpoint of the organism's ability intentionally to attain Gegenstände. This type of an objective psychology is outlined theoretically in (2) and (3). An article in English concerning the main experimental results and the fundamental concepts is also in preparation.

For another somewhat related treatment of the interconnection of the organism with its environment see the "Umweltlehre" of Uexküll (36).

[10] If the child were able to reach the chocolate himself, the *adbc* part of Figure 2 would suffice. The whole situation would in fact reduce again to that represented in Figure 1.

He requires therefore some second object as a secondary means to the chocolate. And let us suppose further that there are in the room both good-willed and less-favorably willed individuals. The child can use the assistance to be provided by the good-will of one of these good-willed individuals. This good-will will serve, in short, as the second means-object b_1, suitable for achieving the first means-object (the chocolate, b). But

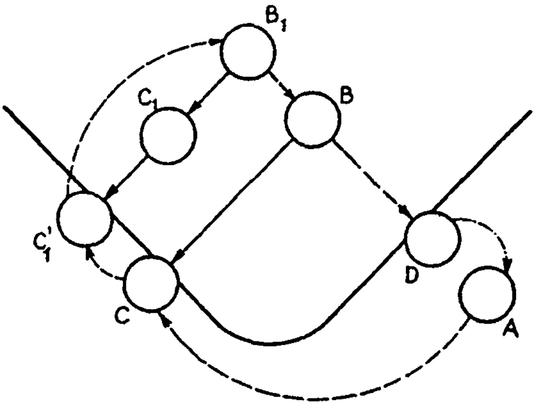

FIG. 2. Example of lengthened means-goal and cue-means chains.

this good-will b_1, this secondary means-object, lies shut-up within the psycho-neural make-up of the other individual. It can send no direct cues to the sense-organs of the child. The perception of it has to be mediated causally through some external characteristics in the other person's face. The facial expression of the other individual must, in short, serve as an intermediate cue c_1 between the final cues c'_1 on the child's retina and the ultimately to-be-perceived means-object b_1—the good-will (or the bad-will) of the other individual. Such an example thus presents a double step on both the reception-side and the means-side of the activity. The retinal effects on the child's eyes serve as local representatives, signs, for the facial expression of the individual. And this facial expression as a local representative serves in its turn as a sign (or sign-system) for the will (good or bad) of the other individual. Again, on the right-hand side of the diagram, the will of the other individual is a local representative of, and the means to, the presence of the chocolate and then this chocolate is, in its turn, the local representative of and the means to (through perhaps some still further steps) final satiation.

It is evident that the general scheme of Fig. 2 could be extended indefinitely to allow for long trains of intervening means-objects or long trains of intervening cues, or both. Or again, it could easily be modified to allow for various special types of case such, for example, as that in which two means-objects have to be behaved to simultaneously—or in which one and the same object will serve both as secondary cue and as secondary means.[11]

Consider now still another type of possible extension of the original diagram which may also sometimes be needed. It must be noted, namely, that any single behavior-object such as *b* must in reality be conceived as subdivisible into three distinguishable aspects. The first of these parts or aspects (groups of Gegenstände) (see Fig. 3) we shall designate as the

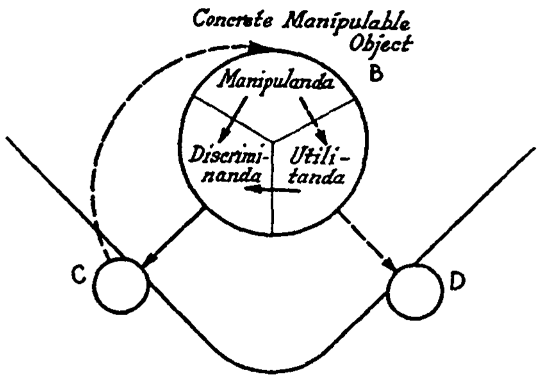

Fig. 3. Aspects within the single behavior-object.

discriminanda properties of such an object. These discriminanda would be such properties (Gegenstände) as the object's color, shape, size, etc., which are the relatively direct causes of the immediate sensory cues. They are the properties whereby the object is differentiated, discriminated from other objects. As the second part or aspect of a single be-

[11] An example for this latter would be paper currency which, at least in former times, served both as a cue for and a means to gold.

havior object we would designate its *manipulanda*-properties. The manipulanda of an object are, so-to-speak, its essential, behavioral core. They are the properties which make possible and support such and such actual behavioral manipulations. They are the object's grasp-ableness, pick-up-ableness, chew-ableness, sit-on-ableness, run-through-ableness, and the like. Finally, as the third aspect or part of a behavior-object we have what we shall designate as its *utilitanda* properties. The utilitanda of a behavior-object lie, so-to-speak, on that side of it which points towards further means-objects or towards an ultimate goal. They are the ways in which the object, given the manipulanda, or its manipulanda and discriminanda combined, can be useful as a means for getting to further objects and goals. Thus, for example, a behavior-object such as a maze alley which has the manipulanda of run-through-ableness will, as such, also have the utilitanda of leading to objects which are distant in space. Or a behavior-object such as a piece of chocolate will have, by virtue of its manipulanda character as something chewable, the utilitanda character of something which will lead towards a full stomach. Or, still again, the behavior-object, the good-will of another individual, will have, by virtue of its manipulanda character of possessing a substitute pair of hands and feet, the utilitanda character of bringing about the reaching of objects which from the position of the original organism are, as such, unattainable. Or, again, a picture which has both the discriminanda properties of a certain pattern of color and the manipulanda properties of thinness and hang-up-ableness will have the utilitanda-properties of aiding in the establishment of a particular set-up for a certain type of æsthetic satiation.[12]

It is to be noted, however, that in this discussion and in Figure 3 we have again been assuming for simplicity's sake only univocal relations. But such univocal relations do not really obtain. Quite different discriminanda may be coupled on different occasions with one and the same manipulanda. Apples are sometimes red but they are also sometimes yellow.

[12] The terms dicriminanda and manipulanda have already previously been used by Tolman (33, 34) The term utilitanda is here, however, now suggested to designate what previously (se especially 34) were called "means-relations."

And one and the same discriminanda will on different occasions be used as signs of different manipulanda. Brown is sometimes coupled with and used as a sign of chocolate but at other times it is coupled with and used as a sign of, say, a negro skin. Similarly, the relations between manipulanda and utilitanda may be equally *equivocal* (*mehrdeutig*). Thus, for example, the run-through-ableness of a maze-alley does probably in somewhat more than 50 per cent of the time have the utilitanda character of getting the organism on towards some further place. But it by no means always has that character, as witness the case of blinds, whose very definition is that they do not thus get an organism on.

A completely adequate diagram of the individual behavior-object and of these its three aspects would have to allow for such internal equivocalities. It would have to be built up, that is, on somewhat the same plan as Figure 4 which we shall come to in the next section.[13]

Finally, before passing on to the next section, we would like here also to point out that just the reverse of the general types of situation allowed for by Figures 2 and 3 also occur. That is, not only are there cases in which the chain between *c* and *d* must be depicted as lengthened, but there are also cases in which this chain is to be conceived as shortened—with fewer, or no, intermediate steps. Thus, in sufficiently primitive, or young, organisms the appropriate diagram would seem to be one in which the arrows in Figure 1 are contracted into a single one running directly from *d* to *c*. That is, in such cases response to cue, manipulation of means and achievement of the goal telescope into but one single process.

For example, Charlotte Bühler and her co-workers Ripin and Hetzer (31) and Rubinow and Frankl (32) have followed the development of the feeding responses in infants. The very

[13] This is perhaps also the place to point out that within the organism there will also be equivocalities as to goals. Professor Charlotte Bühler has pointed this out to us. It leads to such questions as the operation of such fictive goals positive or negative as general "expansion" or general "restriction" of life. [Cf. Charlotte Bühler (6) which with varying degrees of equivocality may perhaps control the more immediate direct goals. See in this connection also the distinction between superordinate and subordinate goals in Tolman, (33) pp. 28 *f.*]

youngest infants responded to the actual touch of the nipple only. But gradually with increasing age the babies began to respond with sucking movements to the laying on of the bib, then later to the approach of any sort of a pointed object. Until finally at about eight months they responded to the presence of a nipple plus a white fluid and to that only. Only at this last stage would the introduction into our diagram of the independent intermediate *hantierbarer Körper b* as in Fig. 1 seem to be needed or appropriate.

We will turn now in the next section to an expansion of Fig. 1 to allow for the sorts of complication which arise upon the introduction of non-univocalities between means-objects and goals and between cues and means-objects.

IV

Figure 1 presented the situation for the organism upon an assumption of univocal couplings of means-Gegenstand to cue-Gegenstand and of means-Gegenstand to goal-Gegenstand. But such an assumption is in reality never realized. The whole uncertainty of knowledge and behavior arises just out of such *equivocality* (*Mehrdeutigkeit*) in the causal surroundings.

Consider for a moment the nature of the causal connections in the physical world independent of organisms. We observe that, whenever any individual event occurs, a more or less extended complex of many independent part causes must have been existentially operative. Further, any specific type of an event will on different occasions and in different places have different causes, or more exactly speaking, different total complexes of part causes. And also, vice versa, any given type of an event will itself operate as a part cause on different occasions and in different places for the production of different final total events. The causal interweavings of unit events among one another are thus, in both directions, equivocal. But some of these connections will be more probable than others.[14]

Exactly this same sort of causal equivocality must be

[14] Concerning the nature of the causal structure of the world in general, see H. Reichenbach (30) and H. Bergmann (1).

applied, now, to the sets of causal chains—those between goals and means and between cues and Gegenstände—in which we are specifically interested. In order, however, not to overcomplicate the discussion we shall consider only a limited number of the actual possibilities.

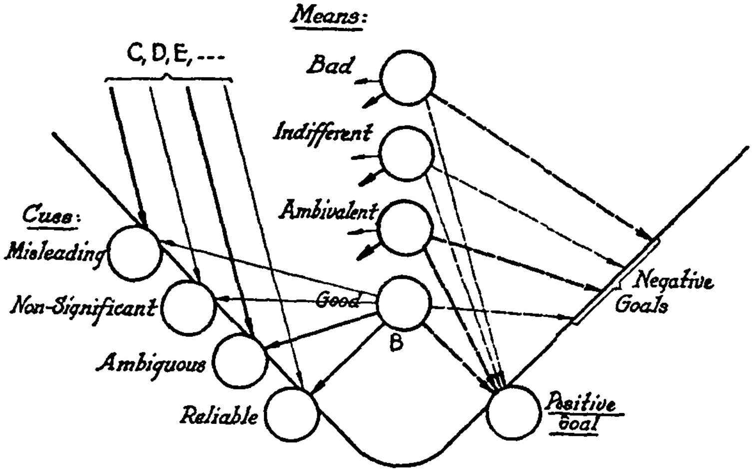

FIG. 4. Paradigm: Four types of goal-means relation; four types of means-cue relation.

Let us examine, first, the right-hand side of Fig. 4. It will be observed that we have depicted one positive goal and several negative goals.[15]

Further, we have shown only four main types of means-object relative to such goals. These four are to be designated as: *good, ambivalent, indifferent, and bad* (*gutes, ambivalentes, indifferentes, schlechtes Mittel*).

The "good" means-object may be conceived as one which, if manipulated, will tend to lead in a relatively high percentage of instances (say up to 95 per cent;[16] heavy arrow) to the positive goal and in only a relatively small number of instances (say 15 per cent; thin arrow) to a negative goal. An "am-

[15] The concept of negative goals is to be conceived here as including not only actually injurious consequences such as real physical injury but also cases which involve, merely, undue expenditures of time or energy in the reaching of positive goals.

[16] The fact that we have chosen examples of percentages which total more than 100 is to allow for the fact that often one and the same type of means-object is capable of leading simultaneously both to the positive and to the negative goals.

bivalent" means-object is to be conceived as a type which will lead with a relatively high probability (*i.e.* with high frequency) to the positive goal but one which may also lead with a relatively high probability to one or more negative goals. An "indifferent" means-object is to be defined as one which will lead with but very little probability, *i.e.* frequency, either to the positive goal or to a negative goal. And, finally, a "bad" means-object is one which will lead with high probability to the negative goal and with but little probability to the positive goal. Finally, we would throw out the suggestion that the "ambivalent" types of means and the "bad" types of means are in some situations (especially, if the negative goals are very intense) to be grouped together under one head and labelled "dangers." For both types will trend to lead with high frequency (heavy arrows) to negative goals.

Turn now to the left-hand side of the diagram. We observe at once a similar analogous lack of univocality. But again in order not to overcomplicate the figure we have depicted only four main types of cue relative to the one "good" means-object, *B*. These four types of cue we have called "reliable" (*verlässlich*), "ambiguous" (*zweideutig*), "non-significant" (*bedeutungsarm*), and "misleading" (*irreführend*). The first type is to be conceived as capable of being caused with great frequency by "other objects" such as *C*, *D*, *E*, etc. The second, or "ambiguous" cue is to be conceived as a type caused with great frequency by both the given object and other objects. The third, or "non-significant" type of cue, is to be conceived as caused with little frequency by either the given object or other specific objects. And, finally, the fourth or "misleading" type is to be conceived as one which may be caused with little frequency by the given object and with great frequency by other objects. Again, we would throw out the suggestion that the ambiguous and the misleading cues may for some individuals and under some conditions constitute a rather special common group to be designated as "hazardous." For both types of cue present a high degree of probability of leading the individual astray, *i.e.* of having been caused by other objects, *C*, *D*, *E*, etc. instead of the to-be-sought for good means-object *B*. (Hazardous cues would thus be analogous to "dangerous" means-objects).

Considering now both sides of the diagram it appears at once that the psychological success of an organism will depend (i) upon its ability to pick out "good" means-objects for reaching the positive goal and (ii) upon its ability to select the reliable cues for this good means-object. An organism will be successful in so far as it can do both.

But let us indicate the real significance and experimental fruitfulness of these classifications of means and cues by turning to some concrete examples.

V

Let us illustrate, first, the right-hand side of the diagram. We may take a case of learning in rats.

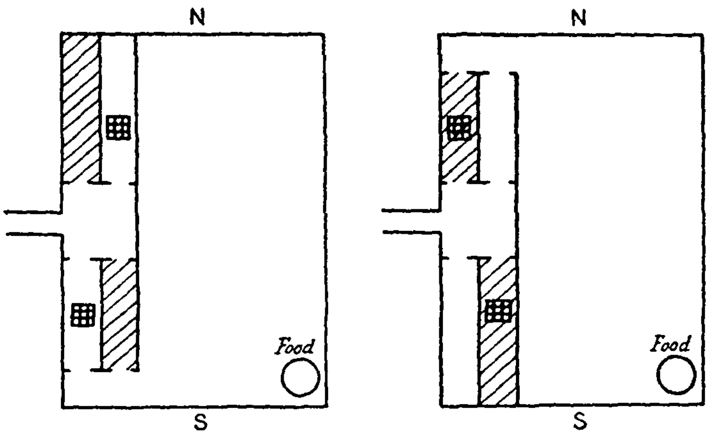

Fig. 5*A* Fig. 5*B*

Fig. 5. Schematic maze for the purpose of illustrating the four basic types of means-object.

Imagine a maze and let us suppose it somewhat unusual in type in that it has choice-points of the two sorts shown in Figs. 5*A* and 5*B*. Suppose, that is, that each choice-point has four alleys, instead of the usual two, issuing from it. Two of these always point south and two north. Further, one alley in each pair is always lighted and the other dark, and one has an electrified grill and the other no such grill. Further, in the cases of the 5*A* choice-points both the two south-pointing alleys will lead on, whereas both the two north-pointing alleys will be blinds. Also in the 5*A* type of choice-point both the lighted alleys will have electric shocks and the dark alleys will have no shocks. In the cases of the 5*B* choice-points, on the other hand, everything will be just reversed; the north-pointing alleys will lead on and the dark alleys will provide the shocks.

Consider, now, a particular maze in which most of the choice-points are of the 5*A* type and only a few are of the 5*B* type. We see at once that in such a maze, the south-pointing dark alleys are "good"; for they will lead with a high degree of frequency to the positive goal, food, (*i.e.* heavy broken arrow from good means to positive goal as shown on the right-hand side of Fig. 4) and with practically no frequency to either of the negative goals (electric shock) or undue exertion (*i.e.* blinds). (See thin broken arrow.) The south-pointing lighted alleys will be "ambivalent"; for they will lead with a high degree of frequency both to the positive goal, food, heavy broken arrow, and to the negative goal, electric shock (also heavy broken arrow). The north-pointing dark alleys will be "indifferent"; for they will lead with little frequency to the positive goal food (thin broken arrow) and with practically no frequency to the worse of the two negative goals—electric shock, also thin broken arrow. And the north-pointing lighted alleys will be "bad"; for they will lead with little probability to the positive goal, food (thin broken arrow) and with high probability (heavy broken arrow) to both the negative goals, electric shock and blind.

The interesting experimental question is: how will the rats behave in such a maze? Will they pick the "good" alleys and avoid the "ambivalent" the "indifferent" and the "bad"? Obviously the answer will depend upon the nature of their innate propensities, their previous experiences and their stage of learning in this particular maze.

Suppose that all the rats to be used in the experiment have an innate propensity to choose dark alleys rather than light. And suppose, also, that this innate propensity has been reënforced by specific preceding training in a discrimination-box where light alleys always led to electric shock. Suppose, in short, that the rats bring to such a maze a strong "hypothesis," based partly on innate endowment and partly on previous experiences, to the effect that dark alleys, as such, have a greater probability of leading to good consequences than do lighted alleys.

And let us likewise suppose that these to-be-used rats have also all had a preliminary feeding-period in the southeast corner of the room—that is, in the actual spot where the food-box in the maze proper is placed. Also, let us suppose this corner of the room to be in some way distinctly characterized, by virtue, perhaps, of the visual features on the ceiling, or because of odors coming from it, or in some other way. Let us suppose, in short, that the rats also bring a second "hypothesis" to the effect that food lies southward and that south-pointing alleys should, as such, be better than north-pointing alleys.

Rats bringing the above hypotheses and presented to the above sort of a maze should, right from the beginning, and without the need of any new learning, behave relatively "correctly"—*i.e.*, they should at once choose the "good" dark south-pointing alleys most frequently and the "bad" lighted north-pointing alleys least frequently. And presumably they should choose the "ambivalent" lighted south-pointing alleys and the "indifferent" dark north-pointing alleys with some sort of in-between frequencies. It is to be noted, however, there are as yet in the literature no experiments which give exact information as to the two latter sorts of possibility. We do not know, for example, whether the rats will show a greater preference (or lack of preference) for the "indifferent" dark north-pointing alleys, which have only a small probability of being either very good or very bad, or for the "ambivalent" lighted south-pointing alleys which have quite a high probability of being very good but also a high probability of being very bad. The possibility and desirability of further experimentation on such a point as this at once suggests itself. And such future experimentation might well prove extraordinarily suggestive. It might even prove a way of differentiating emotional dispositions. Thus, for example, the rat who tended to prefer "indifferent" means to "ambivalent" ones might perhaps be defined as "cautious," whereas the one who tended to prefer "ambivalent" means to "indifferent" ones could perhaps be designated as "courageous" or "dare-devilish." And, granting such definitions, then, such a set-up would also allow us to investigate the effects of such factors as degrees of hunger, or varying degrees of having been "blocked" (in Lewin's sense) and the like, upon such emotional states. Indeed, a whole array of possibilities of this general sort for future research suggest themselves.

Or, again, we may turn, now, to the consideration of other types of experiment. These would be experiments in which the total maze would not, as above, agree with the rats initial hypotheses but in which the rats would have to acquire a new hypothesis (*i.e.* to learn). Two sub-types of case present themselves. On the one hand, there would be the type of experiment in which the detailed hypotheses which the rats brought with them were definitely wrong. And, on the other hand, there would be the type of experiment in which the animals brought no detailed hypotheses but merely a very general hypothesis which expressed itself as an initial readiness to explore equally all alleys. (N.B. This latter would be the perfect pure case of trial and error learning.)

To illustrate the former type, let us imagine a situation similar to that previously described save that the actual maze connections would be arranged just oppositely. That is, imagine a maze in which the great majority of choice-points will be like that in Fig. 5*B* and only a few like that in Fig. 5*A*. To such a maze the rats, with their innate propensities and previous experience just as before will bring absolutely wrong hypotheses. What will they do? Obviously they will learn. That is, although they will begin by selecting the objectively "bad" alleys and avoiding the "objectively" good alleys, soon they will begin to correct these initial selections and to acquire the necessary new hypotheses.[17] But the specifically new and interesting question, which experimentation will be needed to answer, is in what order will the old hypotheses—*i.e.*, the old order of selection of blinds, drop out? What will be the intervening phases of relative preference for the different types of alley through which the animals will pass? Again a whole series of new experiments suggests itself.

Consider now the second sub-type of experiment—that in which the rat brings no specific hypotheses as to north-pointingness nor as to lightedness or darkness, but exhibits merely an initial equal readiness for all four types of alleys, *i.e.*, what we may call the "pure" case of so-called trial and error. What will be the order of learning in such a case? Will the rats drop out the "bad" alleys first, and then the "ambivalent" and then the "indifferent"? Or will they follow some other order? Again important further experiments are needed.[18]

The above must suffice to illustrate the significance, experimentally, of a classification of means-objects based on the probability-relations between such means-objects and goals. We will turn, now, in the next section to illustrations of the experimental significance of the analagous classification of cues, that is, to illustrations of the left-hand side of Fig. 4.

VI

We may imagine a case in which the "good" means-object in the particular instance must possess the property (Gegenstand) of lying at a certain specific spatial distance from the organism. That is, the organism, if it is to be successful, must be able to select correctly the "reliable" visual cues for *third-dimensional depths*. It must be able to distinguish between such "reliable" cues and those which instead are merely "ambiguous," "non-significant," or even "misleading."

[17] The definition of learning as essentially the correction of old hypotheses and the formation of new ones has already previously been suggested by Tolman and Krechevsky (35).

[18] The experiments in the literature which seem already to have made a beginning attack upon such problems as those suggested in this section are those of Hamilton (17a), Kuo (25) and Patrick (27, 28).

As perhaps the best example of *reliable* cues for the visual perception of the third dimension we may take (for organisms with binocular vision) *bi-retinal disparity*. Differences of third-dimensional depth in the environment are projected differently into the two eyes. And the extent and nature of these differences is utilized by the organism as a cue for the perception of distance. But, although such bi-retinal differences do usually stand in almost univocal correspondence with actual differences of distance (relative to the point of fixation), this is by no means always the case. For by means of a stereoscope one can also provoke, as a result of pictures which are really flat, just these same bi-retinal differences. In this latter case the flat pictures produce bi-retinal effects which "normally" are produced only by real differences of third-dimensional depth. But such instances are obviously artificial and exceptional and have but a low degree of "general" probability. They are none the less possible and this possibility is cared for in Fig. 4 by the faint causal line debouching into reliable cues from "other possible objects" *C*, *D*, *E*. . . .

It is interesting to note, further, that the fact that a stereoscope is able to arouse impressions of the third dimension means that the perceptual system as such continues to adhere quite blindly to the hypothesis that bi-retinal disparity is necessarily a cue for third-dimensional depth. And the perceptual system does thus adhere to this hypothesis even when the presence of the stereoscope is an added item among the perceptual data. The perceptual apparatus is, in other words, by itself relatively short-sighted and superficial. It is incapable, at least without specific training, of separating out the case where bi-retinal disparity occurs by itself unaccompanied by a stereoscope from that in which there is the added perceptual data coming from the stereoscope. The perceptual apparatus is incapable of reacting to the former case as indicating with a high probability real third dimension and to the latter as indicating with high probability mere flat pictures. For such a prompt differentiation the superior and more fundamentally accurate processes of discursive thought appear to be required.

Again, let us also note that just the reverse sort of situation can also occur. Bi-retinal disparity cannot only be artificially produced (as by a stereoscope) but it can also be artificially destroyed. Consider, for example, the case in which a scene is observed not directly but in the finder of a camera. In this sort of set-up the effect upon the two retinas is that coming from a flat plane. There is no bi-retinal disparity although there are real differences of third-dimensional depth. In other words, bi-retinal disparity can not only have other causes than real depth in the environment, but real depth can under special, although "normally" improbable, conditions fail to produce bi-retinal disparity. Thus, even for this example of a very *reliable* type of cue, there still obtains some degree of equivocality in both directions,—in the directions both from Gegenstand as cause to cue as effect and from cue as effect to Gegenstand as cause.

Let us consider next an example of *ambiguous* cues for third-dimensional depth. Ambiguous cues we have defined as ones which though also frequently induced by the given type of Gegenstand are of less certain value in that they can likewise frequently result from other Gegenstände than the one in question. An especially good example of such cues relative to third-dimensional distances is *perspective*. Let us explicate. Many objects—especially those common in civilized environments—tend to be right-angled, or to be bounded by parallel lines, or to occur in rows made up of individual items all of equal size. Consider, for example, such objects as: streets, sidewalks, house façades, single windows and rows of windows, corridors, rooms, pieces of furniture and the like. Such single objects or series of objects are, however, very often presented to the organism at an angle, that is, not as face on but as stretching off into a third dimension. Thus it happens that distorted angles and distorted size relations (converging lines and trapezoidal forms, etc.) result with great frequency from differences of third-dimensional depth and the perceptual apparatus comes to use these distorted forms as distance criteria. Much oftener, however, than was true for bi-retinal disparity these distance criteria of "distorted forms" can also result from other causes than actual third-dimensional depth. Such forms can also be produced with great ease artificially—as for example, by a mere pair of carelessly drawn converging lines. And, likewise, there actually exist in the world many objects whose surfaces are really trapezoidal, diamond-shaped and the like. So that these latter objects even when face on also produce "distorted" images. Indeed many of the familiar optical illusions are cases in which just such "distortions" in actually flat surfaces are responded to as meaning stretching-off into the third dimension.

To return now to Fig. 4 we find this equivocality whereby distorted images can be produced very frequently either by really right-angled objects, rows of equal objects, objects with parallel boundaries stretching off into the distance, on the one hand, or by really distorted objects and artificial objects, on the other, allowed for by the forking of the causal lines which debouch into "ambiguous" cues. And the two branches of this fork are both drawn with heavy lines. That is, in terms of our example, the cue of distorted retinal images may result with about equal and relatively great probabilities either from true stretchings-off into the third dimension, on the one hand, or from actually distorted objects or from mere drawings, on the other.

FIG. 6. Failures of perception due to the persistent functions of hypotheses appropriate only in cases of real perspective.

In other words, a pure reliance upon perspective as a depth criterion necessarily leads to many mistakes (illusions). All the cases where appearances of depth are produced solely by drawings fall into this group. Consider, for example, Fig. 6. The row of three angles appears quite strikingly as a chain of three mountains really equal in size but extending back into the third dimension. But it is to be noted that when these curves do thus appear, it means that the perceptual apparatus has over-generalized. For in nature there is no very great tendency for rows of mountains equal in size to stretch away from one as so often happens for windows, trees and the like. In fact, the most frequent tendency in nature would seem to be for the nearer mountains (seen as they usually are from the plain) to be actually the smaller. Or, again, consider the other part of Fig. 6. If the two adjacent parallelograms are seen as an open book the perceptual apparatus has again over-generalized. For it has assumed that these angles (and perhaps all angles of this kind) are in nature really right angles. In a word, too great a reliance upon the ambiguous cues of perspective always means laziness and over-generalization on the part of the perceptual apparatus.

Let us consider, now, an example of *non-significant* cues for third-dimensional distances. A relatively good instance is that of *number of intermediate objects.* It appears that the more such intermediate objects there are between an observer and the main object, the further off the latter tends to appear. And in actual nature there is of course some probability that a longer distance will in truth be filled with more intermediate entities than a shorter distance. But there is also some probability that more intermediate objects may mean (result from) something other than greater distance. Intermediate objects will often lie so that the eye cannot detect them. And in any case, it is obvious that in nature there is no such constant relationship between number of intermediate objects and distance as there tends to be between bi-retinal disparity and distance. The cue of number of intermediate objects is then a good example of a relatively *non-significant* cue. (See again Fig. 4.)

Turn now to *misleading* cues. A relatively good example was found in the work of Holaday on the Konstanz-phenomenon in the perception of size (19, p. 454). In this investigation it so happened that in the main experiment, while working with certain definite distances, the left-hand one of the two objects to be compared (as to size) was at some definitely nearer distance than the other. As a result, it came out that when, in a subsidiary experiment under conditions of poor visibility, the left-hand object was now really the farther away, the subject, because of his preceding training, with the same general range of distances, continued to see it, the left-hand object, as nearer. In other words, the effect of the preceding training in the main experiment perseverated and made the leftness of the given object (under conditions of poor visibility) into a cue for nearerness. Analogous results appeared also in the work of Eissler (**10**, p. 259) on the effect of turning forms out of the frontal parallel plane. Such perseverations (with resulting misleading cues) likewise seem to be frequent and well-known in experiments on weight perception. [See also Izzet, (**20**, p. 316), Brunswik, (**2**, p. 120).]

To sum up for this section, we would emphasize then that, in addition to its task of choosing correct means-objects, the organism has also that of developing an adequate reception system which will tend to select reliable cues, rather than ambiguous, non-significant or misleading ones. And its task is to do this even when all the different kinds of cues are present and competing with one another. The investigation of the degree and manner in which the perceptual system can or cannot do this as well as of its capacity for learning obviously sets the stage for many important further experimental investigations.[19]

VII

In the two preceding sections we have presented examples to illustrate experimentally the different classes of means-objects and cues. And we have seen that these classes are defined by the respective strengths of the causal probability lines between such types of means-objects and the plus and minus goals and between the former and types of cues. Any type of means-object has certain specific probabilities (given the causal structure of the particular environment) of serving as a frequent means for reaching the desired positive goal and

[19] Some beginnings in this direction were in fact contained in the investigations of Holaday (**19**), Eissler (**10**) and Izzet (**20**). For still more recent investigations in the same direction see likewise Brunswik (**2**).

it also has certain specific probabilities of leading rather to one or more of the negative goals. Similarly, any given type of cue has (given the causal structure of the environment) specific, respective, probabilities of having been caused by such and such a Gegenstand or of having been caused by such and such other Gegenstände.

The organism's task is thus, as we have seen, always that of picking out the means-objects and the cues which have the high probability-lines (in the given case) of leading to the required goals and to the appropriate means-Gegenstände. But the next point and the one which we especially wish to bring to the fore in this section, lies in the further fact that the values of these probability-lines are not fixed once and forever for all environments. A means-object, such as a dark alley, which is "good"—*i.e.*, has a strong probability of not leading to the negative goal of injury—in an environment of "free nature" may be "bad"—*i.e.*, have a strong probability of leading to a negative goal such, say, as that of an electric shock—in the special environment of a particular animal laboratory. Similarly, a cue such as bi-retinal disparity, which has a strong probability of having been caused by a true third-dimensional depth in the ordinary environment of hill and dale may have a very small probability of having been so caused in the more special environment of a psychological laboratory which frequently includes, as it does, stereoscopes and other "artificial" devices in front of the eyes.

It appears, however, that an organism usually tends to bring with it to any given new environment a set of already prepared hypotheses. These hypotheses result from its innate make-up and from its previous experiences of "normal" average environments? That is, it will bring with it expectations, based on heredity and early experience that certain types of means-object tend most frequently to serve as causes (routes) to positive goals and that other types tend most frequently as routes to negative goals. And, similarly, it brings hereditarily and from early experience a propensity to expect types of sensory data as having been most frequently caused by certain types of Gegenstände and as having been infrequently caused by such and such other types of Gegenstände. But the particular actual environmental set-up may not correspond to the "normal" average environment. God, or the experimenter, may have introduced rather unique and special causal corrections. In such special cases the organism must adjust itself to the new differentiating features and revamp its hypotheses accordingly.

For example, we have supposed that rats, by virtue of innate endowment or of their previous general experience of "normal" spatial environments, tend to bring with them to any maze the hypothesis that south-pointing alleys have, as means-objects, a very great probability of leading towards the south side of the room. But in a given particular maze it may have been established by the experimenter that, contrary to such "normal" probability, the south-pointing alleys shall, in this special case, have a greater probability of leading to the north side of the room and, *vice versa*, that the north-pointing alleys shall in this instance have a greater probability of leading to the south side of the room. It appears therefore that, if the rats are finally to be successful in this particular maze, they must be able to discover further identifying features which differentiate this maze from the "normal" one. And they must attach their new hypotheses to these further features. If they can do this, then when such further features are present, they will react to the south-pointing alleys as having the higher probability of leading north and to the north-pointing as having the higher probability of leading south. And only when such special further features are absent will they revert to the more general hypotheses—suitable for "normal" mazes and "normal" environments in general,—that south-pointing ways have the higher probabilities of reaching the south and that north-pointing ways have the higher probabilities of getting to the north.

Or, similarly, we may suppose that a binocular organism tends (on the basis of innate endowment and early childhood experience) to bring to the perception of the third dimension an hypothesis to the effect that "normally" bi-retinal disparity, as a cue, had a high probability of having been caused by (and, therefore, of meaning) third dimensional depth. But, in the very special laboratory environments which include stereoscopes, bi-retinal disparity often has a low probability of having been caused by real third-dimensional depth and may become by itself a misleading cue therefore. The binocular perceptual apparatus must, in such a case, correct its initial hypothesis, which was only appropriate for "normal" environments, by including, if it can, within its cue-system the further features as to the presence or absence of a stereoscope. But this, as we saw above, the perceptual system by itself seems unable to do. The organism to be successful must in this situation resort to that more elaborate apparatus which we call discursive thought. That is, in this example the further specifications of the hypotheses needed by the organism for successful immediate adaptations require the cooperation of something more than the purely perceptual apparatus.

Or consider the reverse sort of case. A normally relatively bad means-object for getting to the south side of the room is, as we have said, a north-pointing alley. But under the special "arbitrary" conditions set up by a particular experimenter this round-about route may become a very good means-object for getting there. It appears, indeed, from experiments by Gilhousen [20] that rats which are overtrained on such round-about routes in a special set-up may become so "fixated" on the north-pointing round-about route that they will persist for a long time continuing to try to take it even after it is no longer the correct route. In other words, they can become so overtrained for the special case that when later the special conditions of that case no longer obtain they are unable to drop this special hypothesis.

Similarly, a normally very misleading cue for any specific third-dimensional nearness such, say, as the cue of "being the left-hand one" of two objects, can, as we have seen, under the very special conditions of a particular experiment become a

[20] Gilhousen (13, 14). For other experiments on overtraining and fixation see also Hamilton and Ellis (15, 16), Krechevsky and Honzik (23), Hamilton and Krechevsky (17) Elliott (11) and Everall (12). Indeed, it would seem that what Köhler (24) has designated as "bad" errors (as distinct from "good" errors) are also of the nature of what we are here calling "fixations" resulting from overtraining.

relatively good "reliable" cue. Further, it appeared, however, that the perceptual system can become so overtrained for this special case that when later the requisite special conditions are no longer present the individual may (if the visibility conditions are poor) continue to see the left-hand object as at a certain distance even though it is no longer so. The perceptual apparatus in such a case has also become, by overtraining, so-to-speak "fixated" on lefthandedness as the appropriate and sufficient cue for a certain distance. But if the individual is, under other more "normal" conditions to behave correctly, his perceptual apparatus must be able to abandon this over-fixated hypothesis. The persistence of the latter is an evidence that the organism has become, so-to-speak, lazy and has dropped out some of the essential features of its original "normal" cue system.

To sum up, we may say in general that in the selection both of the means-objects which have high probabilities and of the cues which have high probabilities the organism responds in the form of hypotheses. These hypotheses it brings with it from innate endowment and from previous experience. These hypotheses tend to be correct for "normal" average environments. When, however, the probabilities in the particular environment are not those of a "normal" or average environment, then the organism, if it is not to go under, must acquire new hypotheses. Further, it appears that this new environment may differ from the "normal" either by being more general, or by being more specific, or by being equally, but differently, specific. And still further it appears that in any of these three types of cases the new hypotheses, which must be achieved, require the organism to take into its cue-system and into its selection of means-objects further identifying features. Learning, whether in the perceptual system or in the means-end system, is just such an acquiring of new hypotheses. But, and this is biologically the most important point, such new hypotheses should be attached to the specific identifying features of the particular situations to which they are appropriate. The organism should, that is, become docile to a very developed and subtle system of sensory cues,—in a way which allows it, for example, to respond differently to one and the same part-cue of bi-retinal disparity according to whether or not the further part-cues presented by a stereoscope are or are not so present.[21] And, similarly, it must also be docile to a very wide and subtle set of means-object differentiations. It must be able, for example, to distinguish the particular north-pointing maze-alley in some particular maze which as such leads south from other ordinary north-pointing alleys which are "normal" and lead north.

Thus the wholly successful organism would be one which brings, innately, normal averagely "good" means-end hypotheses and normal averagely "reliable" perceptual hypotheses; but which can immediately modify these innate hypotheses to suit the special conditions of a special environment; which can note and include in its cue-system and in its means-end-system the presence of the further identifying features of these special environments. But further, such an organism must also, if it is to be completely successful, be equally able at once to drop out such new hypotheses when the special features as to cue or means are no longer present.

In the case of ordinary trial and error learning (whether perceptual or means-end) the new features are noted and the new hypotheses acquired only under the hard task-master of actual bitter behavior. In the case of "insight" learning the new features are noted and the requisite new hypotheses are

[21] Or to take, perhaps, a better example for this case of becoming docile to a very developed and subtle system of sensory cues, it appears that this is just what has happened in the case of the so-called Konstanz-phenomenon in the perception of size, color and the like—thus, for example, to take the case of size-perception, it appears that the organism has developed an extraordinary ability and propensity to perceive, as intentionally attained Gegenstand, the "real" size of an object independently of enormous differences in the size of the visual angle which this object presents to the eye when at different distances away. But this means simply that the organism has come to include in its cue system visual angle plus one or more reliable distance criteria. Every type of perceptual "*Ding-konstanz*" depends in fact upon just such a mutual working together of a variety of cues (*e.g.*, direct retinal effects of size, color, etc.; distance criteria; direction criteria; illumination criteria, etc.) *Cf.* in this connection the discussion of Brunswik and Kardos (4) of the "Zweifaktorenansatz" of K. Bühler and the considerations concerning the equivocality of single stimuli by Heider (18) and also by Brunswik and Kardos (4).

evoked as a result of innate endowment and general experience before they have ever actually specifically—behaviorally—been put to the test. In the case of unmodifiable instinct the new features are never noted and the new hypotheses never acquired; the organism continues to behave in the old fashion and goes under. In the case of motivational and emotional inadequacies the organism is either overhasty or overlazy in making observations of the new cue-features and the new means-features and in developing the requisite new more adequate hypotheses.

Indeed, we would like to throw out here, as a final word, the suggestiòn that all the problems of psychology—not only those of visual perception and of learning—but all the more general problems of instinct, insight, learning, intelligence, motivation, personality and emotion all center around this one general feature of the given organism's abilities and tendencies for adjusting to these actual causal textures,—these actual probabilities as to causal couplings.

VIII

In conclusion, we would summarize as follows:

1. The environment of an organism has the character of a complex *causal texture* (*Kausalgefüge*) in which certain objects may function as the *local representatives* (*die Stellvertreter*) of other objects; these latter to be known as the *entities represented* (*die Vertretenen*).

2. This function of local representation has, however, two subvarieties.

(*a*) On the one hand, objects or situations may function as local representatives of others in that they provide (with the cooperation of the organism) *means-objects* (*Mittelgegenstände*) to the others; these latter to be known as the *goals* (*Zielgegenstände*).

(*b*) On the other hand, objects or events may also function as local representatives for others in that, being themselves caused by such other objects or events, they serve as cues (*Anzeichen*) for the latter. These latter in their turn would then be known as the *Gegenstände* relative to such cues.

3. The simplest paradigm involving these two kinds of local representation will be one in which an organism is presented with a single *behavior-object* (*hantierbarer Körper*). This behavior-object is to be conceived as lying "in between" the *need-goal side* (*Bedarf-Erfolg-Seite*) and the reception-reaction-side of the organism. And, as so lying, it may function causally in two ways:

(*a*) This object can (with the cooperation of the organism) function as the means-object for the reaching of some goal.

(*b*) This object can also send out causal trains which may be picked up as cues by the reception-reaction-side of the organism. These cues will then function to represent the Gegenstände which make up the object.

4. These resulting cues, considered as a reactional event, may be said anticipatively to "*lasso*" (*lasso-principle, i.e., sign-gestalt*) the present causal complex on the basis of past causal complexes. In other words, such cue-Gegenstände will be responded to as presenting then and there an actual instance of the given type of means-Gegenstand and as also presenting (transitively) through this means-Gegenstand the possibility of such and such a final goal-Gegenstand.

5. But such a paradigm with only one behavior-object between goal and cues is for some types of situation too simple and for others too complex.

(*a*) In many actual situations there may be more than one successive means-object and more than one successive cue-object. But such cases, although the picture must be complicated to allow for them, do not introduce anything new in principle.

(*b*) It also appears that such a single intervening behavior-object (Gegenstand-complex) may have three, somewhat independently variable and distinguishable, aspects. These are to be designated as its *discriminanda*, its *manipulanda* and its *utilitanda*. These further complicate the picture but they do not demand anything fundamentally new in principle.

(*c*) Finally, there are other types of situation, obtaining for very young or for very primitive organisms, in which there are no distinct intervening Gegenstände, as such, between cues and goals. The whole picture must in such cases be conceived as telescoped.

6. It appears now, further, that the causal couplings between goal and means or between the latter and cue (or between different aspects within any one of these) are seldom, if ever, *univocal* (*eindeutig*). For it appears that any given type of goal will be capable of being causally reached by more than one type of means-object. And, vice-versa, any given type of means-object will be capable of leading to more than one type of goal. Similarly, any given type of means-object can cause more than one kind of sensory cue and any one type of cue can be caused by more than one type of means-object.

7. Such *equivocality* (*Mehrdeutigkeit*) brings it about that the organism has to venture hypotheses as to what the given means-object will "most probably" lead to in the way of goals or as to what type of means-Gegenstand the given cues have with "most probability" been caused by. (Such hypotheses are always capable of purely objective definition.)

8. Further analyses of the actual types of probability-relation which may obtain suggest preliminary, and it would seem experimentally fruitful, classifications of means-objects into the four types: *good*, *ambivalent*, *indifferent and bad* (*gutes*, *ambivalentes*, *indifferentes and schlechtes Mittel*) and of cues into the four types: *reliable*, *ambiguous*, *non-significant and misleading* (*verlässliches*, *zweideutiges*, *bedeutungsarmes* and *irreführendes Anzeichen*).

9. It appears that the organism's task in any given case is to correct whatever hypotheses it brings with it to fit the real probabilities of the actually presented set-up.

10. The organism brings hypotheses based on innate endowment and previous experience which tend to be suitable to the probability-relations of "normal" environments. But in any actual given environment these "normal" probability-relations may not hold.

11. If, therefore, it is to be successful, the organism must eventually develop both cue-systems and means-object systems which are, at one and the same time, both wide and inclusive and yet full of very fine discriminations.

12. Finally, it appears that the study of the organism's abilities and propensities in the development and operation of such cue-systems and mean-end systems and resultant hypotheses involves not only the problems of perception and of means-end learning, but also those of instinct, memory, insight, intellect, emotion—in short, perhaps, all the problems of psychology.

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