

Perceptive Operations^a

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Premise

Perception can be studied from different points of view: that adopted here is the operational point of view, which has been set out at length in previous writings, also in this journal.¹ The operational approach studies perceptive activity in such a way as to permit complete intercommunication with the naturalistic disciplines concerned with man, in particular physiology and anatomy.

Human physiology is by definition a science which first assumes certain activities carried out by man to be functions, and then studies the operations put into action in the body in order to perform them; consequently, the physiologist sees the body as an organism.

Therefore, in order not to create blockages in the physiologist's work, it is necessary to carry the analysis of mental activities to the point of obtaining operational atoms which make it possible to reconstruct, by combination, the results observed, in all their complexity. A blockage of this kind would be set up if, for example, we were to suppose the mental activity from which each separate number results to be elementary, or, worse still, each number to be the product of the operation of a separate organ; since the number series is unlimited, we would have an unlimited number of elementary activities, or even of organs, which is simply nonsense.

A satisfactory criterion for analysis could be that of breaking down perceptive activity into operations which can reasonably be thought of as functions of a single organ. In this way, besides achieving the intercommunication between disciplines already mentioned, it would be possible to transfer the results of the analysis to the construction of a model, thus obtaining a check on the completeness and coherence of the solution proposed.

A check of this kind in fields such as this, in which research is often marred by defective theoretical premises, which are at the very least contradictory and, furthermore, profoundly rooted in traditional philosophical thought,² is extremely valuable and, nowadays, indispensable in pure as well as applied research.

When we leave the purely linguistic sphere, inconsistencies are automatically excluded: they arise because some semantic stipulations are assumed and held to be valid, even though they infringe other, previous stipulations, which also continue to be considered as valid. When description in words is transformed into a series of physical activities, this can no longer happen.

Nevertheless, if we successfully construct a machine which produces the same results as a man, this allows us to conclude only that the procedure adopted is the right one for obtaining the results in question; the machine will be a model of human operation only to the extent that its construction is preceded by and based on the results of an analysis of the operations reproduced. Thus, equality of results is to be considered only as one form of check; the validity of the analysis ultimately depends, like every

^aOff-print from *Thought and language in operations*, I, 2, 1970, pp. 174-198. (The text was interpreted by an OCR, and then reassembled with the original figures, to reduce the file length.)

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¹ AA. VV., *Corso di linguistica operativa*, a cura di S. Ceccato, Milano 1969; G. Barosso, "Universal operational aspects of thought and language", *Thought and language in operations*, I, 1, 1970, pp. 60-82.

² S. Ceccato, *Un tecnico fra i filosofi*, Vol. I e Vol. II, Padova, 1964 e 1966.

theory, on the extent of the phenomena it accounts for.

The traditional approach to the problem of perception

To give an idea of the classic approach to the problem of perception, I feel it is useful to quote various passages from a number of books on psychology.

In a lengthy essay surveying the psychology of perception, the problem is set in the following terms:

«[According to current opinion]... we see many objects because *in reality* there are many objects; we see them with a certain shape because they are, *physically*, that shape; we see them at different distances from us because *in fact* they are at different distances; and if we see some of them move, this happens precisely because they are moving. The existence of a *relationship between the characteristics of physical reality and those of phenomenal (perceptive) reality* thus appears obvious to our common sense, something which does not require explanation, which in fact is self-explanatory and self-justifying; it is seen as a datum not as a problem. The existence of a problem is much more easily grasped in certain paradoxical perceptive situations, which occur much less often... than those mentioned just now. Such situations easily attract our consideration in that for some reason they lack precisely that relationship between physical and perceptive reality to which we are accustomed... These paradoxical situations permit us to realise that the physical existence of a certain “quality”... does not always constitute the indispensable condition for the existence of such a “quality” on a phenomenal or perceptive level: and therefore that certain other conditions must also be present. The study and identification of these conditions in fact constitutes the principal task of the psychology of perception.»³

The problem is set out in a substantially similar way in a book which approaches the subject of perception from one of the more modern points of view, the transactional point of view.

The author maintains that one solution is simply to affirm that there is no external reality; that everything exists in the mind and that in this case the problem of relationship does not arise. A second approach to the problem is to postulate the existence of an external world, guarantee that there is a certain general identity between that world and what we perceive, and seek useful, comprehensible explanations of why this happens. Most of the more important theories of perception are derived from this last type of approach. In general, they agree on the fact that, even if this identity is due largely to learning, at a certain basic level there exists, apart from all learning, an absolute identity between that which is “there outside” and that which is in the “mind”. Disagreement between these theories regards, for the most part, the level at which this basic original identity comes about. At one extreme there are theorists like Titchener, according to whom it comes about at the level of mere sensation or of attributes (for example, colour, lightness, etc.), a level accessible to introspection, beyond which complex experiences are held to be in some way of a composite nature. At the other extreme there are those Gestalt psychologists who hold that complex perceptions like those of shape and depth are the result of an inherent relationship between properties of the thing perceived and properties of the brain. However, disregarding these

³ R. Canestrari, “La percezione”, in *Questioni di psicologia*, a cura di L. Ancona, Brescia 1962, pp. 194-5.

differences theorists seem to agree on the fact that there is a certain perceptive level at which a bi-univocal identity exists between experience and reality.⁴

The most salient aspect of this situation is undoubtedly the more or less manifest tendency to define perception in terms of a relationship between two entities rather than as a process which leads to certain results, as one might have expected.

However, a relationship never creates one of its terms, but can only link two things already possessed; in fact one cannot see how a relationship can be set up if both its terms do not first exist. If a relationship is sought between a “reality” and a “perceived thing”, this means that the “reality” and the “perceived thing” are already present in the mind and that it is absurd to expect to define them in this way. In fact, no knowledge can be defined in terms of a relationship: all Plato’s *Theaetetus* can be considered a demonstration of this impossibility; Socrates concludes each time that the solution attempted is unacceptable, demonstrating that the proposed definition contains the definiendum, leading knowledge to be defined with knowledge. And this is the inevitable fate of any attempt to define one of the terms of a relationship by means of the relationship itself: by postulating the existence of the relationship, in fact we implicitly postulate that of the term to be defined.

Trying to explain perception in terms of a relationship is quite an old solution, as can be seen from the *De sensibus fragmentum* of Theophrastus; it can be instructive to re-consider the observations he makes in the first two chapters. Here he maintains that, as regards sensation, the many, general opinions can be reduced to two: some people hold that it derives from its like, others from its opposite. Parmenides, Empedocles and Plato make it derive from its like; the school of Anaxagoras and that of Heraclitus from its opposite. The former based their affirmation on the following reasoning: knowledge of most other things is based on likeness and it is natural to all animals to recognize the things which are akin to them; moreover, sensation originates from an emanation, and like goes towards its like. Those who admit that sensation derives from a modification, and that like cannot be affected by like, whereas opposite can be affected by opposite, adopted another view. They think that their thesis is confirmed also by the phenomena of touch; in fact, they say, that which is as hot or as cold as our fish does not produce any sensation. These are the opinions about sensation in general which have been handed down to us.⁵

The artifices to which the various authors recur once they have set out in this direction can easily be foreseen. There are basically two solutions: either the perceived thing is improperly transformed from a mental fact into a physical one, or else the thing to be perceived, considered as being physical, is equally improperly designated as if it were a perceived thing, namely as a mental thing.

Here are two typical examples of this, taken, as before, from Theophrastus’ synthesis. He says that Plato defines hearing in terms of sound. Sound is the percussion of the brain and blood, and ultimately of the spirit, by the air through the ears; this movement, started by the air and spreading from the head down to the liver, constitutes hearing.⁶ Theophrastus also says that Alcmaeon maintains that we hear with our ears because there is a vacuum in them and it is this which resonates.⁷ Empedocles also proposed an analogous solution.

Objections immediately arise. Once it is realised, even if the same term continues to be used to describe it, that sound as a mental fact is a different thing from sound as

⁴ Paper by F. P. Kilpatrick in *Explorations in Transactional Psychology*, F.P. Kilpatrick ed., New York 1961

⁵ Theophrastus, *De sensibus fragmentum*, Capp. 1 e 2

⁶ Theophrastus, *De sensibus fragmentum*, Cap. 6

⁷ Theophrastus, *De sensibus fragmentum*, Cap. 25

a physical fact, as vibration of the air, the problem of the relationship between the two reveals all its insolubility. Proceeding from one physical transformation to another, you always end up with a physical transformation: a vibrating string or lamina makes the surrounding air start to oscillate, the oscillation of the air spreads and starts a movement in the eardrum, from here the movement spreads to the cochlea, where it sets off a series of electrical impulses, which travel along certain nervous channels, activate certain neurons, etc. etc.

But it is clear that this approach leaves the problem wide open. The physiologist and Nobel prizewinner E. D. Adrian identified the impasse perfectly when he said that using this approach the point in the functioning of our brain which remains obscure is, naturally, that which regards the mind, that is the point which should explain how a particular type of nervous impulse can produce an idea; or, considering the problem from another angle, how a thought can determine which nervous cells are to go into action.⁸

Even if this approach does not account for the mental fact, the other solution gives rise to even more obvious objections. When a term, such as “sound”, is adopted to describe the thing perceived, the doubling of the perceived thing does not make sense: if I already have the sound as a perceived thing, what is the use of the echo? When the term is adopted to describe the thing to be perceived the doubling still does not make sense, since it leads to an infinite regression; if a thing to be perceived is multiplied, the end result will always be a thing to be perceived, and certainly not a perceived thing.

Theophrastus in his time objected to a thesis like that which he attributed to Empedocles, according to whom hearing derives from outside sounds, when the air, vibrated by a sound, echoes inside the ear. In fact, Empedocles held that the ear is like a trumpet which re-echoes identical sounds.⁹ Theophrastus objected that when Empedocles explains that hearing is caused by internal sounds, likening the internal sound to that of a trumpet, it is odd that he should think that this makes it clear how we hear. Let us concede that we hear external sounds by means of the internal sound; but with what do we hear the internal sounds? It is precisely this point which remains unexplained.¹⁰

Thus aware of various defects in the traditional approach to the problem of perception, we can go on to tackle it considering it as an activity which produces certain results; but, precisely in order to avoid falling into the opposite difficulties - to be explicit, those arising from the idealist solution to the problem of knowledge - it will be advisable to bear continuously in mind the relationships between the mental world and the physical one, at any rate so far as perception is concerned.

The operational solution to the problem of perception

As an introduction to an operational description of perception it is convenient to start by observing that, even when we are awake, besides the activity of organs which determine mental facts, at the same time many other activities take place in our organism which do not give rise to any mental fact. For example, your clothes were in contact with your skin, from time to time you swallowed saliva, the air passed rhythmically in and out of your nostrils, and yet you were completely unaware of all these things, until these words, by attracting your attention to them, turned each into a mental fact.

⁸ Paper by E. D. Adrian in *The Physical Basis of Mind*, P. Laslett ed., Oxford 1950

⁹ Theophrastus, *De sensibus fragmentum*, Cap. 9

¹⁰ Theophrastus, *De sensibus fragmentum*, Cap. 21

Thus the activity of a single organ is not sufficient to constitute a mental fact of this kind; this activity must be accompanied by another operation which has the effect of isolating it from that of all the other organs which is taking place in the organism at the same time.

In human beings, this operation appears to fall within the sphere of the attention - in fact, it is tautological to state that if we pay attention to something it becomes, or is, a mental fact - and we have therefore called it the *attention's activity of "making present"*.¹¹ It was then decided to designate the combination of activities described in the previous paragraph as *activity of "making present"* and its results as *praesentiata, simple praesentiatum or elementary praesentiatum* being those praesentiata which are shown to be elementary in an analysis of mental activity which satisfies the requirements of interdisciplinarity with respect to anatomy and physiology. Praesentiata include the mental constructs designated by terms like "light", "dark", "hot", "cold", "silence", "noise", and so on.

As can be seen, the praesentiatum is constructed mentally by means of an activity, but this does not mean that it is an activity; and this is true of various mental constructs. Reducing mental activity to operations should not therefore be taken to be a form of ontology in the philosophical sense, but is simply a consequence of the point of view adopted, even if this point of view is amply justified by the reasons set out at the beginning of this article.

The relationship between the mental and physical worlds is particularly evident at the level of praesentiata. There is a certain number of organs, the so-called sense organs, whose normal operation - that is, that taken as a paradigm, or term of comparison - is defined precisely in terms of a relationship between certain physical phenomena and certain mental constructs, which in their simplest form are in fact praesentiata. The organ of sight is typical: some aspects of the normal operation of the organ are in fact defined in terms of a relationship between the wavelength of the radiation striking the eye and the praesentiatum - red, orange, yellow, green, blue, etc. - mentally constructed by the subject.

Another means by which mental things can be obtained is that which leads to the so-called *mental categories*. Without going into excessive detail, it should be remembered that the first conquest of the operational point of view concerned precisely this type of mental construct; in fact, the operational approach grew out of this conquest.¹² Firstly, it was observed that in languages some terms - €" the first ones to be identified were "all" and "part"¹³ - even if they are given as the properties of something observational, do not designate observational characteristics of the thing at all, but instead a way of considering it. A classic example is a coffee cup, which can be a whole, if related to the handle, or a part, if related to the complete service, without any of its observational characteristics changing.

The mental things thus identified display many of the characteristics attributed by Kant to his categories - apart from the fact that in the Kantian schema these were limited to twelve and were considered to be innate - hence the name mental categories used to designate them right from the start.

Using the same approach as that adopted to define praesentiata, there are good reasons for supposing that mental categories are based on a single operation. It seems that this can also be traced to the sphere of attention; in fact there are valid reasons, namely unity of consciousness and problems connected with it, for postulating close interrelations between the activity of making present (defined above) and the

¹¹ S. Ceccato, *Un tecnico fra i filosofi*, Vol. II cit., pp. 20 ff.

¹² S. Ceccato, *Un tecnico fra i filosofi*, Vol. I cit., pp. 135 ff.

¹³ S. Ceccato, *Un tecnico fra i filosofi*, Vol. I cit., pp. 147 and 195-196

basic operation which intervenes in the construction of mental categories.

Let us imagine an organ with two possible states, A and B; one of these, A for example, corresponds in our schema with that which is commonly called a state of attention or vigilance, the state in which we put ourselves when someone says to us: «Pay attention!», «Look!», or something similar; the other, B, corresponds, in the schema, with the opposite state. When we come to study attention as a psychological phenomenon, a schema which contemplates two states only is not of course sufficient: in fact it can easily be seen that there are various degrees of attention, that it can be more or less intense. However, all this is irrelevant to a consideration of mental categories, for which a schema with two states only is legitimate.

Mental categories are thus thought to originate from a combination of several states of attention obtained from the alternation of states A and B, with B having the function of fragmentation. The various mental categories are thus differentiated by the number of states of attention they comprise and by the order in which these are combined. From a single series:

$$B|A|B|A|B|A|B$$

two categories arise; the first from the combination:

$$B|\underbrace{A|B|A|B|A|B}$$

and the second from the combination:

$$B|A|\underbrace{B|A|B|A|B}$$

The symbols normally used by the Italian Operational School to illustrate mental categories are the letter S to represent state A fragmented and a horizontal line to represent combination.¹⁴ Using these symbols, the two categories shown above - one of which intervenes in perception also, as we shall see - are depicted as follows:

$$\overline{\overline{SSS}}$$

and

$$\overline{\overline{SSS}}$$

That which has been indicated by an S is often called, in the writings of the operational school, *a state of attention*.

The function of fragmentation, which, as we have seen, intervenes in the sphere of mental categories, also plays a part in that of praesentiata. In fact, most of the wealth we observe in mental life is due precisely to this function.

Quite a clear example of the way in which this function is employed outside the categorial field is offered by listening to any piece of music. The starting point of any musical construction, at any rate in classical music, is a plurality of sounds; these can be organised mentally in a variety of different ways; as a theme or as an arpeggio, harmonically or polyphonically, etc., but the starting point is always a plurality of sounds. It is precisely the function of fragmentation which permits us to obtain this result. The plurality of sounds, in fact, is not in itself a datum; we would be equally justified in starting from the effects of the oscillations of the air which reach our ears to construct mentally a single sound which we could perhaps then describe in terms of variations along the time scale in pitch, timbre and intensity.

Attentional fragmentation depends on quite a numerous series of operational habits, in the case of music the habit of fragmenting a sound by pitch according to the intervals established for a certain musical scale, by the timbres characteristic of certain

¹⁴ E. Maretti, "Modello meccanico di operazioni mentali", *Supplemento a «La Ricerca Scientifica»*, a. 26, Roma 1956.

instruments, etc. but besides these habits there are biological limits: it appears that the intervals between fragmentations cannot be shorter than 1/10-1/20 of a second, and long intervals induce a state of incipient hypnosis.¹⁵

Language is undoubtedly one of the factors which played an important part in determining the length of the intervals of fragmentation. The institution of a language requires fixing certain mental constructs, i.e. those designated by the single words of that language; the criterion is obviously that of choosing constructs which are relatively not very complex, in order to have something which crops up fairly frequently. As we learn to speak we are progressively forced to construct the mental units which, by common agreement, correspond with single words, in order to make thought contents out of these units; as a result this determines a certain range which usually comprises the intervals between two fragmentations.

I will return later to the influence of the semantic convention proper to a language on the course of perceptive activity, above all in the case in which it is particularly active, that is when an attitude which we could call "descriptive" is assumed.

It goes without saying that the attention's function of making present and that of fragmentation are incompatible, that is one excludes the other.

To summarize, when studying mental activity we must postulate an attentional apparatus to which at least three functions must be attributed:

- that of intervening as a component of the activity of making present
- that of fragmentation
- that of providing the so-called "states of attention", in other words the primary constituents of mental categories.

As regards the first of these functions there already exists a fair amount of experimental data, on both a psychological and anatomophysiological level; as regards the second the experimental data on an anatomo-physiological level is fairly scanty, while it is almost entirely lacking as regards the third, partly because this function has been postulated only recently and only in our field of study.

Before going on to describe the operations which constitute perception, it is worth mentioning that the attention's function of making present can be applied to the memory apparatus. Praesentia may thus be obtained in two different ways; and in fact we have recourse to the second of these ways in understanding terms such as "light", "darkness", "heat", "cold", "silence", "noise", etc.

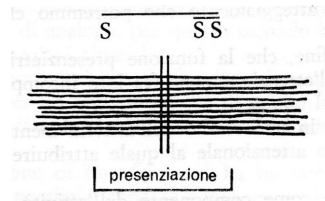
The operations to which constitute perception

Perception, considered from an operational point of view, appears as an enrichment of the operations of making present described above, to be precise, an enrichment by categorial intervention.

In fact in perception the starting point is always the creation of a praesentiatum, to which the mental category indicated above as \overline{SSS} is then applied. (In parenthesis, it is to be noted that this category, when isolated, appears to correspond quite well with what is designated by the English word "object").

The result of the application of this category is the separation of the two parts of the operation of making present, one of which corresponds with the first state of attention, the other corresponding with the combination of two states of attention which follows in the category:

¹⁵ K.S.Woodworth, *Experimental Psychology*, London 1950.

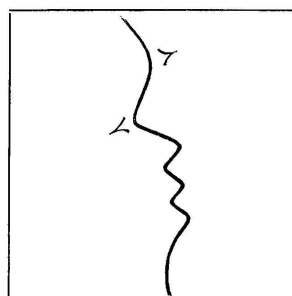
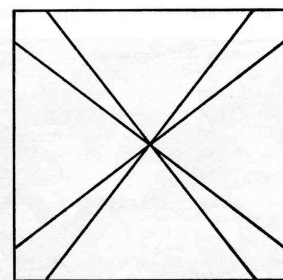
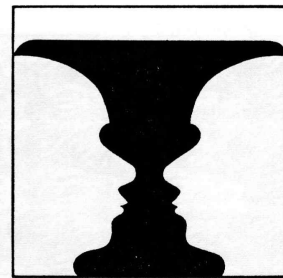


The application of the mental category has the effect of making the first part of the operation be mentally “left”, abandoned, whereas the second part is mentally “kept”. We are concerned with one of the possible functions of certain mental categories, which is another source of the wealth we observe in mental life: that is, it is possible for us to intervene in the sphere of that which is already mental, mentally selecting and rejecting different things.

It goes without saying that in the end we find ourselves with only the part which has been mentally “kept”, and that only this part will eventually be designated, but, as always in mental life, the resulting mental construct is determined by the entire operational history. And it is precisely this which makes redness, for example, a perceived thing rather than a praesentiatum.

The perceived thing is thus never born in isolation, but always coupled with some other thing in the world of praesentiatum, which is mentally abandoned during the perceptive process.

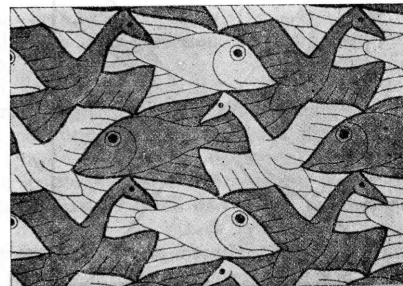
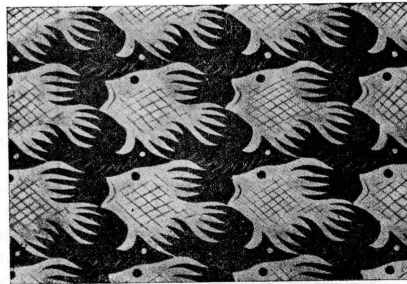
Experimental psychology has constructed various situations which serve quite well to make this evident. Here are some of them:



In the first case,¹⁶ which is perhaps the best known example of an “alternating figure”, one is led to construct a vase or two human profiles, depending on whether the white or black part of the Figure is mentally abandoned during the perceptive process. And it is precisely the presence of this operation which makes it impossible for us to see contemporaneously both the vase and the profiles.

In the second case, which is also taken from the work of Rubin cited above, either a cross or an X-shaped figure can be constructed, in each case abandoning the part of the figure which is kept when the alternative shape is constructed.

The third example, again taken from Rubin, is perhaps that in which it is easiest to become aware of the operation of mental rejection. A further advantage is that the two figures are very well balanced, in the sense that the human profile on the left does not tend to be constructed more often than that on the right, and vice versa. This is not true of the other figures shown: in the first case, for example, the vase tends to be constructed more often than the profiles.



We owe the last two examples to the engraver M. C. Escher;¹⁷ in the first case white fish facing left alternate with black birds facing right; in the second case white fish and birds alternate with black Fish and birds, The last figure is however too complicated to work well as an alternating figure: the time taken to construct a single fish or a single bird is so long that it weakens the link with the shapes already constructed,, the fact that the shapes of the same colour face in opposite directions also lengthens the construction time considerably. One is thus led to interpose a mental break which makes each shape an independent unit, and therefore makes it possible to organise the situation, mentally, in a number of different ways: for example, broken up horizontally with fish and birds of different colours facing in the same direction, or other solutions comprising all four possible shapes (white and black fish, and white and black birds), connected and contraposed in various ways.

In order to complete this outline of the operations which constitute perception it will be useful to mention briefly those by which we mentally represent objects;¹⁸ these

¹⁶ Taken from E. Rubin, *Synsoplevede Figurer*, Kopenhagen 1915.

¹⁷ Given by W. R. Fuchs, *Knaurs Buch der Denkmashinen*, Munchen 1968

¹⁸ S. Ceccato, “A model of the mind”, in *Cybernetics of neural processes*, E. Caianiello ed., CNR, Roma

operations are usually held to belong to the same family as those of perception.

In representation, in fact, the order of the operations appears to be reversed: that is to say, first the category of object is formed and then a praesentiatum is added. This analysis is confirmed both by the fact that we are aware of a kind of “mental blank” at the beginning of any attempt to represent something - a blank which corresponds with the isolated state of attention with which the category of object begins - and by the fact that nothing is rejected in the process of representation, and the thing which we represent to ourselves does not arise in a situation, unlike a perceived thing.

It goes without saying that these are initial analyses which may later be modified and further improved; nevertheless, the hypothesis I have outlined here seems to me to be the most promising one in that it supposes a distinction at the level of mental operations, without appealing to anatomo-physiological phenomena.

The results of perception and representation, together with praesentiata, all form part of the world of observational things, and are seen in this light when contrasted with mental categories, for example. In the writings of the Operational School the term *observata* is frequently used to indicate these types of mental construct.

The constructs of perception

We have now seen what are the operations which constitute perception and representation, that is the operations which characterize these two ways of operating, and in defining them the concept of a pure praesentiatum has been used, in order to give them a sufficiently general character.

We often speak about perception and representation with reference to colours or sounds. However, we speak about perception equally often with reference to a chair, a table, or a vase: in other words, with reference to mental constructs in which the operations of perception play a determining part, but in which other kinds of operation - principally those by which we obtain the figures - also intervene. It is for this reason that I felt it was more appropriate to describe these constructs under the heading “constructs of perception”; nevertheless, the decision to examine them from the viewpoint of perception, rather than from that of representation, which would be equally legitimate, is not of great importance, since in both cases the same operations are involved.

A first analysis of the operations by means of which we arrive at a figure as a mental construct leads one to think of it as being obtained from a plurality of points and from the passage from one to another, keeping present all that which has already been done. The various figures are thus differentiated by the movements made in passing from one point to another, and by the composition of these movements.

However, the “maintainment” which intervenes between the operations which constitute the figure requires further definition, which brings me to describe the activities of the memory and some activities which play a part in the creation of mental constructs.

Reducing the activities of the memory to operations which could be mechanized is a problem which in some respects is yet to be solved; for this reason, and also for brevity's sake, in this article I will limit myself to saying that these activities can be grouped together in a limited number of basic functions.¹⁹

Firstly, there is the function of keeping present for a certain length of time that which has just taken place, that is memory as a continuation of presence, or short

1965, p. 32; the analyses belong to a previous stage of research as regards praesentiata.

¹⁹ S. Ceccato, “Brain mechanisms of learning: psychological approach”, *IVth International Congress of Cybernetic Medicine*, Nice, sept. 1966.

range memory: I will deal with this function in more detail later on. Secondly, memory can make present again that which took place in the past and has been absent, that is memory as recall. Both operations which became a mental fact at the time when they first took place and those which passed unnoticed may be recalled, as is shown, for example, by cases of subliminal perception.

Recall, in its turn, may come about in different ways: recall from a particular point of view, or selective memory; recall of other operations related to that which stimulated the recall, or associative memory; and, lastly, recall may occupy varying lengths of time: a time equal to that occupied by the original operation in the case of literal recall, or a much shorter time in the case of summarized recall.

Furthermore, the memory can stimulate particular operations or chains of operations, rather than acting as the source of something which will become a mental content: we thus have the memory's function of propulsion. We are concerned with an activity which we are very rarely conscious of and which can become the manifestation of a style, a personality, the unconscious, the subconscious, etc. depending on the point of view from which it is studied.

Finally, there are two other functions of the memory not to be overlooked, for even if they appear obvious and to be taken for granted, they are none the less important: the functions of forgetting and of transformation. The function of forgetting in particular is an essential pre-condition for the recall operation.

The activity of maintainment, which is that of greatest interest in this context, in that it is interposed between the operations by which we construct a figure, can be described as the prolongation of the dynamic situation created as a result of the functioning of one or more organs; in particular, as regards the mental world, as a consequence of the functioning of organs which have given rise to a certain mental fact: for example the organs which have been involved in the operation of making present, or in the construction of a given mental category or of a perceived thing.

If we suppose that this function is performed without further employing the organs from whose activity that which is to be maintained originated - this hypothesis is extremely useful, for example in the construction of a model of mental operations - we have to imagine a further organ, which "reverberates" the operations in question, and in which the dynamism induced continues for a certain length of time, as an effect of the characteristics of the material from which the organ is made and of its internal structure. In man, this function could be performed by the cerebral cortex, onto which all other organs are more or less directly "projected".

Among other things, the presence of this other organ offers the researcher a first possible explanation of how it is possible to speak about operations and results without invalidating the premise of a total dynamisation of mental life: the induced dynamism which is responsible for the function of maintainment can in fact be imagined as a result of the inducing activity. We can thus distinguish between the operation of making present and its relative praesentiata without being obliged to abandon the operational approach.

However, even if maintainment allows us to make use of a result (which is at the same time a potential new construction unit), which is something of operational origin, it cannot be an activity which gives rise to constructs. In describing mental categories the word combine was used, and this operation was indicated in the diagram used to represent them by a horizontal line placed over the elements combined.

The operation indicated by this symbol (which does not only intervene in mental categories) has been called *combination by addition or summational combination*, in order to differentiate it from other forms of combination. In our schema of mental activity, it must be considered as another elementary function, which has to be imag-

ined as having its own specific organ. It always combines two elements only and gives rise to a result which:

- depends both on the elements and on the order in which they are combined, and
- eliminates the separate identity and the further availability of the elements combined;

as regards the second characteristic, it resembles a chemical reaction.

The memory, by means of the function of maintenance described above, thus ensures for a certain length of time the availability of these results for incorporation in further summational combinations or for other mental operations.

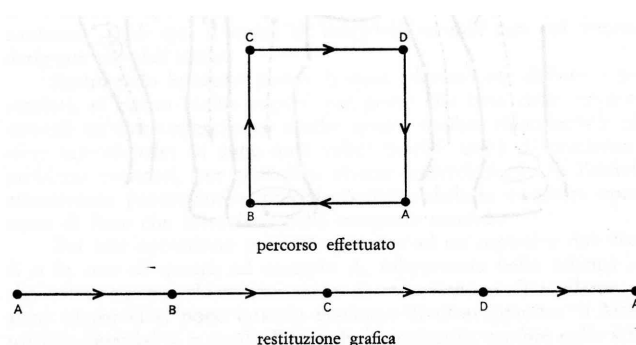
The construction of a figure implies continuous combination by addition; we can become aware of this if, instead of using our sight, which we are highly accustomed to using, and which thus permits us to work very quickly, we use a slower means to construct the image, such as touching the shape with our hands or walking around it. If one tries walking along thinking about the outline described by one's movements, one easily realises not only that one's various changes of position are continuously being added together, but also that all the movements made and added together remain mentally present.

This does not exclude the possibility of quite a complex articulation of the mental activity of constructing a figure, incorporating breaks, the recall of intermediate products, etc. An episode which occurred in the course of a series of experiments designed to increase the capacity of blind children to move around in their surroundings seems to me particularly illuminating in this context.²⁰

In order to move around deliberately in any space one has to be capable of imagining it; in the case of a blind person, the number of external references is drastically reduced and thus kinaesthetic data (that is, the movements made by the subject) must be sharpened and exploited to the utmost. Furthermore, the subject must possess an extremely precise, analytical spatio-topological image of his surroundings, almost like a mental map, and must then mentally trace on it an equally precise image of the course he has already followed and of that which he has yet to follow. Thus in both cases the activity involved is of a figurative nature.

The method of instruction used in this experiment consisted of making the child walk along progressively more complex courses and draw each time on a block of plasticine the path he followed. In this way, the habit of mentally reproducing the path followed was fostered in the subject.

A six-year-old child, blind from birth but free from motor disabilities, followed a square-shaped course perfectly, and yet played it back graphically as a single line:



It is fairly clear that the child omitted to interpose the right-angles between the

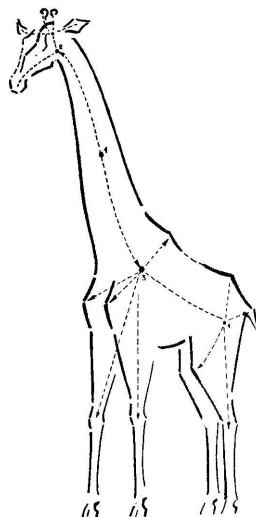
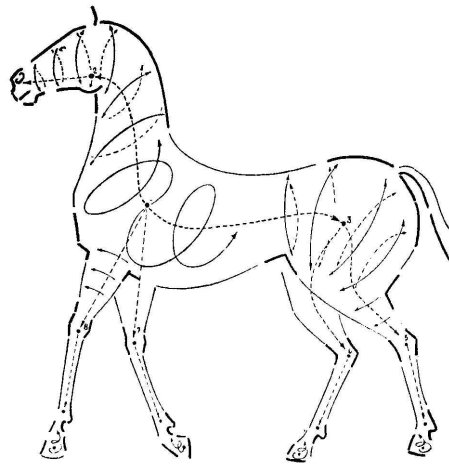
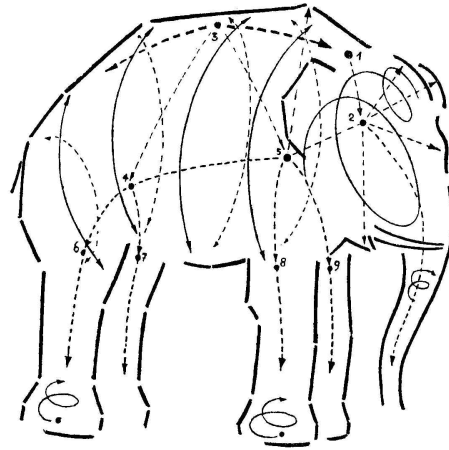
²⁰ I. Terzi, "Impostazione e applicazione di un metodo per educare il cieco al senso e alla nozione di spazio", *Infanzia anormale*, 52, mar.-apr. 1963.

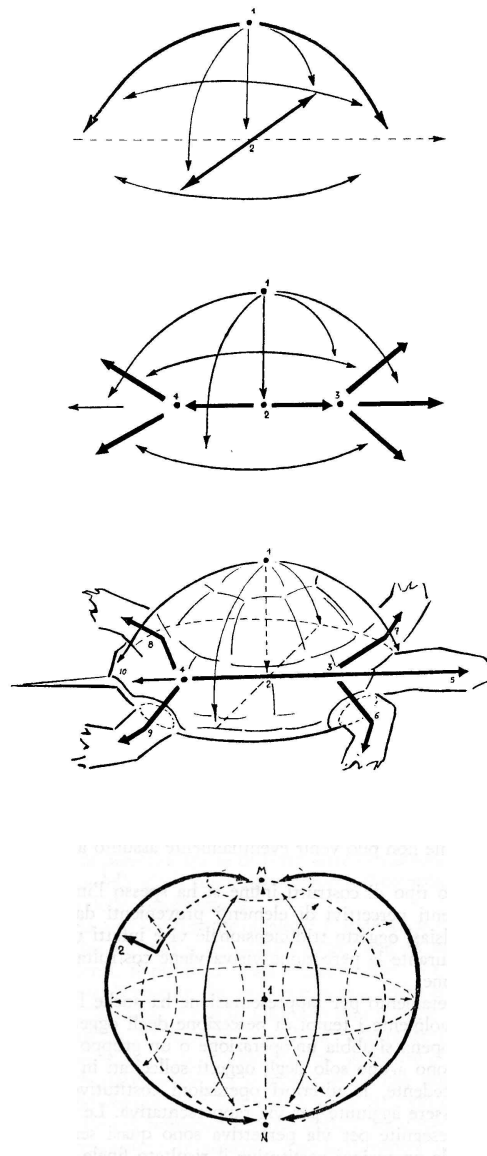
rectilinear stretches of the course, even though he physically turned through 90° on the track. And it is probable that, at any rate at the beginning, he did not even carry out a mental fragmentation at the points at which he turned, that is to say, that he re-constructed the course as a single continuous line.

To give an idea of the complexity of figurative articulation in everyday cases, we have reproduced here a number of analyses, which do not go into minute detail, carried out by the painter Pino Parini.²¹

The elephant, the horse and the giraffe, the tortoise, analysed at various successive stages, and, finally, the apple:

²¹ P. Parini, *Figure e movimenti*, Euratom Report, 1963.





Other examples of figurative articulation are to be found in the report cited.

An analysis of shapes and subsequent description of them in terms of elements and relationships can reveal only internal relationships: that is, the shape is not created in relationship with something else or even in relationship with a reference system. For this reason it remains unchanged when rotated or moved to a different position, or in general, moved rigidly in any way i.e. leaving the distances between points unchanged.

Furthermore, since figurative activity requires at the very least a transition from point to point, maintaining the transitions, the articulations and the combinations previously formed, it traces an operative path which determines almost entirely a subsequent discourse in terms of lines, areas and volumes. This is the reason why the perceived object which possesses a shape, even though it is not conceived of as being one, two or three-dimensional at the moment of perception, is constructed in such a way that one finds that it is one, two or three-dimensional, when one comes to ask oneself how many dimensions it has.

The activity of figuration is independent of that of perception and of that of representation. Nevertheless, in constructs of perception it is to a large extent guided by perceptive elements, in the sense that the points through which it passes usually correspond with the breaks determined by the application of the category of "object",

which, as we have seen, constitutes perception. In the case of visual perception, this generally happens when the eye encounters differences of luminosity or colour.

In the perceptive construct, figurative and perceptive elements grow together; this is one of the main reasons why the final result cannot be assumed other than as being concrete.

Finally, elements of representative origin are often incorporated in this type of construct side by side with perceptive elements: in any three-dimensional object there is a part which cannot be seen, and thus in the process of visual perception is constructed by means of representation.

Completion by representation also has the effect of considerably shortening the time taken to perceive familiar objects. In fact, in the case of an operation or a group of operations referring to only one of the objects summoned up in the memory by previous operation, the further operations necessary to constitute the object tend to be added by representative means. The operations actually carried out by perceptive means are almost always only a part of the operations which constitute the final result; this involves a considerable saving in time, but also the well-known possibility of errors. And these are also the criteria on which the “machine which observes and describes” was designed.²²

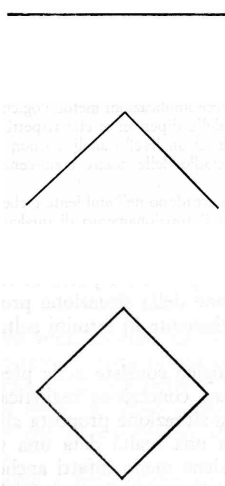
The traditional approach to the problem of perception, seen in operational terms

Having proposed a definition of perception in operational terms, we can now go back to the traditional approach to the problem and ask ourselves whether it should be altogether ignored as being simply the product of an incorrect way of envisaging the whole problem of knowledge, or whether perhaps it does not raise issues worthy of consideration, even if they are not those considered most important by its adherents.

In research on mental activity, two kinds of problem arise:

- analysis of this activity to the point of arriving at elementary operations, in the sense defined above, and
- study of the laws which govern the execution of single elementary operations and their concatenation.

A few simple examples will illustrate these problems even better. The first figure may be designated as a line, or as a segment; the second as a line, a broken line, or as an angle; and the last figure may be designated as a rhombus, a square, or a quadrilateral.



²² R. Beltrame, “Osservazione e descrizione meccaniche”, in *Corso di linguistica operativa*, cit.

But in each case we have provided only a few examples of the almost indefinite variety of forms that a discourse based on a certain physical situation can assume.

Even though we are concerned with designations which are all possible and each of which corresponds with a different series of operations, in the absence of further stimuli some designations are more likely than others. In the second example, for instance, the presence of a cusp on which the eye lingers makes the designation “line” fairly unlikely; in the last example, the position of the figure encourages the designation “rhombus”.²³

The traditional approach to the problem of perception has tended to concentrate more and more on this second aspect, that is on the study of that on which the chains of operations which lead to given perceptive results depend.

The description of the operations which intervene in perception set out above provides two useful contributions to the study of these “dependences”.

The first is the fruit of a finer analysis and articulation of the perceptive products whose dependences are studied. It consists of a more complex conception of perceptive processes in themselves, which does not affect the research approach and does not touch on any methodological problem. The second, on the other hand, has fairly direct methodological implications.

A description of dependences which fully respects interdisciplinarity brings one to a level of analysis which is not always either manageable or possible at the present state of our knowledge. In fact, it would be necessary to arrive at:

- physical processes which take place in our surroundings and which induce, by physical means, the operation of one of the organs of the person performing mental activity; or, alternatively,
- the operation of organs seen as inducing or inhibiting the operations of certain other organs, and thus also certain mental operations.

In practice, therefore, it is preferable to relate the results of perception to a description of the situation to be observed, a description which need not necessarily be formulated exclusively in terms of physical dimensions.

The methodological contribution consists of awareness that any realistic conception is totally impossible, from which it follows that no description of the situation to be observed is theoretically more appropriate. Once we have rejected the conception of a reality understood realistically, and thus given once and for all, it becomes superfluous to rank different descriptions in terms of a greater or lesser distance from “reality”.

But once the realistic conception has been excluded, it is also no longer possible to consider one’s own description as being interpersonal without first having demonstrated that this interpersonality effectively exists.

One can no longer attribute to another subject a mental activity identical to one’s own, without having first checked carefully that this identity exists: in other words, identity is not a postulate, but a fact to be proved case by case.

And it is not always easy to prove; identical linguistic behaviour in response to the same situation set up for perception does not allow us to conclude, without further enquiry, that the mental operations performed are identical: a different state of knowledge and experience, just as a different point of view, all constitute sources of differences.

There are many common examples of this; a telephone or a typewriter have different significances for the user and for the servicer. Botany offers some lampant

²³ An operational analysis of the rhombus is given in S. Ceccato, “A model of the mind”, *loc. cit.*, p. 33.

examples: most of us think of an apple tree as a tree which bears apples, and not as a tree with a given form of trunk, branches, etc.; between these two extremes there is a whole series of intermediate stages.

On the other hand, a study of dependences cannot prescind from a choice of paradigms: these are indispensable both for classification, and for introducing explanations and constructing theories. Certain chains of mental operations and certain schemes of dependence must therefore be adopted as a point of reference for both classifying and explaining the variety of perceptive results encountered. The choice of them, in the approach outlined in this article, is theoretically altogether arbitrary, even if, as with any choice, this is not true in practice.

Thus there intervene those factors of utility, simplicity and, at times, formal elegance, which govern the choice of paradigms and theories in every field.