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Physiology. — *"On inhibition proceeding from a false recognition."*

By Dr. F. ROELS. (Communicated by Prof. Dr. C. WINKLER).

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The present publication derives its origin from a series of researches concerning the phenomenology of remembrance. The experiments were conducted in the following way: various kinds of stimuli were presented to the subject, who was asked to recall later on what he had seen. Each single and individual experiment was divided into three periods: the fore-period, in which the stimulus was exhibited; the after-period for recollection, including the recognition of the stimulus; and the interval between them. In spite of the instruction given to the subject to avoid as much as possible any representation of the stimulus during the interval, it not infrequently happened that images were evoked similar to the primary stimulus or differing from it in some way or other. In the latter case there was absence of recognition in the third period of the experiment; nay, the stimuli even aroused a sensation of novel experience, a "conscience de nouveau venu". Absence of recognition, a fortiori the occurrence of a so-called "conscience de nouveau venu", is under these circumstances, by no means to be considered as a matter of course, since from the fact that the experiencing person proves incompetent to faithfully call up the stimulus, it does not follow, that he will fail to identify it when it is presented again.

The researches, bearing particularly on the analysis of these constantly recurring phenomena, were carried out in the psychological Laboratory of Louvain, Prof. Dr. A. MICHOTTE and Mr. G. PAPENS acting as subjects.

The stimuli were meaningless, coloured figures of a somewhat complex pattern, painted on pieces of cardboard (10 cm. by 10 cm.).

Twelve of them were shown to the observer in succession in the first stage of the experiment. They appeared in a slit of a screen, behind which a cardboard disc, provided with two open sectors of 90°, was made to rotate with constant speed. Every time when one of the sectors flitted past the slit, one of the stimuli became visible and was exposed to view for about 760 σ . Each set was exposed five times with intervals of 3 minutes. A number of control-tests showed us that after a fivefold impression the subject had got sufficiently familiar with the stimulus.

At a second sitting, which took place exactly 24 hrs. after the first, five stimuli were applied just as before. They resembled more

or less some of the first set as to form, or colour or both. Next the observer was required to image those original figures of which a fragment would be shown him, and to transfer his mental reproductions to paper while reporting the various details of form and colour as faithfully as could be. Our object in repeating the impression of some of the original stimuli was to see whether and how far the recognition was acted upon by them, and thus to secure a touchstone by which to test the influence of the mental reproductions upon the recognition.

Both influences were the object of an investigation at a third sitting, which again took place 24 hrs. later. The primary stimuli were presented again to the observer, who was then required to say whether or not he recognized them. The time needed for recognition was registered by means of a chronometer.

In order to ascertain the extent to which the recognition had been facilitated by the impression of the fragments of the original stimuli, applied at the second sitting, the two observers were subjected to a set of control-tests. Here also our material was uniform and meaningless. After familiarizing themselves with twelve figures of the kind, in the way indicated heretofore, the experimenter again selected five, of which fragments were shown at a second sitting, the subject being again called on to avoid, as much as possible, any reproduction of the complete figure. Then again a third sitting followed for the recognition of the original stimuli. To throw the observer into confusion, the intervals between the experiments proper, as well as those of the control-tests were filled up with "Vexirversuche", so that the observer could not tell beforehand whether the stimulus presented for recognition, was or was not one of the familiar series.

Each observer was subjected to 180 experiments, 60 of which served for comparison.

The drawings made during the second sitting, fell into three groups upon the basis of their likeness to the primary figures, viz. accurate, fairly accurate and inaccurate drawings. A drawing was considered accurate, when it was in every detail a faithful copy of the original figure; fairly accurate when it differed from the latter in certain details as to position and extensions of the parts. Such drawings as showed an essential departure from the principal features of the primary stimulus were called inaccurate. Our criterion is, it is true, open to objection, but in our judgment it is the only one at our disposal.

In the following table the drawings of our subjects are grouped under the 3 headings mentioned above. The colour-sensation has been subtracted, since as to colours the reproductive tendencies are

hardly adapted to quantitative analysis, owing to the fact that the experimenter exhibits the colour together with the fragment of the figure, and that the omission of part of the drawing necessarily involves the absence of its colour :

TABLE I.

	M	P
Number of drawings	71	61
Accurate drawings per 100	42	9,8
Fairly accurate drawings per 100	16	8,2
Inaccurate drawings per 100	42	82

The experiments upon P had far advanced, when we noticed that the influence of the reproductions of the second sitting upon the recognition varied much according as they were dependent upon memory or upon imagination. We, therefore, requested M to report whether his drawings were based on the one or on the other. P could not furnish satisfactory information on this head.

The recognizing process may be readily traced out along the following lines :

A. Recognition of the figures reproduced in the interval.

B. Recognition of the figures altered objectively at the second impression.

A. The recognizing process reveals the influence of the various kinds of reproductions in two ways :

1. the character of the phenomena
2. the lengthening or the shortening of the recognition-time.

As regards the effect of the reproductions upon the character of the phenomena, which play some part in the recognizing process, we tabulated the relative frequency of recognition and sensation of novel experience either for the entire figure or for one or more of its fragments. In my calculations I started from 100 experiments for the several groups. (See table II p. 1415).

a. Accurate reproductions. The figures constructed accurately, in the interval, are most times recognized directly. (With P only one exception in 9 cases, viz. a fragment of the figure is not recognized; with M there were only 2 departures from the general rule in 26

TABLE II.

	Accurate reproduction	Fairly accurate reproduction	Inaccurate memory-image	Inaccurate image of imagination
Sensation of novel experience for the entire figure	M 3,85 P —	20	80	15,8
Sensation of novel experience for a fragment	M 3,85 P 11,1	40 60	—	10,5
Recognition of the entire figure	M 92,3 P 88,9	40 40	20	73,7

cases: once a "conscience de nouveau venu" for the entire figure, and another time there was a sensation of novel experience for a special fragment).

In addition we must observe that in M's case all accurate reproductions depend upon memory.

b. *Fairly accurate reproductions.* In this group the figure evokes far oftener a sensation of novel experience and in far the most cases observed, this occurs especially with those fragments, whose imaging and drawing at the second sitting had been inaccurate; recognition exists for the fragments that had been represented accurately. With M as well as with P recognition resulted from an inaccurate reproduction of a fragment in $\frac{2}{3}$ of the cases; however, it relates rather to the "Gestaltsqualität" of the entire figure than to this particular fragment.

c. *Inaccurate reproductions.* It is of the utmost importance to distinguish between the influence of reproductions that are to be considered as the outcome of the imagination and the influence of such as originate from the memory. M reported this differentiation almost from the outset; what is said about the results, therefore, refers to this observer only.

a. *Inaccurate images of imagination.* In comparatively few cases the subject reports a sensation of novel experience, persisting, whole or part, in new imaginal formations. Only 5 out of 19 cases. Most times the entire figure is recognized at once (in 13 out of 14 cases).

β. *Inaccurate memory-images.* They are few and far between, only 3 having been reported. The process of recollection differs essentially from the process following upon an image of imagination in that a sensation of novel experience is the rule here, whereas recognition is the exception ($\frac{1}{3}$ of the cases).

The cases here reported, do not comprise two in which the

remembrance upon which the reproduction depends, is of a more or less questionable nature. When studying the protocols of the recognition of these figures, we see that the sensation of novel experience, evoked immediately after the incoming stimulus, is ousted after the analysis of the figure by a "conscience de déjà vu", weak though this may be. In this respect they approximate the imagination type.

It is plain then, that the course of the experiment upon the recognition of the primary figures varies considerably according as the reproduction in the interval is the result of memory or the product of imagination. This accounts for the essential anomalies in the results obtained with P, whose experimentation, as we alluded to before, was drawing to a close, when our attention was directed to the diverse influences of memory-images and of images of imagination. Figures reproduced inaccurately, either as a whole or in part, are identified in one case, while in other cases they arouse a sensation of novel experience. This anomaly may be unreal. However, being destitute of any knowledge of the nature of the mental reproductions made in the interval, we are not in a position to assign the cause.

The tabulated data lead to the following conclusion: recognition is inhibited by a more or less inaccurate representation, in so far as the latter evokes a complete or partial sensation of novel experience, the more so as the representation is farther removed from the primary stimulus. The considerable increment of the percentage of the "consciences de nouveau venu" and the rapid fall of the percentage of the recognitions in the first three columns reinforce our conclusion. The peculiar effect of the inaccurate images of imagination upon the recognizing process, in contradistinction to that of the inaccurate memory-images induces us to attribute the inhibition, affecting the later recognition, to the totally or partially false recognition — *fausse reconnaissance* — attending the more or less accurate and the inaccurate memory-images and which is lacking with the image of imagination. If, moreover, we bear in mind, that in the case of M — whose account is the only one we possess — all accurate images are memory-images, and, therefore, must be considered as true recognition-types, we are justified in ascribing chiefly to the latter the favourable influence upon the later recognition.

An analysis of the times, required for the recognition of the primary stimuli, lends support to this view.

A mental reproduction, as has been observed, does not affect only the nature of the phenomena in the recognizing process, but also the times needed for this process.

The following table shows for the several groups of reproductions the arithmetical average, the median and the average difference of the reaction-times of those experiments that resulted into a total or a partial recognition of the original figures.

TABLE III. (time, seconds).

	Arithmetical mean	Median	Mean deviation
Accurate reproductions	M 1,2	1,2	0,22
	P 1,9	1,5	0,64
Fairly accurate „	M 1,5	1,4	0,46
	P 4,1	4,2	1,47
Inaccurate „	M 1,7	1,6	0,38
	P		

An inaccurate reproduction made in the interval lengthens the recognition time in proportion as it differs from the original figure. M. reports only one case, in which recognition follows later on in spite of an inaccurate memory-image. We are, therefore, not enabled to publish any data illustrating the influence of a preceding false recognition upon the duration of the subsequent recognizing process.

Whereas, on the one hand, an inaccurate reproduction occasions a slowing of the reaction, on the other hand an accurate reproduction reveals itself in a quickened process. This is clearly demonstrated in the following table. It comprises the data regarding the recognition time, obtained after an accurate reproduction in the interval, by the side of those obtained after a series of control-tests, in which the interval between the impression and the recognition was the same, but without the pre-existence of a reproduction.

TABLE IV. (time, seconds).

	Arithmetical mean	Median	Mean deviation
Accurate reproduction in the interval	M 1,2	1,2	0,22
	P 1,9	1,5	0,64
No reproduction in the interval	M 1,4	1,3	0,41
	P 3,8	3,8	1,57

These results confirm the hypothesis put forward heretofore, that the accurate reproductions, which in M.'s case are invariably dependent upon memory, and consequently comprise a recognition of the reproductions, facilitate a later recognition, as appears from a shortening of the reaction time.

As it might be supposed, that the quickening of the reactions in the case of an accurate reproduction in the interval, is due to a deeper impression of that fragment of the figure that was exhibited at the second sitting, with a view to facilitate a reproduction, we must observe that there is no reason whatever, why it should not affect the more or less inaccurate reproductions, as well as the accurate. Moreover, our control-tests have proved that a quickened reaction is undoubtedly due — anyhow chiefly due — to the effect of the accurate reproduction. This is borne out by the fact that in some of these tests the observer was shown, during the interval, a fragment of the primary stimulus, while he was asked to avoid as much as possible any representation of the specified stimulus. We have calculated the recognition time for 25 of such experiments upon each subject; we subjoin the results together with the times needed for a preceding accurate reproduction.

TABLE V. (time, seconds).

	Arithmetical mean	Median	Mean deviation
Accurate reproduction in the interval	M 1,2 P 1,9	1,2 1,5	0,22 0,64
Exhibition of a fragment of the figure, without re- production in the interval	M 1,4 P 3,9	1,3 3,7	0,32 1,88

The experiment upon P. also shows, in the reaction times of the recognition with preceding inaccurate reproduction, the different effects of the inaccurate memory-image and of the images of imagination upon the later recognizing process. We wish to call particular attention to the very considerable mean deviation:

Arithm. av. 4.7; median 4.8; mean deviation 2.35.

The average time needed for recognition is almost the same for fairly accurate and for inaccurate reproductions preceding the recognition, whereas the mean deviation is considerably larger here. This tallies with our hypothesis that the calculated times constitute the average of two very distinct groups of data, whose differences, of

course, stand out clearly in the calculation of the mean deviation of the reaction times.

B. At the second sitting, the observer was shown, under the same laboratory conditions as before, a series of pictures, more or less like the previous set as to colour and form. He had only to observe them closely and to prevent any interfering association with words, objects, or familiar figures. Our object was to apply the effect of this impression upon the recognition of the original figures as a touchstone by which to test the influence of the reproductions.

In the following table we illustrate the relative frequency of recognition and of sensation of novel experience, either for the entire primary figure or for one or more of its fragments. I started from 100 experiments with objective alteration of the stimulus in the interval; the numbers obtained by the experiment underwent a corresponding reduction:

TABLE VI.

	M	P
Sensation of novel experience } for a fragment of the figure }	11,1	14,8
Sensation of novel experience } for the entire figure }	18,5	14,8
Recognition of the entire } figure }	70,4	70,4

The relatively slight effect of the second impression upon the recognition is very obvious: with either subject recognition takes place in 70 % of the cases, in spite of an objective alteration of the stimulus in the interval. When comparing these data with those of Table II, we will see at once, that the effect of an objective alteration of the figure upon its later recognition is very much like the influence of an inaccurate image of imagination. In Table II the percentages of sensations of novel experience were with M respectively 15.8 % and 10.5 %; that of the recognitions 73.7 %, which values agree fairly well with those of Table VI. If, in this connection, we take into account, that the inaccurate image of imagination, unlike the memory image, is not recognized as identical with a reproduction of a previous observation, we are most likely justified in ascribing the absence of a distinct inhibition of the second impression at work with the later recognition, to the absence

of a false recognition following upon the presentation of the altered figures. This hypothesis is based not only upon the agreement of the quantitative data, but also upon the arrangement of our experiments, the instruction being given to the observer at the exhibition of the altered figures to prevent, if possible, any association, including those with figures previously impressed, in order not to exert any influence upon the appearance of a true or a false recognition. However this may be, our experiments do not throw light on the question, whether a false recognition of the objectively altered stimulus affects the later recognition of the primary stimulus in the same way and in the same measure as it is influenced by the false recognition of the reproduction. Before long we hope to decide this point in a new group of experiments specially suited to the purpose.

The following times have been calculated for the recognition of the original stimuli after impression of the objectively altered figures in the interval. They are taken from the experiments that led to a complete or partial recognition of the primary figures.

TABLE VII. (time, seconds)

	Arithmetical mean	Median	Mean deviation
M	1,6	1,5	0,41
P	3,5	3,4	1,33

From a comparison of these results with the data communicated in Tables IV and III it appears, that, with M the recognition time shows an increase of 0,2 sec. only; likewise that the effect of the second impression upon the recognition is very similar in intensity and direction, to that of an inaccurate image of imagination. In P's case a shortening of the recognizing process is out of the question; on the contrary we note a slight quickening of the recognition of the original figures after a second impression.

The relatively short time needed for recognition again points to absence of a distinct inhibition of the second impression. Moreover, the striking accordance, in M's case, of the times obtained here, with those obtained with inaccurate images of imagination in the interval, corroborates our view that the absence of a distinct inhibition of the second impression is owing to the absence of a false recognition at the impression of the objectively altered stimuli, which absence is due again to the arrangement of our experiments.

CONCLUSIONS.

1. A memory-image of the stimulus either entirely or partially inaccurate, exerts on its recognition at a later time an inhibition, revealing itself in a complete or partial sensation of novel experience for the stimulus.

2. In the case of an inaccurate image of imagination the absence of a false recognition reveals itself in the absence of this inhibition; the figure reproduced inaccurately is recognized at a repeated impression in a vast majority of cases.

3. Presumably the absence of a distinct inhibition to the recognition of the stimuli, which have been altered objectively at their second presentation, is to be ascribed to the absence of a false recognition in the interval.

Anatomy. — "*The phylogenetic development of the cerebellar nuclei.*"

By J. J. L. D. BARON VAN HÖVELL. (Communicated by Prof. WINKLER).

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The problem of the cerebellar function, or functions, has of late years attracted a great deal of attention. Its solution is being looked for in the direction of co-ordination of movement and tonus, and both of these again in connection with somatic and labyrinth stimuli. As regards the comparative anatomy, comparative morphological research first drew attention to the connection between cerebellar development on the one hand, and bodily form and the accompanying muscular functions on the other hand, as has been demonstrated by BOLK¹⁾, whose researches have been confirmed repeatedly by physiologists, recently by THOMAS and DURUPT²⁾.

Microscopical comparative anatomy also shows most clearly the connection between the cerebellum and the static central organ; as has been pointed out, in particular by EDINGER³⁾.

The result of a comparative anatomical study of the cerebellar nuclei, which I conducted in the Institute for Brain Research at Amsterdam, also pointed to a connection with the vestibularis. Just as the cerebellum has developed in the lower vertebrates at a place

1) L. BOLK: Das Zerebellum der Säugetiere 1906.

2) THOMAS et DURUPT: Les fonctions cerebelleuses. VIGOT frères. Paris 1914.

3) L. EDINGER: Ueber das Kleinhirn und den Statotnus. Deutsch. Zeitschr. f. Nervenheilk. 45 Vol. (1112).