

THE INFLUENCE OF ATTENTION IN ILLUSIONS OF REVERSIBLE PERSPECTIVE.

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I.

THE interest which experimental psychologists have for long displayed in the subject of illusions of reversible perspective has of late years shown no signs of diminishing. But though the work of recent authors has brought to light a considerable number of new facts and given rise to interesting discussions of old problems from new points of view, there exists as yet no general agreement as to the conditions which underlie the reversals of perspective, or as to the exact nature of the psychological processes involved.

The explanations hitherto advanced may be roughly classified into two main groups, according as they regard the essential conditions of reversal to be found in (1) peripheral, or (2) central factors. Among earlier investigators of note, who have held the view that the changes of perspective depend primarily upon changes in the sense organ, may

be mentioned Brewster, Necker and Wundt. Of these Wundt has probably exercised a greater influence on subsequent thought than any other writer on the subject. Among those who have attributed most importance to changes of central origin the best known are perhaps Wheatstone, Helmholtz and Hering.

Until a few years ago the former school was probably in the ascendant, but the most recent writers on the subject have generally expressed dissatisfaction with the view that the reversals are determined solely or principally by peripheral factors, and are inclined to seek an explanation in terms of purely psychological processes, or, at least, of physiological processes affecting the brain rather than the eye.

Thus Becher¹ disputes the validity of Wundt's rule according to which the nature of the perspective seen in an ambiguous figure depends solely upon the direction of fixation or upon eye movements. He comes to the conclusion that at least three factors must be taken into account, viz. fixation (in Wundt's sense), the direction and distribution of attention and 'set' (as manifested in will, preperception, etc.). Benussi², starting from observations showing that the time required for an ambiguous figure to be seen in any perspective at all varies according to the position in which the figure is drawn, argues the importance (though not the exclusive importance) of associative factors, and in an interesting theoretical discussion brings the reversals of perspective into relation with the concept of 'shape quality' (*Gestaltqualität*).

De Boer³, in a recent paper, upholds the importance of associative as against peripheral factors. Wallin also, who in his earlier book⁴ was a staunch supporter of the peripheral theory, has, in a later paper⁵, suggested an explanation in terms of the 'refractory period of the nervous arc' demonstrated by Sherrington and others.

Those who have endeavoured similarly to account for the reversals of perspective by means of corresponding cerebral changes have, for the most part, brought the perspective illusions into relation with those other cases of alternating mental contents frequently classed together as due to 'fluctuations of attention'; they have in fact regarded the illusions of reversible perspective as constituting only a particular case

¹ "Über umkehrbare Zeichnungen," *Arch. f. d. ges. Psychol.* 1910, xvi. 397.

² "Über die Motiven d. scheinbaren Körperlichkeit bei umkehrbaren Zeichnungen," *Arch. f. d. ges. Psychol.* 1911, xx. 363.

³ "Über umkehrbare Zeichnungen," *Arch. f. d. ges. Psychol.* 1910, xviii. 179.

⁴ *Illusions of Reversible Perspective*, Princeton, 1905.

⁵ "The Duration of Attention, Reversible Perspectives, and the Refractory Phase of the Nervous Arc," *J. of Philos., Psychol., etc.* 1910, vii. No. 2.

of a more general mental characteristic, which in turn is due to some general condition affecting the activity of the cerebrum. Slaughter¹, Bonser² and others have produced some interesting experimental evidence that this condition is to be found in vaso-motor changes, and more especially in the Traube-Hering waves.

Approaching the problem from a rather different point of view, McDougall³ has maintained that the illusions we are here considering represent only a special case of a very general psychical characteristic, viz. the rapid fatigability and general instability manifested in all the higher levels of consciousness, and has shown grounds for believing that the physiological basis of this characteristic is to be found in the rapid changes of resistance at the synapses brought about by any nervous discharge affecting the higher centres.

The present investigation was started in the hope of bringing some further light to bear on the problem of the intimate nature of the psychological processes concerned in these illusions, by carrying out some observations which, to the best of the writer's knowledge, had not been made before, or at least had not been made the object of systematic experimentation. The research owes its origin to Prof. Carveth Read, who suggested the line of investigation to be adopted and who collaborated with the writer in the earlier part of the experimental work. Prof. C. Spearman has afforded much valuable help and criticism, both as regards devising and carrying out the experiments and the interpretation of the results obtained. The writer's thanks are also due to those who have at one time or another submitted to the often rather tedious experiments with much patience and goodwill. The observers throughout the investigation were all trained subjects, being teachers, researchers, or advanced students of psychology. Great importance was attached to systematic introspection; and as all the observers were given a very considerable amount of practice with the reversible illusions that were used, and as the reports of their experiences under similar experimental conditions remained on the whole remarkably consistent even throughout long

¹ "The Fluctuations of Attention in some of their Psychological Relations," *Amer. J. of Psychol.* 1901, xii. 913.

² "A Study of the Relations between Mental Activity and the Circulation of the Blood," *Psychol. Rev.* 1903, x. 120.

³ "The Physiological Factors of the Attention Process," *Mind*, 1902, xi. 316; 1903 xii. 289, 473; 1906, xv. 329. Especially xv. 340 ff.

series of experiments, considerable reliance may be placed on the results thus obtained.

The principal apparatus used in all the experiments consisted of a triple time marker writing on a smoked drum and a Jacquet chronograph, adjusted to record seconds, electrically connected with one of the levers of the time marker. The subject recorded his experiences by means of a two-way switch, making contact on the right side during the appearance of one perspective and on the left side during the appearance of the other. The right and left contacts were connected with different levers of the time marker. When neither perspective was seen or when the subject was in any way uncertain as to the nature of the perspective, he refrained from making contact in either direction. Each subject was allowed to choose for himself which contact should correspond to which perspective, and was allowed to practise the method of recording whenever necessary. Each experiment was timed to last one minute. In some cases it was difficult to obtain a typical record in a shorter time than this, while with longer periods the attention of the subject was apt to flag and subsequent introspection became difficult and unreliable.

II.

The first experiments to be described consisted in observing the changes of perspective that occurred in two ambiguous figures presented simultaneously to the subject. It was considered that such experiments, by showing whether the perspective of the two figures tended to change together or independently of one another, would be likely to throw some light on the nature of the processes involved, and would in any case be of interest in view of some of the explanations that have been offered. Thus, if the reversals depend primarily upon some physiological factor which must affect the whole of the cortex simultaneously or nearly simultaneously, we should expect that the changes of perspective would take place in both figures at approximately the same moment. A similar correspondence in the behaviour of the two figures might be looked for, if, as Wundt's results tended to indicate, the reversals are dependent upon some one peripheral factor such as fixation, though the changes in any particular case would depend on the figures used and the direction and extent of the eye movement. If, on the other hand, the fluctuations in the two figures take place with any considerable degree of independence, it would seem that they must depend at least

in part upon strictly localised conditions, though this would not of course exclude the partial operation of a more general factor also.

Three sets of experiments were carried out in this connexion. In each case the two figures chosen for use were those of a prism and a table as depicted in Figs. 1 and 2. In the first set of experiments two *identical* figures (*i.e.* two drawings of the same figure, prism or table as the case might be) were placed alongside one another and the subject fixated a point between them. The drawings were of

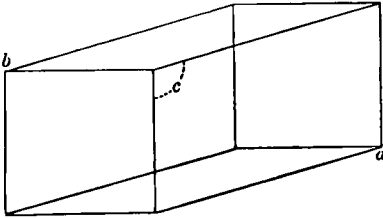


FIG. 1.

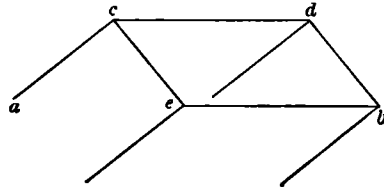


FIG. 2.

such a size and placed at such a distance from the subject that the whole of both figures could be clearly seen in perspective without any wandering of the fixation¹. In the second set of experiments two *different* figures (*i.e.* one drawing of the prism and one of the table) were placed alongside one another in the same way as the two identical ones in the first set, while in the third set the images of two different figures were *superposed* with the help of a stereoscope. In all these experiments the subject was provided with two two-way switches as described above, so that the fluctuations of each figure might be recorded independently, and such additional registering apparatus was provided as was necessary. The process of observing and recording the changes of perspective in the two figures simultaneously was found in the case of all the subjects to be considerably easier than was anticipated, and no serious difficulty was experienced in obtaining reliable records after a little preliminary practice.

The most interesting features of these experiments are shown in Tables I, II and III. Table I contains the results obtained with two identical figures. In this Table are indicated the totals of the individual appearances of each perspective occurring during a single period of

¹ The drawings were made on slips of cardboard 4.5 cm. long and 2.5 cm. broad, the figure occupying almost the whole of each slip. The eye of the subject was about 40 cm. distant from the table on which the slips were placed. An interval of .25 cm. (in which was situated the fixation mark) separated the slips from one another.

observation (in this case one minute). As it was not found possible or desirable to keep the total periods of observation always exactly of the prescribed length (though they seldom varied from it by more than two or three seconds), it has been found convenient to reduce the total of the individual periods during which a particular perspective was seen to a percentage of the total period of observation. Thus, in the columns

TABLE I.

Subject	Prism						Table							
	Right figure			Left figure			% of opposite phase	Right figure			Left figure			% of opposite phase
	R	U	L	R	U	L		T	U	B	T	U	B	
C. R.	47	0	53	28	0	72	32	75	0	25	75	0	25	2
	21	0	79	32	0	68	13	62	0	38	62	0	38	5
J. C. F.	56	0	44	70	0	30	33	57	0	43	58	0	42	2
	72	0	28	53	0	47	43	32	0	68	32	0	68	0
F. A.	72	0	28	67	0	33	11	62	0	38	62	0	38	0
	61	0	39	75	0	25	35	57	0	43	58	0	42	3
C. S.	26	0	74	31	0	69	16	71	0	29	71	0	29	0
	17	0	83	24	0	76	12	54	0	46	51	0	49	10
N. C.	27	20	53	75	20	5	69	42	0	58	31	0	69	28
	12	0	88	100	0	0	88	63	0	37	57	0	43	29

Two juxtaposed drawings of the same figure seen simultaneously. The numerical records refer in each case to the percentage of the total period of observation during which the figure was seen in any particular perspective. The last column to the right in the records for prism and table indicates the percentage of this total period during which the simultaneously observed figures appeared in opposite phase. Two experiments are recorded for each pair of figures with each subject.

For prism : R = 'right end forward.' L = 'left end forward.' U = 'uncertain.'

For table : T = 'top visible.' B = 'bottom visible.' U = 'uncertain.'

relating to the prism, the numbers under R indicate the percentage of the total period during which the figure was seen with its right end forward, *i.e.* nearer the observer, those under L indicate the same as regards the time during which the figure was seen with the left end forward, and those under U the same as regards the periods of uncertainty. In the columns relating to the figure of the table, T indicates that the top or upper side of the table was visible, *i.e.* turned towards the observer, B that the bottom or under side was visible and U has

the same meaning as before. In this experiment, however, it is more especially the difference between the two figures seen simultaneously that interests us and I have therefore, in a separate column, added the percentage of the total period of observation during which the figures appeared in opposite phase.

An inspection of Table I reveals the following facts of interest for our present purpose:—

1. In all five subjects there are periods in which the figures are in opposite phase.

2. In all cases except two (the observations made by subject N. C. on the prism figure) the total period of opposite phase is less than 50% of the total period of observation.

3. The two prisms have in every case longer periods of opposite phase than the two tables¹.

4. With both prisms and tables subject N. C. has longer periods of opposite phase than the other subjects.

Introspection showed that the perspective of the figures was just as clear and as easily recognisable during their periods of opposite phase as during their periods of similar phase.

Taken as a whole, the results show clearly that two similar juxtaposed figures seen simultaneously tend to fluctuate together, but that this tendency is insufficient to prevent some periods during which the figures are distinctly seen in opposite phase.

In Tables II and III are shown the most reliable results obtained with two different figures juxtaposed and superposed respectively; these figures being the same prism and table as were used in the preceding experiment. In these tables I have indicated, besides the usual percentages for each figure, the percentage of the total period during which either phase of one figure coincided with either phase of the other. Thus under R (in the last two vertical columns) is shown the percentage during which the prism was seen with the right end forward, which in turn is subdivided into two parts according as it coincided with 'top visible' (T) or 'bottom visible' (B) in the table. It is evident that there exists on the whole a remarkable degree of independence in the behaviour of the two figures, though the results obtained are irregular. These experiments confirm the previous series in showing that two figures seen simultaneously may fluctuate independently of one another, but beyond this the results are chiefly negative. They show no strong tendency for either aspect of one figure to correlate highly with either aspect of

¹ For the probable cause of this see footnote, p. 391.

the other, nor do they bring to light any marked uniformity of behaviour on the part of any of the subjects. This irregularity of the results shows that the essential factors governing the changes of perspective have been left uncontrolled in these observations and can therefore only be isolated under different experimental conditions. So far as they go, however, these experiments corroborate those recorded in Table I.

TABLE II.

Subject	<i>Juxtaposed</i> Prism right, Table left						<i>Juxtaposed</i> Table right, Prism left					
	Prism		Table				Prism		Table			
	R	L	T	B	R	L	R	L	T	B	R	L
C. R.	0	100	100	0	T	0 100	3	97	37	63	T	3 34
					B	0 0					B	0 63
J. C. F.	92	8	2	98	T	2 0	91	9	0	100	T	0 0
					B	90 8					B	91 9
F. A.	54	46	63	37	T	27 36	47	53	55	45	T	25 30
					B	27 10					B	22 23
C. S.	41	59	52	48	T	25 27	38	62	64	36	T	36 28
					B	16 32					B	2 34
N. C.	3	97	14	86	T	0 14	100	0	20	80	T	20 0
					B	3 83					B	80 0

Two juxtaposed drawings of different figures seen simultaneously. Numerical records refer, as before, to percentages of the total period of observation. To the right of the percentages for the two figures are indicated the percentages during which the different phases of the two figures coincided, the columns referring to the phases of the prism, the (horizontal) rows to the phases of the table. Thus the results obtained with subject C. R. with the prism on the right and the table on the left indicate that the phase 'left end forward' of the prism coincided with the phase 'top visible' of the table during 100 % of the total period of observation, and that consequently the other combinations 'right end forward' and 'top visible,' 'left end forward' and 'bottom visible' and 'right end forward' and 'bottom visible' did not occur at all.

For prism: R = 'right end forward,' L = 'left end forward.'

For table: T = 'top visible,' B = 'bottom visible.'

In spite of this lack of uniformity in the results, our experiments on two figures seen together afford on the whole some very conclusive evidence as regards the problems on which it was hoped that they would have some bearing. Thus the fact that two figures seen simultaneously exhibit a considerable degree of independence in their fluctuations makes it difficult or impossible to suppose that these fluctuations

can depend to any great extent upon some one physiological factor such as the Traube-Hering waves, which would affect the whole of the central nervous system almost at the same time.

TABLE III.

Subject	<i>Superposed</i> Prism right, Table left						<i>Superposed</i> Table right, Prism left					
	Prism		Table				Prism		Table			
	R	L	T	B	R	L	R	L	T	B	R	L
C. R.	27	73	64	36	T 16 48 B 11 25		19	81	63	37	T 10 53 B 9 28	
J. C. F.	84	16	5	95	T 5 0 B 79 16		87	13	5	95	T 5 0 B 82 13	
F. A.	51	49	63	37	T 32 31 B 19 18		61	39	51	49	T 37 14 B 24 25	
C. S.	48	52	47	53	T 38 9 B 10 43		58	42	57	43	T 33 24 B 25 18	
N. C.	66	34	50	50	T 26 24 B 40 10		28	72	64	36	T 21 43 B 7 29	

Two superposed drawings of different figures; same arrangement as Table II.

Similarly, the results obtained in these experiments are difficult to reconcile with the view that the sole conditions governing the reversals are to be found in fixation and eye movements. According to this well-known theory, that reversible part of a figure which is fixated will invariably appear nearer than that which is seen in indirect vision; and, in the case of eye movements, that point from which the movement starts is seen nearer than that to which the movement proceeds. In the present observations no point of either figure was directly fixated; in view, however, of the recently demonstrated and now generally admitted fact that fixation of any point is never quite accurate for more than a very short space of time, it would seem legitimate to expect on this theory that, in the absence of direct fixation of any part of the figure, that part which is nearest the fixation point would behave as if it were itself fixated. Thus, in the case of the two juxtaposed tables, the part of the right-hand figure which is nearest the fixation point is the end of the leg *a* (Fig. 2); we should therefore expect, according to the above view, that this figure would be seen during the greater part

of the time with *a* nearest the spectator, i.e. in the phase 'bottom visible.' As regards the left-hand figure, the point *b* is nearest the fixation point, and this figure should therefore appear in the phase 'top visible.' The two figures seen simultaneously under the conditions of our experiment should then have appeared during the greater part of the time in opposite phases, whereas in reality the periods of similar phase greatly predominated. Similarly, in the two juxtaposed prisms, the points *a* and *b* (Fig. 1) were nearest the fixation point in the left- and right-hand figures respectively, and the two figures should likewise have been seen in opposite phases during the greater part of the time, whereas a glance at Table I shows that, although the periods of opposite phase are considerably longer than in the case of the two tables, the total length of all the periods of opposite phase exceeds 50% of the total observation time with only one subject out of five. Again, in the observations with different juxtaposed figures, we should, on the same principles, expect certain combinations to predominate and others to occur but very seldom if at all. Thus, with the prism on the right hand and the table on the left, the table should appear with its 'top visible' and the prism with its left side forward, while the combination 'bottom visible' with right side forward should be very difficult or impossible to bring about, because it would involve fixating the more distant parts of both figures. Nevertheless, the Table indicates that this combination did actually occur with very considerable frequency.

Thus, the experiments made with two figures seen simultaneously seem to give as little support to the view that the changes of perspective can be entirely accounted for in terms of eye movement (or at least to the form in which this view is usually met), as to the other theory which would explain them as due to general circulatory conditions such as the Traube-Hering waves.

III.

In the hope of obtaining more positive results than those described in the preceding section, a fresh series of observations was started under new experimental conditions. These observations were all made with a single figure only, this figure being the well-known truncated pyramid of Mach. The new conditions were of two kinds:—

1. Whereas in the experiments recorded in Section II the attitude of the subject toward the figures had not been specially determined, apart from the general instructions that he was not consciously

to favour any one perspective and that he was, as far as possible, to regard the figures in the same way throughout the observations, the subject was now definitely instructed to adopt one of three attitudes towards the figure, the instruction running: 'Will to see the figure as a chamber' or 'Will to see the figure as a boss' or 'Remain indifferent as to the perspective,' as the case might be.

2. It was thought that some help might be afforded in the attempt to isolate the principal factors upon which the reversals of perspective depend, if some means could be found of gradually making the reversals less easy, so that finally the figure might appear in one perspective only. For this purpose a series of drawings was prepared¹, in which, though starting with the simple Mach truncated pyramid, each subsequent drawing contained an increasing number of details calculated to make the main outlines of the figure (which remained the same throughout) appear in the 'chamber' rather than in the 'boss' perspective. The series consisted of eight such drawings (Figs. 3—10), which are reproduced on the two pages following². The figures were presented to the subjects in the order there given, *i.e.* in order of increasing complication, and with each figure records were made with each of the three attitudes 'indifferent,' 'willing chamber' and 'willing boss' in this order. The experiments were made upon the same five subjects as before, and with every subject one figure only was observed at each sitting, which thus consisted of three periods of one minute each. Only one record was taken for each attitude but only such records were accepted as were considered thoroughly satisfactory both by subject and experimenter, the experiment being repeated whenever necessary, until such a record was obtained.

The principal results of these experiments are shown in Table IV, where, as before, the numbers indicate the percentage of the total time of observation during which a particular perspective was seen. The letters C, U and B over the columns for each figure represent the periods during which the figure was seen as 'chamber,' of uncertain perspective, or as 'boss' respectively. No results are recorded under U for the first two subjects in the Table, as the desirability of recording periods of uncertainty had not become fully apparent until the experiments had been completed with these two subjects.

¹ I am much indebted to Miss Maud Klein for her kindness in designing and executing the drawings used in these experiments.

² Figs. 8, 9 and 10 differ in a few minor respects from the drawings actually used in the experiments. All essential features however (*e.g.* number and position of the persons amount and nature of detail on ceiling, walls and floor) remain unchanged.

An inspection of the Table shows that on the whole the complications in the drawings possess surprisingly little power to produce the favoured perspective and to prevent reversal. With the 'indifferent' attitude, Fig. 8 produces 'chamber' the whole time with only two of the five subjects; in the 'willing boss' observations it produces almost

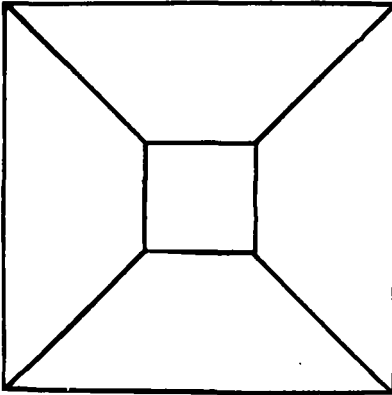


FIG. 3.

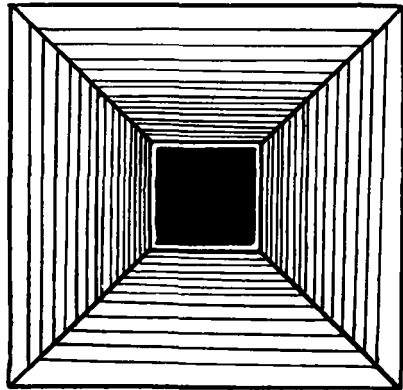


FIG. 4.

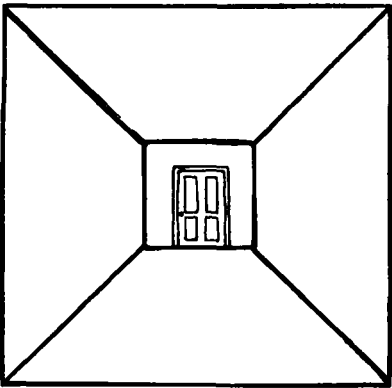


FIG. 5.

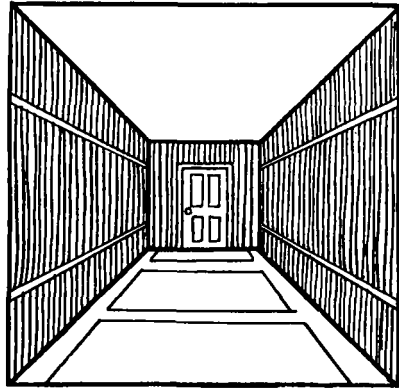


FIG. 6.

complete predominance of 'chamber' with only one subject. In the 'willing chamber' experiments, however, we find complete or almost complete predominance of 'chamber' in the last four, three and two figures respectively; in subjects N. C., C. S. and J. C. F. Thus, when will and the details added to the figure work in the same direction, they are more effectual than when either is alone. In the record of F. A. there is shown a strong and increasing tendency to avoid seeing the figure as

'chamber,' which neither will nor increasing complication of the drawing is able to check. In general there appears no constant tendency for the percentage of 'chamber' to increase from figure to figure. No doubt a nearer approach to such a constant tendency would have been revealed, had the average of several observations been taken instead of one observation only for each attitude. Further observations were

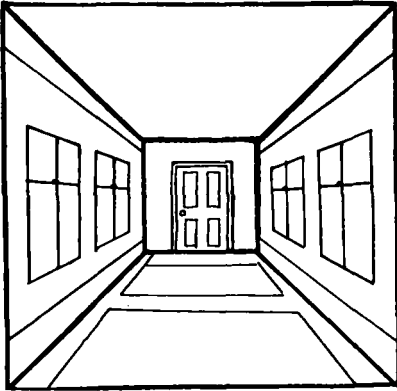


FIG. 7.

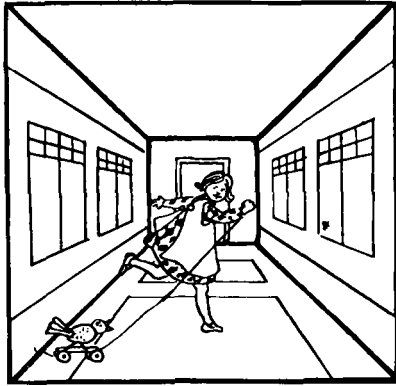


FIG. 8.

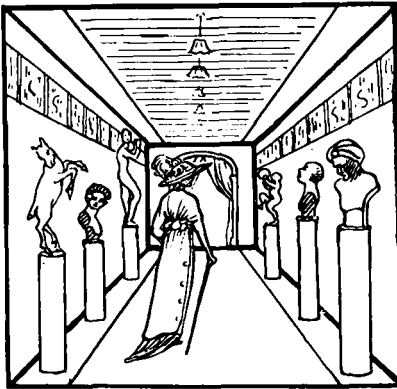


FIG. 9.



FIG. 10.

not made however, since introspection showed that what appeared to be the more fundamental conditions for reversal were not really controlled by the present experiment and at the same time indicated a more hopeful way of investigating these conditions.

It will be noticed that as regards effectiveness of willing, the subjects fall into two fairly well-marked classes—one being represented by N. C. and the other by the remaining four subjects. These individual

TABLE IV.

Observations with the series of drawings, Figs. 3-10. C = 'Chamber,' U = 'Uncertain,' B = 'Boss.'

Subject	Fig. 3			Fig. 4			Fig. 5			Fig. 6			Fig. 7			Fig. 8			Fig. 9			Fig. 10		
	C	U	B	C	U	B	C	U	B	C	U	B	C	U	B	C	U	B	C	U	B	C	U	B
C. R.	77	23		65	35		73	27		83	17		74	26		67	33		82	18		84	16	
	71	29		57	43		74	26		76	24		71	29		72	28		64	36		70	30	
	52	48		45	55		68	32		81	19		60	40		68	32		67	33		66	34	
J. C. F.	80	20		77	23		56	44		90	10		86	14		84	16		95	5		98	2	
	79	21		84	16		69	31		85	15		89	11		83	17		98	2		100	0	
	66	34		54	46		63	37		63	37		73	27		83	17		86	14		95	5	
F. A.	60	0	40	63	0	37	41	0	59	17	31	52	11	61	28	14	76	10	43	25	33	14	57	29
	50	0	50	52	0	48	40	0	60	22	30	48	6	50	44	0	80	20	39	18	43	0	84	16
	42	0	58	25	0	75	26	9	65	7	16	77	2	48	50	0	85	15	9	19	72	10	45	45
G. S.	54	4	42	82	6	12	48	44	8	73	20	7	86	14	0	98	2	0	98	2	0	100	0	0
	45	6	49	41	37	22	50	26	24	69	13	18	49	51	0	67	33	0	82	18	0	100	0	0
	49	7	44	43	0	57	40	31	29	46	27	27	27	50	23	64	36	0	22	73	5	67	30	3
N. C.	87	10	3	88	3	9	84	16	0	93	7	0	100	0	0	100	0	0	100	0	0	100	0	0
	33	27	40	25	75	0	27	65	8	13	24	63	82	18	0	47	8	45	34	66	0	67	33	0
	5	5	90	29	7	64	17	0	83	0	0	100	74	6	20	0	13	87	0	0	100	0	8	92

differences in the power to control the reversals of perspective are among the most interesting facts brought to light by the present investigation. They will be met with again in the later experiments, but in order not unduly to complicate the problem with which we are here primarily concerned, I shall defer a discussion as to the real nature of these differences until after the presentation of some further data on the subject, which I hope to bring forward in a subsequent paper.

Although it does not appear in Table III, it may be mentioned that will had little influence on the average duration of all the periods composing a single observation, the lengthening of the periods of the desired perspective being compensated by a corresponding shortening of the undesired perspective.

The most useful and interesting results of this series of experiments are probably to be found in the introspections. These explain to some extent the cause of what is at first sight the rather surprising inability of the details of the figures to prevent reversals of perspective, and at the same time bring us a step nearer to the end we have in view—the discovery of the true psychological conditions upon which the reversals depend. The most fundamental fact brought out by the introspections of all the subjects is that, in nearly every case where the details of the more complicated figures failed to prevent reversals of perspective, these details were less *attended to* than were the main outlines of the figure. As regards the observations with ‘indifferent’ attitude, there are at least two conditions of the experiment which may be supposed to have played a part in producing this comparative neglect of the details. There is first the general instruction to the subjects to observe and record any reversals of perspective that occur, which in the absence of any instruction to the contrary, would naturally tend to make the subject concentrate his attention chiefly on the main outlines, since it was here alone that reversal could be observed. There is, in addition, the fact that with all the subjects the earlier observations were made upon the simpler figures, which contained only the main outlines or but few complicating details, and the attitude necessarily adopted in the case of the early figures seems to have perseverated to a considerable extent in the observations made with the later figures. This is expressly mentioned by two subjects and seems to have occurred also in the other cases.

All the subjects seem to have spontaneously adopted distinct attitudes in the case of the ‘willing boss’ and ‘willing chamber’ experiments respectively. In the case of ‘willing chamber’ there

seems to have been generally a more or less conscious endeavour to concentrate attention on the details of the figures and to allow them to enter clearly into consciousness. Comparative neglect of details on the other hand is reported in nearly every case where 'willing boss' was conspicuously successful. In the few remaining cases those details which still remain prominent seem to have been incorporated into the 'boss' perspective by acquiring some definite meaning in connexion with the boss, *e.g.* by becoming lines or marks upon the sides of the boss. An extreme instance of this is when the details of Fig. 10 were seen as the ornamentation upon a 'Japanese paper basket,' the bottom of which was towards the observer. In a very few instances a detail might remain clear, but fail to be incorporated into the predominant boss perspective. Thus, the child in Fig. 8 was seen by one subject to have no connexion with the boss, but to be superposed upon it in some way as an irrelevant detail, much as an insect or a piece of dirt lying on the paper. In extreme cases, however, inability to neglect the details, in spite of a high degree of attention to the main outlines, would bring about a splitting up of the figure into two incongruous perspectives. Thus, in Fig. 7, 'chamber' would suddenly change into 'boss' while the windows retained their original ('chamber') perspective. One subject describes an appearance of this sort as like looking through a transparent boss into a corridor. While willing 'chamber,' on the other hand, the subjects seemed to have allowed the attention to move freely over the details of the figure and to have welcomed them as aids to the maintenance of the desired perspective. Several subjects report that failure to preserve the 'chamber' perspective during the whole period, even with the later figures, was due to sudden irruptions into undue prominence of the main outlines and particularly of the inner square, resulting in a momentary neglect of the details.

Thus the introspections seem to indicate that the direction of the attention plays a very important part in the reversals of perspective. In the figures used in the present experiments, clearness in consciousness of the main outlines seems to have been essential to the appearance of 'boss,' while prominence of the details was a great aid to the maintenance of the 'chamber' perspective. The regularity with which these facts came out in the introspections of all the subjects seemed to indicate that they were of fundamental importance, but in themselves they are unable to explain the changes of perspective in the usual kind of ambiguous figures, since here there is no complicating detail. However, the

manner in which the direction of attention operates as a decisive factor in these cases also is brought out clearly in the experiments described in the next section.

IV.

As it was by now probable that some at least of the most essential conditions governing the reversal of the perspective were to be found in the attitude of the subject towards the figure, and in particular, in the relative amount of attention directed to different parts of the figure, a fresh series of experiments was undertaken, in which the subject was instructed to adopt a different attitude towards the figure during successive observations, while the figure itself and all the external conditions of the experiment remained the same throughout, and were, unlike those of the previous observations, of the greatest possible simplicity. For this purpose use was made of the prism (Fig. 1) already employed in the observations described in Section I, experience having shown that on the whole both the perspective itself and the changes from one perspective to another were clearer in this figure than in most others. A list of ten attitudes was drawn up, these attitudes being chosen from among those which had at one time or another been spontaneously adopted by one or more of the subjects in the earlier experiments, and which had been described in their introspections. Each attitude was adopted once at every sitting, which therefore consisted of ten observations of one minute each. In order to avoid as far as possible any effects of the order in which the attitudes were taken and of the perseveration of one attitude upon the succeeding one, the experiments were so arranged that each attitude occupied every possible place as regards order and was preceded and succeeded by every other attitude in the course of ten sittings¹. The actual

¹ As this arrangement has not, so far as I am aware, been described before, and as it is probable that other cases may frequently arise, in which, when repeating a number of performances on different days, it is desirable to neutralise any effects both of the order of presentation and of the perseveration of the mental attitudes occasioned by the various performances, it is perhaps worth while to indicate the method here. For the sake of simplicity let us suppose that we are dealing with four performances only, instead of with ten, as in the present case. Let us designate these four performances 1, 2, 3 and 4 respectively, and take them in this order on the first day. If now for the sake of calculation we insert a 0 before the 1, the rule for the order in which the performances are to be taken on subsequent days is as follows:—

influence of order and perseveration appears however to have been very small as soon as the subjects had become thoroughly used to the attitudes and to the general conditions of the experiment. A small fixation mark was provided in the middle of the figure, and the subjects were instructed to do their best to fixate this mark steadily throughout the experiments, but not to let the effort to fixate interfere seriously with the adoption of the required attitude.

The numerical results obtained from these experiments with the three subjects on whom they were carried out are shown in Table V, in which are given both the percentage of the total time of observation during which either perspective was seen (as in the earlier Tables), and the average duration of the periods of either perspective. As, however, the value of the experiments depends even more upon the introspections of the subjects than upon the numerical results, we will proceed to consider the nature and effect of each attitude in turn, with particular reference to the introspections obtained from each of the three subjects.

It will materially facilitate recognition of the general conclusion to be drawn from these observations, if the reader is informed beforehand of its nature (which was of course only clear to the experimenter at the end of the whole series of experiments), and is thus able to consider the individual results obtained from each attitude in the light of the general result obtained from all. The present experiments make abundantly clear what was already indicated in the previous series of observations—that the nature of the perspective in which an ambiguous figure is seen at any moment is (at least under the present experimental conditions and for the present observers) mainly determined by the

For the second day begin with 2 and take in succession each second performance in the order in which they were taken on the first day.

For the third day begin with 3 and take in succession each third performance, and so on till each performance has been taken first on one occasion.

The scheme for our four performances will thus be as follows :—

Day	Order			
1	1	2	3	4
2	2	4	1	3
3	3	1	4	2
4	4	3	2	1

This arrangement of course necessitates a number of sittings equal to the number of performances or some multiple of this. Unfortunately it does not admit of application to an *uneven* number of performances without considerable modification entailing the non-utilisation of some of the data.

TABLE V.

Attitudes	I.			II.			III.			IV.			V.		
	L	U	R	L	U	R	L	U	R	L	U	R	L	U	R
Subject: C. S.															
%	45	2	53	38	2	60	33	33	34	42	0	58	40	17	43
m. v.	3.6	3.0	5.0	3.9	1.8	4.9	8.2	8.1	6.9	5.3	0	5.3	9.5	9.8	5.3
Av. duration	4.6	1.2	5.5	4.2	1.2	6.6	2.6	2.5	3.2	5.1	0	7.0	4.0	2.0	3.7
m. v.	1.4	0.3	2.1	1.2	0.3	1.8	0.8	0.7	1.3	1.0	0	1.2	1.4	0.2	1.2
Subject: A. W.															
%	25	44	31	28	45	27	11	77	12	56	1	43	7	83	10
m. v.	17.7	40.0	22.7	15.7	29.5	14.3	8.5	13.2	6.0	7.0	1.8	6.8	1.7	7.8	6.2
Av. duration	2.3	15.9	2.5	2.2	14.0	1.8	1.5	16.5	1.5	6.3	4.0	5.0	1.3	10.3	1.7
m. v.	0.8	13.4	1.2	1.3	17.2	0.8	0.5	14.5	0.4	1.4	0	0.8	0.3	3.8	0.8
Subject: N. C.															
%	4	32	64	3	71	26	0	100	0	0	7	93	0	100	0
m. v.	5.6	20.8	17.8	4.6	32.5	28.7	0	0	0	0	12.1	11.6	0	0	0
Av. duration	3.1	8.6	18.1	1.4	27.9	8.8	0	60	0	0	10.1	45.2	0	60	0
m. v.	1.4	6.3	14.3	0.2	24.6	8.3	0	0	0	0	8.3	20.6	0	0	0

Attitudes	VI.			VII.			VIII.			IX.			X.		
	L	U	R	L	U	R	L	U	R	L	U	R	L	U	R
Subject: C. S.															
%	45	7	48	32	4	64	37	11	52	41	6	53	50	4	46
m. v.	7.6	5.6	8.2	6.6	4.9	5.9	8.5	7.3	6.8	6.6	6.3	6.1	5.2	3.9	7.1
Av. duration	4.0	1.2	3.5	2.5	3.3	4.8	3.6	1.6	3.6	3.0	1.5	3.8	5.1	1.6	3.7
m. v.	1.7	0.3	0.5	0.2	0.4	1.2	0.3	0.4	0.7	0.8	0.3	1.0	1.3	0.4	1.1
Subject: A. W.															
%	82	4	14	44	7	49	86	4	10	53	12	35	83	3	14
m. v.	6.2	4.2	3.3	13.0	8.5	16.2	7.2	2.5	9.0	3.0	10.7	10.0	3.0	3.5	3.5
Av. duration	7.6	1.3	1.4	3.5	2.8	4.1	15.9	2.2	2.1	2.1	1.4	1.5	8.3	1.9	1.2
m. v.	1.6	0.3	0.3	1.0	0.7	1.0	8.7	0.6	0.6	0.7	0.3	0.4	1.9	0.1	0.1
Subject: N. C.															
%	100	0	0	—	—	—	95	5	0	100	0	0	100	0	0
m. v.	0	0	0	—	—	—	5.8	6.0	0	0	0	0	0	0	0
Av. duration	60	0	0	—	—	—	44.7	3.7	0	60	0	0	60	0	0
m. v.	0	0	0	—	—	—	18.3	2.6	0	0	0	0	0	0	0

Observations on the prism figure with different attitudes. The Table indicates (i) the percentage of the total period of observation during which the figure was seen in any particular perspective, (ii) the average duration of the individual periods of each perspective. The *percentage results* give the average for the whole period of ten sittings. In cases where any perspective was not observed on every sitting, the results given for the *average duration* refer only to the total number of sittings in which this perspective was observed and not to the whole period of 10 sittings. For description of attitudes see text.

L = 'left end forward,' U = 'uncertain,' R = 'right end forward.'

direction of the attention; and that the direction of the attention determines the perspective according to the following rule:—

As regards all reversible parts of the figure, that part of the figure which receives the more attention is seen in front of that part which receives the less attention¹.

Having thus given in anticipation the general conclusion to be drawn from the whole series of experiments, we will proceed, as briefly as possible, to describe each attitude, to examine its effects as manifested through the numerical results and through the introspections, and to show how these effects of the individual attitudes support the above general conclusion.

Attitude I may be described as that of passive contemplation. The instructions to the subject were as follows: "Contemplate the figure as passively as is compatible with observing and recording the changes of perspective that occur. As far as possible keep out everything from consciousness except the figure you are contemplating, and refrain from willing or wishing to maintain or to change any perspective." The attitude thus reduced all conscious effort to a minimum. Corresponding to the reduced attention there is frequently reported a reduction in the vividness of the perspective (hence frequent large amounts of U with two of the subjects); but as no attempt was made to control the direction of such attention as there was, the conditions were not favourable for bringing out any correspondence between the direction of the attention and the

¹ In view of the many senses in which 'attention' has been understood by different writers, and of the many and varied features which can be introspectively discovered as characteristic of the attentive consciousness, it becomes highly desirable to define more precisely the meaning of the word as it is used here. It is above all intended to signify something predominantly cognitive in nature. Although conative and affective elements are often, perhaps always, present, they are not the most constant or the most characteristic features of what is here called attention, which is perhaps most accurately described as 'clearness in consciousness.' Thus when we say that a particular part of a figure receives the most attention, we mean primarily that that part is more clearly in consciousness than the remainder of the figure. This 'clearness' however must be carefully distinguished from (1) sensory intensity, and (2) sensory distinctness, *i.e.* sharpness of differences as presented in sensation, of both of which it would seem to be very largely independent. The relation of 'clearness' to intensity of mental process as a whole presents a more difficult problem, since such intensity is dependent more on conative and affective than on purely cognitive factors. This problem, however, though of considerable interest in itself, is not of great importance for our present purpose, since it is the cognitive elements which varied most in our observations, the conative and affective elements, and therefore also the total intensity of consciousness, remaining (with few exceptions) comparatively unchanged from one experiment to another.

nature of the perspective. Two of the subjects seem to have found the maintenance of this attitude a pleasant and easy task, disturbed only, in the case of N. C., by occasional doubts as to whether or not there was any perspective at all (and hence considerable variations in the amounts of U were found in her records). To A. W. however the attitude presented some difficulty, owing to the fact that (in his own words) "the endeavour to record any changes of perspective frequently occasioned a turning of the attention to one side or the other to see if that side were forward or back," and, as the side which received this increased amount of attention invariably appeared forward, this procedure seemed to contravene the instruction to be passive and indifferent. In the earlier sittings A. W. also reported the interesting phenomenon of both ends of the figure being forward simultaneously, but subsequent introspection showed this to consist in an extremely rapid oscillation between the two perspectives, accompanied by equally rapid changes in the direction of attention. These introspections of A. W., together with the loss of clearness of perspective in the case of N. C., are of course in strict agreement with the general conclusion mentioned above. Perhaps the chief use of this attitude, however, does not lie in the results obtained, considered by themselves, but in the fact that it afforded a standard of 'normal' or 'natural' observation for judging the results of the subsequent attitudes, in which the direction of the attention and the other conditions of observation were more precisely determined.

Attitude II may be described as being one of distributed attention. The instructions were: "Contemplate the figure with a high degree of attention, this attention to embrace continuously the whole of the figure. Refrain from willing or wishing to maintain or to change any perspective." In A. W. these instructions seem to have produced two distinct attitudes—(1) a really successful attempt to embrace the whole figure simultaneously, (2) in default of this, a continuous rushing of the attention over the whole figure, taking in the different parts in rapid succession. (1) seems to have produced long periods during which the figure was seen without perspective; (2) very short periods of alternating perspective. This difference accounts for the high m. v. of the results obtained with A. W. from this attitude¹. The introspections of N. C. show that during the earlier observations she had some

¹ The various other cases of unusually high mean variation with this subject and with N. C. are, almost without exception, similarly traceable to noticeably different distributions of the attention having been adopted on different sittings.

difficulty in keeping the whole of the figure steadily in attention, and that as soon as the distribution of attention became conspicuously uneven, that part of the figure which received the more attention was seen forward. In the later observations the attention is reported as being more successfully distributed over the whole figure, with the result that the figure is seen without perspective. Thus the introspections and numerical results obtained from A. W. and N. C. are in full agreement with the general conclusion. When the attention is equally distributed over the whole figure no perspective is seen, since neither of the reversible parts of the figure receives a greater amount of attention than the other. Less characteristic results were however obtained from C. S. The effect of the different attitudes is indeed throughout less marked with this subject than with the others. In the present case this lack of effect is increased by the fact that in C. S. the tendency to see the figure in some kind of perspective is apparently considerably more marked than it is with the other subjects (this tendency being manifested in smaller amounts of U throughout the experiments). This probably counteracted the natural tendency of the attitude to make the figure appear flat. As, however, this subject also appeared to experience greater difficulty in maintaining a steady distribution of attention over the whole figure, the results are not opposed to our general conclusion.

Attitude III demanded concentration in place of distribution of attention. The instructions were as follows: "Contemplate the figure with a high degree of attention, this attention being concentrated on the central part of the figure. Refrain from willing or wishing to maintain or to change any perspective." The effect of the attitude is shown unmistakeably in larger amounts of U with all three subjects. Concentration on the centre of the figure produces a corresponding neglect of the sides and inability to see the figure in perspective. In the case of A. W. and C. S. this is perhaps partly due to the ends of the figure being insufficiently in consciousness for the subject to be certain whether they were in perspective or not; it is, however, beyond doubt due also in part to a general flatness of the figure. As before, short appearances of one perspective or the other usually coincide with observed movements of the attention to the corresponding side. With N. C. there seems never to have been any doubt as to the flatness of the figure during the whole time. "The sides were nevertheless sufficiently in consciousness for any perspective to have been noticed, had there been any." Thus the results are again in harmony with our general

conclusion; when attention is withdrawn from either of the reversible parts the figure is seen without perspective.

For Attitude IV the instructions were as follows: "Contemplate the figure with a high degree of attention, this attention being concentrated on the end which happens to be forward for the time being. Refrain from willing or wishing to maintain, or to change any perspective." The effect of the attitude is, as might be expected, to increase the length of the periods during which either perspective persists uninterruptedly, since as soon as any perspective appears, attention is so directed as to make the conditions (according to our general rule) most favourable for its persistence. With N.C. this attitude suffices to maintain one perspective (the 'right forward' or naturally favoured one, in the absence of any instructions to the contrary) nearly the whole time. A.W. reports that he could have done the same, if only he could have prevented the attention from wandering off to the other side. C.S. also frequently observes that the changes of perspective coincide with a noticeable relaxation of attention to the side that had been forward. Both A.W. and C.S. are powerless to prevent these relaxations or wanderings of attention, though of course their occurrence may be considerably delayed by an act of will, as in the present case. The results obtained from this attitude are then again in strict conformity with our general conclusion.

Attitude V. Up till now the subjects had been instructed to preserve a neutral attitude towards the figure. This was now abandoned in favour of a distinct effort of will to see the figure in some definite manner. The instructions for Attitude V were as follows: "Will to see the figure without perspective, but take care that the whole figure remains in consciousness." With all three subjects the willing seems to have been positive, and not, as the instructions might suggest, negative; *i.e.* they willed to see the figure *in* some definite way or *with* some definite appearance, not *without* the appearance of perspectivity. With A.W. and N.C. the attitude seems to have become very like that of the distributed attention in Attitude II; their efforts were directed chiefly to distributing the attention evenly over the whole figure; when this was successfully accomplished, the absence of perspective followed automatically without any further effort of will. C.S. seems to have relied chiefly upon seeing the figure as a geometrical design, a method which was also from time to time adopted by the other subjects. In so doing, those parts seem as a rule to have

been most clearly in consciousness which are least connected with either of the dominant perspectives. It is interesting to note that this subject records a smaller amount of U when (as in this case) he is actually willing to see the figure without perspective, than in Attitude III, when he is concentrating attention on the centre. The effort to keep the whole of the figure well in consciousness (demanded by the present instructions) makes it necessary to give a good deal of attention to those parts of the figure most closely associated with the perspective, and it is probable that a very slight increase of this attention suffices to bring in the perspective, whereas the danger of this happening is considerably reduced when the whole of the attention may be concentrated on the centre of the figure. This indicates that the direction of the attention is of much greater importance than any mere effort of will in determining the presence or absence of perspective. This is fully in harmony with the results obtained from the subsequent attitudes and with the introspections of the subjects.

For Attitude VI the instructions were: "Will 'left forward' (by this was meant in this and the subsequent attitudes—'Will the figure to appear in such a perspective that the left end is forward') by pulling the left end towards you." In the introspections obtained from this attitude all three subjects report that both willing and pulling are in themselves of no assistance in producing the desired perspective, which can be obtained just as well by the mere concentration of attention upon the left square. The subjects are, however, successful in producing this perspective (even with C. S. the amount of L is only surpassed in one other attitude) just because the attitude permits and demands the direction of attention principally upon the left square. As before, it is reported that appearances of 'right forward' frequently coincide with observed fluctuations of the attention in the same direction.

Attitude VII was as follows: "Will 'left forward' (in the above-mentioned sense) by pushing the right end away from you." All three subjects find this attitude one of great difficulty and have but poor success in producing the desired perspective. N. C. indeed says that she finds the attitude itself impossible to attain, and failed to produce what she could regard as a satisfactory record after the first two attempts. Pushing the right end back involves paying attention to that end, and as soon as the necessary amount of attention was given to the right end, it came forward with such vividness as to make it appear hopeless and impossible to will to see the figure in any other

perspective. A. W. also described the attitude as being very difficult, and only achieves some measure of success by the help of an artifice;—in contemplating the right square he directs his attention particularly to the right-hand part of the diagonal line joining the upper right-hand corners of the two squares contained in the figure, and sees *this* in front of the right-hand square itself. This of course produces the desired perspective of the whole figure and is in accordance with our general rule; to judge from the introspections however, this procedure seems to have alternated rather than coincided with the pushing back of the right square demanded by the instructions, which, in itself, is probably as inconsistent with the appearance of 'left forward' as in the case of N.C. In agreement with this is the fact that A. W.'s willing, with this attitude, is distinctly less successful than usual. With C. S. this attitude, in spite of the willing, actually produces a smaller amount of 'left forward' than any other. The introspections from this subject show that whenever the left side was forward there was a considerable relaxation of attention to the right square and a corresponding increase of attention to the left, the willing to push back the right square, if continued at all at these moments, being performed only "in a helpless Platonic sort of way."

In Attitude VIII willing was combined with concentration of attention upon quite a small area of the figure. The instructions were: "Will 'left forward'; in so doing concentrate the attention upon the angle indicated," this angle being the one indicated as *c* in Fig. 1. The results from this attitude, while confirming those already obtained, do not give any fresh information of particular interest. The attitude is not difficult and the willing is attended with a considerable amount of success, since attention can be concentrated on a point which it is desired to see forward. The introspections indicate, however, that at the moments when the 'left forward' perspective was clearest, a considerable amount of attention was given to the left square as well as to the angle.

Attitude IX. The instructions for this were: "Will 'left forward' by means of preperception of the desired perspective, when it is not present. When it is present, adopt the 'passive contemplation' of Attitude I." For two of the subjects (A. W. and C. S.) this attitude resolved itself into an alternate strengthening and relaxation of attention and will. Preperception and will, however, were found, here as before, to be of no importance, the perspective apparently being determined solely by the direction and the amount of the attention. All three

subjects present interesting individual characteristics in the results obtained from this attitude. A. W. exhibits most clearly the effects of the alternating increase and relaxation of attention in a considerable shortening of the periods during which each perspective lasted. As soon as he had obtained the desired perspective by means of vigorous attention to the left square, he relaxed attention according to the instructions. This was immediately followed by a reversal of the perspective, frequently accompanied by a noticeable increase of attention to the right side. This reversal necessitated a fresh concentration of attention upon the left square, which brought back the 'left forward' perspective, and so on. With C. S. these alternations seem to have been almost equally well marked subjectively, but, owing to the fact that there was considerable inertia in passing from the state of strained to that of relaxed attention, the periods are not appreciably shorter than usual. With N. C. there are few if any reversals of perspective with this attitude. Judging from the introspections, the initial stage of the attitude was much the same as with the other subjects, but the relaxation of attention does not, as with them, seem to have involved a marked increase of the relative amounts of attention given to the right square. The absolute amount of attention was decreased without undergoing any considerable change of direction. Thus the 'left forward' perspective, when once obtained, was in the majority of cases enabled to persist uninterruptedly during the whole time of observation.

The tenth and last attitude was as follows: "Will 'left forward' by means of calling up suitable auxiliary images or ideas." In some preliminary experiments, as well as in several of the experiments recorded in the earlier sections, there had appeared to be some evidence in favour of the view that 'willing' was both easier and more effective when the figure was given some definite meaning, or incorporated into some system of imagery or ideas tending to make it appear in the desired perspective, than when attention was merely concentrated on the figure as actually presented. The present attitude was included in the series with a view to obtaining some further evidence on this point. It would seem, however, that this influence of the method of willing, if it exists at all, can only manifest itself in so far as it affects the direction of the attention. There is perhaps some slight evidence in the case of C. S. to show that it is easier to keep the attention fixed upon the left square, by this indirect, than by the more usual direct method; but our data do not

enable us to say whether this is a general rule, or is peculiar to this subject.

The experiments we have described in this section seem to supply on the whole a very consistent body of evidence in favour of the general conclusion we have already enunciated, viz. that, as regards all reversible parts of the figure, that part of the figure which receives the more attention is seen in front of that part which receives the less attention. Before going on to consider how far this rule, which seems so clearly demonstrated in the case of the present observations, admits of application to all cases of reversible perspective, it may be well to draw attention to the interesting individual differences between the three subjects of the experiments recorded in this section. As already indicated, I intend to postpone a consideration of the underlying causes of these individual differences until I am in a position to present some further data on the subject; but a brief summary of the actual facts as revealed in the present experiments may not be out of place here.

The principal feature of these individual differences is concerned with the power of voluntary control over the perspective, or, in other words, the power of producing and maintaining a given distribution of the attention. N. C. possesses this power of voluntary control in a remarkably high degree; with C. S. it is present only to a comparatively small extent, while A. W. occupies an intermediate position in this respect. Throughout the attitudes N. C. exhibits the results of a very stable condition of the attention. Thus the 'distributed attention' in Attitude II produces a much larger amount of U than in the case of A. W. or C. S., since the attention, once evenly distributed over the whole figure, is less liable to fluctuations than with the latter subjects. The same difference is almost equally marked in the case of the 'concentrated attention' in Attitude III. In Attitude IX relaxation of the attention does not lead to its redistribution and the consequent change of perspective, as it does with the other subjects. In Attitude IV concentration of attention on the end which happens to come forward suffices in most cases to keep that end forward during the whole period of observation. The same applies to all the 'willing' attitudes. In Attitude VII however, in which willing 'left forward' had to be combined with attention to the right, this remarkable stability of attention seems to have been a positive disadvantage. As soon as the necessary attention was given to the right square to 'push it back,'

it came forward with such persistency as to make it appear impossible to see the figure in any other perspective without removing the attention from this square, and thus abandoning the 'pushing back.'

With A. W. there is a tendency for the attention to fluctuate very rapidly in the absence of any effort to keep it constant (cf. the very rapid fluctuations resulting in the appearance of 'both ends being forward simultaneously' and the short periods resulting from the alternate strengthening and relaxation of attention in Attitude IX). Nevertheless this subject possesses very considerable powers of voluntary control over the direction of the attention, and the general results obtained from the different attitudes are (except in the case of IX) in the same direction as those of N. C., but are less marked; *e.g.* IV produces longer periods but no complete predominance of one perspective, VII is difficult and the willing is not successful, but the attitude is not pronounced impossible.

C. S. possesses the least voluntary control over the direction of the attention, and is as a rule, even under favourable conditions, unable to maintain either perspective uninterruptedly for any length of time. He shows, however, a more marked tendency than either of the other two subjects to see the figure in some kind of perspective, as is shown by the very small amount of U to be found throughout his records. As a consequence of these characteristics the effect of the different attitudes is generally much less marked than it is with the other subjects, but is nevertheless usually in the same direction; *e.g.* there is an increased amount of U in III; there is a distinct lengthening of the periods in IV; and 'willing' meets with least success in VII, though the attitude is not so difficult as it is to A. W. (and therefore still less difficult than it is to N. C.).

V.

Although the results detailed in the last section seems thus to indicate throughout that the direction of the attention is the principal factor determining the nature and the reversals of perspective, it may perhaps be objected that, in obtaining these results, we have insufficiently guarded against the intrusion of another factor, namely the influence of fixation. At the conclusion of the last set of experiments, however, both the experimenter and the observers were strongly of opinion that variations in the nature of eye movement and of

fixation were utterly inadequate to account for the often markedly different results obtained with the different attitudes. Eye movements and fixation were frequently mentioned in the introspections of all three subjects, and, except in a very few cases, the eye movements were neither sufficiently extensive nor sufficiently regular for it to appear possible that they could have influenced the results in any considerable manner. These considerations were supported by the results of the experiments with two figures seen simultaneously described in Section II, which, as we saw, are difficult or impossible to reconcile with the view that would regard eye movement as the main principle or explanation of the phenomena of reversible perspective. They are likewise in agreement with the observations of most other recent investigators, who seem to be of opinion that changes of perspective may occur without the corresponding eye movements which should, according to a widely held theory, invariably accompany them. In view, however, of the extreme importance which has been attached by some writers to the influence of eye movement and fixation, it seemed desirable to submit our results to a severer test than was afforded by the instructions regarding fixation in the experiments recorded in the last section and by the introspections on this point incidentally obtained in the course of these experiments. For this purpose a special set of observations was made, with the same figure and under the same general conditions as these experiments, and with the same subjects as had taken part in them. For the small ink fixation point in the middle of the figure there was, however, substituted a small piece of black paper, 2.5 mm. square, the actual fixation point being given by a pinhole in the centre of this. After this had been fixated for a few seconds in a bright light (such as was used throughout our experiments) any wandering from the fixation point could be observed by means of the negative after-image of the black square, which appeared as a very white patch upon the duller white of the paper on which the figure was drawn. By this means the subjects were able, after a little practice, to note and to report both the direction and the extent of their eye movements¹. It was found that when the subjects fixated the centre of the figure and at the same time attended to one or other of the ends (as was done in the 'attitudes experiments') the after-image seldom, if ever, went into the square to which the attention was directed, and was indeed seen only as a narrow white

¹ Similar observations had already been made by Becher (*op. cit.*) with much the same results as those obtained in the present case.

strip immediately in contact with the black square. The subjects, who by this time possessed a very considerable amount of practice in this kind of observation, were quite positive in their assertions, and the observations were repeated often enough to show that the reports remained constant from one sitting to another. Although the eye movements were thus found to be very small, if not altogether negligible, the nature and reversals of the perspective followed the direction of the attention exactly as before.

TABLE VI.

Attention Fixation	Left Left			Left Centre			Left Right			Right Left			Right Centre			Right Right		
	L	U	R	L	U	R	L	U	R	L	U	R	L	U	R	L	U	R
Subject : C. S.																		
Attention primary	95	0	5	64	15	21	84	0	16	43	0	57	5	0	95	19	0	81
Fixation primary	95	0	5	29	21	50	46	0	54	45	0	55	15	0	85	33	0	67
Subject : N. C.																		
Attention primary	100	0	0	100	0	0	54	46	0	0	80	20	0	0	100	0	0	100
Fixation primary	73	0	27	100	0	0	0	100	0	0	100	0	0	0	100	0	0	100
Subject : J. C. F.																		
Attention primary	83	5	12	80	0	20	22	48	30	18	61	21	31	7	62	24	0	76
Fixation primary	76	10	14	55	0	45	9	60	31	33	47	20	33	5	62	31	8	61

Observations on the influence of simultaneous attention and fixation to various parts of the prism figure, attention and fixation being made in turn the primary and secondary task respectively. Numerical results refer to percentages of the total period of observation.

L='left end forward,' U='uncertain,' R='right end forward.'

This, while showing that the changes of perspective *can* be independent of fixation and eye movements, does not of course prove that they actually were so in the 'attitudes experiments,' since the conditions were not the same in these experiments as in the special observations on fixation just reported. The effort to fixate and to observe the movements of the after-image in the latter case was greater than that usually devoted to fixation in the 'attitudes experiments,' where the subject was expressly directed not to allow the effort to fixate to interfere at all with the adoption of the required attitude. In order to obtain some idea of how far there existed a mutual interference between strict fixation and observation of the after-image on the one hand and successful attention to the squares on the other hand, a few further observations were made, in which the subjects were alternately instructed to devote their primary efforts

(1) to the maintenance of the fixation and observation of the after-image, and (2) to the concentration of the attention upon one of the squares, all other conditions meanwhile remaining unchanged.

In these experiments three fixation points were used—the usual one in the centre of the whole figure and one in the centre of either square. With each fixation point, attention was directed in turn to either square. Some typical results are recorded in Table VI. These refer, as usual, only to the perspective (and hence indirectly to the attention given to the squares), since it is only with regard to this that an objective record was obtained. These observations show that very accurate maintenance and recording of the fixation and simultaneous attention to another part of the figure do, to some slight extent, inhibit one another, but that this mutual inhibition is never sufficiently great as to make the results obtained under the two sets of conditions totally incomparable¹. We thus seem fairly justified in assuming that the results of the ‘attitudes experiments’ themselves are not due to fixation any more than are the results obtained in the experiments in which fixation was specially controlled; and we saw that, in the latter case, attention to either square was capable of bringing forth the corresponding perspective, under circumstances in which eye movements sufficient to account for the perspectives could be definitely observed not to occur. The most that can be said as regards the influence of fixation in the ‘attitudes experiments’ is, that, if sufficient attention had been paid to the fixation as to preclude the possibility of any appreciable effect of eye movements (as was the case in the special fixation experiments), then the attention to the squares would have suffered to some extent, and the variation of the results with the different attitudes would have been less marked, though they would still have been in the same direction as were the results which were actually obtained. Of any real explanation of the results in terms of eye movement and fixation, there can, in our opinion, be no question.

VI.

Having thus disposed of the objection that the results apparently due to the direction of the attention are in reality to be attributed to

¹ In the absence of an objective record, it is difficult to speak with certainty of the amount of deterioration undergone by the fixation, when efforts were directed primarily to concentration of attention on the squares. If we rely on the introspections, it seems to have been somewhat similar in amount to that undergone by the attention during the primacy of fixation.

eye movements and fixation, it remained to be seen how far the general rule as regards the influence of the direction of the attention on the perspective, so clearly demonstrated in the case of our prism figure, holds true of other cases of reversible perspective. For this purpose a number of observations were made with several other well-known figures; in these observations a point in the centre of the figure was fixated by the aid of a small square of black paper, as in the experiments described in the last section (though the subjects were no longer instructed to regard fixation as the primary task), and the attention was then concentrated upon various parts of the figure in turn, the resulting perspective being recorded in the usual manner.

The figures selected for these observations were the table (Fig. 2) and the Mach truncated pyramid (Fig. 3), already used in previous experiments, the Beaunis cubes (Fig. 11) and the wedge depicted in Fig. 12. The observers were N. C. and C. S., who had taken part in all

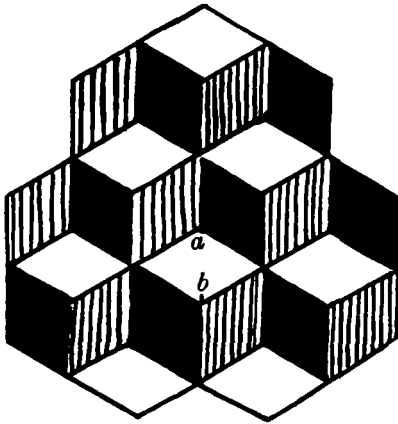


FIG. 11.

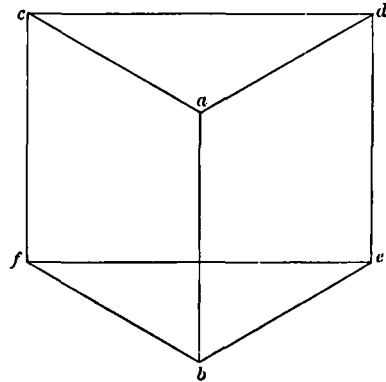


FIG. 12.

the experiments hitherto described. As the reader is already familiar with the nature of the numerical records obtained from this kind of experiment, and as the results were, almost without exception, very clear and unequivocal, I refrain from giving tables, and will merely indicate in a few words the principal conclusions to be drawn from these observations. With the wedge and the Beaunis cubes the results obtained from both subjects were very similar, if we make allowance for the usual individual differences in the power of voluntarily controlling the attention manifested by these subjects. With the wedge figure it was

found that when attention was concentrated upon the line *ab* and its immediate neighbourhood, the thin end of the wedge was seen pointing towards the observer; when attention was strictly confined to the line *ab* itself, there was a tendency for all perspective to be lost, since the more peripheral parts of the figure were often not sufficiently in consciousness for the figure to be seen as a whole at all. When either of the horizontal lines was attended to, on the other hand, the wedge was always seen with its flat end toward the observer. The same was the case when the whole of the rectangular parallelogram *cdef* was the part attended to.

In the Beaunis cubes it was similarly found that attention to the point *a* caused the cubes to be seen from below, while attention to the point *b* caused them to be seen from above. In the case of the truncated pyramid, when attention was given to the outer square, the figure was seen as 'chamber'; when attention was given to the inner square, it appeared as 'boss.' In the latter case, however, a certain amount of attention had at the same time to be directed towards the outer square, as, when the attention given to this part of the figure fell below a certain minimum, the whole figure tended to become flat, the outer parts apparently not being sufficiently clearly in consciousness to become incorporated in any perspective whatever.

With the table figure, in the case of observer N. C., attention to the line *cd* brought out the 'bottom visible' perspective, attention to the line *eb* the 'top visible' perspective.

At the time these observations were made, observer C. S. had a very strong tendency to see the table in the 'top visible' perspective. As a consequence of this, it was easy for him to produce 'top visible' and maintain it almost uninterruptedly by attending to the line *eb*; attention to the line *cd* failed, however, to produce a predominance of the 'bottom visible' perspective, the legs of the table usually refusing to turn and obstinately continuing to appear as in 'top visible.' It was found, however, that the desired 'bottom visible' could be produced with comparative ease when attention was turned not upon the line *cd*, but upon the upper pair of legs themselves and particularly upon the left-hand member of the pair (*ac* in Fig. 2). The cause of this is probably to be found in that mutual inhibition of fixation and attention to which we referred above; for, as soon as the fixation point in the centre of the figure was removed and the subject was allowed to fixate some part of the line *cd*—*i.e.* to fixate and attend to the same part of the figure—'bottom visible' could be maintained during a considerable portion of

the observation. Such mutual inhibition of attention and fixation is probably stronger when the parts of the figure attended to and fixated respectively are near one another than when they are more remote. This is indicated not only by the above results with the table (attention to leg *ac* more effective than attention to line *cd*) but also by some special observations, made with and without fixation on the truncated pyramid, which showed that fixation of a point in the middle of the figure detracted considerably from the efficacy of attention to the inner square, but had no such effect when attention was given to the outer square. These results are very possibly due to the fact that when the fixation point is abolished, eye movements frequently take place to the neighbourhood of the inner square, so that fixation and attention coincide during part of the time, and the inhibition between them is lessened; whereas the eye movements seldom extend as far as the outer square, so that the inhibition is the same as regards this part of the figure, whether a fixation point be present or not.

It will thus be seen that all our observations with these four additional figures are in close agreement with the results of the experiments upon the prism figure. We have then good ground for assuming that the general conclusion as to the dependence of the perspective upon the direction of the attention in that figure admits of application to all illusions of reversible perspective¹.

This conclusion, in fact, seems to afford an accurate expression of the general rule for the behaviour of such illusions, and in view of the importance which it thus comes to possess, it may perhaps be well to re-state it once more here. It is as follows: '*The nature of the perspective in which a reversible figure is seen at any moment is—at any rate, mainly—dependent upon the direction of the attention; and this dependence of the perspective upon the attention is of such a kind that, as regards all reversible parts of the figure, those parts which receive the more attention are seen in front of those which receive the less*

¹ As our experiments were made upon a few subjects only, it remains of course possible (though unlikely) that this conclusion may not hold good for all observers. Since the value of our experiments depended largely upon the accuracy of the introspections, and since this accuracy can only be assured by taking a large number of records from well trained subjects, it was not found possible to repeat the experiments with a larger number of observers. Some attempt was indeed made to allow a number of junior students of Psychology to perform for themselves some of the experiments on fixation and attention reported above (Section V). But the results were not numerous enough to bring out clearly any individual differences as regards the dependence of the perspective upon the direction of attention, if such existed. Such as they were, however, these results on the whole agreed closely with those obtained from the practised observers.

attention...' The word 'attention,' as was indicated above, is here used as equivalent to 'clearness in consciousness¹.'

It may perhaps seem strange that such a simple empirical rule, if it really does successfully account for by far the greater part of the phenomena connected with illusions of reversible perspective, should not have been more generally recognised by those who have written on the subject, especially in view of the great amount of consideration which has, at one time or another, been given to these illusions. The general failure to attribute to the direction of the attention anything approaching the importance which, judging from our own experiments, it seems in reality to possess, may perhaps be partly accounted for on the three following grounds:

(1) The obscurity of the word 'attention,' which has notoriously been given many different shades of meaning by different writers. Even those who do attribute some importance to attention in connexion with the present subject have, as a rule, failed to define at all precisely the sense in which they were using the word, with the result that the expression has either been too vague to be of much service, or has given rise to direct misunderstandings on the part of subsequent investigators².

(2) The importance which, since the work of Wundt, has been attributed to fixation and eye movements. This has probably tended to divert investigators from the importance of the attention, since there is no doubt that the two factors work, for the most part, in the same direction, that point of the figure which is fixated usually

¹ In the light of this conclusion we may perhaps explain some results of the earlier experiments with two figures seen simultaneously, described on p. 363. Thus it was found that the two prisms had longer periods of opposite phase than the two tables. In view of the fact that in these experiments no special instructions were given as to the direction of the attention, and that the point fixated lay midway between the two figures, we should naturally expect to find that the maximum of attention was frequently given to those parts of the figures which lay nearest to the fixation point. In the case of the prism this would, according to the above rule, always tend to produce a condition of opposite phase. With the tables we should not expect to find any such marked tendency, since here a distribution of the attention upon quite neighbouring parts of the two figures (*e.g.* upon *a* and *d* in Fig. 2) would result in the figures appearing in the same phase.

Although this seems a probable explanation of the difference in the results obtained with the prism and the table respectively, it must be remembered that the *general* tendency exhibited throughout the experiments with two figures seen simultaneously—viz. for the figures to appear in the same phase—shows that attention, under these circumstances, is usually given to corresponding rather than to neighbouring parts of the two figures.

² For the meaning of the word in the present paper see footnote, p. 376.

also receiving the most attention. It is indeed an important consideration in favour of our view, that it is consistent with the general validity of Wundt's rule as regards the relation between fixation and perspective, while at the same time (since fixation and attention do not *invariably* go together) it affords an explanation of those exceptions to the rule, which have been, among recent authors, generally admitted to occur.

(3) The difficulty of investigating the effect of the direction of attention. Partly on account of its usual agreement with fixation, partly for other reasons, it has not been easy to isolate the direction of the attention as a separate factor of the experimental conditions. It was only during the course of a long and laborious series of observations that its importance gradually became manifest in our own experiments. Further, all evidence as regards the direction of attention must, it would seem, in the last resort depend upon introspection, and introspection in this matter is by no means easy. It is not such a simple task as it might at first appear, to evaluate with any degree of accuracy the relative amount of attention given to the different parts of a figure at a given moment, and to observe in what way and to what extent the changes of perspective correspond to changes of attention. For this reason it is *only* by obtaining consistent records from a long series of observations with well-practised subjects, that reliable evidence can be procured.

It is of course true that, in spite of these difficulties, the influence of attention has been frequently noticed and referred to by previous investigators. They have, however, for the most part, regarded it as a factor of secondary importance only. Among the authors whose works are known to the present writer, there is nevertheless one whose views seem to be in close agreement with those we have been led to adopt as the result of the experiments here described. As the result of pure introspection upon a variety of figures, von Aster¹ seems to have come to the same conclusion as regards the influence of the direction of the attention, as that to which we have ourselves arrived as the result of introspections carried out under a variety of experimental conditions. Our own results, in fact, support the views of this investigator in a remarkable manner.

¹ "Beiträge zur Psychologie der Raumwahrnehmung," *Ztsch. f. Psychol.* 1906, XLIII. 161.

VII.

We have now indicated sufficiently clearly the conclusions which seem to arise from the experiments here described. It will perhaps be of interest to indicate the nature of some of the further problems which seem to arise from these conclusions.

There is, in the first place, the genetic problem as to how the direction of the attention came to have the determining influence upon the perspective of a reversible figure. Wundt's hypothesis to account for the supposed influence of eye movements and fixation—that in viewing solid objects we normally direct the line of regard to a near point, and from thence explore more distant points as may be necessary, and that there has thus arisen an intimate association between the point fixated and the point from which an eye movement starts on the one hand and apparent nearness on the other—would probably admit of re-statement in terms of attention instead of fixation and has no doubt much to recommend it. In the absence of any experimental proof, however, it cannot at the present moment be accepted as anything more than an interesting suggestion.

Another closely allied problem is the question of the general place of the direction of attention as a factor in space perception. Our observations show that in illusions of reversible perspective drawn upon a plane surface, the direction of the attention is frequently the sole—or at any rate by far the most important—condition determining in which of two or more possible perspectives the figure shall appear. But it is obvious that with the majority of *solid* objects, a mere change in the direction of attention is no longer capable of producing such far-reaching changes in the apparent spatial relations of the object. It is known, however, that with certain objects occupying three-dimensional space, reversals of perspective can be observed exactly similar to those obtained with drawings such as those we have here used. This is particularly the case with real models made to resemble these drawings¹. It would be an interesting subject of investigation to discover what is the *rôle* of the direction of the attention in the space perception of three-dimensional objects, under what conditions and to what extent it influences our perception of these objects in the same way as it does that of our reversible drawings, whether it exists as

¹ See especially Burmester, "Theorie der geometrisch-optischen Gestalttäuschungen," *Ztsch. f. Psychol.* 1906, xli. 321; 1908, l. 219.

a factor of varying importance in all our spatial perceptions, or whether it is called forth only under particular circumstances¹.

A third interesting problem, arising from our view of the importance of the direction of the attention in illusions of reversal perspective, is concerned with the nature of this attention itself. In this connexion I will venture to conclude with a suggestion which, while no doubt requiring much further elaboration in the way of details, seems in its main outlines to harmonize well with the principal facts brought out

¹ A few observations in this direction were made in connexion with the present investigation. Two wire models of the prism (Fig. 1) were prepared, in one of which the two ends were made of the same size, while in the other some attempt was made to allow for the effect of perspective by making that end of the model which was placed nearer the observer smaller than that which was remote from the observer. When looked at from a suitable distance this latter model gave a retinal image which was nearly (the construction of the model was not quite accurate for this purpose) the same as that given by our drawing of the prism figure; while with the other model the image was of course different, in so far as the effects of perspective were not counteracted. By comparing similar observations made upon these two models we were thus able to compare the influence of a simple perspective effect with that of the direction of the attention. It was found that the perspective effect (as produced by the model in which the perspective had not been corrected) did not in any way appreciably hinder the reversals occasioned by the movements of attention, since it could easily be 'allowed for' by an alteration in the apparent relative size of the two ends of the model. When the end which was in reality remote from the observer appeared the nearer, it seemed to be a good deal smaller than the apparently remote (in reality the nearer) end, whereas when there was no such reversal, the two ends appeared (as they really were) to be of the same size. No such apparent change in the relative size of the two ends occurred with the model in which the perspective had been corrected, but otherwise the behaviour of the two models was practically identical. [A similar but less marked effect, however, could sometimes be observed with this model also and with the drawn figures. In this case the retinal image of the two ends was the same size, whereas in the case of a real object whose ends were the same size, the image of the more distant end should be smaller. This was 'allowed for' in the interpretation of the image, with the result that the apparently more distant end—whatever this happened to be—appeared slightly larger than that which was apparently nearer.]

By observing the models with one eye and two eyes alternately, it was similarly possible to compare the influence of attention with that of disparation. Unlike the perspective effect, it was found that disparation offered considerable difficulties in the way of reversal, in so far as it was much easier to obtain reversals with one eye than with two. But while reversals could not be obtained so frequently with two eyes or maintained so long, the reversed perspective itself, when present, was quite as clear and unmistakable as when observed with one eye. It is interesting also to note that the individual peculiarities of the observers as regards the power of voluntary control over the perspective by means of the attention were maintained under these circumstances. Thus N. C. was able, by means of strong concentration of attention upon the remote end, to resist the effect of disparation more successfully than was C. S. Here then we have a case, probably worthy of further investigation, in which the effect of the direction of the attention seems to be struggling for the mastery against another important factor of space perception.

in the course of this investigation. In a recent paper¹ much evidence was brought forward in favour of the view that the energy concerned in any mental performance is largely derived from a single common fund, which is drawn upon for every task the individual undertakes. If we may accept this hypothesis, it would seem not unreasonable to suppose that the 'clearness' of any particular content of consciousness, which is the most prominent feature of what we have here described as attention, is the result of the concentration of this 'general intellectual energy' upon that content; or, to express the same idea in physiological terms (and there seems every reason to believe that this common fund of energy is physiological, as well as perhaps also psychical in nature), that the 'clearness' of any mental content is due to the concentration of a fund of nervous energy derived from the whole brain (or at any rate from the whole cerebrum) upon the physical substrate of that content. To take a particular instance, in the case of our prism (Fig. 1), the direction of the attention to, say, the right-hand square (*i.e.* the greater 'clearness' of the right-hand square in consciousness) is, we may suppose, a consequence of the direction of the general nervous energy upon the nervous elements corresponding to the perception of the right-hand square. In so far as the whole figure is perceived, part of the total energy is no doubt going also to the other parts of the figure, but the proportion of this energy going to these latter is smaller than that going to the right-hand square.

In order to account for the appearance of the 'right forward' perspective under these conditions, we must suppose further:

(1) That the perception of the right-hand square is more closely associated with the appearance of 'right forward' than it is with the appearance of 'right backward' (or, what is practically the same thing, 'left forward')².

(2) That, owing to this association, the energy directed to the right-hand square more readily overflows into the 'right forward' than into the 'left forward' system. In this way the observed coincidence of 'right forward' perspective with 'clearness' in consciousness of the right-hand square can be readily accounted for, as can also the coincidence of 'left forward' perspective with 'clearness' of the left-hand

¹ Bernard Hart and C. Spearman, "General Ability, its Existence, and Nature," this *Journal*, 1912, v. 51.

² As regards the *existence* of such an association there can, I think, be little doubt. To account for its *origin* we need, however, some such hypothesis as that of Wundt referred to above.

square. The absence of perspective which seems usually to accompany the even distribution of attention over the whole figure (p. 377) is, we may suppose, due to the mutual inhibition of the two perspective systems, owing to an approximately equal amount of energy overflowing into both simultaneously; while the similar absence of perspective observed when attention is strongly concentrated on the centre of the figure (p. 378) is possibly the result of an insufficient overflow of energy into either system. The observed very high correlation between attention to any part and the 'forward' appearance of that part seems to indicate that the association between the perception of that part and its 'forward' appearance is *very much* stronger than is the association between the same perception and its 'backward' appearance. There can, however, be little doubt as to the existence of a weak association of the latter sort, and in virtue of this association there should be little difficulty in accounting also for such exceptions to the general rule as may occasionally be observed to occur.

If we provisionally accept this hypothesis as affording a plausible explanation of the main problem of the nature of the attention involved in illusions of reversible perspective, there still remains a number of allied questions of very considerable interest. To mention a few of the most important: Why cannot the attention be steadily maintained upon any one part of the figure, so as to maintain the same perspective indefinitely? To what are due the large individual differences in the power of thus steadily maintaining the attention? What, if any, are the relations of the movements of attention which accompany the reversals of perspective to the so-called 'fluctuations of attention'? I hope to be able to enter upon a consideration of some of these questions in a future paper.

Summary of Principal Results and Conclusions.

Two reversible figures, seen simultaneously, fluctuate to some extent independently of one another. This is shown to take place with (a) two identical juxtaposed figures, (b) two different juxtaposed figures, (c) two different superposed figures. These results afford strong evidence against (1) any theory which attributes the reversals of perspective to any physiological cause (*e.g.* the Traube-Hering waves) affecting the whole of the central nervous system at the same time, (2) the usual form of the theory which attributes the reversals to eye movements.

Experiments with a series of drawings designed to make the appearance of one perspective progressively more difficult show that complicating detail is of assistance in preventing reversal when it is attended to; but that reversals may persist, even with very considerable complication, so long as attention is concentrated on the main outlines of the figure.

Observations of the prism figure with different attitudes show that the direction of the attention is a factor of the greatest importance in the reversals of perspective. The general rule is that that part of the figure which receives the more attention is seen nearer the observer. There exist considerable individual differences in the power of controlling the perspective.

Experiments on fixation with the help of after-images show that these results cannot be due to eye movements, though strict fixation and attention to neighbouring points probably inhibit one another to some extent.

The results obtained with the prism figure are confirmed on other figures.

Owing to various causes, the influence of attention has been unduly neglected by most previous investigators.

The important part played by attention in illusions of reversible perspective gives rise to several further interesting problems.

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