A REVIEW OF GESTALT STUDIES IN JAPAN —DEVELOPMENT OF STUDIES ON FORM PERCEPTION—

Shin NOZAWA

University of Sacred Heart, Tokyo

Toshio IRITANI

Tokai University, Tokyo

In Japanese psychology, the field of visual perception has by tradition been most actively investigated. One can not deny that Gestalt psychology has directly or indirectly influenced the research. It has indirectly, in the sense that even those psychologists who have taken some critical attitude toward Gestalt school, eg., Obonai (1955), Kido (1927a, b), Yokoyama (1943), Yuki (1952), etc. have, somehow or other, been influenced by Gestalt theory, and have held certain relations with it.

This paper will primarily review those studies of perception which have strongly been influenced by Gestalt theory and secondarily, those studies which have indirectly been influenced. As a consequence, concerning those scholars who have contributed to problems of various kinds, e.g., Obonai, those parts which have a close relation with this theory, will be reviewed without going into other details. The same holds for other investigators.

Before going into main issues, the authors will briefly discuss the outline of its historical development. The active researches on Gestalt psychology is divided into the following three periods. First decade: the period started with Wertheimer's article on apparent movement in 1912; Katz's study on the mode of appearance of color (1911); and best represented by the publications of Köhler's work on 'Intelligence Test of Apes' (1917) and 'Physical Gestalten' (1920) and the article by Koffka on 'Perception' (1922). Second decade: the period for activities through the publication of 'Psychologische Forschung' centered around the University of Berlin. Third decade: the period after the emigration of those proponents in America. In accordance with these periods, the influence of Gestalt theory upon Japanese psychology is divided into three periods. The first period: Those ten years after the publication of the Japanese Journal of Psychology in 1926 upon the return of Sakuma and Onojima from their stay at the University of Berlin (1923-25), a propagating period of Gestalt psychology in Japan. During this period, 'Twelve Lectures on Current Psychology' by Onojima (1930), 'Gestalt psychology' by Kubo (1930) and seven monograph series entitled 'The problem and the theory of Gestalt' (1933) including the introduction of 'Physical Gestalten' by Köhler under the editorship of Sakuma were pub-

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* According to Sakuma (1949), it was Koffka's article (1922) that directly motivated them to go to the University of Berlin.

lished. The following ten years (from 1936 to post war period) is regarded as the most flourishing period of Gestalt psychology, and the period thereafter to the present may be called the 'new period of development'.

In the first issue of this journal, Sato (1957) presented a table showing the current status of perceptual studies in Japan since 1951.

Table 1 Distribution of Papers on Perception at the J. P. A. Conventions by Problem Areas.

Problem Areas	1926-1935	1936-1950	1951-1957 from (Sato 1957)
1 Induction field (Figure)	8, (227) pages	23, (397)	} 84
2 Illusions	14, (235)	5, (73)	
3 F. A. E. (Inspection)	—	—	46
4 Constancies	3, (50)	9, (119)	34
5 Space	9, (132)	14, (195)	} 40
6 Movement	8, (280)	20, (313)	
7 Time	5, (193)	1, (21)	
8 Comparisons	4, (82)	10, (158)	26
9 Dynamic, Social	2, (77)	—	20
10 Developmental (Comparative)	8, (176)	5, (76)	25
11 Audition	13, (214)	22, (244)	—
12 Sensations	21, (432)	10, (172)	—
13 Theoretical. Methodological	6, (121)	4, (29)	6
14 Others	7, (176)	3, (50)	83
Total	108, (2395)	126, (1847)	364, (2359)

Following this table, the authors constructed a table showing the studies related to perception under the period from 1926-35, and 1936-50 (Table 1). In the first ten years, studies on sensation predominate and one can find scarce influence of Gestalt psychology. The studies on the illusion of visual angles and anisotropy of space are fairly remarkable, (especially, Obonai, Kido, and Tachibana and Morinaga's studies; however, a little influence of Gestalt psychology is observed in them). When one examines the research on movement (second rating) and time perception (sixth rating) however, a strong influence of Gestalt psychology is observed. From this table, it is clear that the interests of Japanese psychologists were gradually moving toward Gestalt theory. In the next fifteen years, (in which the vacuum period by war is included) the research on sensation diminished in large, and instead, re-examining experiments on perception bearing on the color of Gestalt psychology or, if not re-examining experiments, those in which ideas and methods were explicitly based on Gestalt psychology became predominant, and the majority of these studies obtained results which could directly contribute to the theory of Gestalt psychology. For example, Mori (1940) re-examined the experiments on brightness contrast by Benary (1924), in contrast to the original study which merely considered the effect of contrast. He newly brought up the figure by Fuchs (1923) which exhibited assimilation effect, and after comparing the configurational characteristics of both figures, Mori concluded that whether or not contrast or assimilation occurs depends on the Gestalt properties in which

the part of the figure in question holds a certain relation to the whole figure. With regard to the so-called Tau effect, Abbe (1936) carried out an investigation on the influence of spatial distance upon temporal interval, the existence of which had been denied by Gelb (1914). As a result, he pointed out that Gelb's negative result is due to the stimulus figure used, the methodology, and the analysis of data. Thus, Abbe demonstrated a positive effect*, and attempted to develop an 'induction theory of neural currents' in an opposition to Köhler's 'das Prinzip der Freizügigkeit des Stromfäden'.

Through the illustrations cited above, and those to be discussed below, a consistent attitude of Japanese investigators is observed in which, while formally agreeing on the fundamental concepts of Gestalt psychology rooted in the original studies, they re-examine, supplement and revise them, discovering the problems which had been untouched by original authors. Few studies can be noticed in which, from the beginning, researchers have taken a critical attitude toward original works and have fought against them by proposing a hypothesis which stands in a direct opposition to this school, except those authors mentioned earlier. In comparison with the position of Gestalt psychology in the history of American psychology described by Roback (1952) for example, a noticeable difference is observed between the trend of Japanese research studies and that of Americans. As the discussion concerning these reasons is beyond the scope of the present reviewers, they will not refer to them in this paper.

Even restricting the scope to the field of perception, the research related to Gestalt theory following the second period have covered various topics such as seen in Table 1. Among them, the studies on illusion (Oyama 1960), constancies (Akishige 1957) and transposition (Sato 1957) have already been introduced, and concerning the rest, not a few studies are desirable to be described by some independent authors. Therefore, changing our viewpoint, the present paper will bring up those topics which have a close relationship with the development of Gestalt thinking, limiting its scope to the perception of visual patterns. The authors will discuss them under the following classification of issues, being different from Table 1: i) phenomenal distance, ii) measurement of visual field, iii) movement phenomena, iv) figural after-effects, and attempt to clarify the characteristics of Gestalt studies in Japan.

1. ISSUES ON PHENOMENAL DISTANCE

One of those issues which essentially attracted attention of Japanese investigators of perception is phenomenal distance, although the classification by such a term is not indicated in Table 1. This issue originated from the experiment by Jacobs in 1933. When subject compares the brightness of two objects separated at a distance, by focussing on the fixation point located in the middle, Jacobs found that, with the increase of the distance between them, the brightness threshold went higher, and he questioned whether the distance in this case manifested the physical distance based on retinal image or the phenomenal

* This effect was independently discovered by another author Abe (1935) almost simultaneously, and thereafter it has been called 'Abbe effect'.

distance based on some higher processes. With an ingenious experiment, he demonstrated that it is due to the latter.

In 1935, Amano re-examined the experiment by Jacobs and Kleinbub (1933) on the comparison of brightness, and confirmed their results. The experiment by Kleinbub was the following: in the comparison of the brightness of two objects, subjects were allowed to move their eyes freely in contrast to Jacobs' experiment in which eye movements were prohibited, and he found that the value of brightness threshold indicated scarcely no change with the variation of the distance between them. Amano further conducted an experiment on the comparison of weight by finger tips (1938), and of pressure sensation (1939), and confirmed the results by Jacobs. Amano's latter experiment was the following: in the comparison of pressure sensation by giving pressures simultaneously to the middle fingers of right and left by means of two pressure pans, the physiological distance between both finger tips remained constant regardless of the change of physical distance by widening or closing both arms. However, with a well-controlled experiment, in which the physiological condition on that part of fingers was assumed to be constant, the threshold of pressure became higher with the increase of the distance between the two finger spots.

In 1936, Ogasawara studied the phenomenal distance in β -movement on the assumption that the function of phenomenal distance discovered by Jacobs is not the special problem of discriminatory process, but it extends to the general problem of various perceptual phenomena. In Korte's law, $\varphi = f\left(\frac{s}{g}\right)$ where φ stands for apparent movement, s for spatial distance between stimuli, g for the length of exposure interval of stimulus light; the spatial distance s here has many implications, at least, of having following three meanings: i) physical distance, ii) retinal distance, iii) phenomenal distance. Ogasawara, using a similar condition as Jacobs, carried out an experiment on temporal factors to obtain an optimal β -movement*. Based upon his result, he concluded that of these three kinds of distance, phenomenal distance is the sole determinant**, namely, spatial distance s in Korte's law refers to phenomenal distance.

Later, with regard to Abbe effect described above, Sudo (1941) conducted an experiment to determine whether the influence of spatial distance upon phenomenal time is a real manifestation of phenomenal distance or not. He questioned the problem of spatial distance in which three light spots on a line flashed on and off successively at a certain exposure interval, constructing the condition in which physical and phenomenal distances contradict each other by adding the oblique lines of Müller-Lyer figure on the three light spots. After all, he concludes that the factor which influences upon time perception is not the physical distance between stimuli, but the phenomenal distance based on the transformation of physical distance.

In 1940, Takagi, S. brought up the question of proximity factors in perceptual

* Varying the distance between light spots and the distance of observation (constructing four conditions by combining the above two variables), and varying the brightness of laboratory, Ogasawara constructed the situations in which the distance between the light spots is influenced or uninfluenced by size constancy.

**Re-examining Ogasawara's experiment, in 1957 Oba and he pointed out that the retinal extent which influenced the β movement should not be neglected under the condition of the dark room.

grouping. According to him, because the problem of proximity has been treated only in terms of two dimensional configurations, the three kinds of distances namely, physical, retinal and phenomenal distances coexist without causing a conflict; thus one cannot determine which of these distances is the chief determinant of the phenomenon. Therefore, he

Fig. 1

The numbers in a indicate the distance between each rods.

The lines in b and c indicate the grouping of rods.

From Takagi (1940)

attempted to get a solution by constructing a three dimensional constellation in which the above three distances coexist in conflict. As indicated in Fig. 1-a, thin rods were lined up, and subjects were asked to observe them through a small aperture, and to report the appearance of 'fence' caused by the grouping of rods. The results are produced in Fig. 1-b and c. Under binocular vision, depth phenomenon was observed, although the upper and lower ends of rods were hindered by a reduction screen, the phenomenon of grouping was observed as indicated in Fig. 1-c. Under monocular vision, though the depth phenomenon was not observed, the phenomenon of grouping was observed as indicated in Fig. 1-b. In b., the rods which were objectively separated at a long distance were perceived as a group, while in c, the rods which were retinally separated at a long distance were perceived as a group; it was only the phenomenal distance that did not cause a conflict throughout the both conditions.

About the same time, Tsuzuki (1939, 40) conducted an experiment by stereoscope on the assumption that in the tridimensional observation, the after-images caused by removal of stimuli for both eyes would make a fusion earlier when the phenomenal distance between stimuli is closer, and obtained the result which approximately confirmed the

above assumption.

Indow (1948) re-examined the experiment on pressure sensation by Amano described earlier, by the successive comparison at four seconds exposure intervals, in which the position of finger was displaced, and making various distances between two positions (same as Kleinbub's situation). The result showed that no change in judgment was observed regardless of the increase of distance between the two positions, while in the Jacobsian condition, indeterminable zone of judgment was observed with the increase of distance. The same trend as Kleinbub's experiment on the comparison of brightness threshold was observed.

This problem has also been treated by the study of figural after effects. In the phenomenon of so-called figural after-effects the amount of illusion changes with relation to the distance between inspection and test figures. Morioka (1947) re-examined the function of distance by measuring figural after-effect caused by the influence of tilted line (IF) * upon vertical line (TF) *. The results were compared with respect to the following four conditions: i) presentation of TF on the same position of IF in a dark room, ii) presentation

of TF located in front of IF in a dark room (the distance between two stimuli was not noticed), iii) same as the condition of (i) except in a semi-dark room, iv) same as the condition (ii) except in a semi-dark room (the distance between two stimuli was noticed). Under the conditions of (i), (ii) and (iii), almost the same amount of figural after-effect was observed, under the condition (iv) however, no effect was obtained. Based on these results, Morioka concluded that the factor which determines the extent of figural after-effect is not the retinal distance, but phenomenal distance between stimuli. In another experiment, he conducted the same examination as Kleinbub in which subjects were allowed to move their eyes from the position of IF to TF.

It is a very significant fact that the investigation on the function of phenomenal distance has been carried out by many Japanese researchers in those fifteen years since Jacobs's experiment. Wertheimer and Köhler proposed very sketchy hypotheses, Japanese researchers have attempted to model them, supplementing their details, making their effort to build a ground for further experiments. In all their studies, it has been concluded that the phenomenal distance is the sole determinant of discriminability, estimation of time and figural after-effects, etc., they do not, however, remain in confirming the relation between the phenomena: they refer, somehow or other, to some central process in which they agree on the discussion of phenomenal distance, while not always agreeing with respect to the discussion of retinal distance. The present reviewers think, therefore, that the title for this issue is more appropriate to call 'functional distance' than to call phenomenal distance'.

In a study of figural after-effect of IF (the curved line) upon TF (straight line), Nozawa (1953) tested the Köhler-Wallach hypothesis that when IF and TF are little separated from one another, the amount of figural after-effect is greater than when both figures are superimposed on one another, and confirmed this hypothesis. In his study, two conditions of distance at 1 mm, and 0 mm between both ends of IF successively by giving a fixation point in the middle, the difference between both conditions (less than 9° of visual angle) was not noticed by subjects. Under such circumstances, this conditional difference caused a remarkable shift of the amount of figural after-effect. (In two minutes inspection of IF, some eye movements are assumed to occur, therefore, one cannot assign a significant role upon retinal image.) In such case, it is not appropriate to use the term 'phenomenal distance'. The correct expression would be the effect of distance in accordance with the process of IF and TF in some part of central areas. One can present the problem of phenomenal distance in such fashion. We shall however, refer to this problem again in a later chapter.

Returning to the earlier problem, those investigators described above, aimed at the attack of isomorphism through the study of the function of distance, by going beyond phenomenological studies. However, one must admit that, although they succeeded in confirming the relation between the phenomena in various perceptual situations, they could not, unfortunately, beyond Köhler's hypothesis (1920) with respect to the theoretical development of central processes.

The thinking of many Japanese psychologists with respect to isomorphism may be roughly indicated in the following Indow's statement (1951), "In general, one of the great

* Inspection figure hereafter abbreviated as IF, test figure as TF.

advantages on isomorphic thinking is that it has opened the way to infer some physiological schema which directly corresponds to the facts of perceptual properties. It has achieved a significant productivity to observe as many perceptual facts as possible based on the same principle, without making an assumption of physiological something which makes it hard to understand its essential nature. It has constructed with precision the functional properties and conditions in which physiological correlates must be assumed. . . . A day will come when the physiological process in correspondence to our consciousness can be studied physiologically. Therefore, it does not seem to be worthless at present to arrange and systematize phenomenological facts in terms of psychophysical correlates." In other words, he proposed to make an intervening construct in which stimuli are correlated with perception. If we observe the problem in this fashion, it is not restricted to the problem of distance between objects, but is extended to the problem of the function of surrounding areas of object, and this nothing but the problem of field.

2. ISSUES OF 'FIELD' IN PERCEPTION.

Contour Effect: Those who are interested in the problem of 'Physical Gestalten' proposed by Köhler, may wish to examine whether or not the constellation of electro-magnetic field exhibited in textbook of physics can also be observed in perceptual field. However, when one makes an assumption on the process of whole as the fundamental principle of Gestalt, he meets with a methodological difficulty that it is not correct to combine the data obtained by the investigation of parts in measuring the effects without changing the whole process. Although Koffka (1935) gave an explanation based on the field hypothesis in perception, he did not attempt to prove the existence of this 'field'. Japanese investigators have been making an effort to establish a so-called 'structure of the field' apart from its methodological appropriateness or inappropriateness.

In 1927, Takagi, K. studied the effect of contour (which he called 'figure line') upon surrounding areas of stimuli by his own method. With a modified Wundt's successive tachistoscope, he presented figure *a* (contour figure) and figure *b* (solid square, larger than *a*) at the exposure duration of 8 m sec. with an interval of 32 m sec., and subjects perceived a figure Fig.3-c, a fusion of the two figures due to the short latent period. Figure *b* served as a ground stimulus against figure *a*. In the neighboring area of the contour, the color faded being influenced by the contour; in the area surrounded by the contour, the color of the texture completely faded out, and appeared white. According to Takagi, this study qualitatively grasped the process of field effect which occurred in the surrounding of the contour.

Eight years later, Werner (1935) reported his study on contour. In his case, however, contour figure was presented afterwards, and only questioned the inner effect of contour.

In 1937, Okada varying the duration and exposure interval of both figures studied by Werner, clarified that with the decrease of the interval of exposure, the preceding stimulus is likely to disappear if other things being equal. He examined quantitatively the effect of brightness, size, and configuration of the contoured figure, taking the critical exposure interval as an indicator.

Fig. 3 Takagi (1927)

Examples of c by various a figures

Fig. 4 Sayanagi (1942)

Sayanagi (1942) re-examined the study by Takagi (1927), taking homogeneous surface as figure *a* and the patterns of various contour as figure *b*, and compared the results of different exposure intervals of stimulus presentation. As seen in Fig. 4, the shorter the exposure interval, the more contour effect extended at a long distance and its shape became closer to a good Gestalt. When one draws graphs by overlapping the results obtained at different conditions as shown in Fig. 4, they directly indicate the field effects of contour. The other remarkable results by Sayanagi are that, in the case of ambiguous figure, an identical figure induces completely different field effects depending on which part becomes the 'figure' in terms of a figure-ground relationship; and in the case of much simpler figure, again a different field effect is obtained depending on which part is focussed by subjects.

In other studies, Shibata (Yokose) (1936) pointed out the influence of the contour figure of projective surface upon after-image, and Yagi (1938) observed the locational differences of the effect of contour upon surrounding areas in his study of Lieberman effect.

Yokose in 1942, measured the threshold of the intensity of light spot in the neighboring

Fig. 5

Yokose, 1955

ing area of various contours, by extending the experiment by Gelb and Granit (1923), and obtained the following results: i) the closer the light spot to the contour, the higher the threshold of light spot was, ii) in the inside of folded lines or closed figures, the threshold of light spot was higher than in the outside. Based on this result, Yokose and Uchiyama (1951) established a method for the measurement of the field occurring in and outside of figures, i. e., by means of the threshold measurement of light spot in various parts of the figure under rigorous conditions and procedures. Reference of their results was made then to the law of electro-magnetic field in physics, and eventually arrived at the formulation of a theory of potential field in visual perception as seen in the article in vol.1 of this journal (1957). In Fig. 5, when the intensity of potential field of the figure at the point *p* neighboring the line *AB* is expressed by *MP*, the formula becomes,

$$MP = \frac{\sin \theta_1 + \sin \theta_2}{D}$$

Obonai, Iwahara and Nomi (1950), Obonai and Kaneko (1952) investigated the phenomena of visual field by similar methods. However, those authors consider their results to be the extension of Heymans' law (1899), and do not regard them as the effect of Gestalt. For example, in a segmental figure or in the inside of an angle, the influence of figure is extremely strong and, they explain it in terms of the effect of summation of induction. According to them, when the intensity of the stimulus influencing upon the other is weak, the lowering of the threshold of light spot surrounding the stimulus is observed. Suzumura (1958) under the direction of Obonai, examined the process of induction of a figure at low intensity, taking 'utilization time' as an indicator in which a weak light spot is discriminated, and confirmed the following results: first, a weak facilitation effect appeared, then gradually it changed into inhibition effect increasing with time, and after removal of the figure, it gradually decreased and again a weak facilitation effect appeared. Yokose (1955) insisted that when the intensity of influencing stimulus is strong, the surrounding field also receives an inhibitory influence, and his theoretical formula cannot explain the facilitation effect obtained by Obonai, et al.

The investigation on the field surrounded by a figure by means of the measurement of threshold of light spot was also undertaken by Tanaka, F. (1956), and Takino, C. and Yoneda (1958).

Recently, Torii (1961) pointed out that the field effect which mentioned above can be explained not only by the isomorphic hypothesis, but also by the 'glare effect' which is attributed to the stray light in the eye.

Ohshima (1950), Ohkawa (1954), Mori, To. (1956) and Ito (1956) measured the critical flicker frequency of a small light spot near a figure and demonstrated the existence of field effect. In their case, CFF became higher in the areas where the influence of the figure was strong, and it lessened when the distance between the light spot and stimulus figure increased. Since it is believed that with the increase of the sensitivity of light spots, CFF becomes higher, the results described above contradict with those obtained by the method of measuring threshold of light intensity, and further examinations with respect those results are necessary. By the method of CFF, Obonai and Hachino (1953) obtained a reverse effect when the intensity of influencing stimuli was weak, in contrast to the strong condition of intensity.

Mori and Obonai (1956) presented a light spot at various distances from a solid light circle, and measured the influence of the latter. In their experiments two conditions were used: i) the stimulus circle was preceded by test spot (causing the retroactive effect of the latter), ii) the test spot was preceded by the stimulus circle (causing the proactive effect of the former). When the distance between the stimuli became closer, a larger inhibition effect was observed. When the interval of exposure between them exceeded 100m sec., a facilitation effect was observed to some extent.

Uchiyama (1960) made clear the developmental process of field followed by a duration of exposure after the presentation of stimulus, and decaying process of the field after removal of the stimulus.

In connection with figural after-effects, Nozawa (1956) by giving a fixation point in IF as shown in Fig. 7, measured the threshold of the disappearance of light spot projected at the points of *a*, *b* in TF after the removal of IF. As a result, it was observed that, in com-

parison with the condition where IF was not presented, the threshold became higher at the point *a* in the inside of IF (inhibition), while the threshold became lower at the point *b* in the outside of IF (facilitation). This phenomenon may be called one kind of field effect, however, it considerably differs in character from the study by Yokose, et al., where a figure and light spot coexist in the same stimulus constellation.

Fig. 6 Mori & Obonai (1956)
From Obonai (1955)

Fig. 7 Nozawa (1956)

Field theory of visual form: In contrast to the above mentioned method which investigates the field or visual form, taking the discrimination threshold of light spot of a neighboring figure as an indicator, one may consider a visual field in terms of the amount of displacement and direction of test figure (small spot). This method is related to the study of geometrical illusions. However, since they were already described at the other issue of this journal (Oyama, 1960), the authors will only mention its theory.

Yokose and Kawamura (1952), Yokose and Ichikawa (1953) measured the displacement of small black spot in the neighbor of a visual form, and developed the vector field theory, referring their results to the potential field mentioned earlier. Taking VP as the strength of a vector which interacts at p in the neighbor of a straight line AB in Fig. 8, the formula is expressed as $VP = 2MP \cos \frac{\theta_1 + \theta_2}{2}$.

Fig. 8 Yokose, (1955)

Yokose demonstrated the fitness of this formula by referring to his empirical results same as in the case of potential field. He insisted furthermore, that this formula well fits the empirical results of illusions obtained by many investigators.

Since 1926, Obonai has undertaken the investigations of various illusions; especially, the illusions of concentric circles and filled-unfilled illusion (1933a,b), made the starting point of his research. Taking filled-unfilled illusion for example, when one varies the length of

the vertical line which is interpolated at two points, the distance between the two points systematically varies in accordance with the line, i.e., when the interpolated line is short, an overestimation of distance between the points occurs, then gradually diminishing with the increase of the length of the line, and finally changing into underestimation. According to the Obonai's hypothesis (1955), this phenomenon is due to the fact that, when the interpolated line is projected on the retina, a spread of excitability occurs in the surrounding part of the retina, and in the corresponding part of the brain (He calls this process 'psycho-physiological induction'). According to him, the change of the above mentioned excitability of light (cf. p. 63) is considered as another aspect of the same mechanism. He maintains that i) the induction consists of two antagonistic activities: facilitation and inhibition; and the intensity of induction is determined by the equilibrium of these two forces; ii) the spread of induction is determined by the spatial and temporal conditions of stimuli; however, it does not rest on such an ambiguous character as Gestalt, but on the characteristics of additivity which can be studied analytically; iii) a considerable number of illusions can be explained by the mechanism of induction.

His theory is based on a kind of field theory similar to isomorphism, but his research procedure is analytical and quantitative; in this respect, it differs drastically from the research studies by Gestaltists. He also maintains that it is not yet ripe for constructing a theoretical formula and for setting deductively the experiment derived from such formula, and stays satisfied with the empirical formula.

By contrast, Yokose's theory (1955) explicitly takes a standpoint of Köhler's physical Gestalten. However, his intent of research is not directed toward physiological hypotheses, but rests on the statement of quantitative changes of phenomena by the use of theoretical formula, confirming the adequacy of the latter by referring to the empirically measured values and attempting to proceed a step further to the prediction of the phenomena. In these respects, it differs from Obonai's methodology.

In a close connection with those psychological research studies of visual field described above, the authors will present here Motokawa's electro-physiological research. Its outline has already been introduced in this journal (1957). His measurement of field is based on the determination of the threshold of electrical phosphene as an indicator to the electrical stimulus impinging on the retina (1948). Fig. 9 illustrates a visual field obtained by this method. He called this phenomenon retinal induction. Asserting that the spread of this effect is due to the wave motion by induction, he measured its wave length and velocity. Through the assumption of such a field, he maintains that the various perceptual facts such as illusions, depth perception, apparent movement and figural after-effects can be explained in this fashion (1950, 56, 57a). He has accepted these perceptual facts brought up by Gestalt psychologists. He maintains, however, that their causes already exist in the retinal processes. Theoretically he shows a sympathy with Köhler's theory; to those who hold an unequivalence theory of cerebral process in an opposition to Köhler's, he advocates that the assumption of the equivalence of a field is quite reasonable as a first-step hypothesis. To the oppositions made against Köhler by the experiment of inserting silver pins into the cortex of monkeys by Lashley, et al. (1951), he considers that at the present stage, an effective examination cannot be expected by such a rough treatment. Furthermore, he points

Fig. 9

Field around a T-square presented with an I-angle (below), and field around a I-square alone (above). From Motokawa et al. (1957)

out that according to the Köhler's hypothesis on cortical field, the difference between the left and right hemispheres should be expected. In his actual observations however, such a difference did not bring up any importance. At this point, he maintains that Köhler's assumption is not complete, but the phenomenon is well explained by his theory of retinal induction without difficulty (1957b).

The experiments that deserve attention as a criticism of Motokawa's theory are those carried out by Indow et al. (1958 a,b,c, 1959). They re-tested Motokawa's experiment using almost the same apparatus as his, examined especially with respect to the spread of induction and confirmed the facts of induction and neutralization. In addition to the ordinary stimuli, they presented a kind of frame-work figure simultaneously, and by displacing the position of the frame during the course of experiment, they discovered that even when the position of the preceding stimulus and test light held a certain relation on the retina, the response of subjects appeared often not in terms of retinal relations, but in terms of relative positions of the framed figure. They repeated this experiment under various conditions of stimulation

and concluded that the spread of induction is not due to the positional relation on the retinal image, but to the relations of phenomenal positions in visual space. The above facts cast a serious doubt upon Motokawa's theory which states that the induction effect is due to the fact of retinal process. This holds a certain relationship with the fact on figural after-effects studied by Nozawa (1953) described earlier, and presents a new set of data for the explanation of the phenomenon of the frame-work effect described by Koffka (1935). Indow and Koyazu (1960, 61) examined the existence of the induction by causing an interaction of one eye upon the other using Motokawa's method.

With regard to the phenomena of field in various perceived forms described above, Ogasawara (1961) points out that it is premature to propose a unified principle judging simply from the similarity of those phenomena. The time has not yet ripened for determining whether or not the process of light threshold, which led Yokose to induce a formula of potential field, and the process of displacement in the formation of a vector field, can be ascribed to the different aspect of the same process. Ogasawara warns that there exist such possibilities that the displacement phenomena can be ascribed to different mechanisms, and the results obtained with different indicators such as light threshold, CFF and electro-stimulation method cannot be adequate to the explanation of an identical process.

From the standpoint of Gestalt studies, one needs an examination as to whether measurement of a field is methodologically adequate or not. Motokawa and Obonai are not Gestaltists, and even Yokose who holds Gestalt theory as his fundamental principle calculates field forces by the operation of simple addition. Furthermore, with respect to the potential and vector fields, their whole process is composed by the sum of parts which were individually measured, and as a result, this is not an adequate method for Gestalt theory.

In this sense, although its precision is lower, the method utilized by Takagi (1927) and Sayanagi (1942) are more loyal to the observation of Gestalten. However, as Sayanagi pointed out, the structure of field occasionally takes different forms, depending on where the subject focuses.

When one attempts to measure a field, he has always to consider the interaction of two field forces, i.e., one under measurement and the other caused by the measurement itself. To control the latter is extremely difficult, and there is no complete method at present. Under such circumstances, a mutual comparison of the results obtained by several different methods would become a clue to a solution, not restricting ourselves to one general method. Since the process of field is not considered as static, one has to develop the investigation of its dynamic aspects. As a matter of fact, the studies by Uchiyama (1960a) and Obonai (1955) are progressing toward this line. Recently, Obonai, et al. attempted to compare the field effects obtained by several different indicators (e.g., the size of stimulus figure and the brightness of stimulus).

Fig. 10 From Obonai (1962)

Linear relations between logarithms of inspection-time (T) and half-decay-time (τ_0) after-effect or duration (t_0) of after-image.

between the inspection time of the figure and the change of the duration of after-effect (figural after-effects and after-image) or between the inspection time of the figure and the change of light threshold in the neighboring area of the figure can be expressed by the formula, $T_0 = KT$. Here T_0 refers to half-decay time, T refers to the duration of inspection time (Fig. 10). Based on these results, Obonai maintains that these three phenomena, e.g., figural after-effects, sensitivity and after-image cited above grasped the different aspects of a common psycho-physiological process.

The above is the outline of the research studies based on the field of visual form, through which the present authors believe they have been able to show the characteristics of perceptual studies in Japan. Though this has obviously been created by the conspicuous influence of Gestalt psychology, one may expect that they would contribute in the long run to a new development of Gestalt psychology, going beyond the traditional theory.

3 OBSERVATION OF MOVEMENT PHENOMENA.

In this section the authors will describe those researches that are based on observational and descriptive studies, as being directed toward the observation of dynamic aspects of form

Obonai, Tomiie and Kurashima (1961), using two parallel rectangles instead of two concentric circles, measured the effect of the size of outer rectangle upon the inner one. At the same time, they investigated the influence of the size of outer rectangle upon the brightness of inner rectangle. According to their results, a parallel relationship was observed in the change of the size and brightness of the inner rectangle, and it was proved that the perceived size and brightness were related to show the different aspects of an identical process. Obonai and Kawashima (1961) confirmed an accurate correspondence of the change of size of after-image during the course of time—enlargement and shrinking—and the alternation of the positive and negative phases of after-image. Obonai (1962) also confirmed that the relationship

perception (They will not refer here to such studies as constancies of speed and velocities).

In 1939, Ohtsuka made a observation based on the study on phenomenal identity by Metzger (1934). Through a vertical movement of a piece of white paper of a wide, beltlike shape, in which black lines as Fig. 11 were drawn, and subject, through the observation of the latter by a narrow horizontal slit set on the screen in front of him, perceived two black points which appeared from both sides of the slit, passed each other at the center, or collided and departed again. Ohtsuka, using various conditions of observation, attempted a conditional analysis of shooting and rebounding of the two points, and also investigated the distance of depth between the two points when they were superposed on one another. This experiment is closely related to the one which Michotte (1946) called 'la perception de la causalité'.

Ogasawara (1937, 38) observed the displacement of the path way of apparent movement by the influence of fixation point.

Ogawa (1938) studied the path of real movement of a light spot in a dark room, and observed that it was influenced by the spatial framework surrounding the stimulus, and especially determined by the main direction of the frame-work, and as a whole, the change of path coincided with the main direction. When one examines the path in an elevator room which suddenly goes up and down, it is strongly influenced when the room starts to move (1939).

Kamiyama (1941) observed the change of the path of real movement influenced by a neighboring figure, and especially by the edge of an angle figure.

One may consider such a change of path in connection with the similar facts observed in a static figure. A certain amount of time is needed for the establishment of the path. Under such circumstances, the circuit under way is occasionally influenced by the one that was already formed, and it undergoes a further change. Fujii (1943) moved a light spot along the line of square or of a triangle in a dark room, and observed a characteristic change as shown in Fig.12 a,b. This phenomenon can be explained to some extent by the hypothesis by Brown and Voth (1937). However, when one sets the spot 360° in rotation by means of a bracket and makes it draw a circle, a chestnut-shaped circuit is obtained. According to Brown et al., one could expect the light spot to go incide forming a whirl. However, this latter part is not well explained by the above hypothesis. The phenomenon would rather be a tendency to make a completion of the figure in which the circuit goes back to the starting point. Anyhow, this is a difficult phenomenon to give a clear explanation.

Apart from this, Tsuzuki (1938) examined the circuit of movement of a sound source in a sound proof room, and showed that it obtained a strong tendency to become a circle in each case when the sound source went along with a square or triangle.

Tanaka, Y. (1942, 44) induced a horizontal movement of several figures under various conditions of speed, and examined the change in shape. The circle came closer to

Fig. 11

The arrow indicates the direction of motion.
From Ohtsuka (1939)

an ellipse, and its short axis coincided with the direction of movement. In the regular triangle, the base line coinciding with the direction of movement shortened and the top

Fig. 12

Fig. 13

angle became acute. It showed the tendency that the back part became larger than the front part, though not forming an equilateral triangle (Fig. 13 a). Furthermore, when the speed was accelerated, each figure became an ambiguous figure closer to a circle, finally forming strips. The contour figure was harder to collapse than the solid figure, however, once it collapsed, the subject could not grasp the shape at all. Especially, an interesting point to notice is the case of making movements of two figures one after another: When one makes two isometric squares move along an identical path, they tend to fuse together when the speed of both figures is extremely fast, then it appears in two figures of broken lines when the speed goes down. In the case of the latter, the preceding figure appears much smaller than the succeeding one (Fig. 13b). This tendency appears remarkably even when the speed of both figures is less faster. This is also observed when both figures are not along the identical path, but separating at a certain distance.

Concerning those phenomena of movement described above, it is not easy to have a measurement. There are numerous experiments in which only the descriptions of the phenomena by subjects are arranged at most. However, among them there are not a few studies which arouse interests from the standpoint of Gestalt psychology. In a certain sense, it is considered that the exploration of new methods that develop along this kind of research would certainly make a clue for developing the Gestalt theory.

4. STUDIES ON FIGURAL AFTER-EFFECTS

Studies on this issue was once extremely active throughout the world. Above all, there has been noted the abundance of Japanese research. The reason for this may be due to the profound interests of Japanese researchers toward Gestalt psychology. Since the review concerning these researches was already given by Sagara and Oyama (1957), the present authors will present those researches that have appeared afterwards, supplementing some comments on the central issue of this study.

Researches after 1958

The relationship between figural after-effects and simultaneous illusions

Yokose (1955) compared the result of the well-known study of figural after-effects by

Fox (1951) with the theoretical values of his formula of vector field, and insisted that the displacement of figural after-effect occurs conversely to the field in the case of simultaneous illusions; however, that the point of the maximal displacement derived from his formula, coincides with that of Fox's result (so-called distance paradox). However, it is well known that the maximum point of the figural after-effect of concentric circles and that of simultaneous illusions under the same constellation do not always coincide. Ikuta (1956, 60) examined this point using a similar condition as Fox, and approximately confirmed Yokose's hypothesis that, when the exposure interval between the removal of IF and presentation of TF is very short, the maximum points of the amount of both illusions coincide, however, when the exposure interval becomes longer, the discrepancy between the values of maximum points becomes larger. According to Yokose's theoretical value, it is expected that, when TF is located extremely close to IF, the reversal of the direction of the displacement would occur; but, this was not observed by Ikuta's result.

Suto (1961) performed an experiment in which the effect of illusions, figural after-effect and time error were mutually compared under the situation of concentric circles and of the comparison of the length of straight lines, etc.

Mori, To. (1960) compared the amount of figural after-effect of concentric circles IF with that of a single circle, and demonstrated that the illusion of the former is not the simple addition of the latter.

Morinaga and Noguchi (1961) compared figural after-effect with simultaneous illusions using curved and tilted lines, and showed that the amount of figural after-effect was greater than that of simultaneous illusions. When they were tested in a competing situation, the figural after-effect predominated at first, then decreasing gradually, being replaced by the predominance of the simultaneous illusions.

The effect of brightness and color.

Yoshida (1960) using a solid figure as IF, demonstrated the change of the amount of figural after-effect depending on the ratio of the brightness between the figure and ground. He pointed out however, some exceptional cases in which the amount of figural after-effect does not always vary as a function of the contrast percent of brightness as proposed by Graham (1961), and suggested that one should consider the ratio of the apparent brightness, and qualitative differences of the effect of white, gray and black backgrounds, not only questioning the reflection ratio between the figure and ground.

Takagi and Ishikawa (1957) demonstrated the difference in figural after-effects depending on the difference of color of IF and TF, using the solid figure as IF.

By contrast, Oyama and Imai (1959) and Oyama (1960) demonstrated, using a concentric circle situation, that the difference of the brightness and color of IF do not cause the difference in the amount of figural after-effect. Oyama ascribes the discrepancy between his result and those by others to the difference of stimulus figures used, i.e., whether IF is a contoured figure or solid figure, or whether IF and TF osculate or not.

Apart from this, Nozawa (1958) examined the figural after-effect of contoured figure by means of the utilization time similar to the one used by Mori and Obonai (1956) described before, and obtained the result that when the color of IF contour and that of TF small spot

were the same (red, e.g.), TF at the outside of IF underwent an inhibitory effect, and inside TF underwent a facilitatory effect; when the color of TF was a contrast color (green, e.g.), this effect of TF underwent a reverse effect. He obtained a similar effect when the difference of brightness was based on achromatic color.

Takino, M. (1957), using a stereoscope, compared the figural after-effect of IF projected on one eye upon TF projected on the other or the same eye. According to his result, a difference in the amount of figural after-effect was not observed in either case when a solid figure or contour figure was used as IF under binocular vision. However, the difference was observed under monocular vision, i.e., the amount of figural after-effect was larger in the case of the former. Based on this result, he points out the role of retinal process in the occurrence of figural after-effect.

Temporal factors.

Yokoyama (1957) examined the techniques of measurement in regard to the decaying process of figural after-effects. After comparing the measurement of the effects at many successive trials with one inspection time with the repeated measurement of the sequence of one trial with one inspection time, he pointed out that some unnecessary factors were involved in the measurement by the former.

Yoshida (1957, 59) attempted a measurement of the temporal process of figural after-effects by the partition of 20-30 m. sec. of time, and confirmed that the growth and decay of after-effect undergo a change as a whole toward a certain direction forming a finite wave length, and measured the wave length and the change of its amplitude.

With regard to the figural after-effects of concentric circles, Nozawa (1960) confirmed that, even when the exposure time of IF was too short to permit perceiving (10 m. sec.), a normal figural after-effect is obtained if one presents IF five times before the presentation of TF.

To investigate the process which is not obtainable by the use of threshold measurement of light spot, Uchiyama (1960 b) examined the growing and decaying process of field under an extremely short successive presentation of IF and TF by means of the utilization time of TF. According to his result, when the exposure time for IF was 100 m. sec., and the corresponding perception of the figure did not occur, the field influencing upon TF was already observed, existing to such an extent over 800 m. sec. of time interval.

The measurement of the strength of field.

Kaneko and Obonai (1957) by adding the inspection process of IF to their measurement of figural induction, compared figural after-effects to simultaneous illusion, and studied the distance paradox phenomenon.

Mori and Obonai (1957) re-examined Nozawa's method (1956) and confirmed his results. They also compared these results to that of Kaneko and Obonai's method.

Nozawa (1958, 1961 b) clarified the process of growth and decay of the figural after-effect by the threshold measurement of light spot described above, and confirmed that it was based on the same nature of the process measured by the displacement of TF. He also described the necessity for examining the details of the change occurring under the condi-

tion when IF and TF were alternated which could not be obtained by the above-method. Nozawa (1961 a) also re-examined the experiment by Bevan (1951) by the same method, showing that the after-effect of vertical line as IF lessened when the separation from the figure was increased, and there was no phenomenon of distance paradox.

Shinjo (1957) and Adachi (1958) studied the figural after-effect of a circle by the measurement of CFF, and obtained the result in which a distance paradox was observed in the inside of the circle.

The phenomena of figural after-effects and Gestalt studies

From the standpoint of Gestalt psychology, the phenomenon of figural after-effects plays a significant role. Köhler once attempted to develop his hypothesis of isomorphism through the experiment of figural after-effects. Apart from his physiological studies, this investigation bears a possibility for clarifying the dynamic aspects of the figural process with time, proceeding a step further to the traditional studies by Gestaltists. Furthermore, it can be said that the fact that Köhler at last concretely demonstrated his idea of field in visual form through the study of figural after-effects attracted attention of Japanese researchers. The given field of visual form is measured by the displacement of TF as an indicator, and its characteristic is represented in the phenomenon of distance paradox. Köhler and Wallach (1944) considered that the distance paradox phenomenon is the fundamental principle of figural after-effects and insisted that all the figural after-effects can be explained in the application of this principle.

The phenomenon of distance paradox was measured and confirmed by Oyama (1954, 56), Motokawa (1957) and Ikuta (1956) under the situation of concentric circles, square and dot figures. However, Yoshida (1953) and Kogiso (1956) demonstrated that, in the measurement of the after-effects of contour figure of IF influencing upon the surrounding dotted figure of TF, the distance paradox was not always occurred. Nozawa (1953) measured the figural after-effects of curved line IF upon straight line TF with varying the distance between them, and showed that the after-effect occurred as a linearly decreasing function with the increase of the distance between them, and he opposed the Köhler-Wallach statement that the Gibson effect is due to the distance paradox based on the difference of distance between IF and TF in the center and peripheral parts of both lines.

The effect of contour upon the displacement of the neighboring points cannot be measured solely with respect to those neighboring points; to measure a relationship with others e. g., the examination of the effects of distance upon other points, or whether or not the point in question is located on the line with two other points is necessary. Morinaga (1952) obtained a different result of the after-effect using the same IF upon TF located at the same distance by the use of different criteria of measurement which the authors related above. Though giving a high evaluation to the theory of satiation by Köhler et al., Morinaga states the following criticism: 'At the present stage, the theory of satiation is only adequate to explain a certain limited part of the phenomenon. In the study of figural after-effects, there are some such cases in which one has to take into account the total configuration of preceding and succeeding figures, and we need a satiation theory of one step forward by which such configurations can be explained.'

It is worth noting that the application of the distance paradox by Köhler et al. is often treated as *ungestalt* thinking by many Japanese researchers. Furthermore, its physical and physiological models can only be adequate to an extremely simplified situation, and since the characteristics of field such as gradient of effect, etc., has not yet been specified, to apply this model directly to the fields of various figures is not possible at the present stage. It can hardly be considered that this model would overcome the methodological difficulty which we observed in the measurement of field.

With regard to the temporal characteristics of Gestalt in the figural after-effects, little explanatory power can be given to the theory of satiation. Ikeda and Obonai (1953) and Oyama (1953) clarified the temporal aspects of figural after-effects, and the studies thereafter (e.g., Yoshida, 1957, 59) brought up further delicate issues. Especially, Obonai (1955, cf p 137) attempted to understand the phenomena from the side of proactive and retroactive effects; however, a unified theory with respect to these processes has not yet been established.

To sum up: it can hardly be said that we have succeeded in theorizing with respect to figural after-effects starting with the theory of satiation. One can only point out, as was observed in the measurement of field, that Japanese researchers have contributed to the clarification of the process by supplementing the numerous data. It is to be hoped, however, that we will have a new methodology and synthesis of the results toward the complete solution of the phenomena.

Conclusion.

The studies on the process of visual forms have many difficult aspects; there are not a few cases in which one falls into methodological mazes if he hastens to get a conclusion. The founders of Gestalt psychology have hitherto discovered new aspects and problems of the phenomena with a new philosophy of science and with excellent observations. Japanese successors have developed these problems by new devices of methodology and accurate observations. In the retrospect of their methodology however, all have used the psychophysical method originated by Fechner as their basic method. This casts a doubt whether one can correctly demonstrate the Gestalt qualities proposed by Gestalt psychologists through the synthesis of the data. For the sake of the advancement of Gestalt psychology, isn't it necessary to have an establishment of a new methodology?

With regard to the studies of Japanese researchers, they have left such shortcomings as impossibility of the precise comparison of the data, since they have differed to some extent in their experimental conditions and methodological procedures when they investigate in parallel the same kind of phenomena. With the improvement of the above mentioned points, one may expect an establishment of the law based on much higher objectivity.

SUMMARY

In this review, the authors introduced Japanese studies of visual forms originated from Gestalt theory, illustrating a specific feature of these studies in the light of the present status of Gestalt psychology.

- i) Studies on the issues of so-called phenomenal distance was presented, and the authors described the

fundamental attitude of Japanese researchers toward isomorphism.

ii) The studies of the field in visual forms were presented, and the authors referred to their central issues. The physiological studies by Motokawa and mathematico-deductive approaches by Yokose rest on the extension of the issue (i), and have achieved significant contributions to Gestalt theory. The psycho-physiological studies by Obonai have a certain relationship to Gestalt theory, but it takes a different standpoint.

iii) Several studies which focussed on the dynamic aspects of movements were introduced.

iv) The most recent studies of figural after-effects were presented, and in parallel with this it was pointed out that Köhler-Wallach theory was not always oriented toward Gestalt thinking.

v) Throughout the above-mentioned theories, the significance of Japanese researches contributed to the development of Gestalt theory was discussed, and methodological retrospects necessary for the further advancement of the theories were pointed out.

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Shin Nozawa (野沢 晨 1922-), 1948, graduated from Univ. of Tokyo; 1962, Doctor of Letters, Hokkaido Univ.; 1948-1950, Assistant, Hokkaido Univ.; 1950-1957, Lecturer, Hokkaido Univ.; 1957-1960, Assistant Prof., Otaru College of Commerce; 1960-63 Assist. Prof., Univ. of Sacred Heart, Tokyo; 1963- Prof., Univ. of Sacred Heart.

Toshio Iritani (入谷敏男 1932-), B. A., Tokyo Univ. of Education, 1955; M. A., Tokyo Univ. of Education, 1957; Fellow, Clark Univ., 1957-1961; Graduate Student, Harvard Univ., 1958; Research Assistant, M. I. T., 1960 Research Associate., M. I. T., 1961; Ph. D., Clark Univ., 1961; Research Fellow, Univ. of Geneva, 1961-1962; Research Fellow, Tokyo Univ. of Education, 1962-1963; Instructor, Tokai Univ., Lecturer, Seijo Univ., 1963-