music" (p. 268). A bibliography of several hundred titles adds to the usefulness of a book which ought to be in the hands of every student of art and man.

Die Urgeschichte der Familie von Standpunkte der Entwickelungslehre. VON WAGNER. Biologisches Centralblatt, XIV. Bd. (1894), s. 65-71.

This is a review of a special chapter in the recent and important work of H. E. Ziegler, "Die Naturwissenschaft und die sozialdemokratische Theorie, etc. (Stuttgart, 1894),"— a work which may be styled "Principles of Sociology upon the Basis of Natural Science." Ziegler deals at considerable length with the primitive family and criticises sharply the well-known views of Morgan and his school, maintaining that the evidence for the family life of the anthropoids points to monogamy, and laying stress upon the psychological aspect of the question, — the instinctive nature of conjugal love, jealousy, love of parents for their children,— he holds that in all probability, even in primitive times, the family life of man was monogamous. In this he agrees with Westermarck. In zoölogical life Ziegler recognizes three stages of development in the sexual relations: 1. The lowest stage, among the sponges, echinoderms, etc., where the sperm-cells are emptied in the water and wander about seeking the eggs, which are likewise migrating. 2. The "Begattungspaarung," found among many worms, arthropods, molluscs, and among the vertebrates, with fishes, amphibia and reptiles, — where two individuals unite for the purpose of reproduction and soon after separate again. Here not seldom appears a sort of love-play, an instinctive wooing and fleeing, or a caressing which precedes the copulation. After copulation, the care of the offspring devolves upon only one sex, usually the female, more rarely, as is the case with the *Gastrosteus aculeatus* and the *Alytes obstetricans*, the male; the highest stage of the method of sexual reproduction entails permanent pairing and the sharing of both sexes in the bringing up of the young— the typical method among birds and mammals. Although the permanent pairing is not everywhere developed in the same manner, but there is everywhere a *psychical relation* between the paired individuals, recognition, dependence, instinctive impulse (love), jealousy. The sexual relation may be either polygamous or monogamous, and for man a monogamic sexual relation seems primitive and natural.

III. EXPERIMENTAL.

RECENT STUDIES OF AN INTERESTING OPTICAL ILLUSION.

(1) *Optische Urtheilstäuschungen.* MÜLLER-LYER. Du Bois-Reymond's Archiv, 1889, Supplement-Band, 263-270.

(2) *Ueber ein optisches Paradoxon.* BRENTANO. Zeitschrift für Psychologie, III., 1892, 349-358.

(3) *Optische Streitfragen.* LIPPS. *Ibid.*, 493-504.

(4) *Ueber ein optisches Paradoxon (Zweiter Artikel).* BRENTANO. *Ibid.*, V., 1893, 61-82.

(5) *Une nouvelle illusion d'optique.* DELBŒUF. Revue Scientifique, LI., 1893, 237-241.

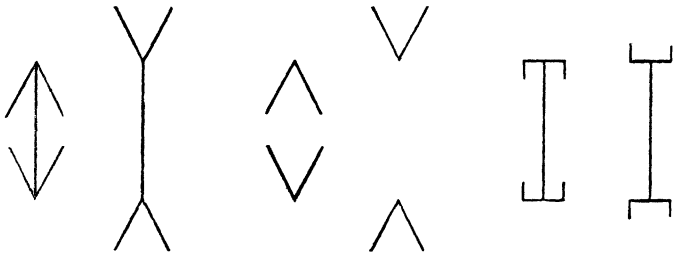
(6) *Les illusions d'optique.* BRUNOT. *Ibid.*, LII., 1893, 210-212.

(7) *Zur Lehre von den optischen Täuschungen.* BRENTANO. Zeitschrift für Psychologie, VI., 1893-94, 1-7.

(8) *Erklärung der Brentano'schen optischen Täuschung.* AUERBACH. *Ibid.*, VII., 1894, 152-160.

Reference may also be made here to the article of JASTROW in this JOURNAL, IV., 381, which contains matter upon this illusion.

The typical form of the illusion that is discussed in the papers above is shown in the first two figures below. The distance between the apexes of the angles in both cases is the same; it appears, however, considerably greater in *B* than in *A*.

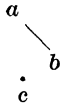


(1) This illusion was first mentioned, so far as the reviewer is aware, by Müller-Lyer, who described it with a number of others of similar character, in 1889, in an article reviewed soon after in this JOURNAL (III., 1890-91, 207). It seems worth while to recall this important paper, as it has been generally overlooked by subsequent writers. Müller-Lyer's explanation, which rests in part upon analogous effects observed in other figures, is that in judging such distances we involuntarily take into account not only the distances themselves, but also a portion of the surrounding spaces also. If, for example, figures *A* and *B* are completed by drawing vertical lines connecting the tips of the short oblique lines, the spaces enclosed would be smaller in *A* than in *B*.

(2) Brentano, without knowing of the work of Müller-Lyer, set about explaining the illusion himself. Of possible explanations he mentions four, but rejects the first three, namely: First, that the small added lines suggest traction and consequently compression in *A* and extension in *B;* second, that the addition of the small lines obscures the termination of the longer ones, which might be expected to result in overestimation in one case and underestimation in the other; and third, that we compare the lines by means of the muscular feelings resulting from running the eye along them and that the small added lines attract attention, which causes the eye to start and stop a little beyond the end of the lines in one case, and a little short of the end in the other. These Brentano rejects for the following reasons: The first, because curves (which do not suggest traction) may be put in place of the short lines without lessening the illusion, and also because the illusion persists, as in *C* and *D*, when there are no central lines to be stretched. The second, because where there are no central lines there can be no question about their termination [a plausible statement, but one that has little force, for an imagined line is almost certainly substituted for the actual one removed—a performance of which Brentano makes much in his

second paper]. The third, because the illusion ought to hold, and does not in figures *E* and *F*. [A remnant of the illusion does remain, as the author recognizes in later papers.]

Brentano's own explanation is based upon the well-known principle that small angles are relatively overestimated. By a series of simplifications of the typical figure, he finally reduces it to a single line and a point, as shown in figure G. The distance *ac* seems a little shorter than it actually is, and this is due in Brentano's opinion to an overestimation of the angle *bac* and an underestimation of the angle *abc*, the lines *ac* and *cb* being furnished by imagination. The overestimation and underestimation thus combine to produce a slight illusory rotation of the line *ab* about its middle point, which would in turn produce an apparent shortening of *ac*. This explanation, once admitted, is easily applied to the more elaborate cases.



G

Brentano's article concludes with the presentation of a group of figures devised to illustrate and further substantiate his explanation.

(3) The first half of the paper of Lipps is devoted to a question of after-images and need not be regarded here; the second half is a critique of Brentano's paper just noticed. Lipps urges, among other objections, that the overestimation, which Brentano assumes, ought to produce a bending of the short line and not a rotation of it; that the principle of the overestimation of small angles and the underestimation of large ones is not of universal validity, but depends on the attendant conditions, and that Brentano's appeal to it is, therefore, unjustified; and finally, that certain of Brentano's own figures (not to speak of others) cannot be explained by this principle, even if admitted. In support of these objections Lipps offers two striking figures of his own, in which the apparent reversal of Brentano's principle is very marked.

The explanation of Lipps (based upon principles worked out at length in his "Aesthetische Factoren der Raumanschauung," Helmholtz Festgruss, Hamburg and Leipzig, 1891) is somewhat as follows: The lines of such figures represent ocular movements. When these movements are free and favored, as they are by extending and expanding lines, the distances passed over seem longer; when they are hindered, as happens with lines of contrary direction, the distances seem short. In Lipps' words, "*Solche frei, 'siegreich' aus sich herausgehende Bewegung nun wird überall in ihrem Erfolg, d. h., hinsichtlich der weite des Weges, der durch sie durchmessen wird, überschatzt, die gehemmte überall unterschatzt.*" This explanation is evidently not very different from the third of the explanations rejected by Brentano, allowing for Lipps' somewhat picturesque way of stating it, and there is, perhaps, some justification for a general statement of this kind, but it is to be noticed that in the familiar illusions of filled and open spaces, hindered movements appear to give a lengthening and free movements a shortening.

(4) In his reply, Brentano takes up the objections of Lipps point by point. He first fortifies his general principle that small angles are relatively overestimated and large ones underestimated by citing further instances, insisting, however, on the relative character of such judgments and on the terms small and large instead of acute and obtuse; of two angles both of which are acute and both are overestimated absolutely, the larger may be less overestimated than the smaller, and so relatively underestimated. He admits readily enough that, like other psychological "laws," this principle

is dependent for its effect in part, at least, on other conditions, but holds that it is sufficiently general for the use which he makes of it. He is wholly successful in explaining the first of Lipps' figures, but (in the reviewer's opinion) only partially so with the second. His replies to Lipps' criticism of some of the figures from his first paper, while apt in the main, do not in every case carry full conviction that he himself is right. Some slight remnants of illusion persist occasionally, and these, he is forced to admit, may have another cause.

Brentano in his counter critique of the explanation of Lipps, denies the special feelings which the latter finds in connection with extending and contracting lines, and holds that if the short oblique lines suggest motion, as they might from their resemblance to arrow heads, it is motion in the contrary direction to that conceived by Lipps — motion outward in *A* above, and inward in *B*. On this supposition, he presents a number of figures, in which an effort is made to strengthen or weaken the illusion by drawing the arrows more fully, but with practically no effect upon it. [This point seems to the reviewer of little significance, for Lipps can certainly reply that the movement suggested by the picture of an arrow is not at all the same as that suggested by a free line; the two belong to totally different psychical levels.] Other figures in which the central line is extended beyond the summit of the angle in both *A* and *B*, with no weakening of the effect or even with a strengthening of it, are much more to the point. A final set attempts to place in opposition the principle of Lipps (in the case in which Brentano admits it) and the principle of the over and underestimation of angles. The figures show a decided triumph of the latter.

(5) Delbœuf was also moved to reply to Brentano's first paper. After giving a careful summary of it, reproducing all the important figures, he adds a number of figures of his own, showing the same or a similar illusion, but in a way not to be explained by Brentano's principle, nor, indeed, by that of Lipps. One of the most interesting of these is one in which the distances to be compared are marked by dots, and the direction of the oblique lines, which in this case do not touch the dots at all, is wholly changed without destroying the illusion. From these he goes on to develop a set of figures of which the type is shown in the diagram below. In this figure the distance from the right edge of the left ring to the left edge of the middle ring is exactly equal to the distance from that point to the right edge of the right ring.

Delbœuf's explanation is essentially the third of those rejected in Brentano's first paper, and not different in the main from that of Lipps. Such illusions are due "to the attraction that lines drawn on an even surface exercise upon the eye;" and again "to the attraction that figures, whatever their form, set at the ends of distances to be measured, exercise upon the eye."

(6) Brunot objects to the explanations of both Brentano and Delbœuf. His opinion is that "in order to judge the mean distance of two objects, the eye instinctively takes the distance of the centres of the figures of the two objects." It is easy to see, then, why *B* should seem longer than *A*, and why the middle ring should seem nearer to the right in Delbœuf's figure. By skillful modifications,

the author applies this same principle to a number of standard cases and, in a somewhat similar way, by taking the general direction of motion suggested by the oblique lines in Zöllner's figure, explains that also.

(7) Brentano's third paper is devoted to Delbœuf. He contends that even if Delbœuf's explanation be true, it does not exclude his own, and presents figures designed to show the two principles in opposing action, with the decided triumph of the latter. [Such figures are really inconclusive, for they would, from Delbœuf's point of view, show nothing more than that lines arranged in different ways are different in effect, which every one would admit.] Of much more force is his objection, supported by clever modifications of Delbœuf's diagrams, that Delbœuf's explanation does not fit his own most characteristic figures, but that they are to be explained in a wholly different way. As to this proper way he is in essential agreement with Brunot above. In concluding he admits that this source of illusion may have coöperated in his typical figures (*A* and *B*), but considers it of subordinate influence.

(8) Auerbach also throws over the explanations of both Brentano and Delbœuf and returns to that of Müller-Lyer, though the paper of that author was unknown to him till his own was in type. The illusion is, he says, "a consequence of the influencing of that which one ought to see by what he sees indirectly in addition," that is, in judging the length of the central line, we take into account the spaces (or imagined lines) to the right and left between the arms of the angles. If this is so, certain deductions are possible with reference to the length of arms, size of angles, and character of the lines forming the arms, etc., which the author finds verified by trial. The points giving the distances to be estimated are quite subordinate things in sensation as compared with the arms; they are simply "not present at all as independent points, they exist only as the places where the arms meet." When means are taken to give the points a certain independence (making them larger, or separating the arms a little from them or making the points different in color), the illusion is weakened, because vision (or attention, perhaps) is less inclined to take the side spaces into account. Variations upon the typical figure are given in support of the author's general view. A few quantitative tests were also made.

As residual from these eight papers, we have, besides a number of interesting observations and a large collection of variant figures, four explanations of the typical illusion. Müller-Lyer and Auerbach explain it by an involuntary regarding of the adjacent areas; Brentano chiefly by over and underestimation of angles; Lipps and Delbœuf by a tendency of the eye to overrun or to come short of the movement required to follow the lines with the eye; and Brunot by an established habit of treating figures or parts of figures as wholes and estimating distances from their centres. A still more general grouping is possible, if we assume, as seems probable, that the misjudgment of angles itself depends in the last analysis on eye movements. Müller-Lyer, Auerbach and Brunot depend on a synthetic tendency in vision; Brentano, Lipps and Delbœuf on a motor tendency. It is almost certain that several causes conspire to produce the illusion in question, simple as it appears, but in what degree each is present cannot be told from present information. The answer to that question must await a thorough quantitative study of the subject.