

## WEEKLY EVENING MEETING,

Friday, April 25, 1879.

THE DUKE OF NORTHUMBERLAND, D.C.L. LL.D. the Lord Privy Seal,  
President, in the Chair.

FRANCIS GALTON, Esq. F.R.S. M.R.I.

*Generic Images.\**

IN the pre-scientific stage of every branch of knowledge, the prevalent notions of phenomena are founded upon general impressions; but when that stage is passed and the phenomena are measured and numbered, many of those notions are found to be wrong, even absurdly so. This is the case not only in professional matters, but in those with which everyone has some opportunity of becoming acquainted. Think of the nonsense spoken every day about the signs of coming weather, in connection, for example, with the phases of the moon. Think of the ideas about chance, held by those who are unacquainted with the theory of probabilities; think of the notions on heredity, before the days of Darwin. It is unnecessary to multiply instances; the frequent incorrectness of notions derived from general impressions may be assumed, and the object of the following discourse is to point out a principal cause of it.

Attention will be called to a source of error that is inherent in our minds, that vitiates the truth of all our general impressions, and which we can never wholly eliminate except by separating the confused facts upon which our general impressions are founded, and treating them numerically by the regular methods of statistics. It is not sufficient to learn that an opinion has been long established or held by many, but we must collect a large number of instances to test that opinion, and numerically compare the successes and the failures.

Our general impressions are founded upon blended memories, and these latter will be the chief topic of the present discourse. An analogy will be pointed out between these and the blended portraits

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\* This memoir is in part an abstract, and in small part an extension of the discourse that was actually delivered. The greater part of the subject matter has been treated more fully in the July number of the 'Nineteenth Century,' but the autotype illustrations which are given here are not inserted there.

first described by myself a year ago under the name of 'Composite Portraits,'\* and specimens of the latter will be exhibited. Then the cause will be explained that renders the mind incompetent to blend memories together in their just proportions.

The physiological basis of memory is simple enough in its broad outlines. Whenever any group of brain elements has been excited by a sense impression, it becomes, so to speak, tender, and liable to be easily thrown again into a similar state of excitement. If the new cause of excitement differs from the original one, a memory is the result. Whenever a single cause throws different groups of brain elements simultaneously into excitement, the result must be a blended memory.

We are familiar with the fact that faint memories are very apt to become confused. Thus some picture of mountain and lake in a country which we have never visited, often recalls a vague sense of identity with much we have seen elsewhere. Our recollections cannot be disentangled, though general resemblances are recognized. It is also a fact that the memories of persons who have great powers of visualising, that is, of seeing well-defined images in the mind's eye, are no less capable of being blended together. Artists are, as a class, possessed of the visualising power in a high degree, and they are at the same time pre-eminently distinguished by their gifts of generalization. They are of all men the most capable of producing forms that are not copies of any individual, but represent the characteristic features of classes.

There is then, no doubt, from whatever side the subject of memory is approached, whether from the material or from the mental, and, in the latter case, whether we examine the experiences of those in whom the visualising faculty is faint or in whom it is strong, that the brain has the capacity of blending memories together. Neither can there be any doubt that general impressions are faint and perhaps faulty editions of blended memories. They are subject to errors of their own, and they inherit all those to which the memories are themselves liable.

Specimens of blended portraits will now be exhibited; these might, with more propriety, be named, according to the happy phrase of Professor Huxley, "generic" portraits. The word generic presupposes a genus, that is to say, a collection of individuals who have much in common, and among whom medium characteristics are very much more frequent than extreme ones. The same idea is sometimes expressed by the word typical, which was much used by Quételet, who was the first to give it a rigorous interpretation, and whose idea of a type lies at the basis of his statistical views. No statistician dreams of combining objects into the same generic group that do not cluster towards a common centre, no more can we compose generic

\* 'Journal of the Anthropol. Institute' (Nov. 1878); or, 'Nature' (p. 97, 1878).

portraits out of heterogeneous elements, for if the attempt be made to do so the result is monstrous and meaningless.

It might be expected that when many different portraits are fused into a single one, the result would be a mere smudge. Such, however, is by no means the case, under the conditions just laid down, of a great prevalence of the mediocre characteristics over the extreme ones. There are then so many traits in common, to combine and to reinforce one another, that they prevail to the exclusion of the rest. All that is common remains, all that is individual tends to disappear.

The first of the composites exhibited on this occasion is made by conveying the images of three separate portraits by means of three separate magic lanterns upon the same screen. The stands on which the lanterns are mounted have been arranged to allow of nice adjustment. The composite about to be shown is one that strains the powers of the process somewhat too severely, the portraits combined being those of two brothers and their sister, who have not even been photographed in precisely the same attitudes. Nevertheless, the result is seen to be the production of a face, neither male nor female, but more regular and handsome than any of the component portraits, and in which the common family traits are clearly marked. Ghosts of portions of male and female attire, due to the peculiarities of the separate portraits, are seen about and around the composite, but they are not sufficiently vivid to distract the attention. [This effect is well seen in the composite of Napoleon in the autotype photographic plate here annexed.] If the number of combined portraits had been large, these ghostly accessories would have become too faint to be visible. [See the very faint indication of the various ears in the co-composite of the criminals.]

The next step is to compare this portrait of two brothers and their sister which has been composed by optical means before the eyes of the audience, and concerning the truthfulness of which there can be no doubt, with a photographic composite of the same group. This latter has been made by the process described in the memoir already referred to, and which is analogous to that by which memories are blended. The portraits to be combined are adjusted very carefully one in front of the other, so that the features shall be as exactly superimposed as is possible from the nature of the case. [This is done by making two pin-holes in the bottom of one of them, then placing it on each of the others in succession when held before a strong light, so that the two are seen in transparency, and pricking each through the same pin-holes. These pricks serve as fiducial marks for their subsequent arrangement.] The packet of adjusted portraits is next placed in front of the object-glass of a photographic camera, and the portraits are then removed one by one. Thus the impression left on the sensitised plate is that of a succession of different portraits thrown one on the top of another on the same part of it. The result is a composite portrait. A photographic composite prepared in this way from the portraits of the two brothers and sister is now placed in

a fourth magic lantern with a brighter light behind it, and its image is thrown on the screen by the side of the composite produced by direct optical superposition. It will be observed that the two processes lead to almost exactly the same result, and therefore the fairness of the photographic process may be taken for granted. However, two other comparisons will be made for the sake of verification, namely, between the optical and photographic composites of two children, and again between those of two Roman contadini.

The composite portraits that will next be exhibited are made by the photographic process, and it will now be understood that they are truly composite, notwithstanding their definition and apparent individuality. Attention is, however, first directed to a convenient instrument not more than 18 inches in length, which is, in fact, a photographic camera with six converging lenses and an attached screen, on which six pictures can be adjusted and brilliantly illuminated by artificial light. The effect of their optical combination can thus be easily studied; any errors of adjustment can be rectified and the composite may be photographed at once.

It must not be supposed that any one of the components fails to leave its due trace in the photographic composite, much less in the optical one. In order to allay misgivings on the subject, a small apparatus is laid on the table together with some of the results obtained by it. It is a cardboard frame, with a spring shutter closing an aperture of the size of a wafer, that springs open on the pressure of a finger, and shuts again as suddenly when the pressure is withdrawn. A chronograph is held in the other hand, whose index begins to travel the moment the finger presses a spring, and stops instantly on lifting the finger. The two instruments are worked simultaneously; the chronograph checking the time allowed for each exposure and summing all the times. It appears from several trials that the effect of 1000 brief exposures is practically identical with that of a single exposure of 1000 times the duration of any one of them. Therefore each of a thousand components leaves its due photographic trace on the composite, though it is far too faint to be visible unless reinforced by many similar traces.

The composites now to be exhibited are made from coins or medals, and in most instances the aim has been to obtain the best likeness attainable of historical personages, by combining various portraits of them taken at different periods of their lives and so to elicit the traits that are common to each series. A few of the individual portraits are placed in the same slide with each composite to give a better idea of the character of these blended representatives. Those that are shown are (1) Alexander the Great, from six components; (2) Antiochus, King of Syria, from six; (3) Demetrius Poliorcetes, from six; (4) Cleopatra, from five. Here the composite is as usual better looking than any of the components, none of which however give any indication of her reputed beauty; in fact, her features are not only plain but to an ordinary English taste are simply

hideous. (5) Nero, from eleven; (6) A combination of five different Greek female faces, and (7) A singularly beautiful combination of the faces of six different Roman ladies, forming a charming ideal profile.\*

My cordial acknowledgment is due to Mr. R. Stuart Poole, the learned curator of the coins and gems in the British Museum, for his kind selection of the most suitable medals and for procuring casts of them for me for the present purpose. These casts were, with one exception, all photographed to a uniform size of four-tenths of an inch between the pupils of the eyes and the division between the lips, which experience shows to be the most convenient size on the whole to work with, regard being paid to many considerations not worth while to specify in detail. When it was necessary the photograph was reversed. These photographs were made by Mr. H. Reynolds; I then adjusted and prepared them for taking the photographic composite.

The next series to be exhibited consists of composites taken from the portraits of criminals convicted of murder, manslaughter, or crimes accompanied by violence. There is much interest in the fact that two types of features are found much more frequently among these than among the population at large. In one, the features are broad and massive, like those of Henry VIII., but with a much smaller brain. The other, of which five composites are exhibited, each deduced from a number of different individuals, varying four to nine, is a face that is weak and certainly not a common English face. Three of these composites, though taken from entirely different sets of individuals, are as alike as brothers, and it is found on optically combining any three out of the five composites, that is on combining almost any considerable number of the individuals, the result is closely the same. The combination of the three composites just alluded to will now be effected by means of the three converging magic lanterns, and the result may be accepted as generic in respect of this particular type of criminals.

The process of composite portraiture is one of pictorial statistics. It is a familiar fact that the average height of even a dozen men of the same race, taken at hazard, varies so little, that for ordinary statistical purposes it may be considered constant. The same may be said of the measurement of every separate feature and limb, and of every tint, whether of skin, hair, or eyes. Consequently a pictorial combination of any one of these separate traits would lead to results no less constant than the statistical averages. In a portrait, there is another factor to be considered besides the measurement of the separate traits, namely, their relative position; but this, too, in a sufficiently large group, would necessarily have a statistical constancy. As

\* The accompanying illustrations have been *photographically* transferred (on a reduced scale) to stone, and lithographed by the Autotype Company, 36, Rathbone Street. They are very successfully done, and are nearly equal in clearness to the originals. The composite of the Roman ladies comes out unfortunately a little too dark, and some of the beauty of the original is thereby lost.

a matter of observation, the resemblance between persons of the same "genus" (in the sense of "generic," as already explained) is sufficiently great to admit of making good pictorial composites out of even small groups, as has been abundantly shown.

Composite pictures are, however, much more than averages; they are rather the equivalents of those large statistical tables whose totals, divided by the number of cases, and entered in the bottom line, are the averages. They are real generalizations, because they include the whole of the material under consideration. The blur of their outlines, which is never great in truly generic composites, except in unimportant details, measures the tendency of individuals to deviate from the central type. My argument is, that the generic images that arise before the mind's eye, and the general impressions which are faint and faulty editions of them, are the analogues of these composite pictures which we have the advantage of examining at leisure, and whose peculiarities and character we can investigate, and from which we may draw conclusions that shall throw much light on the nature of certain mental processes which are too mobile and evanescent to be directly dealt with.

A generic mental image may be considered to be nothing more than a generic portrait stamped on the brain by the successive impressions made by its component images. Professor Huxley, from whom, as already mentioned, the apt phrase of "generic" has been borrowed, has expressed himself to a similar effect in his recent life of Hume (p. 95). I am rejoiced to find that, from a strictly physiological side, this explanation is considered to be the true one by so high an authority, and that he has, quite independently of myself, adopted a view which I also entertained, and had hinted at in my first description of composite portraiture, though there was not occasion at that time to write more explicitly about it.

In my original memoir on composite portraits a phrase was used which was written with some hesitation, and which I have since quoted, but which it will now be the object to examine and amend. The words were: "A composite portrait represents the picture that would rise before the mind's eye of an individual who had the gift of pictorial imagination in an exalted degree." The question to be considered is whether this is a strictly correct statement. If the eye of such a man were placed in the position of the object-glass of a camera when taking the composite portraits, and if we suppose him free from mental bias, would the resulting picture in his brain be identical with the composite? (Here again we are supposed to ignore such small differences as may exist between the photographic and optical composite.) The answer is distinctly, No. Suppose that one of the portraits has been exposed for a period fifty times as long as any of the rest, in the photographic composite the effect would be the same as that of fifty coats of transparent pigment, but in the mental composite it would have nothing like that importance; and therein lies the source of error in our mental impressions that it is the object of

this discourse to point out. Exceptional occurrences leave an impression on the brain of far greater strength, and conversely habitual occurrences leave one of far less strength, than their numbers warrant. The physiological effect of prolonged action, or of reiteration, is by no means in direct proportion to the length of the one or to the frequency of the other. The magnitude of the "subjective" effect never bears a simple, direct proportion to the magnitude of the "objective" cause. The relation between them, in a very wide circle of physiological phenomena, is expressed by the law of Weber or Fechner, which it is sufficient for our present purposes to state in its original form, because it is exceedingly simple, and is at the same time sufficiently correct for all except extreme cases, in which certain alien considerations begin to exert a sensible influence. According to this law (sensation = log. stimulus) the more the senses are stimulated, the more is their discriminative power blunted. If a room is lighted by only a single candle, and a second one is brought in, the eye feels a certain increase of light. Now, if 1000 candles had originally been in the room, it would require the addition, not of one candle, but of another 1000 candles, to produce the sense of a similar increase. In order that the magnitude of any sensation should increase by a series of equal steps, the magnitude of the stimulus that causes it must increase by successive multiples. The one follows an arithmetic progression, the other a geometric one.

A few simple experiments will illustrate this. Five perfectly black cards are taken, each of the size of half a sheet of note paper; also a sheet of perfectly white note-paper. The latter is torn in two, and one half is laid upon card No. 5, which it exactly covers. The remaining half is carefully folded down its middle, and torn in two, and one portion is laid on card No. 4, of which it exactly covers one half. The same process is continued, so that card 3 is covered to the extent of one quarter of its surface, 4 to one-eighth, and 5 to one-sixteenth, and there is a remnant of one-sixteenth, which may be thrown away. To avoid fractions, let us count the quantity of white on the black card No. 1 as one, then that on Nos. 2, 3, 4, 5 will be as two, four, eight, and sixteen respectively, the latter standing for pure white. The next step is to cut the portions of paper into shreds, and to scatter them uniformly over their respective cards. In the specimens now upon the table this has been already done, and the shreds are pasted down. The effect, when they are looked at from a little distance with the eye not focussed too sharply upon them, is that of a series of greys, which appear to be separated by equal intervals of tint from one another, although we know that the differences in the amount of white material is by no means uniform. The eye judges card No. 3, which contains four portions of white, to be of a medium tint between Nos. 1 and 5; but, as No. 1 contains one portion, and No. 5 contains sixteen portions, the medium quantity of white is really eight and a half (because  $\frac{1+16}{2} = 8\frac{1}{2}$ ), and this

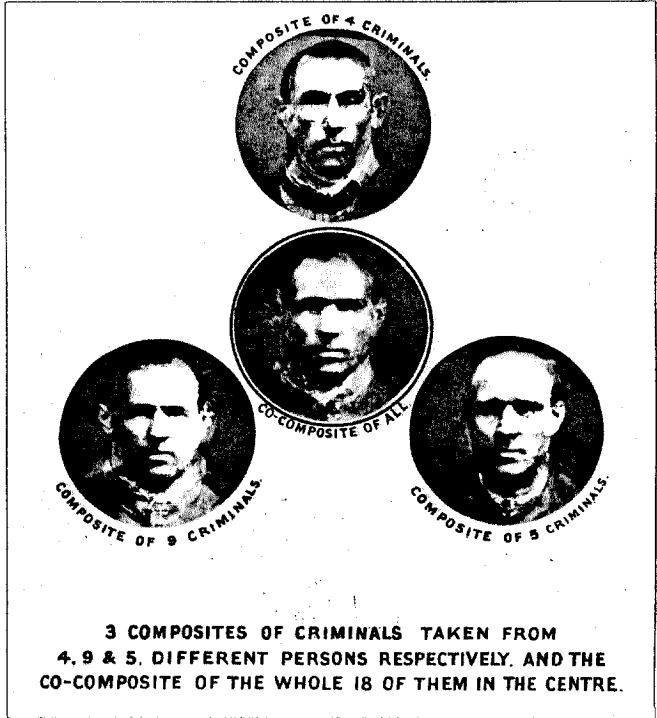
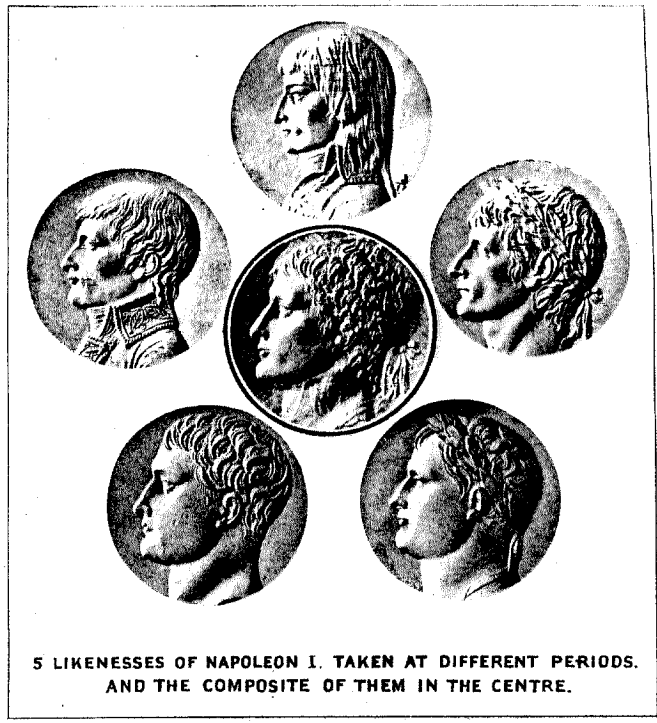
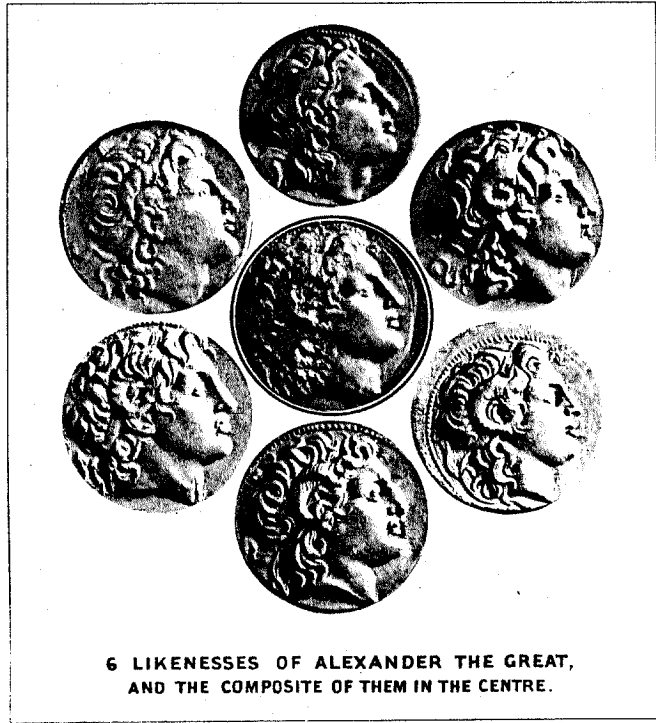
is somewhat lighter even than card No. 4, which contains eight portions.

The same relation is true as regards sound. The difference of noise made by the fall of one shilling or of two shillings is not readily perceived, unless we are specially attending to it. Neither is the difference readily perceived between firing a 38-ton gun or two such guns from the turret of an ironclad, as was proved by the evidence in the late terrible accident on board the 'Thunderer.' Here is an apparatus of eight arms that may be lifted in succession and then let drop by turning a cylinder like that of a musical snuff-box. Each arm as it falls makes the same amount of noise. The catches are so arranged on the cylinder that the effect of turning it is to lift and let drop first one arm, then two arms simultaneously, then four, then all the eight. It will be observed that the apparent loudness of sound increases by equal intervals, and not at all as the numbers 1, 2, 4, 8.

Finally, two large revolving discs are exhibited under illumination. They are painted black and white in five concentric rings, with a perfectly black centre. In the first of the two discs, counting pure white as 5, the proportions of white to black in the successive rings are as 1, 2, 3, 4, 5, thus forming an arithmetical series. On turning the wheel, the eye utterly repudiates the effect as being that of a series of equally graduated tints, and yet the actual quantities of white form such a series. In the second of the two discs, the proportions of white to black in the successive rings follow Weber's law, or rather, Delbœuf's modification of it; the disc is, indeed, a reproduction of that described in Delbœuf's memoir. On revolving it, the eye at once recognizes the effect of a beautifully exact gradation; but in order to show this properly, the illumination has to be very carefully adjusted.

These illustrations of Weber's law are submitted in order to make manifest the great difference between the progressive increase of objective causes and that of their corresponding subjective effects, and to afford a *prima facie* evidence of the small influence likely to be exercised upon a generic mental image by a repetition of similar impressions. I do not venture as yet to assert that the law of Weber applies to this case, but the probability of its doing so is pointed out, and also the fact that the true law, whatever it may be, is certainly in some sense analogous to that of Weber. According to that law, if it required a tenfold experience or a tenfold period of exposure to produce a mental impression that should contribute to the composition of a blended image in twice as large a degree as a single experience or a single period of exposure, it would require a hundredfold experience or exposure to result in a threefold contribution.

The law of Weber has a further application to the topics under consideration. When the comparison was made a short time back between the blended image in the artist's brain and the photographic composite, it was stated that a fiftyfold period of exposure would produce in the latter case a fiftyfold effect, in the sense of being



equivalent to fifty layers of transparent colour. It was not intended to imply by this that the tint *as estimated by the eye* would be fifty times increased in depth. The law of Weber tells us that it would not be anything like so deep as that in appearance. Objectively speaking the tints of a photographic composite are correct, but subjectively speaking they are not. Hence there are three degrees of accuracy, respectively corresponding to the three processes of (1) numerical averages, (2) of optical or photographic composites, and (3) of mental images. Numerical averages are absolutely correct in every sense. Optical and photographic composites are objectively correct, but subjectively incorrect. Mental images are objectively incorrect, and they are subjectively incorrect in a double degree. Supposing Weber's law to be applicable throughout, a white mark in any one of the portraits would leave a mark on the optical or photographic composite whose *apparent* intensity would vary as the logarithm of the time of photographic exposure, but the intensity of the white mark that it would leave on the mental composite would be only as the logarithm of that logarithm.

Even this result is much too leniently calculated. It is based on the supposition that the visualising power is perfect, the memory absolutely retentive, and the attention perfectly free from bias. This is very far from being the case. Again, some of the images in every presumed generic group are sure to be aliens to the genus and to have become associated to the rest by superficial and fallacious resemblances, such as common minds are especially attentive to. Seeing, as we easily may, what monstrous composites result from ill-sorted combinations of portraits, and how much nicety of adjustment is required to produce the truest possible generic image, we cannot wonder at the absurd and frequent fallacies in our mental conceptions and general impressions.

Our mental generic composites are rarely defined; they have that blur in excess which photographic composites have in a small degree, and their background is crowded with faint and incongruous imagery. The exceptional effects are not overmastered, as they are in the photographic composites, by the large bulk of ordinary effects. Hence, in our general impressions far too great weight is attached to what is strange and marvellous, and experience shows that the minds of children, savages, and uneducated persons have always had that tendency. Experience warns us against it, and the scientific man takes care to base his conclusions upon actual numbers.

The human mind is therefore a most imperfect apparatus for the elaboration of general ideas. Compared with those of brutes its powers are marvellous, but for all that they fall vastly short of perfection. The criterion of a perfect mind would lie in its capacity of always creating images of a truly generic kind, deduced from the whole range of its past experiences.

General impressions are never to be trusted. Unfortunately when they are of long standing they become fixed rules of life, and assume

a prescriptive right not to be questioned. Consequently, those who are not accustomed to original inquiry entertain a hatred and a horror of statistics. They cannot endure the idea of submitting their sacred impressions to cold-blooded verification. But it is the triumph of scientific men to rise superior to such superstitions, to devise tests by which the value of beliefs may be ascertained, and to feel sufficiently masters of themselves to discard contemptuously whatever may be found untrue.

[F. G.]

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