LETTERS TO THE EDITOR.

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Measurement of Resemblance.

At the distance of a few scores of paces the human face appears to be a uniform reddish blur, with no separate features. On a nearer approach specks begin to be seen, corresponding to the eyes and mouth. These gradually increase in distinctness, until at about thirty paces the features become so clear that a hitherto unknown person could thereafter be recognised with some assurance. There is a similarity in the history of obelisks to that of distance in confounding human faces than by watching soldiers at a review. Their dress is alike, their pose is the same, the light falls upon them from the same direction, and they are often immovable for a considerable time. It is then noticeable how some faces appear indistinguishable at distances where great diversity is apparent in others, and the rudely-defined idea will be justified that the distance at which two faces are just distinguishable for one another might serve as a trustworthy basis for the measurement of resemblance. The same may be said of obscurity, of confusion, and of turbidity of light; but in the present case I shall confine myself almost wholly to the effects of distance under the conditions of ample light and a transparent atmosphere. Beyond this I shall say nothing, except in one paragraph almost at the end.

The measurement of resemblance has, of course, to be taken into account. This is of much less importance in living persons than in portraits, because the differences in scale of the adult human face are not very great, whereas those in photographs and paintings—ranging as they do between miniatures and life-sized portraits—are so. It is necessary to adopt a method based on some specific dimension. That which I use is the vertical distance between the middle of the line that joins the pupils and the parting of the lips. It is unaffected by head-dress or by the thickness of the hair on the top of the head, while its lower boundary can be located in a bearded face more accurately than the chin. I call this u. If the portraits have different units, they are distinguishable as u and u'. If d and d' be the critical distances at which distinguishability first occurs, then u/d and u'/d' are necessarily the same; I want them to serve as dimensions of distinguishability; but as u is very much smaller than d, this fraction would always be a decimal preceded by one or two zeros. Therefore I take the index of distinguishability, which I will call N, as \( u = \frac{1000}{u} \). It is, however, convenient to measure u and d by different scales; u in millimetres, and d in centimetres, distinguishing it as \( u_{d} \). Then \( N = \frac{100}{u_{d}} \).

Of course, N could be expressed by the arc or angle of which \( u_{d} \) is the chord, but it would be a roundabout method, as angles could not be measured directly without special and troublesome apparatus. I find it very convenient for my purposes to employ a nomenclature for chords based on that of the metrical system, d, the distance, being the radius or "rad." So a chord of 1000 becomes a centrad, and that of 1000 a "milliard." A centrad is the chord of \( \pi/4 \) radian; a milliard of minutes of a degree is a trifle larger than the apparent diameter of the sun or moon. It is equal to the apparent size of one-tenth of an inch at 10 inches distance from the eye, which is a convenient distance for reading small type. A milliard which subtends between three and four minutes of a degree, and a centrad 1 1/4 inches at 10 inches, is an angular interval as can usually be detected in photographs without scrutiny, though a normal eye is able to distinguish one-third or even one-fourth of that interval between sharply defined objects.

Distinguishability is only an approximate measure of resemblance, for it depends more on the scale of the distinguishing features than on the amount of difference of those features. This peculiarity is well exemplified, though greatly exaggerated, by what is seen in the time-tables hung up by railway stations. From across the road, say, they all appear alike as a shade of uniform grey. On approaching nearer, differences are observed in the headlines; nearer still, varieties in paragraphing come into sight, and at a reading distance the figures are all simul-

A strong likeness in small details may so dominate the perception that a want of likeness in larger features is overlooked. Here lies the whole trouble of the art of misleading by photographs. With close-up features at one distance the portraits appearing more unlike when removed further off, and the small details cease to be visible. Extreme cases of partial likeness, whether in contour or in detail, would, of course, be noted and allowed for. With these exceptions the index of distinguishability appears to be a fair, even, as I think, a close, approximation to an index of resemblance when the quality of the observed likeness is recorded by appropriate letters, as will be described later on.

The observational value of distinguishability lies in its asking a simple question which different persons would answer in the same way, when they had become familiar with the method. On the other hand, likeness includes mutual suggestibility, a highly complex perception dependent on the mind of the observer, and consequently differentiated differently by different observers, as is notoriously the case.

The apparatus I now use with ordinary photographs acts very well, but I wasted much time before I contrived if, and more before sending it to be made in a workmanlike manner. I think it still could be improved, so I will describe, not my own, which I made for my life-models, but the Baker 240 High Holborn, but such as I should order if I required another one.

It is a long, thin, light box or framework 6\( \frac{1}{2} \) feet (2 metres) long, 10 inches (25 centimetres) wide, and 2 inches (5 centimetres) deep, which admits of being divided for sake of portability. It stands on two folding supports 2\( \frac{1}{2} \) feet apart, which fold back when out of use; when in use they can be clamped to any ordinary table. These raise the long box in a sloping position, the end towards the eye being the most convenient for a chair, but the further end being lower, because it is easiest to look somewhat downwards. Two rollers, 4 and 6 (Figs. 1 and 2), run independently on a horizontal axis at one end of the box, and two corresponding ones, a and b (Fig. 2) at the other end. The box is harnessed in front to a tape graduated in centimetres, which passes over and round a, back to and around 4, and thence forwards to the back of the sledge. (By inadvertence the path of the tape between the lower margins of 4 and 6 has been omitted in Fig. 1. The reader might put it in pencil.) A similar sledge and tape is adapted to 2 and 3. The tapes tie half an inch above the box (Fig. 1), and can be manipulated by the hands severally, so either or both sledge can be easily pulled either backwards or forwards while sitting in the chair, and their distance from the rollers may be easily varied in some range of degrees. (A winch and handle are superfluous.) The photos are mounted on two easily detachable standards (Figs. 1, 2), with clips at the bottom to hold them (not shown in the diagram), and standing on circular bases. These fit quite loosely into hollows in the tops of the sledge. The standards can be lifted out, the photographs inserted, and the whole replaced with perfect ease. The circularity of the bases of the standards enables either of them to be set a little askew, which is convenient when the broad, full face of one photo appears to be compared with the narrowed, three-quarter face of another. A board stands vertically across 4 and 6, and above them as a bridge. An eye-slit of half an inch width runs below its upper edge (Figs. 1, 2, 3, 4), through which the photos are viewed, and from which the distances of the sledge are reckoned. A ledge 1 inch below the eye-slit (Fig. 4), with a parapet a little less than 1 inch high, forms a long,
The procedure adopted after many trials was to measure the \( n_m \) of each portrait to the nearest half-millimetre and to write it below. Then to mount the two portraits, each on a separate sledge if their facial units differed, otherwise on the same. When they differed, the facial unit of the one about to be used for \( d_e \) was distinguished as \( n_m \), the other was in brackets as \( (n_m) \). Next, after referring to the above table, to send them to their respective \( d_e \) for \( N=5 \), to consider them carefully, and to note the result. Then to do the same for \( N=10 \), and so on, until the eye became familiarised with the differences between the portraits.

Finally, guided by these provisional attempts, to fix on the suitable index and letter, adding such remarks as may seem wanted.

I became gradually more consistent in judgment, as ascertained by comparing the results on different days, but have felt all along that it would conduces to trustworthiness if two or more companions worked together and criticised one another, and recorded their common verdict.

A very brief example will suffice. Usually an entry consists of more lines followed by general remarks.

Two Sisters, Registers (so and so).

\[ n_m = 85 \quad (n_m = 90) \]

<table>
<thead>
<tr>
<th>( N )</th>
<th>( d_e )</th>
<th>Character of likeness</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
<td>170</td>
</tr>
<tr>
<td>5</td>
<td>85</td>
<td>( b )</td>
</tr>
<tr>
<td>5</td>
<td>85</td>
<td>Nearly ( b )</td>
</tr>
<tr>
<td>After trials</td>
<td>115</td>
<td>Just ( b )</td>
</tr>
</tbody>
</table>

Accept \( N(h) = \frac{580}{115} = 74 \).

I will add a few words on dealing with mistakes caused through obscurity or other hindrances to clear vision. I prepared test cards, each containing numerals printed in different types, and, having ascertained by experiment the value of \( d_e \) for each kind of type when just able to read it in a clear light, wrote that value boldly by its side. An appropriate test card was put by the side of the portraits, and at the time when the portraits themselves were just mistaken, the written \( d_e \) of that row of figures which were just unreadable, was noted. The value of \( d_e \) remains constant whatever be the character or amount of the optical hindrance. If the hindrance increases, the portraits and the accompanying test card must be brought nearer to the eye. They will increase simultaneously in legibility. The written \( d_e \) will always show what the \( d_e \) would be in a clear light.

The applications of the process are numerous, as must always be the case when a hitherto vague perception is brought within the grip of numerical precision. To myself it has the especial interest of enabling the departure of individual features from a standard type to be expressed numerically. The departure may be from a composite of their race, or from a particular individual. The shortcomings of a pedigree animal from a highly distinguished ancestor could be measured in this way. Many other examples might be given.

I must not conclude without expressing gratitude for answers to a request, published by me some time again in *Nature*, for waste photographs from amateurs and professionals. If I be allowed to mention a single name, it would be that of Mr. Norman Campbell, whose photographs have been eminently serviceable.

**FRANCIS GALTON.**

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**Models of Atoms.**

An interesting and instructive variant of Prof. Mayer's experiment with floating magnets, which has been used so much to illustrate the structure of atoms, is to do away with the *centripetal* magnetic force and to arrange that its place be taken by forces arising from capillarity. This is managed as follows: