

THE PERCEPTION OF NUMBER

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The perception of number by J. Franklin Messenger

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J. FRANKLIN MESSENGER

**THE PERCEPTION
OF NUMBER**

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THE PERCEPTION OF NUMBER.

BY
J. FRANKLIN MESSENGER, M.A.

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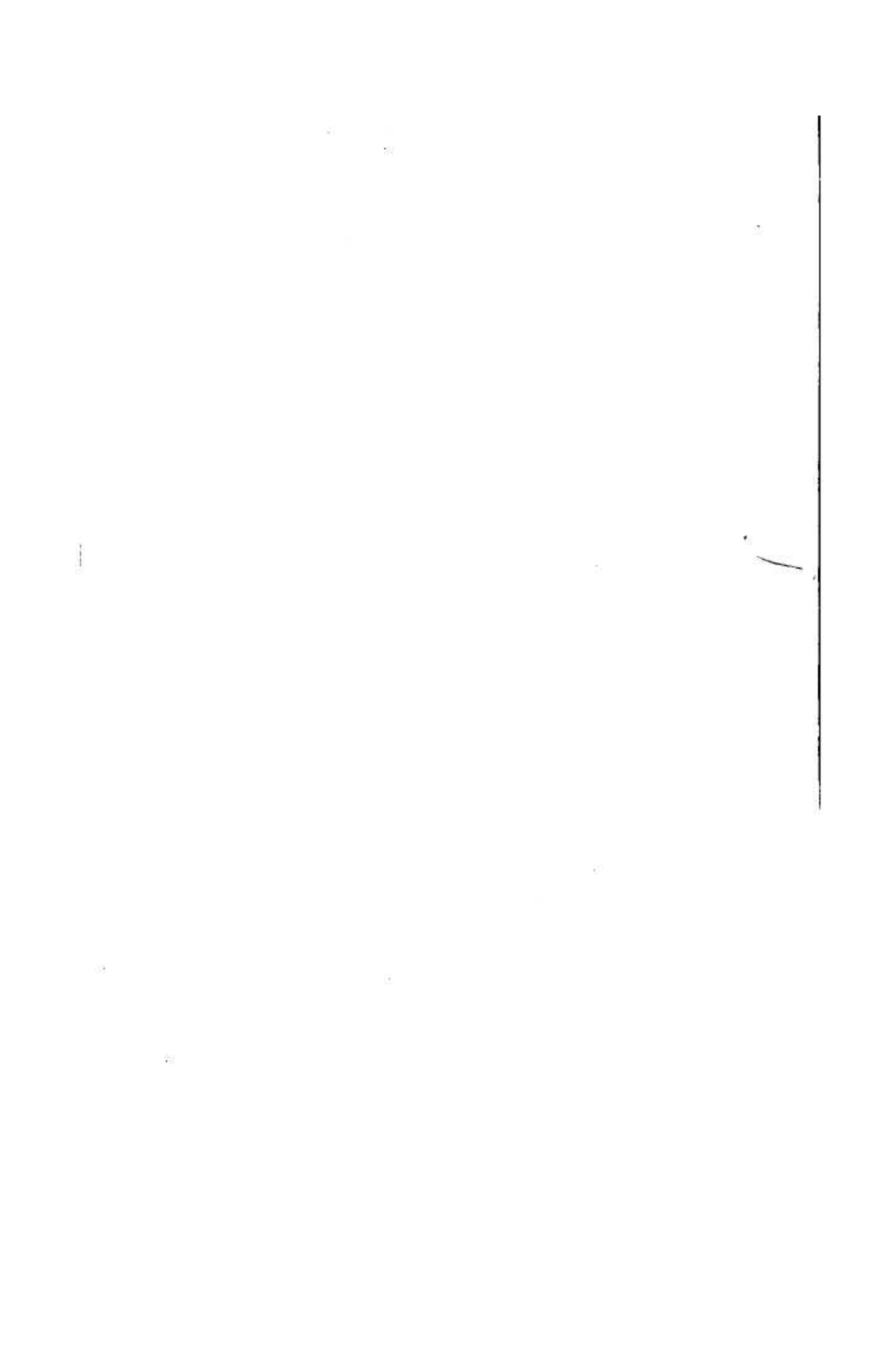
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INTRODUCTION.

The experiments upon which this work is based were begun in Harvard University and later were carried on in the laboratory of Columbia University. Part of the results have already been published in the Harvard Psychological Studies, Volume I. It is my purpose in this paper to report some additional experiments and give a more extended theoretical discussion of the questions involved.

The experiments already published had reference entirely to the perception of number through touch. In this report I shall give a brief summary of such of those results as may be useful in the discussion, add a few more from the same field, and then report some experiments on the sense of sight which were intended to throw light on the same general problem.

The investigation began as a study in the fusion of touch sensations when more than two contacts were possible. I had no very definite idea of what 'fusion' meant, and I am even yet unable to find in psychological literature a satisfactory definition or explanation of it. In the absence of uniform usage or common understanding of the term I shall state my own views in regard to fusion in general, in order to make perfectly clear what I mean when I deny that there is fusion of touch sensations when two objects resting near together on the skin are perceived as one object. Inasmuch as the attitude of the subject plays so important a rôle in all of the experiments, it will be necessary also to devote a few paragraphs to the relation of the motor to the sensory elements of consciousness. The conclusions of other experimenters with whom I do not agree also suggest some remarks on that subject.

FUSION.

In Külpe's 'Outlines of Psychology'¹ I find this statement: "If the connected elements are temporally and spatially identical,

¹ English translation by Titchener.

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but differ in quality, their connection must be termed fusion; if they differ in duration or extension, colligation."² I do not find this distinction useful. If we revolve a black and white disk on a color mixer the elements become temporally and spatially identical. To be sure, there is externally a rapid alternation, but the duration of retinal processes makes the result the same as if the gray were made by actually mixing the pigments. Elements so mixed are sometimes said to 'fuse,' and I presume it would be misleading to deny that meaning to the word. I should prefer, however, a more restricted use of the word, and to call it fusion when two or more qualities are inseparably connected so that one cannot be perceived without the other, *e. g.*, pitch and timbre, color-tone and brightness, and, so far as sight is concerned, color and extension. When two or more elements, which might, under other conditions, be perceived separately, are so connected that their combined effect produces a single quality of sensation, we certainly have a combination of a very different sort, and it is with reluctance that I apply the same term to it. To avoid confusion I should prefer to call it a mixture instead of a fusion. As an example of this, red and yellow mixed give the sensation of orange, which is a single quality of sensation entirely distinct from the other two. With what Külpe calls a colligation I have nothing to do in this connection. A place will be found for that later. It will be noticed that in the above the matter of spatial identity is left entirely out of account. As a matter of fact, two elements which are not spatially and temporally identical usually *can* be perceived separately, and hence do not fuse. It does not follow, however, that they *are* perceived separately; it is sufficient if they *can* be.

Külpe says: "A simultaneous connection of tones may stand as a typical example of fusion. Colligation occurs, on the other hand, when the cognizability of the separate qualities is either unaffected by combination, so that they retain their original independence, or is actually increased." An important factor, it seems to me, is left out of this classification, *viz.*, the distinction between having a sensation and perceiving an

² The German word is *Verknüpfung*.

object. We must also distinguish between qualities which can be conceived separately and those which can produce sensations separately. We can conceive color-tone separate from brightness, but we cannot have a sensation of pure color except when fused with brightness. On the other hand, we can not only conceive each separately but we can also have a simple sensation of red or of yellow or of orange.

It should be noticed in connection with Külpe's statement that 'a simultaneous connection of tones' might be produced by two tuning forks vibrating at the same rate, although their combined effect is a sensation of a single quality. In that case the only way we could recognize fusion would be by finding out the number of objects producing the sensation. However, Külpe's definition of fusion quoted a moment ago excludes such a combination, because they do not differ in quality. But suppose we have one fork vibrating at the rate of two thousand times per second and the other at the rate of two thousand and one times per second. The qualities must be different, and hence the tones fuse; but the difference in the qualities is not perceptible, hence experience could never discover the fusion and we could find it out only by calculating the number of vibrations. According to my classification neither of these cases would be fusion, because either of the two elements could be perceived separately, *i. e.*, neither exists by virtue of the other nor is either in any way dependent upon the other.

Perhaps the question is largely one of nomenclature, but the term fusion has been used in such wide and often vague senses that I think it necessary to state certain distinctions which seem to me to be fundamental. If any one wishes to indicate the distinctions by other terms than those I use I have no objection; but I do insist on the distinctions which my classification emphasizes, however they be designated.

The classification briefly stated is this: There are three kinds of combinations which are fundamental in explaining the relations of consciousness to the external world.

1. Elements may be inseparably connected for perception yet separately conceivable, *e. g.*, pitch and intensity of sound. Neither of these can be perceived without the other, but we can

perceive a variation in one without any variation in the other, hence we come to conceive them separately. This represents the most intimate connection of elements possible and might be called fusion proper.

2. Elements which can be perceived separately may be combined so as to produce an entirely new and distinct quality of sensation, *e. g.*, red and yellow produce orange. In this case a variation in one of the elements produces a variation in the quality which results from the combination of the other two. In this class two qualities combine to produce a third, while in the first class the combination of two elements does not produce a third. It must also be noticed that in the first class each element exists by virtue of the other, and in the second class neither of the original elements entering into the combination owes its existence to the other, but the third quality exists only as the product of the other two. This is a much less stable combination than the former and might be called a mixture. And furthermore, it includes combinations of the first class and thus really represents combinations of a second order.

3. There remains another class of combinations which, for want of a better term, I shall call constructive combinations. By this I mean the combination of different qualities to form a single object. The qualities may be either different qualities of the same sense or of different senses, *e. g.*, we may, by using a single sense, combine weight, hardness, etc., to form an object, or we may, by using two senses, combine color, weight, etc., to form an object. There are many kinds of constructive combinations and one might attempt to classify them, but I am not sure that he could find any very satisfactory basis for such a classification. It will be noticed that this class includes those combinations of sensations of different senses which have sometimes been called 'complications'; but it also includes more than that and it is not determined by the same characteristics.

There is still another way of experiencing the external world, which at first thought might suggest a fourth class of combinations. We sometimes perceive objects in groups, and this grouping might be called a combination of elements into a