Especially in the magnetic and electrical quantities is there a great advantage in eliminating the mass dimension and using energy with time and space in its stead. Take, for example, the strength of pole in the electro-magnetic system. This quantity is derived from the experimentally observed fact that between two equal and opposite magnetic poles, of strength 'm,' and at a distance 'l' apart, there is a force which is proportional to m^2/l^2. Hence $m^2 = FL^2$. But $E = FL$, hence $m^2 = EL$, and therefore $m = E^{\frac{1}{2}}L^{\frac{1}{2}}$. The superiority of this expression to $L^{\frac{3}{2}}M^{\frac{1}{2}}T^{-1}$ in practice, as well as in theory, will be admitted by all.

It is noteworthy that all the magnetic quantities in the electro-magnetic system are independent of time. From the usual conception of these quantities this evidently should be the case, and it appears that the time dimension given in Table I. is erroneously introduced by the use of mass as a fundamental quantity. It is, however, unnecessary to go further into detail. The expressions in Table II. are so plain that 'he who runs may read.'

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DISCUSSION

DR. MONTAGUE'S THEORY OF TIME-PERCEPTION

IN the January number of *The American Journal of Psychology* for 1904, Dr. W. P. Montague has given a theory of time-perception and in particular, of the specious present, which is so clear-cut and ingenious as to be well-nigh captivating. And yet, after reading this article, I cannot refrain from calling attention to one or two points which, as it seems to me, need at least some reconsideration.

If I have correctly read Dr. Montague, he sets out to explain how that finitely extended segment of time in the individual consciousness known as the 'specious present,' can exist in the metaphysical present which is infinitesimal, that is, which is a segment of time whose extent is zero. "How is it that at any one moment there can appear to be present several moments?" "Every psychosis," he continues, "has two distinguishable but inseparable aspects, the subjective and the objective. The subjective element or 'knowing thought' is the whole system of conscious contents taken collectively and *including the incoming content*" (my italics), "while the latter is the *object* of the (normally prospective) act of attention. . . . We may describe every psychosis as the assimilation of an entering sensation-mass by a receiving apperception-mass." The explanation is: "Let Δo symbolize the amount of change or alteration in the objective content o produced in any

period of time Δt, and let Δs symbolize the resulting change produced in the subjective aspect of consciousness during the same time. Then $\frac{\Delta o}{\Delta s}$ will represent a change in the objective as compared with the change in the subjective element in the time Δt. As Δt is made to decrease without limit, Δo and Δs will correspondingly decrease, but the fraction $\frac{\Delta o}{\Delta s}$ will not necessarily decrease, but will either approach, or if the rate of change be uniform, will maintain the finite value $\frac{do}{ds}$. Now this derivative of the objective change with regard to the change of the subjective element is a finite quantity, but one that is realized at each infinitesimal moment of time.''

As Dr. Montagues says, he is applying calculus to increments of change, as it is ordinarily applied to increments of substance; and the one kind of increment produced in a conscious state differs from the other in that the increment of change, 'while it varies directly with the stimulus causing it, also varies inversely with the content in which it is caused.' This is already a prime difference, and suggests that before 'change' is subjected to ordinary differentiation it should be examined to see if this novel property does not need to be taken into account. But there is a more striking and pertinent difference between change and substance; the latter is defined without reference to time while the former can not be. An amount of change is always an amount of change in a certain amount of time, that is a *rate of change.* Therefore the increment in the amount of change ('produced in any period of time Δt') which Dr. Montague symbolizes with Δo or Δs, has to be an acceleration in the rate of change of o or s. It follows that $\frac{do}{ds}$ is already what Dr. Montague wishes to call a second derivative. Now this quantity would not serve to represent or to explain the peculiarities of the specious present, as may be seen from a single illustration: when the rate of change is constant, the ideal condition supposably for a perfectly normal specious present, the derivative is zero. That is, there is no specious present.

The force of this criticism comes out specially if, as Dr. Montague suggests, one interprets his quantitative symbols 'as applying to the physiological concomitants of conscious states'; for it is obvious enough that any change in physiological processes can not be defined except as change taking place in a certain amount of time, that is, except as rate of change, so that any *increment* of change would have to be an acceleration in this rate.

Apart from this difficulty, there would come up another and

equally serious one, if a definition of 'change' were attempted which should satisfy Dr. Montague's requirement that the 'change produced in a conscious state . . . varies directly with the stimulus causing it, also varies inversely with the content in which it is caused.' Clearly the definition must involve not only the amount of incoming sensation but also the amount already present; but this last involves considering the amount which is all the time disappearing from consciousness, a quantity which I believe that Dr. Montague does not speak of. It is furthermore absolutely necessary to define the condition under which a given sensational element is said to belong to the 'objective content'; how long will it remain 'objective,' and when will it pass over and become a part only of the 'subjective aspect'? Until these two 'aspects' are exactly defined in relation to each other and the meaning of 'change' in these 'aspects' is defined, I can not see how anything at all can be said about the value of the derivative of a change in either kind of content. In short the function, even when ascertained, is, as likely as not, to be undifferentiable; in which case it would be meaningless to speak of a derivative.

The foregoing criticisms concern only the application of the differential calculus to the entities which Dr. Montague posits, and it may be that he could overcome the difficulties mentioned and obtain that derivative which he requires. There would then be a more serious objection to offer, and that would relate to the *interpretation* of his ratio. This quantity might vary as the theory requires, and still not be a measure, or as Dr. Montague says a representation, of the specious present. The derivative of two variables has, of course a fixed interpretation; and this is in the case in hand bound to be a rate of change, or a rate of rate of change, et cetera. The desired solution will be at best some such rate of change. Now I submit that the specious present of consciousness is not a rate of change; nor can I find any meaning in the statement that the specious present is 'represented' by such a quantity. The specious present, as I apprehend it, is a number of conscious elements which somehow exist together; it does not mean for us any rate of change or the like, but it means a *number of objects* which are temporally successive but yet which are by us experienced together. The few succeeding notes of a melody of which we are conscious all together, are a case in point; they do not coexist in time, but they do coexist in us. These coexisting objects, however, are not to be confounded with a rate of change; not even by one who should not believe with Russell[1] and other mathematicians, that derivatives 'are never magnitudes but only real numbers.'

[1] Russell, B., 'The Principles of Mathematics,' Cambridge, 1903, Vol. I., p. 173.

If it should appear that Dr. Montague's theory does not solve the question, 'How is it that at any moment there can appear to be present several moments?' we may still return to the older solution. It is that several moments are in fact not present at any one infinitesimal point of time or moment. They are present all together in consciousness but not altogether in time, as the question paradoxically insinuates. How this can be so has been so clearly discussed by Professor Royce[2] that one may almost wonder at a reappearance of the problem. Even the plain experimental psychologist who takes no delight in metaphysical explanations, to say nothing of a philosopher and logician, ought to find no difficulty in defining a personality or a consciousness as such an entity as does not exist in any one infinitesimal moment, but which occupies time as an acre occupies space. The familiar concepts of second, minute, hour, day and year are so defined, and I can see no logical or practical difficulty in defining a consciousness in exactly the same way. If any one is minded to wonder how a whole year or a specious present of consciousness can 'exist at any one moment,' he will find a clear and simple solution of the difficulty in Professor Royce's essay.

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ACCOMMODATION AND CONVERGENCE—A PROTEST

A DOCTORATE thesis is but a small item in the annual output of psychological literature. If, however, it is worth reviewing at all, the reviewer may be expected to discuss what it says rather than what it distinctly does not say. Dr. Wallin's review not only failed to give my paper its proper setting in the literature, but ascribed to me a position which the paper itself definitely rejects. Moreover, the reviewer has made various misstatements in referring to minor points. In his reply to my former protest, he arranged his defence under six headings (*Psychological Bulletin*, I., 6, pp. 208ff); these I shall consider in order.

1. He still insists that I accept nativism in part, notwithstanding the fact that I reject it *in toto*. Having failed to persuade him by direct statement, I will make use of an analogy. Let us suppose that a writer on visual sensation had concluded his paper with the statement: "The Helmholtz theory seems to explain color-mixture, but it fails to account for the other facts; Hering's theory covers all the facts so far as known. Moreover, a closer examination shows that

[2] Royce, J., 'The World and the Individual,' New York, 1901, Vol. 2, Lecture III.; specially pages 113-142.