On the Nature of Sensation - Intensities and qualities

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In his Manual of Psychology, Stout, following Stumpf, gives the following argument to prove the existence of "mere sensations", or sensations which exist without being known: ".... within limits we can vary a stimuly without producing any perceptible difference in the object cognized. If this variation in the stimulus is accompanied by variation in the sense-experience, then we have a variation in the sense-experience which make no difference to cognition. There is a difference in more sensation, but not in perception. That, as a matter of fact, this is so may be demonstrated as follows. We may vary the physical conditions on which the fitch of a musical note defends, so as to produce a graduated scale of notes increasing or decreasing in pitch. Symbolie the series by P., P., P., P., P., P., Mow, if the variation of the physical conditions is sufficiently gradual, P, may be quite indistinguishable from P2, and similarly P2 may be quite indistinguishable from P3. and P3 from P4. None the less, P4 will be perceived as distinctly different from P. But this would be impossible unless the change in the physical conditions were assomptioned by a change in the sensation, even when the change is Amperceptible. I be the pitch - sensation P, is regarded as identical with the pitch-sensation P2, merely because the one note is indistinguishable from the other, and if in a like manner P2 is regarded as identical with P3, and P3 with Py, and soon, then P, must be identical with En, and it would be impossible that any perceptible difference should ever arise"."

It is obvious that in this passage, the word <u>sensation</u> is not used to refer to any given sense datum, like This tone 9 am hearing now, but to a property common to a number of sense. I In his Doince and Hypothesis, p.20 (Idalstede translation) Poincare work much the same argument as stout uses the point-instead of the translation of

data, or to a certain collection of sense - data, for were this not so, it would be nonsense even to entertain the hypothesis that P, and P2, evoked by different physical conditions, and occurring under different irroumstances, could be identical, in the only justifiable sense of this much-abused term. Now, sensations, Stant says a few pages further on are pyphical states, and he defines a psychical fast as different from a psychological fast, which is merely a fact of which psychology mottake account, in that it is a past of consciousness Do it would seem that stout means to maintain that the differonce between P, and P2 is that they are fundamentally different sorted objects of consucueness. Stout abridually wishes to assert also that in the sense of consciousness in which they are different sorte of objects of consciousness, we do not have the consciousness of their difference: otherwise, his argument in favor of the existence of mere sensations loses its point. Now, as his own argument to shows, we know by inforence what the difference between P, and P2 is : it is fairly clear, then, that what Stout wishes to assert is that we know what P, and P. are by some other way than by inference : he does not merely want to show that the sort of inference by which we know P, and P2 is not the same as that by which we prov their difference. Now, he gives absolutely no argument what ever which is inconsistent with the suffosition that we know P, and P2 only ly inference. Do, in order to discover whether Stoute argument is valid we are led to the important questions Anow a sensation - intensity or quality? I have are the questions ? propose to discuss in the present paper. a little introspection will convince one that it

is only through the comparison of one sense- datum with another that we are able to arrange our sensations in stages of intensity and quality. I am never able to say that a given note is of a certain fitch without comparing it with othernotes, and even in the case of those who have what is called a sense of absolute pitch, their power of naming immediately the pitch of a give note which they hear rests probably in the extreme tenasity of their auditory memory which renders then able to compare a note which they hear now with one which they heard a considerable time ago. What I mean to say when I assert that a sense-datum z is of a given intensity is that it bears some relation with a given standard sense-datum of the same sort which I shall call acquipotent, and similarly a similar statement holds good in the case of sensory qualities of a given kind, such as ptch. It is merely the prejudice of common suse and the aristotelian logic, in favor of propositions involving predicates, and against relational propositions, which makes me use in every-day life the phrase of the same intensity as to a 'aequipotent with', and of makes meaphen to derive this relation from the intensities themselves.

But Dumpfs arguments prove, if they prove anything at all, that we do not recognize directly that two sense data are of the same snowy quelty of interesty, if we take the relation of being of the same when acquipotent as have a transitive relation: that is, if, when a is acquipotent with b, and I is acquipotent with c, a must be acquipotent with c. Moreover, the argument stumpf gives shows us exactly how we are able to find out when two sense data are tonally acquiptent, and when they are not. I he fact that a sense data me tonally acquiptent, and when they are not. I he acquiptent is discovered to find a tone - datum of fitch, say, Ph.

which is noticed to be of higher fitch than a tone datum of Pulch P, , but which is not of noticeably different fitch than a datum of fitch Ps. Now, since the only criterion which we are even given for the subliminal difference in intensity of two sense data, other then tests which bring in such extraneous matters as the physical intensity of the stimulus producing a given senseone of the saiginal sense-data, and indistinguishable from the other, and since the soleway we have of discriminating the genuine acquiptince of two data from the relation which holds between them when they are not noticeally different as to intensity or as to quality is that in the case of true acquiptence there can be to subliminal difference between them in respect to intensity or quality, we may define the acquiptonce of a and I in a given respect as that relation which holds between them when all the data which can be discriminated from a in that respect can also be descriminated from &, and vice versa. Moreover, if Weber's law holds good, or any together ical low which makes it impossible for the upper or lower limina of discrimination from two sense- data produced by stimuli of different intensity to coincide, then we can easily show that this definition of acquipotence has the desirable property of rendering two sense data acquipotent when and only when they are produced by stimuli of the same physical intensity. or quiet wot agin range we have, then, shown how the notion of sensation-intensity

or guilting of again name on the analysed in terms of the relation which holds between two sense data of the shire sort when one is noticeably different from the other This relation in regard to its intensity or quality. I his relation is manifestly derived stand from that which holds between one datum and another when the first is noticeably of greater intensity, or higher fitch, but more vivid lue, etc. than the second. I am not

meaning to say that we may not have some sout of a direct experience that a is of different intensity or futch, etc., from &, apart from any experience that a is of greater or of less intensity, higher or lower pitch than to, but it seems to me fairly alrisus that we would have some experience of the direction of the difference between a and I when we experience them as different, and that often what we mean to assert in Daying that they are felt to be different is that one is experienced as noticeally more intense or of notiseably higher pitch, etc., than the other. These relations of noticeally greater and less in intensity, noticeably higher and lower in fitch, etc. whether they are given as such in our experience, are certainly for more primitive than any experience we wer have of a sensation intensity. If we take the latter as a property: namely, the property of being apquiptant with a given sense-datum in a certain respect, then whatever with a point it is simply a paraphrase for certain things we say about the relation of noticeably more intense than, since we know the relation of acquipotence only as a function of the latter relation. If a sensation intensity be taken as a class of sense-data, determined by the relation of acquipatence with a given sense-datum, then, sense, as mar. Russell have pointed out, a proposition about a class does not really concern the class at all but only the function property by which the class is defined, our knowledge of sensation - intensities is even more a knowledge by inference, and the sensation -intensities themselves are even further from being presented to us. It seems to me, moreover, that the sort of inference through which we know that a given sense-intensity is different from another is not of a fundamentally different character than that through which we know anything at all about a sensation-intensity. Since sensation-intensities, in the only sense in which anything which Stout or Stumpf songe demands that they exist, are not ever presented to us, it follows that Stants argument that in favor of mere' sensations is utterly without any point

On the nature of Ranges of Sensation - Intensities and qualities "

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This article is based on some Mathematical - Ingrical work of mine, which was published, under the title, <u>Studies in Synthetic Logic</u>, in the <u>Proceedings</u> of the Campridge Philosophical Society, vol. XVII, part 1.

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I wie Monual of Peychology ? Stout, following Stumpf, gives the following "Book I, chapter 1, 53., Ed 1.

argument to prove the existence of "mere' sensations, or sensations which exist without presturing any presture of the senset of the s difference in the object cognized. If this variation in the stimulus is a companied by variation in the sense-experience, then we have a variation in the sense experience which makes no difference to cognition. There is a difference in mere seasation, but not in perception . That, as a malter of fact, this is so may be demonstrated as follows. We may vary the physical conditions on which the fitch of a musical note depende, so as to produce a graduated scale of notes, increasing or decreasing in pitch. Symbolize this series by P, , P2, P3, P4, P5, Pn. now, if the variation in the physical anditions is sufficiently gradual, P, may be quite indistinguishable from P2, and similarly P2 may be quite indistinguishable from P3, and P3 from P4. None the less, P4 will be perceived as distinctly different from P. But this would be impossible unless the change in the physical conditions were arcompanied by a change in the sensation, even when the change is imperceptible. If the pitch-sensation P, is regarded as identical with the pitch - sensation P2, merely because the one note is indistinguishable from theather, and if in a

like manner P2 is regarded as identical with P3, and P3 with P4, and so on, then P, must be identical with Pn, and it would be impossible that any perceptible difference should ever arise"

The meaning of this passage is a little hard to follow, owing to the ambiguity of the terms, 'sensation', 'note, and "identity? If "identity be understand as <u>numerical</u> identity, then P, P2, etc. must be regarded as species of sense-data, and not as individual sense-clata - as notes in the sense in which the chromatic scale is a collection of notes, and not in the sense in which this fasticular time-datum presented to me when I now press this piano . key is a note for it is manifest that Stout regards as worthy of refutation the view that P, and Ps are identical, and means to maintain that two instances of the some species of note are identical in some sense in which two instances of different notes are not, whereas if P, and P2 are individual tones, evoked, as Stout says, by different physical conditions, whether P, and P2 are of the same pitch or not, P, must be numerically different from P2, and the hypothesis that P, and P2 are not numerically different would be so abviously false as to be unworthy of a reputation. If, on the other hand, "P, and P2 be regarded as individual sense-data, the only and of identity which any some man would ever assert to hold between them would be some kind of qualitative identity, and the difference between them in which stout is interested is a qualitative difference hard to avoid the interest that the he interes to assert in the passage quoted above that the difference which P, is inferred to have from P, is the same retation which one perceives P, to have from P4, and not merely a

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relation which happens to hold between Pand Q whenever Pand Q are perceived to be different. He unshes to say that what we mean by the relation of difference which we notice to hold between P, and P4 is a relation which also holds (although we only know this by inference) between P, and P. His argument in favor of this conclusion consists in substance solely in pointing out that unless this is the case, we can have two sensations, each qualitatively identical with another sensation, yet qualitatively different from one another. He denies that this latter circumstance is possible, without, nowever, giving the grounds for his denial. If it be said that the impossibility that P, be qualitatively identical with P2, and P2 with P3, while P, and P3 are qualitatively distinct, follows from the fast that 'P is qualitatively distinct from Q' means, P possesses a quality which a does not possess', then Stouts argument implies that what we notice when we see that P and P, are distinct is that P, possesses some quality absent in Py. If, on the other hand we do not derive the relation of qualitative childerence in some such manner from the relation of logical difference, in order to justify Stouts arguments one would have to have recourse to the alleged obviousness of the transitivity of the relation of qualitative identity. Now, to say that it is obvious that the relation of qualitative identity is transitive would, in this connection, be equivalent to asserting the that the relation we notice when we notice P, to be different from Py must be one whose regation is transitive. That is, it must be obvious that the a certain relation we notice must have properties dependent on it its behaviour where we do not notice it . This seems to me to be palpably false, and its whole plausibility appears to depend upon an equivocal use of

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the terms identity and difference. In order to understand what stant's position meansif we are to understand P, P2, etc. as species of sense-data, we must see what he means by the term 'sensation'. Now, sensations, Start says," are psychical states, and he defines a psychical the fact as different from a psychical fact, which is merely a fuct of which psychalongy must take account, in that it is a fact of consciousness? Too » altist, Introduction, Chapter 1, 53. it would seem that Stout means to maintain that the difference between P, and P2 is that they are essentially different sorts of objects of consciousness stout obviously also wishes to assert that in the sense of "consciousness" in which they are different sorts of objects of consciousness, we do not have the consciousness of their difference: otherwise his argument in favor of the existence of mere' sensations loses its point. Now, as his own argument shows, we know by inference that there is a difference between P, and P, : it is fairly clear, then, that Stout wishes to aspert that we know P, and P2 in some other way than by inference - he does not merely care to show that the details of the process whereby we obtain an inferential knowledge of P, and P2000 not the same as those of the process through which we learn their difference. Whether P1, P2, etc. be mental events or kinds of mental events, therefore, Staute argument in favor of the existence of mere sensations assumes that we know sensation-qualities by means of a process involving no inference. Now, Stout gives absolutely no argument to show that we have other than inferential knowledge of sensation-qualities. Therefore, in order to discover whether Stouts arguments in favor of the existence of mere' sensations are valid, we are



led to the important questions, how do we know a sensation quality or intensity 's and, what is the nature of a sensation quality or as the theories of manges of sensation-qualities and ranges of sensation-intensities are precisely parallel, I shall now use the one term in my discussions, and now the other, and shall draw my examples from whichever field may be most convenient. Everything I say about the one will, mutatis mutandis, be true of the other. For the purposes of this poper, such circular ranges of sensory qualities as the periphery of the base of the color-pyramid must be regarded as a consisting of several non-circular parties -for example, we divide the base of the color-pyramid, as is made natural to do, into the region between red and yellow, the region between yellow and green, the region between green and blue, and the region between blue and red. We shall also regard it as possible for a given sense-datum to belong to several ranges at onte. intensity? These are the first questions I propose to discuss in the present paper. a little introspection will convince one that it is only through the comparison of sense-data that we are able to arrange

through the comparison of sense-data that we are able to arrange them in stages of intensity and quality. I am never able to say that a given note is of a certain fitch without comparing it with other notes, and even in the case of those who have what is alled a sense of absolute pitch, their power of noming immediately the pitch of a note which they hear rests probably in the extreme tenseity of their auditory memory, which renders then able to compare a note which they hear now with one which they heard a considerable time ago. What I mean to say when

I assert that a sense-datum & is of a given intensity is that it bears some relation, which I shall call isocrasy of a given sort, to a certain standard sense-datum of the same kind. It is merely the prejudice of common sense and the aristotelian logic in foror of propositions involving predicates, and against propositions involving relations, which makes me use in every-day life the phrase, 'of the same intensity as', instead of some such expression as "isocratic with , and causes me to derive this relation from some such hypothetical entities as intensities. But the arguments of Stumpf and of Stout prove, if they prove anything at all that we do not recognize directly that two sense-data are isocratic, if we mean by isocracy a transitive relation: that is, if a must be isocratic with c, when a is isocratic with 1, and b is isocratic with E. Moreover, if we mean by isocracy a transitive relation, the epample Istout discusses shows us how we can derive it from the relation two sense data of a given kind when we say they are noticed to be different. This relation, which I shall term helerophany of a given sort, or some other relation formally equivalent to it, are the only relations we have any right to say we notice when we observe that two sense-data of a certain range are of different intensities, for we know of no process of inference which will entitle us to to conclude that the identical relation which we notice to hold between a and b, holds although we do not notice it, between and I. now, the fact that the tonal sense-data P, and P2 are not isocratic is inferred by Stout from the fact that there is some tonal sense-datum Pp, which is in heterophanic

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to P, , but not to Ps. Moreover, apart from criteria involving such extraneous considerations as that of the physical intensity or we have of the stimuli which produce them, the only real test absence of isocracy (or, as I shall call it, heterocracy) is not demonstrated by their heterophany, are isocratic, is to see whether or not there is some sense-datum theterophanic to one and not to the other. That is, our sole made of demonstrating that two sense-data of a given sort (i. e. two members of the field of a given relation of heterophany) are isocratic with one another, is by showing that all the sense-data with the one are heterophanic to the other? We may, then, define 9 t is possible, it is true, to show that X is isocratic with y by for showing that all the data peterophonic to x are heterophanic toy, without discussing whether all the sense-data heterophanics to y are heterophanic to Z. This condition is, as an empirical fast, equivalent to the above, for, were it not, then we should have some such condition as the following: P, would be a tone datum indistinguishable in pitch from P2, which in its turn, would be indistinguishable from P3, In while there would be a datum, P4, noticeably higher in pitch than P, and noticeably lower than P3, while as a matter of fact, no such condition everoccurs. Moreover, did such a condition occur, we should certainly not term P2 and P4 isocratic: i. e. of the same actual pitch. I herefore it seems obvious that the fact that all the data

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beterophanic to x are also beterophanic to y only proves the isocracy of 2 and y when combined with the empirical premise that if all the data heterophanis to 2 are beterophanis to y, all the data beterophanic to y are heterophanis to z, and hence that, in this case the immediate criterion of the isocracy of & and y is that all the sense-data heterophonic to the isopracy of the and the agiven respect as the relation which holds Stiven them when they both belong to the field of the appropriate sort of heterophony, and when all the sense-data heterophonic to the one are also hiterophanic to the other. Moreover, if Webere law holds good, or any similar law which makes it impossible for the upper or lower limina of discrimination from two sense-clata, produced by stimuli of different physical intensity, or wave-length, etc. to coincide, we can easily show that this definition of isocracy has the desirable property of rendering two sense-data isocratic when and only when they are produced by stimuli of the same physical intensity. We have, then, shown how the notion of a sensation-intensity or quality of a given range can be analysed in terms of the appropriate sort of teterophany. The relation of heterophany is manifestly not itself known quite directly by us, but, as a function of the relation which holds between a and I when a is of noticeably greater intensity thank, or of noticenbly higher pitch than k, or of noticeably more vivid hue than I, etc. These latter relations I shall term various sorts of hyperfrany. I am not meaning to deny that we may have some sort of a direct experience that a

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is of different intensity or fitch, etc. from b, apart from any experience that a is of greater or of less intensity, higher or lower putch, to thank, but it seems to me fairly obvious that we usually have some experience of the direction of the difference between a and to when we experience them as different, that often what we mean to assert in saying that they are felt to be different is that one is experienced as noticently more intense, or of noticeably higher pitch, etc., than the other, and that this sense of "tefferent "notiseably different" is precisely the one which is relevant in our discussion of the analysis of sensationintensities and qualities. These relations of hyperphany, whether they are given as such in our experience or not, are certainly far more primitive than any experience we ever have of a sensation-intensity. We have seen that such a proposition as 'a is of the sensation - intensity of is really a paraphrase for such a proposition as, a is isocratic with the standard sense-datum, b': if we take the sesation-intensity as being the property of isocracy with b, then whatever we seen to provabout it is really known about & and the appropriate sort of isocracy, or, if we carry our analysis further back, about b and the appropriate sort of hyperphany. If, as is more interesting convenient, we regard the a sensation - intensity as the class of all the sense-clata isocratic with a given sense - datum, our providence of sensation - intersities is even more thoroughly interential than in the preceding case, since and the sensation-intensities are even further from being presented to us, since, as mr. Russell has pointed out, a proposition about a class does not really concern the class at all, but only lite property by which the class is defined. The only sensation-intensities and qualities, then, whose existence is in any way demanded by anything strut , says, are not presented to us, but are known by inference, whether

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there are any directly known entities which may be called son sation intensities and qualities or not. Morenver, it seems to me that the sort of inference through which that we know that a given sense-intensity is different from another, is not of a fundamentally distinct character from that through which we know anything at all about a sensation - intensity. I herefore, I cannot can see no cogency whatever in stouts argument in favor of the existence of mere sensations. ? It should be noted that even if the whole of Stouts argument which we have criticized above were valid, it might entitle him to say that there may be variations in sensory qualities without their correlates in cognition, but not that there are uncognized sense-data or sensory qualities, which is what he sets out to prove. If the sensation-intensities and qualities whose structure we have explained above are to have the properties which we usually associate with intensities, and qualities which admit of degrees, they must in some way form a series, in which a greater intensity always follows a smaller one. Interpreting this statement in logical terms, it means that there must be a relation?, such that (1), its field is a class " If. Whitehead & Russelle, Principia Mathematica, # 200 - #204 of all the sensation-intensities or qualities of a given kind (1. l., derived from a given relation of hyperphany), (2) if it relates a pensation intensity or quality & to another son B, we should naturally say that B is a greater intensity, than &, (3) if it relates & to B, & cannot be identical with B, (4) if it relates a to B and B to y, then it relates d to y, and (5) if a and B are the distinct sensation - intensities or

qualities of the appropriate kind, then it either relates & to B on B to a. Let it be noticed that relations of hyperphany, although they satisfy conditions (3) and (4), fail to satisfy conditions (1), (2), and (5). How, then, are we to find a relation satisfying all five of these conditions? If we turn back to the argument of Stout and Stumpf, we shall find a simple answer to this question. P, and P2, it will be remembered, were taken not to be directly distinguishable from one another in pitch, and some Pk was supposed indistinguishable from P, , but of noticeably higher fitch than P2. Dince the difference between Ph and P2 is subliminal, while Pk is supraliminally higher and pitch than P,, Start says that the putch of P2 is really different from that of P, , and he obviously infers also that it is really higher than that of P. . The relation which one sensory quality or intensity of a given range bears to another quality or intensity of the same range is, then, regarded by Stout as a lower than or less than relation when some sense-datum of the second intensity or quality is not heterophanic to some datum hyperphanic to a datum of the first intensity. Dince no sense datum is heterophanic to itself, our criterion of less than or lower than will apply to supraliminal intervals as well as to subliminal intervals. It will not, however, apply to intervals near the upper threshold of a given quality or intensity of sensations: if x be the highest note of a galton whistle, and y be a subliminally lower note, there will be no note subliminally higher than x and supraliminally higher than y. However, there will be a note supraliminally lower than x and subliminally lower than y. Since, then, when a is an intensity subliminally or supraliminally less than 3, either some member of & will bear the relation of not being betersphanic to something hyperphanic to a member of a, or will be hyper-Manic to something not heterophanic to some member of a, and since whenever this relation holds between dand B, when dand & are interesties,

we would always call a less than p, we may define this latter relation, when it holds between sensation - intensities of the proper kind, as the relation of being less than, which generates a given series of sense-intensities.

But this brings us to the question, when will this relation actually generate a <u>series</u> of sensation-intensities - when, that is, well it have properties (1) - (5). What we have just said proves that it will have property (2), and shows also that it will have property (1), unless there is some sense- datum of a given range not notice ably different in intensity nor inquality from anything - a supposition which is fallfably false. Furthermore, (3) and (5) are invariably patiofied by it. This follows from the fact that if x and y are pensations of the appropriate sort, attes one of the just following five conditions, which are all mutually inconsistent, must be Batisfied: (a). Everything heterophanic to X may be heterophanic to y. (b) Something hyperphanic to X may not be heterophanic to y. (c) Something to which X is hyperphanic may not be heterophanic toy. (d) Something hyperphanic to y may not be heterophanic to x. (e) Something to which y is hyperphasis may not be heterophasic to r. In case (a), x and y are isocratic, and , owing to the transitivity of sooracy, if x belongs to an intensity &, y does also, and It is the only intensity to which y belongs. In cases (t) and (e), if x to of intensity of, and y of intensity B, or is less than B. In cases (c) and (d), if x is of intensity of and y of intensity B, B is less than a since these two eather hypotheses are inconsistent with the first, (3) is satisfied; since either dis identical with Bon is less or greater than it, (5) is satisfied (4) must practically be assumed as it stands,

and it is an assumption which we constantly make without thinking of it. We may, it is true, assume instead that the relation of either being hyperphanic to something not heteraphanic to agiven something else or of notherny heterophanic to something hyperphanic to it is transitive. The assumption in this form is equivalent to supposing that the relation of being either supraliminally or subliminally more intense than is transitive.

- are of the same intensity. It follows that if such a have holds, (5) will be satisfied. The truth of such a low, though a necessary condition of that of Webers law, is many times more contain in each range of sense intensities and qualities than even the approximate truth of Webers low. We have seen, then, that under two on three hypotheses of avery general nature, which are almost certainly satisfied by such relations of hyperphany, the relations between sensation intensities and qualities which we have defined as being less inten than? 'lower than', etc. will generate series of intensities and canges of qualities. Let it be noted however, that sensation-intensities and qualities are not thereby treated as quantities. Although we have shown how the pressure data, brightness data, etc. that we experience can be arranged in what we may call their natural order, not only are we not thereby entitled to speak of one intensity as the sum of other intensities, but we have not even any method given whereby we may correlate the series of sensation - intensities with the series of the real or rational numbers, and the treat one interval between two sensalion intersities is equal to another. It is true that we are able to state one form of Weber's law in terms of the relations of hyperphany. We are able to state that is, the hypothesis that if y is a given sense-datum, evoked by a stimulus of intensity &, and if y is a sense datum hyperphasic to z, evoked by a stimulus of intensity of, then, whatever & may be, the To minimum possible value, or lower limit of the possible values, of 1 is constant. This is the really correct statements of Webers how as applied to just noticeable differences of perspections. It involves no reference to just noticeable

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differences at all, for it closes not require refer to any hypothetical first datum whose intensity is noticeably greater than that of Z. I his is an important advantage, as no experiment that ever has been devised, or could conservably be devised, could ever be adequate to prove the existence of Duch a datum. This statement of Weber's low also involves, let it be noted, no reference to the constructions which we have called sensationintensities.

But it is by no means evident that we should regard the limina of discrimination from all sense-data of a given sort as equal. If we should define all just notiseable differences as equal, we have not yet found an unambiguous way af assigning a real number to each sensation - intensity, which is one of the things we must do to be able to regard sensationintensities as quantities, for we are not thereby given any unambiguous method of subdividing the interval between two sensation intensities whose members are only subliminally different into two equal parts. If, on the other hand, we take some relation which holds between pairs of sense-data of a given sort when the interval between the members of the first pair is not noticeably different in magnitude from the intensity-interval between the members of the second pair, as primitive in our experience, and derive from this some numeration of our sensation interesties of a given kind, Iten it is a proposition which is not a priori certain, and which stands in need of experimental justification in

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exactly the same sense in which Webers how, in either of its interpretations, needs experimental verification, that all just noticeable differences', to put it crudely, are equal. Weber's hur may well be true in one of these senses and false in the The Morbert Wiener Harvard University

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some method of measurement starting from sen-Dation-intervale as primitive, and derive from this a numeration of our sensation - intensities, then the proposition that all just-noticeable differences are equal needs experimental verification in the same sense in which Weber's law in either its quantitative or its non-quantitative sense needs experimental verification, and Weber's how may well betwee in one of these sense yet false in the other. To we see that the proper interpretation of the notion of sensation - intensity clears up many problems connected with Weber's In conclusion, I wish to contrast my method of handling the problem of senestion-intensity with that of I tout and Stumpf. Stout and Stilmpf see a contradiction in the intransitivity of the relation the treat the the "in distinguishable from', and Day that to resolve this contradiction, we must postulate differences of sensation-intensity where none are seen. They assume unconsciously, that is, that the differences of intensity between senpations are I in the first instance differences between sensation- intersettes. We take the differences of intensity as primitive, and device the intensities as function of them. I key have to postulate that the

ON THE NATURE OF SENSATION- INTENSITIES AND QUALITIES.

In his Manual of Psychology, Sont, following Stumpf, gives the following argument to prove the existence of "mere sensations", or sensations which exist without being known: "..... within the limits we can vary a stimulus without producing any perceptable difference in the object cognized. If this variation in the stimulus is accompanied by variation in the sense-experience, then we have a variation in the sense-experience which makes no difference to cognition. There is a difference in mere sensation, but not in perception. That, as a matter of fact, this is so may be demonstrated as follows. We may vary the physical conditions on which the pitch of a musical note depends, so as to produce a graduated scale of notes increasing or decreasing ,....P . Symbolize the series by P , PN, P , P Now, in pitch. if the variation of the physical conditions is sufficiently gradual, P may be quite indistinguishable from P, and similarly P may be quite indistiguishable from P, and P, from P. 2 3 3 4 None the less, P will be perceived as distinctly different from P .

But this would be impossible unless the change in the physical conditions were accompanied by a change in the sensation, even where the change is imperceptible. If the pitch-sensation P is regarded as identical with the pitch -sensation P, merely because one note is indistinguishable from the other, and if in a like manner P is regarded as identical with P, and P with P, and so 2 on, then P must be identical with P, and it would be impossible 1 that any perceptible difference should ever arise".

It is obvious that in this passage the word "gensation" is not used to refer to any given sense datum, like "this tone I amhearing now," but to a property common to a number of sensedata, or to a certain collection of sense-data, for were this not so, it would be nonsense even to entertain the hypothesis that P and P, evoked by different physical conditions, and occurring under different circumstances, could be identical, in the only justifiable sense of this much-abused term. Now, sensations, Stout says a few pages further on, are pluckical states, and he defines a physical fact as different from a psychological fact, which is of merely a fact, which psychology must take account, in that it is a fact of consciousness. So it would seem that Stout means to maintain that the difference between P and P is that they are fundamentally different of objects of consciousness. Stout obviously wishes to assert also that in the sense of "consciousness" in which they are different sorts of objects of consciousness, of their difference: otherwise, his argument in favor of the existence of "mere" sensations loses its point. Now, as his argument shows, we know by inference what the difference between Pland Pais: it is fairly clear, then, that Stout wishes to assert that we know what P and P are by some other way than by inference he doea not merely want to show that the sort of inference by which we know P and P is not the same as that by which we know their difference. Now, he gives absolutely no argument whatever which is inconsistent with the supposition that we know P and P only by inference. So in order to discover whether Stout's argument is valid we are led to the important questions how do we know a sensation-intensity or quality? and, what is a sensation-intensity or quality? These are the questions I propose to discuss in the present paper.

A little introspection will convince one that it is only through the comparison of one sense-datum with another that we are able to arrange our sensations in stages of intensity and quality.

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I am never able to say that a given note is of a certain pitch without comparing it with other notes, and even in the case of those who have what is called a sense of absolute pitch, their power of naming immediately the pitch a note which they hear rests probably an the extreme tenacity of their auditory memory which renders them able to compare a note which they hear now with one which they heard a considerable time ago. What I mean to say when I assert that a sense-datum % is of a given intensity is that it bears some relation with a given standard sense-datum of the same sort which I shall call acquipotence in a given respect and a similar statement holds good in the case of sensory qualities of a given kind, such as pitch. It is merely the prejudice of common Throughout this poly we shall trust intensities and qualities in just the same way. sense and the Aristotelian logic, in favor of propositions involving predicates, and against "relational propositions, which makes me use in every-day life the phrase "of the same intensity as" instead of some phrase such as "acquipotent with", and makes me appear to derive this relation from the intensities themselves.

But Stumpf's arguments prove, if they prove anything at all, that we do not recognize directly that two sense-data are acquipotent, if we take the relation of being acquipotent as a <u>transitive relation</u>: that is, if when a is acquipotent with b, and b is acquipotent with c, a must be acquipotent with c. Moreover, the argument Stumpf gives shows us exactly how we are able to find out when two sense-data are tonally acquipotent, and when they are not. The fact that a sense-datum of pitchP, and another of pitch P, are not acquipotent is discovered when we find a tone-datum of pitch, say, P_{k} , which is noticed to be of higher pitch than a tone-datum of pitch P. New, since the only criteion which we are ever given for the subliminal difference in intensity or quality

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which is noticed to be of higher pitch than a tone datum of pitch P, but which is not of noticeably different pitch than a datum of pitch P. Now, since the only criterion which we are ever given for the subliminal difference in intensity or quality of sense-data, other than tests which bring in such extraneous matters as the physical intensity of the stimulus producing a given sense-datum, is that there is some datum distinguishable in intensity of quality respectively, from one of the original sense-data, and indistinguishable from the other, and since the sole way we have of discriminating the genuine acquipotence of two data from the relation which holds between them when they are not noticeably different as to intensity or as to quality is that in the case of true aequipotence of there can be no subliminal difference between them in respect to intensity or quality, we may define the acquipotence of a and b in a given respect as that relation which holds between them when all the data which can be discriminated from a /in that respect can also be discriminated from b and vice versa. Moreover, if Weber's law holds good, or any similar law which makes it impossible for the upper or lower limina of discrimination from two sense-data produced by stimuli of different intensity/to coincide, then we can easily show that this definition of acquipotence has the desirable property of rendering two sense-data acquipgtent when and only when they are produced by stimuli of the same physical intensity.

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We have, then, shown how the notion $d\mathbf{r}$ a sensation-intensity or quality of a given range can be analysed in terms of the relation which holds between two sense-data of the appropriate sort when one is noticeably different from the other in regard to its intensity or quality. This relation is manifestly derived from that which holds between one datum and another when the first is noticeably of greater intensity, or higher pitch, more vivid hue, etc. than the second. I am not meaning to say that we may not have some sort of a direct experience that <u>a</u> is of <u>different</u> intensity or pitch, ste., from <u>b</u> spart from any experience that a is of greater or of less intensity, higher or lower pitch than b, but it seems to me fairly obvious that we usually have some experience of the direction of the difference between a and b when we experience them as different, and often what we mean to assert in saying that they are felt to be different is that one is experienced as noticeably more intense or of noticeably higher pitch, etc., than the other. These relations of noticeably greater and less in intensity, noticeably higher and lower in pitch, etc. whether they are given as such in our experience or not, are certainly far more primitive than any experience we ever have of a sensation intensity. If we take the latter as a property: namely, the property of being acquipttent with a given sense-datum in a certain respect, then whatever we seem to know about it is simply a paraphrase for certain things we know about certain sense-data and the relation of inoticeably more intense than', since we know the relation of acquipotence only as a function of the latter relation. If a sensation intensity be taken as a class of sense-data, determined by the relation of acquipotence with a given sense-datum, then since, as Mr. Russell has pointed out, a proposition, about a class does y <u>Principle</u> Mathematica, Witched & Russell, #202 introduction. not really concern the class at all, but only the property by which the class is defined, our knowledge of sensation-intensities is even more a knowledge by inference, and the sensation-intensities themselves are even furtherkfrome being presented to us than if they were properties. It seems to me, moreover, that the sort of inference through which we know that a given sense-intensity is different from another is not of fundamentally different character from that through which we know anything at all about a sensation-intensity. Since sensation-intensities and qualities, in the only sense in which anything which Stout or Stumpf says demands that they exist, are not ever presented to us, it follows that Stout's argument in favor of 'mere' sensations is utterly without any point

In order that sense-intensities and qualities may have those properifies usually associated with their names, it is necessary that in some sense they should form series, in which a greater intensity always follows allesser one. Interpreting this statement in logical terms, it means that there must be a relation, such that:

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- (1) Its field is a class of sensation-intensities of a given kind,
 7 he field of a relation is the close of entities which forth into the relation.
 (2) if it relates a sensation-intensity & to another sensation-intensity
- (2) if it relates a sensation-intensity α to another sensation-intensity say β , we should naturally say that β is a greater intensity than α
- (3) if it relates α to β , α cannot be the same as β_{1} ,
- (4) if it relates \propto to β and β to γ , then it relates α to γ , and,
- (5) if α and β belong to its field and are distinct, then it either relates α to β or β to α .

Let it be remarked to start with that the relation, noticeably less than between sense-data, although it satisfies (3) and (4), fails to satisfy (1) and (3) and (5). Now, how are we to find such a relation? If we turn back to the argument of Stout and Stumpf, we shall find the answer P and P , yourremember, were taken to this question very readily. to be 'tones' indistinguishable directly from one another, and some Pienes takentah indistinguishable from P , but noticeably higher in pitch than P Stout says that P is really higher than P. The relation which one sense-intensity of a given sort has to another intensity of the same sort is, then, taken by Stout to be a 'greater-than' relation when some datum of the first intensity is not noticeably different in intensity from some datum which is of noticeably greater intensity than some datum of the second intensity. It will, if Weber's law be true, be a sufficient condition fort one datum tele more intense than another if this relation relate the second datum to the first, but it need not be a necessary condition. Our ranges of sensation-intensities do not go on in infinitum: sooner or later, in ascending such a range,

we find an experience such that there is no other experience noticeably more intense than it. It will be impossible to arrange one such experience before another by the criterion we have just discussed, for our criterion consists in discovering whether there is some datum noticeably more intense than one of these, and indistinguishable in intensity from the other. Nevertheless, it seems natural to call one latum really more dintense than another if there is some datum only subliminally less intense than the second and noticeably less intense than the first. This criterion is irreducible to that already given, and may hold between two experiences of such intensity that there is nothing noticeably more intense than either. Let us, therefore, define the relation, Lless intense than!, among sense-data of a given kind, as the relation between ondatum and another when De, is either indistinguishable in the appropriate respect from some datum noticeably less intense than the other, or is noticeably less intense than some datum indistinguishable from the other, and one intensity less than another if some member of it is less intense than some member of the other.

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This relation 1 less than' among sensation-intensities evidently has the properties which we numbered (1) and (2) above, whatever properties the relation 'noticeably less intense than' may have (3) is satisfied on account of the definition of the relation: for suppose that \propto stands in this relation to α - then there is a term belonging to α which is noticeably more intense, or noticeably less intense, than some sense-datum indistinguishable from another member of α . It follows th that there are two terms of α which are not acquipotent, for x and yare defined as acquipotent when and only when all the terms noticably different from x are noticeably different from y, and vice versa. Now, a sensation-intensity is defined as the class of all sense-data possessing a certain **sort** of acquipotence with a given sense-datum, and it follows from the definition of acquipotence that if \underline{x} is acquipotent with \underline{y} and \underline{y} is acquipotent with \underline{z} , \underline{x} is acquipotent with \underline{z} . We thus show that it is contradictory, according to our definition, for \underline{c} to be a greater intensity than \underline{d} .

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In a similar manner, we show that it is logically demonstrable that (5) is satisfied by the relation 'greater then' among sensation-intensities. For, if two sensation-intensities are different, as the relation D acquipotence is transitive, some member of the one must not be acquipotent with some member of the other. That is, some member of one must not be indistinguishable from some member of one must be either noticeably more intense or noticeably less intense than something indistinguishable from some member tof the other. Therefore, by the definition D 'less than', one is less or greater than the other, as some member of it is less intense or more intense than some member of the other.

In a similar manner, it can be shown that a sufficient condition Fort (4), be satisfied is that the relation between \underline{x} and \underline{y} when \underline{x} is more intense than \underline{y} , be transitive: that is, that if \underline{x} bears this relation to \underline{z} , and \underline{z} bears it to \underline{y} , \underline{x} bears it to \underline{y} . This relationwe assume in our everyday life to be transitive.

We have seen, then, that under a single hypothesis of a very general nature almost certainly satisfied by the relations, 'is a noticeably brighter than', etc., the relation between the sensation-qualities and intensities in question which we have defined as 'is a less degree of pressure than', 'is a lower pitch than', 'is a smaller degree of brightmess than', will generate the series of pressures or tones or brightmesses; , as the case may be.

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9 Let it be noted, however, that our theory up to this point, has been purely ordinal, and that we have not said anything which will entitle us to treat these pressures, brightness and tones, as qualk ities. Such a theory can be developed, but it, far more complicated than that here developed, and it starts with tetradic relation, "the interval between Z and W seems greater than that between M and M2, r rather than, the dyadic relation, "noticeably more intense than". In our ordinal theory of sensation- intensities, not only are we not entitled to speak of sums or products of sensation-intensities, but we have not even any indication of any way to correlate the series of sensation-intensities with the series of real numbers, and to treat one interval between two sensation-intensities as equal to another. It is true that we are able to state one form of Weber's law in terms of the relation of noticeable difference between the sensations. We are able to say, for example, that if Z is a given sound-datum, evoked by a stimulus of g vibration per second, and Y a sound-datum evoked by a stimulus of n vibrations per second, and noticeably higher in pitch than X then, when X is fixed, the minimum or lower limit of M is constant*.

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* This, I remark parenthetically is the really correct formulation of Weber's law applied to "just noticeable differences" of pitch-sensation. It involves absolutely no teference to "just noticeable differences" for it may well be that there is no datum whose pitch is noticeably higher than that of X, such that no datum of lower pitch isnoticeably higher, than X. It also involves no reference to the constructions, we should termed tone-qualities.

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But it is by no means evident that we should take all "just noticeable differences" as equal. If we define all "just noticeable differences" as equal, then we have not yet found an unambiguous way of assigning a rael number to each sensation-intensity, which is one of the things we must be able to do in order to be able to regardit asaquantityse, for we are not thereby given any definite method of subdividing the interval between two sensation-intensities whose members are only subliminally different into equal parts. If, on the other hand, we take some method of measurement starting from sensation-intervals as primitive, and derive from the proposition that all "just noticeable metiocable differences" are equal needs experimental verification in he same sense in which Weber's law in either its quantitive or its non-quantitive sense needs experimental verification, and Weber's law may well beforue in one of these senses yet false in the other. So we see that the proper interpretation of the notion of sensation-intensity clears up many problems connected with Weber's law.

In conclusion I wish to contrast my method of handling the problem of sensation-intensity with that of Stout and Stumpf. Stout and Stumpf see a contradiction in the intransitivity of the relation "is indistinguishable from", and say that to resolve this contradiction, we must postulate differences of sensation-intensity where none are seen. They assume unconsciously, that is, that the differences of intensity between sensations are in the first instance differences between sensation-intensities. We take the differences of intensity as primitive, and derive the intensities as functions of them. They have to postulate that the indistinguishability of subliminally different sensations is due to our inability to perceive relations of difference which really subsist between them: to us the relation of indistinguishability is not merely an ill-perceived qualitative identity,, but qualitative identity is defined as a perfectly determinate logical function of indisting ishability. We postulate nothing, and need be bothered by no qualms of conscience as to the existence of t anything postulated: we construct all the relations and classes we need from a more relation, "noticeably greater than". This is the chief methodological point to notice in this paper, and is due to Mr. Russell.

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