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I. The end and aim of the study of hearing is to explain it. Everyone may be supposed to know what is meant by explanation, so that it is usually considered superfluous to state what that meaning is, especially in the introduction to a scientific book. We expect explanation to follow of itself from a full and correct statement or description of the facts and their connexions. Indeed a thinking mind usually desires no more than this. Not that the thinking mind delights in prosaic formulations. Far from it; it supplies for itself the poetry or the atmosphere; the mere statement of the facts and their connexions arouses this atmosphere. And by atmosphere we mean the sympathetic surroundings, kindred facts and connexions from other spheres of reality. Thus explanation seems really to mean the full and correct classification of facts and their connexions, so that they may be grouped by the mind along with already established sets of facts and connexions of a similar kind.

But more than this is usually required by the scientist. He has also to show how his system of facts is connected with those that surround it in the world of reality. Or if only a part of the events he is interested in can be fully and correctly described, he is required to show to the best of knowledge and belief what set of facts and connexions, or in a word what set of processes, already observed and familiar in other regions, occupy the unobserved regions of the events he studies. Or he endeavours to clarify his thought of one set of facts etc. by his already clear thought of other sets of facts etc. This effort of scientific thought is known as theory and in its incipient stages as hypothesis.

The study of hearing therefore begins with the statements of the facts of hearing and their connexions. These are wholly and solely matters of experience; they are psychical. For hearing means experiencing. A clear statement of these facts will call up in the mind of the thinking reader similar facts and connexions from other departments of experience, especially from the fellow processes of hearing,—the other senses. And here again these facts will be wholly and solely psychical. Where the facts of hearing cannot be observed or have not yet been successfully observed, the study of hearing will feel impelled to draw

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upon its knowledge of the other senses and so to form a complete statement of the facts of hearing that shall at least be most probably true. Thus far the study of hearing belongs to the science of psychology.

II. At the present time even this primary part of the study is full of the keenest disputes. Several reasons may be brought to account for the prevailing difficulties and doubts. The chief of them is the peculiar complexity of even the simplest auditory experiences, which makes their observation anything but easy. It is not only hard to arrange for the occurrence of an exactly simple sound by the isolation of its physical stimulus, but only a few persons possess the power of making fine and accurate observations on sounds, whether they happen to have educated that power or not. Complexity and obscurity are naturally increased manifold if they suggest the wrong atmosphere of classification. And this seems to have happened in the study of hearing in so far as vision has been held to be the pattern according to which the experiences of hearing might best be arranged. It seems probable that in another sense than vision or in a comparative inductive study of all the senses a better guide to the elucidation of hearing might be found. For we must expect similar parts of experience, in this case the various senses, to work in essentially the same way. Inductive methods are obviously best if the common essential functions of all the senses are to be separated from what is special to each and from what might mislead us, if we take any single sense as the standard and pattern for hearing.

It is a familiar fact that hearing depends upon the work of the ear and of the neural organs attached to it. The study of these is physiology. But the physiology of the ear finds itself very often unable to complete its statement of the facts regarding the working of the ear and its connected organs. It is forced to theorise about the remainder. And it naturally turns for information to the psychology of hearing. If our experiences of hearing are dependent upon the ear, etc., what is more likely than that the facts of hearing will make possible some good inferences regarding the functions of the ear, etc., which cannot be directly observed. But it is obvious that if we are to have good inferences, we must base them upon the best possible psychology. Inferences from one side dare not contradict facts of the other side, but facts of the one side, especially the simpler and clearer facts of experience that are direct objects of observation, form a rule or standard for the theory of the other side. Ultimately we expect to find complete harmony
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between the two sides, the physiology of the ear and the psychology of hearing. And, of course, the more advanced and complete study will tend to lead the way. That is at the present time undoubtedly the psychology of hearing.

Let us then see what the psychological study of the other senses may lead us to expect of hearing. The senses may be divided for this purpose into three groups.

III. The first group contains the senses that are distributed generally throughout the body, especially over the surface of the skin and the underlying tissues and in various other parts. These are called the cutaneous and visceral senses, and include the senses of pain, touch, cold and warmth. There never has been any doubt about their great psychological similarity. They can be described in almost the same terms, and if we omit unimportant variations of degree and frequency, they can be easily included under one formula. Let us consider the nature of these terms and of the resultant formula.

The difference that is immediately evident to us between pain and touch, or between either of these and cold or warmth is called a difference of quality. We do not usually look upon cold and warmth as being so different from one another as they are from pain and touch, but there can be no doubt that once we compare them with such differences in mind, we must admit that they are very different from one another and really have nothing in common. We therefore say that warmth and cold also differ in quality, though we may readily allow that they may be more akin to one another than they are to the others. We are for the moment less concerned with their possible kinship than with their obvious differences. This difference is confirmed by the fact that warmth and cold are acknowledged to be physiologically separate senses. That applies in fact to all four—touch, pain, cold and warmth. Physiological research has recently discovered that each of these senses seems to be served by more than one set of organs or receptors, as physiologists now call them, in order to avoid the ambiguity of the word 'sense,' which is now used only in reference to experiences. The question thus arises: do these different sets of receptors for one and the same sense give sensations of different quality. And the answer is: no differences can with certainty or even with any probability be established. Thus we arrive at the highly probable conclusion: each of the cutaneous and visceral senses gives only one quality of sensation.
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A second way in which these sensations vary is familiar to every one; that is intensity. We know of course that various things may happen to make a pain more intense; the skin may be heated more, a thorn may be pressed more heavily on the skin, inflammation may increase, etc., but we never fail to recognise in all this that the mere ‘feeling’ of pain varies in intensity. We never confuse the intensity of the pain with the process going on in the skin, so as to say, for example: ‘pain has no intensity; it is only the process on the skin that has intensity.’ The same holds for all the other sensations of this first group.

IV. It is quite easy to recognise that quality and intensity are attributes of sensation, and these two form the nucleus of probably every list of attributes. The constant disputes that have attended the formulation of a list of attributes are concerned with the various additions to this nucleus that have from time to time been proposed. Even yet no list has been definitely accepted by the majority of psychologists, so that the science of psychology is still devoid of any precisely formulated and methodically established foundations. The cause of this lack of agreement is to be sought in no simple confusion of thought, but in a fundamental weakness of method, namely in the assumption that, since the two attributes of quality and intensity are acceptable and accepted as they come and appear to our untutored observation, all other attributes must also be taken over from among the details of our sensory experiences as they are found and appear in our search. But this assumption ignores the possibility that while quality and intensity may be very simple and are almost never complicated attributes, some or all of the others may always be wrapped up in the complications and modifications which experiences produce upon one another. And that is just what the method we are to follow teaches us to believe to be true.

One list of attributes for example would propose to add ‘localisation’ as a third to its list, since all sensations have some kind of localisation, although some of them seem to have a much more precise and ready localisation than others. Another list would exclude ‘localisation’ because the localisation of sensations varies and so seems to be due to something else, and not itself to be a primary attribute. Why not suppose it then to be a product of the bunching together of quality and intensity, exclude it from the list, and adopt the attribute of extensity instead? The objection to this fourth attribute is that it
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would force us to classify the extensity of pain and touch with the volume of sounds and would leave us inquiring as to the extensity of smells. Not that such a classification is wrong, as we shall see, but no good reason was given for classifying things together that seem so different.

Some lists have included feeling-tone, using this peculiar term to express in one word the two variations of feeling-tone—pleasantness and unpleasantness. But most psychologists agree that feeling-tone cannot be an attribute. For why should it have two forms? Are not these forms more different from one another than are the variations of the intensity of either of them, say pleasant feeling-tone? And if intensity is already in the list, why is it brought in here a second time with another attribute? And why does pleasantness not pass gradually into unpleasantness without passing through a stage in which there is no feeling-tone? (Some psychologists have invented an ‘indifferent’ feeling-tone to fill up the gap.) But if the feeling-tone can be absent altogether, can it still be an attribute? Psychologists seem to have agreed in this case that if a given sensation possesses any attribute, that attribute cannot be made to disappear without the total disappearance of the sensation itself, and that therefore feeling-tone cannot be reckoned an attribute of sensation. These reasons do indeed seem to exclude feeling-tone altogether.

Let us consider more closely the axiom just stated: a sensation disappears if its attribute disappears. Why? Because whatever thus comes and goes without detriment to the continuance of sensation cannot really be a property of sensation but must be adventitious to it or a product of the complication of sensation. Against this it is vain to urge that even the obvious quality and intensity are intrinsically detached from one another and devoid of inner connexion. For even if we do fail to grasp their inner connexion, we are none the less concerned to discover which attributes form a constant group in the sense of the axiom. Nor does it really matter that in the course of the briefest observation, lasting a fraction of a second, the attributes are not always all observed to be present. That may be due to the rapidity of observation and not to the absence of the attributes. We are searching for firm ground upon which to build psychological theory; and if a constant group of attributes occurs, that is of the highest importance for theory, whether very brief duration seems to destroy the constancy of the group or not.

The axiom thus becomes in the first place a verbal definition: the
attributes of a sensation are to be those attributes that on sufficient observation are always found together. But certain discoveries would turn it into much more than this—into a real definition. One of these is the constancy of this group of attributes, not merely for one and the same sensation, but for all kinds of sensation. The first axiom would then take on much wider scope and become: if any one sensation has a certain attribute, so has every other. Or: only those attributes are to be held to be the real attributes of sensation that on sufficient observation are found together in all sensations; and there are such. The second discovery is the different psychical status and origin of the inconstant features of sensation that we might feel disposed to call attributes. Thus we should obtain with unimpeachable methods a sure ground for a purely psychological theory of sensations and allied experiences. We may therefore proceed, remembering that attributes other than quality and intensity may not appear in so uniform a guise and that if our determination of attributes is to give us a good foundation for a science of sensations, each attribute to be possible must be discoverable in every kind of sensation.

V. A third way in which the sensations of the first group vary is their localisation. Pain, touch, cold and warmth are always clearly, and often very distinctly, localised. And it is easy in the case of these sensations to show that localisation is an experience. When one has toothache or rheumatism, for example, one can hardly ever in any way see where the pain is. Without exploring the skin for tender spots, one feels the pain ‘somewhere’; and rheumatism often flits about in spasms from one place to another, each twinge of pain at once marking itself out from the others by its localisation. And pain often seems to be in the wrong place. Cases are familiar in which pain is localised in the fingers and toes of a lost limb. The pain somehow appears as if it were in the lost member. Localisation is therefore a feature of experience that can be denied as little as can pain itself no matter how ‘wrong’ it is.

But localisation is not therefore an attribute of sensation. Touch, pain or cold are merely what they are; we ask for no more enlightenment about them when we have them; we take them just as they are; we do not need to refer to touch when we name pain; and pain is not any more truly pain after we compare it with touch or cold, than before; reference to touch is only a way of bringing the difference of quality logically clearly to mind. Not so with localisation: we cannot even
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experience, far less think, the localisation without some reference in our experience to the painful part, toe or tooth. If we could completely isolate a sensation, it would have no localisation. But there must be something in the sensation which justifies its getting a localisation; if we cannot localise one pain in a finger and another in a toe without some conscious awareness of these parts, by thought, or mental image or the like, there must nevertheless be some difference inherent in each pain, in virtue of which it can be referred to the correct part. This difference would be an attribute, possessed by the sensation without dependence on any other experience.

How shall we name it? That depends upon whether the supposed attribute is simple and primary or complex and derived. The schools of psychologists have divided on this alternative and have even received distinctive names, the genetic school holding to derivation and the nativist school to primacy. The former school urges that localisation may be derived by association from combinations of the qualitative and intensive differences already admitted. But it has never succeeded in showing that there is in existence a fraction of the variations of quality and intensity which would be required to account for all the variations of localisation which occur. Nor has it established any convincing theory of the means by which the association of these differences come about. Association merely begs the question. What we need to know is how a particular quality comes to attach itself by association to a particular intensity, when both are given. If we say: ‘Well, aren’t they at the same place?’ we merely beg the question. For if localisation is derived, they have of themselves no place at all; they are merely a quality and an intensity. And lastly even if they did hitch on to one another somehow, why should that give rise to a localisation? Why not to a feeling, or an idea?

The genetic school is thus defeated at every point, and the field is left to the nativistic theory. It claims no miracle of unfounded association and transformation. It is true a development must be admitted: the primary attribute develops into localisation. But how it does so is a problem which may be left for later study. Looking at the development backwards in order to determine the nature of the attribute out of which localisation develops, nativism claims that the primary attribute has a psychical kinship with localisation; it is like the latter. Is it justified in doing so?

Most assuredly. For we can readily in thought strip from localisation its garment of reference, considering only the primary differences
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upon which it rests. We can do so in observation as well. Let the forefinger of each hand be touched. Cease to consider the spots as being in the fingers and consider only their inner differences, staring at them as it were, as one does at times with the letters or sounds of a word, when they lose their meaning and become so oddly absurd. Their differences as mere sounds stand out more clearly than usual. So with the touches: we notice a primary inherent difference between the two which seems best describable as a difference of order. It is the same kind of difference as that between one and two, between first and second.

Thus we may conclude; every sensation of any sense of the first group differs from every other in respect of the attribute of order, as we may see from the differences of localisation that are so obvious in these senses. The careful and correct study of this attribute is of vital importance for the psychology of hearing as of many other departments of experience.

VI. A fourth attribute is closely connected with order. But its distinction and its study will for that reason be much easier. When we put a hand into warm or cold water, we have a mass of sensation varying in extent as more or less of the hand is immersed. Now although the extent of the cold or warmth varies, each experience is alike in being extensive. Each extent of cold or warmth feeling is just as extensive as any other. This extentivity is not so closely bound up with localisation, as with primary order; for we should hesitate to say a localisation was extensive; space is extensive, so is a finger or a toe; but a touch’s reference to a point of space or to the finger or toe is not extensive; only the touch is extensive. In other words spatiality is not implied in extentivity any more than it is in mere order.

The seeming independence of extentivity and localisation may largely account for the fact that extentivity and its temporal counterpart, durance, usually appear even in those lists of attributes that do not contain localisation or order. Given extentivity, those of the genetic school thought it possible by one means or another to manufacture positions within it out of the natural groupings of differences of quality and intensity. W. James, who was a nativist as regards extentivity, thought that the perception of positions within it resulted from subdividing (36, 73). But a moment’s consideration shows that orders cannot originate from mere extentivity. We could make tactual or visual areas of the same size all over the sensory field; but they would be identical, unless they included differences of order. Even an increase
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of extent is unthinkable apart from inherent differences of order. Of course differences of quality and intensity which accompany ordinal differences may draw the attention powerfully to the latter; but they cannot create them. Probably James felt this in some vague way. He said (36, 79): “he who will have thoroughly answered this problem of discrimination, will have laid the keel of psychology.” Well, one beam of that keel is a nativistic attitude towards order as well as towards extensity.

Two other attributes remain that concern our awareness of time and its differences. They are very clearly akin to the attributes of order and extensity. They may be termed order and durance. To distinguish temporal order from the order upon which localisation rests, the latter may be called systemic, as it is the order that appears when a system of receptors yielding one quality is given. But, as the psychology of hearing is in no way seriously affected by the distinction and study of the temporal attributes, important as they are in themselves and for experience in general, we shall omit any further reference to them. Our attention will be confined to the first four attributes—quality, intensity, order, and extensity.

The sensations of taste may conveniently be added to those of the first group. They present no new feature of psychological interest unless it be their variation in quality. Tastes occur in four qualities, sweet, sour, bitter and salt. Although we seem to have as good reason of a physiological kind to call them the qualities of independent senses, as in the case of warmth and cold, most people would deem the qualities of taste more akin to one another than those of the cutaneous senses. Unfortunately we have as yet no other means of gauging the kinship of different qualities than our direct introspective impression of their kinship. Thus far at least the rule holds that for every physiologically independent sense only one psychological quality occurs.

VII. The senses of the first group detach themselves from the others chiefly because the study of the attributes of sensation in them presents least difficulty and so formulates the problem to be pursued through all the other senses. This clarity and simplicity are doubtless due to the comparative physiological simplicity of their receptors and to their cognitive functions in dealing with the objects immediately surrounding the body. They are known to physiologists as the simple exteroceptive senses. A second group of senses is naturally formed by the receptors of the body (known as proprioceptive and interoceptive) that obtain
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for cognition data regarding the states and operations of the body itself and regarding the stimuli that affect its inner surface, i.e. the alimentary tract exclusive of the parts near the month. But as these states and operations are for the most part controlled without the aid of cognition, it is not surprising to find that the sensations of this group are in various respects obscure and difficult of study and somewhat complex. But we have every reason to believe that the formula derived from the first group is perfectly adequate to the second group. This includes the articular, and the muscular (proprionceptive) senses, and the large group of the organic (interoceptive) senses (106, 317 t., 336 t.) (that are stimulated by emptiness or fullness, filling or evacuation, of various organs).

The articular sense provides data dependent on the relative positions of the jointed limbs. It is physiologically distinct from the senses of the first group, more particularly from touch. We have no reason to suppose that more than one quality occurs in this sense. Of the other attributes intensity is the most obscure. This is almost certainly due to a want of variation in the physiological conditions upon which that attribute is dependent, and not to its psychological absence. If a limb is placed very comfortably and in perfect relaxation, awareness of its relative position gradually disappears entirely; but it is at once restored by renewed innervation. A uniform intensity would be cognitively irrelevant and therefore introspectively indefinite.

But we have still to deal with the datum of position conveyed by this sense. And our thoughts naturally turn to the attribute of order. Could it be the basis of position? To this proposal, we must surely assent. For just as in the case of localisation, position includes a system of orders and yet is more than that; it is position of the limb. To get a notion of the primary underlying attribute we must omit the phrase ‘of the limb’ and express the sensory datum as ‘order of articular quality of uniform intensity.’ Our awareness of the relation of this order to a certain limb must be gained from it by our somehow collating it with other orders. The same applies to our awareness of the particular limb to which the positions apply. In both cases we need presuppose in the sensation nothing but sets of articular sensation of different orders. And the different extents of these sets, e.g. in the contrast of the sensations from a large joint with those from a small one, point us towards the attribute of extensity.

The muscular sense provides an interesting variant upon the obscurities of the articular sense. For while it also has only one quality,