blind from birth by double congenital cataract, was operated on at the age of six years. After removal of the bandages she saw at once, and without learning by experience, all things in their proper positions. Perception of *direction and position* was immediate, but not so the perception of the *relative distance* of objects. The former is a primary gift of sight, the latter a judgment and must be acquired by experience.

In this controversy we have again repeated the three old views on this subject. 1. The *nativistic theory:* It is a direct endowment of the eye or the brain, and there an end. This is the usual popular view. 2. The *empiristic theory:* It is acquired by individual experience, as we acquire the proper manipulation of the glass slide under the microscope. This is Prof. Minot's view. 3. The *metaphysical theory:* It needs no explanation at all. There is no such thing as up and down for the soul. This last we put aside as not a scientific solution. As to the other two, they are completely reconciled and the question, it seems to me, solved, as so many other vexed questions are solved by evolution. It is acquired—yes, but not by individual experience. It is inherited—yes, but not without experience.

Now, as to the legitimacy of my own explanation. A similar acquisition of ideas of direction or position in space by ancestral experience inherited and fixed in structure has taken place in all the senses, but especially in senses of touch and sight. Is it not legitimate to reduce these or their physical concomitants to a common law? Prof. Cattell (SCIENCE for Nov. 15, p. 668) objects that the different sensations are wholly *disparate* and, therefore, they cannot be explained the one in terms of another. This is true of *sensations proper*, such as light, color, sound, contact, etc., but it is not true of *direction* and *position*. These are not sensations; they are not peculiar to one sense. These are ideas underlying all the senses, gradually grown up in the mind as the result of deliverances of all the senses. They are not disparate for different senses. These ideas of direction and position in space are indeed purely psychical, true; but ought we not, if possible, to reduce their physical concomitants to law? This is what I have attempted to do.

I do not, of course, hope to settle this question to the satisfaction of all. I only wish to show that my explanation is not illegitimate as Prof. Cattell thinks, nor unnecessary as Prof. Minot thinks.

In conclusion I confess I do not quite see the relevancy of Prof. Minot's parenthetic remark. I do not see in what way the turning back of the retinal fibres to end in the rods and cones in vertebrates—though not in invertebrates—can affect the question of reference back along the ray line.

JOSEPH LE CONTE.

BERKELEY, CAL., November 29th.

MOUNTAIN CLIMBERS AND THE PERCEPTION OF DISTANCE.

TO THE EDITOR OF SCIENCE: I do not know that the attention of psychologists has been sufficiently called to the experience of mountain climbers as bearing on the problem of the perception of distance. Both Sir Martin Conway in his recent book, 'The Alps From End to End,' and M. Bonvalot in his book, 'Across Thibet,' have some suggestive remarks of the same general tenor on this subject, but I will quote only those of M. Bonvalot, as they seem on the whole the most pertinent. Speaking of the highlands of Thibet, he says: "It is difficult to imagine how hard it is to find one's way among these highlands, where a man loses all sense of perspective, his eye wandering over immense spaces without seeing, at given distances, either trees, houses, human beings, animals, or edifices the height of which is known to him. It is by the incessant and unconscious comparison of such objects as these that he has learned to form an idea of distance. Here in the desert we have in a few weeks lost this sense of distance which we had gained by the experience of our lifetime. All that one sees is so alike; one hill is like another; according to the time of day a frozen pool either sparkles in the sun or disappears, so that one does not know whether it is large or small; a little bird fluttering its wings upon a clod of earth looks like a wild animal which has been lying down and is getting up; a crow flying away with its prey in the morning mist seems to be a gigantic condor carrying off a lamb in its claws, while at sunset this same crow, cleaning itself on the

summit of a rock, looks the size of a yak or a bear."

It is plain from this experience that M. Bonvalot happened upon a new spatial world of size and distance, which he had to learn by a method of local visual signs, just as in infancy he learned the space world of the nursery room. It would be interesting to inquire of such travelers the exact nature of the signs they used in constructing the new space world.

HIRAM M. STANLEY.

MR. SPENCER ON TACTUAL PERCEPTION AND 'NATURAL SELECTION.'

MR. SPENCER concludes his long discussion on 'Natural Selection' by a short note in the October number of the *Contemporary Review* in which he claims that he has received from Prof. Weismann no answer to the crucial question he asked in his original paper (*id*, Feb., 1893). Mr. Spencer writes:

"But the main question he has every time passed over in silence. To my repeated inquiry—*How are the various degrees of tactual discriminativeness possessed by different parts of the outer surface of the body to be explained by 'natural selection' or by 'pannuxia'?* he has not only given no answer, but he has made no attempt to give an answer. The obvious implication is that no answer can be found."

Now, as I have already attempted (*Mind*, Oct., 1893,) to prove that Mr. Spencer's arguments from tactual perception are futile, and as his reply (*Contemporary Review*, Dec., 1893,) shows that he is not likely to be influenced by such evidence as I am able to adduce, I do not return to the subject in the hope of convincing him. I may, however, be able to show others that the facts of tactual perception have no special bearing on the sufficiency or insufficiency of natural selection.

Mr. Spencer found that the sensation areas (the distance apart at which points on the skin can be distinguished) on the tips of the fingers of two blind boys were $\frac{1}{14}$ inch and of two compositors $\frac{1}{17}$ inch, whereas Weber gave $\frac{1}{12}$ inch as the normal size. Mr. Spencer concludes from this experiment that the structure of the peripheral nerves and their connections are altered by use, and that these modifications of structure are hereditary. The fact that the tip of the tongue is more sensitive than the tips of the fingers is said to be because the tongue is continually exploring the teeth, although no advantage is gained thereby; the nose is more sensitive than the top of the head because it is more often rubbed by the fingers, etc. Mr. Spencer says that as the sensitiveness of the tip of the tongue is less important to man than sensitiveness of the finger tips it is impossible that the greater sensitiveness of the tongue could have been developed by the survival of useful variations.

Now this argument is such that the only reason for replying to it is that it is advanced by Mr. Spencer, whose contributions to philosophy are on the whole so important, that his utterances on special matters carry weight that they often do not intrinsically possess.

The experiments and theories of Weber have long since been superseded. Many thousands of experiments on tactual discrimination by a score of investigators have been published, and of these Mr. Spencer is ignorant. It is well known that the tactual discrimination of the blind is likely to be greater than that of others, but this could not have been determined from an experiment such as Mr. Spencer made. Tactual discrimination decreases in five minutes' practice far more than the amount given by Mr. Spencer as the greater sensitiveness of the blind; but this does not mean that the anatomical structure of the peripheral nerves has been modified, and that this modification will be hereditary.

The distribution of tactual discrimination on the skin seems to be exactly what would be expected were 'natural selection' a sufficient or an insufficient account of organic evolution. The parts of the body in which sensitiveness is most useful, the finger-ends and the tongue, are in fact the most sensitive.

There are two adequate reasons why the tongue should be more sensitive than the fingers. In the first place the lower mammals use the tongue as an organ of touch, it being far more sensitive than their hoofs or paws; a horse will reject the smallest bit of gravel from its mess of oats. As sensitiveness of the tongue is extremely useful to man for mastication and speech it is natural that the delicacy early de-