THE SKIN

June - 1941 Vol. 2 No. 9

Samuel Renshaw, Ph. D.
Ohio State University.

Extensity is an attribute of all visual and of all haptic experiences. In order to understand, in simplest and clearest terms, the visual space world we start with the skin.

The reason we begin with the skin is because a large amount of the visual discrimination of position, size, distance, movement, etc. derives from cutaneous, kinaesthetic and motor sources. These components are often wrongly ascribed to vision. Later in this paper we shall describe some simple experiments by means of which you may demonstrate the important role played by the skin in space discrimination.

Psychologically space is originally derived from sight and pressure. With increased age and experience these two functions become fused or blended so that they tend to become more and more interdependent. In physics and geometry there is but a single space and this always and everywhere the same. In psychology there are four spaces: the two dimensional fields of the skin and the resting eye, and the three dimensional spaces of active touch and the moving double eye.

From this point of view the last statement is entirely too conservative. The spaces yielded by the finger, the lips, and the skin of the shoulder blade are three different things. The space of foveal vision is not the space of peripheral vision. Further complication of the problem arises from the fact that fineness of discrimination in any region of the skin can be greatly extended and improved through appropriate training procedures. This must mean that space is an achievement. We learned to construct our world of space discriminations in terms of the consummatory acts and not in terms alone of the patterns of impression which reach our sense organs. The skin becomes increasingly important for students of vision when we understand that it is not only the most extensive of all the sensory surfaces but that practically all of the sensory functions have been developed from it. It includes not only the integumentary covering of the body but also the red area of the lips, the lining of the cavities of the mouth and nose, and the conjunctive and cornea of the eye. Thus every postural adjustment of the visual receptor involves a component of cutaneous stimulation.

Our knowledge of the skin and its functions is still incomplete. About 50 years ago Blix in Sweden, Von Frey in Germany and Donaldson in America independently discovered that the skin, like the retina, presents a distribution of punctiform sensitive points. When the threshold for pressure is studied by carefully exploring a unit area of some skin surface great differences are found. If a horse hair about two inches long is fixed to a match stick with a drop of sealing wax and is pressed down on one pan of precision balance a series of such hairs can be found and calibrated which will just bend when the weight of one mg. is placed in the other pan, and at the other extreme one can be found which will raise 200 times as much. Another method is the use of a limen gauge by which the pressure which

which must be exerted to just perceptibly be discriminated is measured by the amount of energy stored in a small coiled spring. On the tip of the tongue, pressure of 2 gms. per square mm. is the approximate threshhold value. On the tip of the finger this is about 3 gms., on the back of the hand 12 gms., on the calf of the leg 16 gms., on the abdomen 26 gms., on the back of the forearm 33 gms., on the loin 43 gms., and on the thick parts of the sole of the foot 250 gms. Von Frey showed that for pain a pressure of 0.2 gms. per square mm. on the cornea would produce pain. Areas on the back of the hand require a pressure of 100 gms. If a square cm. is carefully explored on the tip of the nose the following distribution of sensitive points has been found:

Pain	Pressure	Cold	Warm
44	100	13	1

On the back of the hand the figure are:

Pain	Pressure	Cold	Warm
188	14	7	0.5

These examples are given to show the unevenness of distribution of sensitive spots in the skin. If an area of one square cm. is thus carefully explored and a map is made indicating the position of the sensitive points and this is done repeatedly for the same area no two of the maps will look alike. This means that on two successive days the number and spatial distribution of sensitive points does not remain fixed. In one famous experiment (Dallenbach, 1927), the sensitive spots were carefully mapped a considerable number of times and those points located which gave a qualitative report 100% of the time. The square cm. of skin was then surgically removed and carefully stained and sectioned histologically. It was then examined under the microscope to see what types of specialized nerve endings could be found to correspond with the sensory qualities yeilded by the various spots. The results of this examination showed first, the presence of almost no specialized nerve endings and second, almost no relation of the position of the dendrites in relation to the snesitive points.

Facts such as the above take on a great importance when we consider them in relation to the fundamental problem of cutaneous and visual space. The resolving power of the skin or retina is exhibited by the ability of an observer to be able to report one or two points when the stimulus is a part of points with small separation. Secure a small drawing compass and grind the points until they are fairly blunt. Set the points about 6 mm. apart and starting at the tip of the middle finger with equal pressure draw them slowly over the finger across the palm, the wrist, the forearm, the elbow and stop about the middle of the biceps. Do this several times and observe that for a fixed distance between the two points they seem to approach each other until they seem like a single line at some positions and to diverge widely at others. Start with the same separation at the edge of the lips and pass slowly around the cheek beneath the ear to the middle of the back of the neck..It becomes obvious that when two points on the skin are stimulated whether we feel them as one or as two is determined only in part by the actual separation of the two points and in part by the region of the skin stimulated. From the best neurological sources the subcutaneous network of nerve receptors in a region of high threshhold does not differ materially from that in a region of low threshhold. It must therefore follow that the discrimination of twoness is a psychological function because it can be demonstrated that regions of low spatial sensitivity can be formed

into regions of high spatial sensitivity if appropriate training methods are used.

If various regions of the skin of the hand and forearm are explored for the two-point threshhold, it will be found that the threshhold will be smaller, the greater the curvature of the skin surface. On a flat surface such as the volar forearm midway between the wrist and elbow the limen will be found to be several times larger than in those regions where the skin surface shows greater curvature. There are several methods which may be employed in determining the least perceptible separation of two points to be perceived as two. One of the most accurate of these is the method known as the constant process method or the method of constant stimuli, where a series of separations varying in small degree is arbitratily selected. Each of these is carefully applied to the same region of the skin 100 times. The subject is required to report whether he feels one or two points. When the observations are all completed, you have two columns of figures; one indicating the actual separations in mm. of the points and another indicating the per cent of <u>two</u> judgments. When these are plotted with the separations on the abscissa and the per cent of positive judgments on the ordinates they should yield an S-shaped or ogive curve. The point at which one can judge the stimulus correctly half of the time is conventionally regarded as the threshhold. Students invariably report difficulty in determining the threshhold for two points because there is always present a marked practice effect, the influence of which is to produce more and more positive judgments with increasingly less separation. If a limiting method is used one starts with smaller separations and gradually increases them until the judgments become consistently two. The procedure is then reversed by starting with a large separation and gradually reducing this until the judgments become consistently <u>one</u>. If this is done carefully, it will be found that the threshhold yielded by the ascending procedure will not be the same as that secured by the descending procedure. The common practice is to list the boundaries of this range and take the midpoint as the value of the threshhold.

Great care must be exercised so that the two points reach the skin at the same instant in time and with identical pressures. Otherwise the judgment will be in error because in this case it will be formed on the basis of successive rather than simultaneous stimulation.

It is known that if a single point and later another point, slightly removed in space, is stimulated, the relative separation of the two points will be a function of the time and intensity relations of the two stimuli. If we assume that the actual separation is 20 mm. and the second point is stimulated one second after the first but with twice the intensity, the first point will seem nearer to the second one. It is easy to demonstrate the phenomenon which Helson has called the Tau effect. Select a flat surface on the volar forearm and stimulate pointA about 2 inches below the elbow, two seconds later stimulate point B with the same pressure 60 mm. toward the wrist, and four seconds later stimulate point C 30 mm. farther toward the wrist. Let A, B, and C lie on the same straight line. After these three stimuli have been applied, take a pencil and make three dots on a sheet of paper representing the phenomenal distances which separate these points. Measure them carefully and compare them to the actual separations. It will be noted that with intensity kept constant, it is possible by changing the timing to produce the same effect as if you changed spatial separation. This finding is of breat importance for it indicates that in experience, time, intensity and space all cooperate in the production of the ultimate phenomenal

discrimination. If this experiment is repeated varying the factors of time, intensity and spatial separation of the three points, you may demonstrate the essential truth of the interrelations of these variables. The studies on the problem of localization have been fruitful in teaching us many things about the genesis of tactual and visual space. In one of the papers last year a series of experijents were described in which localization of points stimulated upon the skin by children and adults were compared. A differentiating experiment was made in which the tactual localozation of congenitally blind children and adults was compared with that of seeing children and adults. The ability to localize a point stimulated is highly important as a factor in the correct perception of form and pattern.

From a flat sheet of soft thin copper, cut out a series of small forms such as squares, triangles, stars, crosses and similar shapes. Let them vary in total area as well as in shape. With the subject blindfolded, place these on various skin surfaces such as the volar forearm, the back of the hand, the palm, the tip of the finger, the center of the cheek etc., and press them gently but firmly into the skin with the tip of a lead pencil or small tweezers. The subject, of course, is blindfolded and is requested to describe or to draw the shape and size of the perceived figure.

These simple demonstrations should give you an introduction to the tremendously interesting and important investigation of the sense perceptual field afforded by the skin. This field is of primary importance for all persons who are ultimately interested in gaining a complete inderstanding of visual phenomena. The skin provides for us a ready means of studying the fundamental concept of extensity in relatively simple form. Visual extensity is not materially different. The conviction of the essential unity of the senses will grow more and more strong as these observations are extended and it will become increasingly clear that perception is essentially a unified process regardless of the sense modalities which contribute to it.

Finally it should be pointed out that in certain types of anamalous vision, the examination of the spatial sensitivity of homolateral skin areas becomes a most useful diagnostic adjunct. This is in line with the general view that the perfect eye examination of the future will not stop with differential procedures of measuring various aspects of vision alon. The ultimate answer to some of these problems will have to be sought in such functions as those which we have made the topic of our present discussion.