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PATTERNS OF PERCEPTUAL ORGANIZATION WITH SIMULTANEOUS STIMULI

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STUDIES of function of the nervous system by any one method will show patterns. This is a general law which applies to motor, perceptual, and psychic functions. Patterns of functions are present in the normal as well as in the abnormal state. For example, normal subjects show variations in the ability to discriminate two closely applied points in different regions of the body. Thus, the pattern for two-point discrimination is one in which the finest differentiation is at the tongue or finger tips, while other parts of the body, such as the back or the thigh, require a greater distance between two points before discrimination of "twoness" can be made.[1] According to Pearson [2] the pattern for the normal sense of vibration is one in which the threshold is low at the clavicle and high over the sacrum. In vision discrimination of targets under daylight illumination is best in the central, and poorest in the peripheral, portion of the perimetric field. And so it is with all other modalities. Each sensation has a pattern in space as well as in time. Each of these patterns is obtained by adopting procedures in which a single stimulus figure is used in testing the subject.

In measuring sensation, we know that there are many factors which influence the perceptual response. Intensity and duration of stimulus, the stimulus figure, the locus in the sensory field, the attention and intellectual capacity of the subject are but a few of the determinants. Recently we have stressed symmetry as having a bearing on perception.[3] Still another factor is age.[4] For instance, there are some perceptual examinations which could not be carried out in children because the ability to respond to these tests depends partly on the ability to concentrate on a particular problem and to cooperate over a matter of many minutes. These are two properties which most very young children do not possess. Moreover, we have found that reactions in the old are not the same as those in the younger subjects.

Another condition which influences the perceptual response is the number of stimuli employed at one time. Two stimuli when applied simultaneously may yield responses which are different from those to stimuli applied in succession. Simultaneous touch of the face and hand may be perceived only on the face, whereas when each of these parts is successively touched with an interval of one or more

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seconds, the same subject perceives each stimulus. The simultaneous application of more than two stimuli may yield other types of perceptual reactions. Cohn [5] applied three stimuli all at once and obtained results which were different from those elicited with conventional single stimuli in the same areas. In 1893 Krohn [6] investigated the effects of simultaneous touch stimulation of multiple (seven) regions of the skin in normal subjects. Parts of the trunk, extremities, forehead, and, at times, the chin were touched simultaneously by tambours. With these tests the subjects made errors in localization of the applied stimuli. However, no distinct pattern was sought. In analyzing Krohn's material, we found a suggestion of a pattern in that there were less errors over the back than over the front. This study was interesting but not very illuminating.

The technique of double simultaneous stimulation had been known since the time of Hippocrates. In 1882 Oppenheim [7] mentioned the method in his textbook. Since this description there had been few intensive studies of the method until 1943, when one of us began a series of investigations. During the past decade we have examined several thousands of subjects with this technique. As we gathered our data, it was noted that in tests involving asymmetrically placed stimuli certain regions of the body yielded correct responses, while others yielded consistently incorrect responses. On numerous simultaneous stimulations of the face and hand a distinct pattern of response has been observed in which errors in identifying and localizing the stimuli on the hand became apparent. Conversely, there were very few errors in perception of the stimuli on the face. In this test situation the face was "dominant" to the hand. Face dominance has been found in normal adults, but it is particularly evident in patients with disease of the brain, in very aged persons, and in normal children, 3 to 6 years of age. This pattern of response, namely, face dominance, has been found so consistently that it prompted us to study body combinations other than that of the face and hand. The object of this investigation was to determine the order of dominance when various combinations of two parts of the body were tested in this manner. A preliminary note on this study was reported at the 76th Annual Meeting of the American Neurological Association, in June, 1951.[8]

METHOD AND SUBJECT MATERIAL

The method of testing was the same as that described for the face-hand test in previous communications.[9] The subject was requested to close his eyes, and two parts of the body were simultaneously touched or stroked. He was asked what he felt and to localize the stimuli. If only one stimulus was reported, the subject was then asked if another was felt.

The subjects used in these studies consisted of patients and normal adults and children. Series I: Patients who showed mental changes or an organic mental syndrome * as a result of disease of the brain, such as arteriosclerotic encephalopathy, senile psychosis, severe cerebral trauma, Alzheimer's disease, toxic encephalopathy, or brain tumor. In general, patients with severe mental changes who made many errors on simultaneous stimulation tests were chosen for a special study group. Patients with aphasia, hemiparesis, or a hemisensory defect were included in another group. Series II: Normal children and adults. The normal children were taken from a day-care center and an orphanage. The normal adults were patients on the wards of the general hospital, those attending hospital clinics, and Army inductees. None of the normal

* The mental changes which make up the organic mental syndrome consist of a combination of at least three or more of the following manifestations: impairment in orientation, memory, calculation, or general information; rigidity and concreteness in mental performance, and marked fluctuations and inability to perform when there is more than one aspect to a situation.

children or normal adults had manifest disease of the nervous system. They had not been previously examined by the method of double simultaneous stimulation. We also examined a group of older people. These were presumably normal, although cerebral arteriosclerosis could not be entirely excluded in people between the ages of 65 and 90 years. Series III: Patients with schizophrenia or manic depressive conditions. These patients were adults in the wards of the Bellevue Psychiatric Hospital and Manhattan State Hospital. No attempt was made to study the specific types of schizophrenia. Most of them were of the paranoid, mixed, or simple schizophrenic varieties.

Inasmuch as previous investigations have shown that patients with severe mental changes due to disease of the brain and normal young children made frequent errors in tests of simultaneous stimulation, it was natural that we should make the most extensive studies on these two groups.[10] Also, since normal adults make few errors after the first two to three trials on double simultaneous stimulation, it was not possible to detect a pattern in these subjects.

From these three series of cases we studied several groups in detail. Group A, which was studied in the greatest detail, consisted of 20 patients with organic mental syndrome (10 males and 10 females). These subjects were tested with the method of double simultaneous stimulation of different parts of the body and in multiple combinations. The following parts of the body were examined: face, shoulder, hand, back, breast, penis, pubic region in females, buttock, thigh, and foot. Patients were tested while they were completely nude and, for the most part, while they were standing. The specific areas stimulated for certain parts of the body were as follows: the dorsum of the hand; the dorsum of the foot; the anterior aspect of the thigh; just below the scapula on the back; close to the midline on the buttock; the nipple and areolar area of the breast; the lower quadrant of the abdomen; the tip of the penis or the mons veneris. Of these body parts there were 45 possible double combinations. It should be noted that the combinations were of regions distributed along the longitudinal axis of the body. Each patient was tested in all 45 combinations in a random but similar order. Twelve tests were done for each combination. These consisted of five tests of the two body parts in a homolateral relation, five tests of the two body parts in a heterologous relation, and two tests in a homologous relation, one for each of the body parts. There were 240 tests in every combination for the total group. Each patient received 540 tests.

The other group, Group B, which we studied in great detail, using thousands of trial tests, consisted of 40 normal children between 3 and 6 years of age. In 20 of these children (12 boys and 8 girls), all body combinations of two were tested except those involving the genital zone. In the other 20 children (12 boys and 8 girls), the genital region combinations were tested as well as some of the other body combinations. The testing was carried out in the same manner as described for patients with disease of the brain except that only half as many tests in each combination were done. The genital zone was usually touched directly, with the child partially nude. The remaining unexposed body parts were usually tested through the clothing.

To supplement these studies, we also examined a group of 692 normal adults, 605 schizophrenic adults, and 664 patients with organic mental syndrome. However, these subjects were not tested as intensively as those of the above two groups. Different body combinations were tested in different subjects. Only one of the following body combinations was tested in any one subject for 10 trials or more; face-hand, face-breast, face-penis, face-back, face-foot, face-shoulder, shoulder-hand, breast-hand, penis-hand, thigh-hand, foot-hand, thigh-foot, breast-foot, breast-thigh, buttock-foot, penis-foot, shoulder-foot, and shoulder-breast. The two parts of the body were first touched in two heterologous relations and then in the two homolateral relations. Particular attention was directed to the first response. If an error was made in any one test, that particular test was repeated until the patient was correct, or for at least five times if the error persisted. At least 10 trials were done on each patient. Stimulation of the unexposed parts of the body, except for the penis, was done through clothing. The penis was touched directly.

The pattern of dominance has also been studied incidental to other investigations on perception in groups such as Group C, comprised of patients with focal brain disease manifested by hemiplegia or aphasia [11]; Group D, patients with long-standing or congenital blindness; Group E, patients who had congenital or long-standing deafness; Group F, normal adults recovering from general anesthesia or while under the effect of intravenous amobarbital (Amytal) sodium [12]; Group G, psychiatric patients receiving electroconvulsive therapy; Group H, mentally

defective adults,[13] and Group I, very aged or senile adults.[4] It must be emphasized, however, that we did not test all the possible combinations of body parts in every one of these groups except in Groups A and B. The emphasis was mainly on determining the relationship of the face and the hand to the rest of the body areas. The results obtained in these incidental studies showed that the pattern of dominance was similar to the one obtained in this study of patients with severe mental changes due to disease of the brain.

RESULTS

The responses on double simultaneous testing of any two parts of the body fell into several groups. Using the face-hand combination as an example, the subject may report the following responses, as recorded in Table 1.

Responses in which there was extinction or displacement † of the stimulus over one area in any combination were tabulated as a single type of response. For example, in the face-hand combination responses in which the face stimulus was correctly perceived but in which extinction or displacement of the hand stimulus

TABLE 1.—*Pattern of Responses to Double Simultaneous Face-Hand Tests*

Combination of Body Parts	Possible Response	Classification	Dominance
Simultaneous touch of face and hand	(*a*) Face-hand	Correct	None
	(*b*) Face only	Extinction	Face
	(*c*) Hand only	Extinction	Hand
	(*d*) Face-face	Displacement	Face
	(*e*) Hand-hand	Displacement	Hand
	(*f*) Face-other part of body	Displacement	Face
	(*g*) Hand-other part of body	Displacement	Hand
	(*h*) Face-and a part in space	Exosomesthesia	Face
	(*i*) Hand-and a part in space	Exosomesthesia	Hand

occurred were tabulated together under "face" responses. Each of the responses indicates dominance of the face over the hand. Hence, the reason for grouping them under "face dominance." Face dominance responses were much more frequent than any of the hand dominance responses.

The responses for all the body combinations were tabulated in a similar manner. For the patients with organic mental syndrome and for the normal children tested in all body combinations, the "dominant" responses for one part of the body as compared with those of the other part of the body in each combination were analyzed by the *t* test. The initial responses of the normal and schizophrenic adults and of the other patients with organic brain disease tested in a single combination were analyzed by the method of chi-square. There were a small number of responses

† The failure of the subject to report one of two simultaneously applied stimuli has been called "the phenomenon of sensory extinction," or "extinction." The part of the body where the stimulus is perceived is said to be "dominant" to the part of the body where the simultaneous stimulus is not perceived. When the subject reports two sensations but mislocalizes one of them, the "displacement" of a percept is said to have occurred. Displacements are usually in the direction of the dominant stimulus and may be partial or complete. Occasionally, one or both stimuli are displaced into the extrapersonal space. This has been termed "exosomesthesia."[14]

TABLE 2.—*Responses of Twenty Patients with Organic Mental Syndrome to Simultaneous Tests of Different Body Combinations*

Face Combinations	Total Errors*	Dominant Responses: Face	Dominant Responses: Other Part	Genitals Combinations	Total Errors	Dominant Responses: Genitals	Dominant Responses: Other Part
Face-genitals	68	37	31	Genitals-face	68	31	37
FACE-abdomen †	109	78	31	GENITALS-abdomen	121	92	29
FACE-buttock	79	60	19	GENITALS-buttock	78	66	12
FACE-breast	122	104	18	GENITALS-breast	106	84	22
FACE-foot	89	66	23	GENITALS-foot	138	115	23
FACE-back	105	95	10	GENITALS-back	98	83	15
FACE-shoulder	154	127	27	GENITALS-shoulder	90	70	20
FACE-thigh	104	85	19	GENITALS-thigh	124	94	30
FACE-hand	149	145	4	GENITALS-hand	143	132	11

Hand Combinations	Total Errors	Dominant Responses: Hand	Dominant Responses: Other Part	Abdomen Combinations	Total Errors	Dominant Responses: Abdomen	Dominant Responses: Other Part
Hand-FACE	149	4	145	Abdomen-FACE	109	31	78
Hand-GENITALS	143	11	132	Abdomen-GENITALS	121	29	92
Hand-ABDOMEN	152	21	131	Abdomen-buttock	99	61	38
Hand-BUTTOCK	132	23	109	Abdomen-breast	111	55	56
Hand-BREAST	163	29	134	Abdomen-foot	104	46	58
Hand-FOOT	136	19	117	Abdomen-back	97	44	53
Hand-BACK	97	28	69	Abdomen-shoulder	90	58	32
Hand-SHOULDER	127	20	107	Abdomen-thigh	115	76	39
Hand-THIGH	142	28	114	ABDOMEN-hand	152	131	21

Buttock Combinations	Total Errors	Dominant Responses: Buttock	Dominant Responses: Other Part	Breast Combinations	Total Errors	Dominant Responses: Breast	Dominant Responses: Other Part
Buttock-FACE	79	19	60	Breast-FACE	122	18	104
Buttock-GENITALS	78	12	66	Breast-GENITALS	106	22	84
Buttock-abdomen	99	38	61	Breast-abdomen	111	56	55
Buttock-breast	94	55	39	Breast-buttock	94	39	55
Buttock-foot	118	43	75	Breast-foot	100	59	41
BUTTOCK-back	104	79	25	BREAST-back	77	55	22
BUTTOCK-shoulder	93	65	28	Breast-shoulder	121	52	69
Buttock-thigh	105	45	60	Breast-thigh	85	48	37
BUTTOCK-hand	132	109	23	BREAST-hand	163	134	29

Foot Combinations	Total Errors	Dominant Responses: Foot	Dominant Responses: Other Part	Back Combinations	Total Errors	Dominant Responses: Back	Dominant Responses: Other Part
Foot-FACE	89	23	66	Back-FACE	105	10	95
Foot-GENITALS	138	23	115	Back-GENITALS	98	15	83
Foot-abdomen	104	58	46	Back-abdomen	97	53	44
Foot-buttock	118	75	43	Back-BUTTOCK	104	25	79
Foot-breast	100	41	59	Back-BREAST	77	22	55
Foot-back	105	49	56	Back-foot	105	56	49
Foot-shoulder	96	51	45	Back-shoulder	131	78	53
Foot-thigh	125	77	48	BACK-thigh	127	86	41
FOOT-hand	136	117	19	BACK-hand	97	69	28

Shoulder Combinations	Total Errors	Dominant Responses: Shoulder	Dominant Responses: Other Part	Thigh Combinations	Total Errors	Dominant Responses: Thigh	Dominant Responses: Other Part
Shoulder-FACE	154	27	127	Thigh-FACE	104	19	85
Shoulder-GENITALS	90	20	70	Thigh-GENITALS	124	30	94
Shoulder-abdomen	90	32	58	Thigh-abdomen	115	39	76
Shoulder-BUTTOCK	93	28	65	Thigh-buttock	105	60	45
Shoulder-breast	121	69	52	Thigh-breast	85	37	48
Shoulder-foot	96	45	51	Thigh-foot	125	48	77
Shoulder-back	131	53	78	Thigh-BACK	127	41	86
Shoulder-thigh	93	58	35	Thigh-shoulder	93	35	58
SHOULDER-hand	127	107	20	THIGH-hand	142	114	28

* Two hundred tests done in each combination were analyzed statistically. The remaining 40 tests in each combination were of homologous body parts and did not lend themselves to this type of analysis.

† Capital letters indicate dominant part as evidenced by a *t* test value of 5% or less.

which were difficult to interpret, and there were a few that showed characteristic perseveration in behavior. These responses were not included in the statistical analysis.

Extinction and displacement occurred in all of the body combinations tested in all groups. The incidence of these phenomena varied with the method of testing. On testing body parts in a heterologous but bilateral relation, extinction and displacement occurred with approximately equal frequency. With tests involving ipsilateral body parts, the majority of errors consisted of extinction.

1. *Patients with Organic Mental Syndrome.*—In Group A 20 patients were tested in all the combinations of the body; there were 27 combinations in which the difference in the frequency of extinction and that of displacement in the two body parts tested was statistically significant, as evidenced by a *t* test value of 5% or less (Table 2). This difference occurred in combinations of the face and

TABLE 3.—*Response on the Initial Trial in Patients with Organic Mental Syndrome Tested in a Single Body Combination*

Combination of Body Part		No. of Subjects	Correct	Responses Indicating Dominance of Body Part		Other Responses
A	B			A	B	
FACE *	Hand	156	15	136	5	..
FACE	Breast	71	17	44	6	4
FACE	Penis	30	8	21	1	0
FACE	Back	30	7	17	2	4
FACE	Foot	30	9	21	0	0
SHOULDER	Hand	32	12	17	1	2
BREAST	Hand	51	7	37	5	2
PENIS	Hand	31	6	23	2	0
FOOT	Hand	49	10	30	7	2
THIGH	Hand	23	8	15	0	0
FOOT	Thigh	60	19	25	12	4
BUTTOCK	Foot	35	5	21	8	1
PENIS	Foot	40	8	30	1	1
Shoulder	Foot	23	1	12	9	1
Shoulder	Breast	13	3	5	5	0

* Capital letters indicate dominant part as evidenced by a chi-square value of 5% or less.

other parts, the genital region (penis in males and pubic region in females) and other parts, or the hand and other parts. In combinations involving the face or the genital region, errors in perception were infrequent. Therefore the face and the genital region may be termed as dominant to all other parts of the body. In combinations involving the hand, the opposite phenomenon occurred; errors in perception were more frequent in the hand. The hand may be classified as the least dominant area of the body. Thus, in face-hand tests the results may be expressed either as degree of face dominance or that of hand errors. There were four additional combinations in which dominance was manifested. The buttock was dominant to the back and shoulder, the breast was dominant to the back, and the back was dominant to the thigh. The remaining 18 combinations showed no dominance between the two body parts tested, as evidenced by *t* values greater than 5% (Table 2). These 18 combinations were retested in a different group of 20 patients. The method was similar to that described previously except that the order of testing was more randomized. When the statistical probabilities of the two series of tests were combined, all of these combinations again failed to manifest dominance.

An analysis of the responses of the group of 664 patients with organic mental syndrome tested in single rather than multiple body combinations showed a similar pattern (Table 3). There were no instances in which dominance in this group was different from that of the preceeding group. However, some combinations manifested dominance which was not shown in the first group. Thus, the face was dominant to the genital region; the foot was dominant to the thigh, and the buttock was dominant to the foot.

In summary, the foregoing results show that double simultaneous stimulation tests of parts of the body exhibit a definite relationship of one part to another. This is manifested by varying degrees of dominance, which may be considered as a gradient of sensation. At the top of the gradient is the face, the most dominant part of the body. The genital region is slightly less dominant than the face but is dominant over all other parts of the body and is thereby the next body area in the order of dominance. At the other end of the gradient is the hand, the least dominant part of the body. The remaining areas of the body fall in the gradient between the

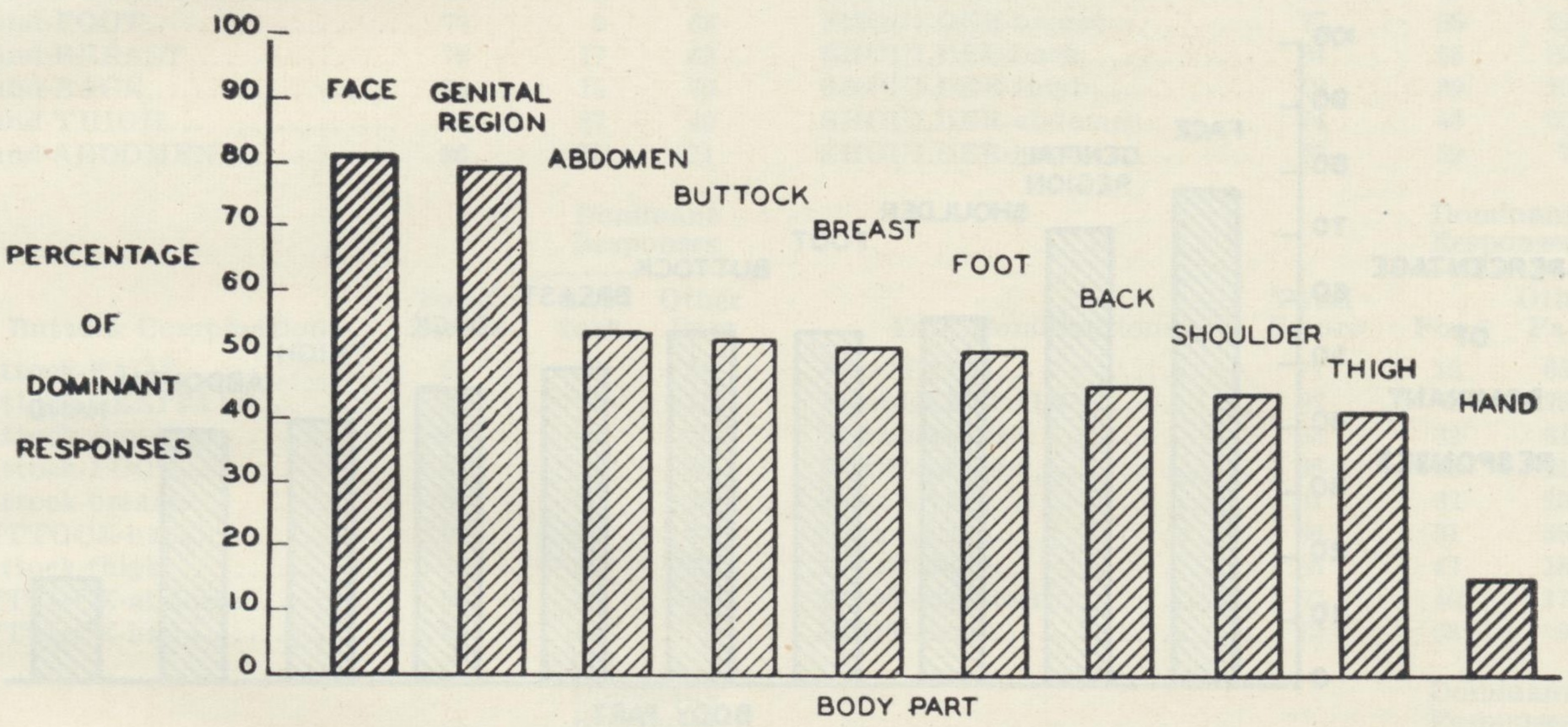

FIG. 1. ORDER OF DOMINANCE IN PATIENTS WITH ORGANIC BRAIN DISEASE

face and genital region and the hand. These parts include the shoulder, foot, thigh, and the areas on the trunk. When tested in combination with each other, these body parts failed, for the most part, to yield differences in dominance among one another. There was a tendency, however, for the buttock, abdomen, breast, and foot to be dominant to the back, shoulder, and thigh. The order of dominance of all body areas may be illustrated by comparing the total number of dominant responses for each area in the group of 20 patients tested in multiple combinations (Fig. 1).

2. *Normal Children.*—It has been shown that normal children make errors in simultaneous cutaneous sensory tests just as do patients with an organic mental syndrome. There was one striking difference, however, between the two groups. Children tended to learn the correct response as the tests were repeated over a period of days, whereas patients with an organic mental syndrome showed but temporary learning tendencies. They soon forgot what they learned and again made the errors.

When various combinations of two parts of the body were tested in the young children, an order of dominance became apparent, just as in the patients with an

organic mental syndrome. The order of dominance in normal children resembled, to a considerable extent, that found in patients with diffuse brain disease. The face was the most dominant and the hand the least dominant area (Fig. 2). The genital region was not so dominant as in patients with organic disease of the brain, since it failed to show dominance to the shoulder, back, and breast, although it was dominant to all other areas. In tests involving the genital region many children snickered, laughed, or showed other signs of special awareness of the sexual organs. Some refused to be touched there and became uncooperative. Because of this attitude, it was necessary to obtain the parents' permission for the test.

The order of dominance for the rest of the body areas in these children also showed little difference from that noted in patients with disease of the brain (Table 4). In only one of these combinations was dominance different from that demonstrated in patients with an organic mental syndrome. In children the foot was dominant to the buttock. The same combination tested in the group of patients with an organic mental syndrome showed the buttock dominant to the foot.

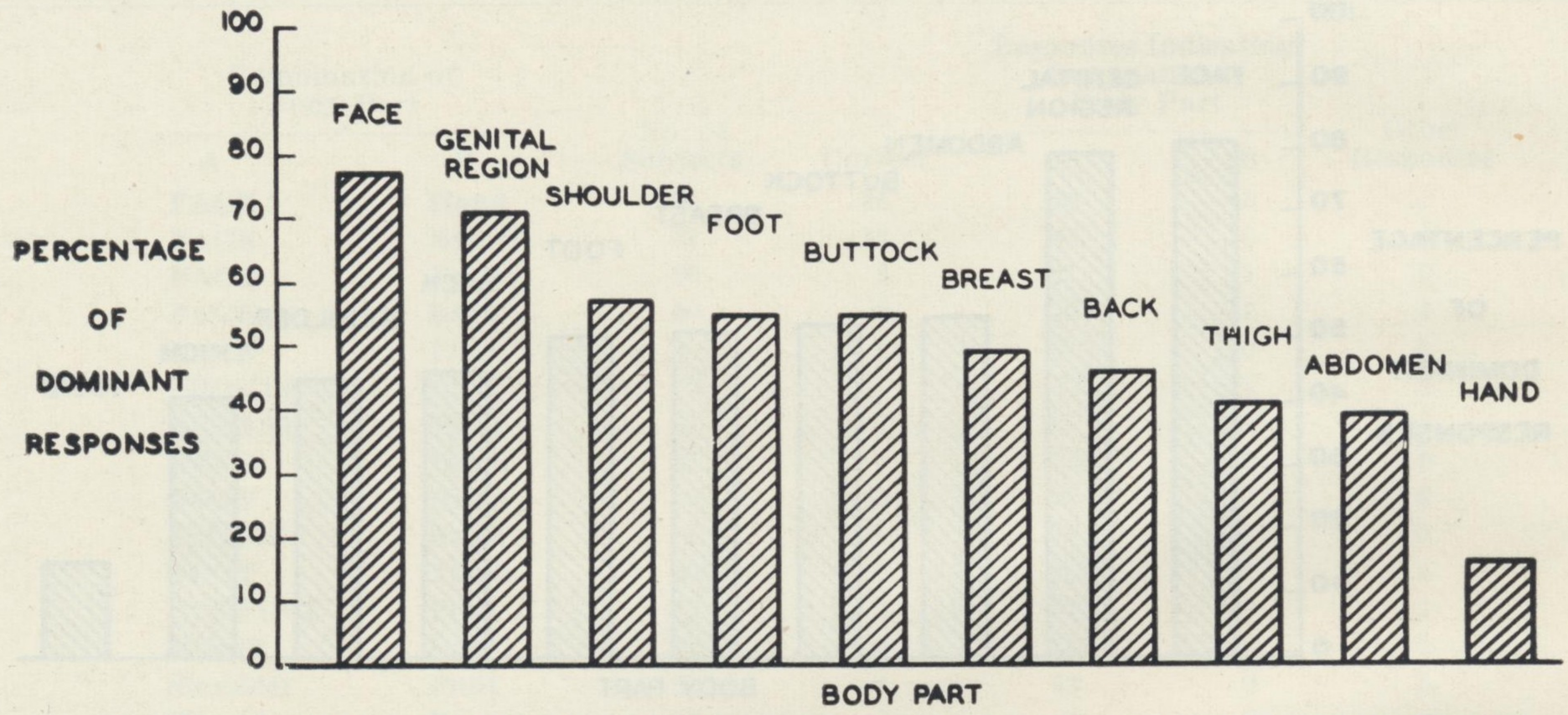

FIG. 2. ORDER OF DOMINANCE IN NORMAL CHILDREN 3–6 YEARS OF AGE

3. *Normal Adults.*—Several groups of normal adults were studied. In previous communications the responses of simultaneous touching of the face and hand were reported. The results showed a high face dominance. Examination of other body combinations showed a tendency to similar pattern, as recorded in the foregoing paragraphs (Table 5). However, the data obtained in combinations other than the face-hand were not very reliable, because the number of experiments were too few in number. It should be noted that the normal adult very readily grasps the idea of "twoness," or the concept that two stimuli are being used. Consequently, his chances of yielding a single response on repeated tests are small, especially if he once correctly reports the perception of the stimuli. Thus, it would be most difficult for us to get a large number of statistically significant data for other body areas.

In order to obtain reliable data it would be necessary to test a very large number of normal adults by statistical methods. For the time being, most of our emphasis was placed on testing patients with organic brain disease, young children, and very old adults. Judging from our data, it may be presumed that the complete order of dominance observed in patients with organic disease would also be present in the normal subject if a greater number of subjects were tested.

TABLE 4.—*Responses of Normal Children Three to Six Years of Age to Simultaneous Tests of Different Body Combinations*

Face Combinations	Total Errors*	Dominant Responses: Face	Dominant Responses: Other Part	Genitals Combinations	Total Errors	Dominant Responses: Genitals	Dominant Responses: Other Part
FACE-genitals †	57	38	19	Genitals-FACE	57	19	38
FACE-shoulder	79	65	14	Genitals-shoulder	56	28	28
FACE-buttock	52	35	17	GENITALS-buttock	65	45	20
FACE-foot	77	65	12	GENITALS-foot	87	78	9
FACE-breast	74	65	9	Genitals-breast	74	46	28
FACE-back	74	55	19	Genitals-back	62	39	23
FACE-thigh	47	38	9	GENITALS-thigh	81	65	16
FACE-abdomen	66	51	15	GENITALS-abdomen	81	65	16
FACE-hand	71	64	7	GENITALS-hand	88	79	9

Hand Combinations	Total Errors	Dominant Responses: Hand	Dominant Responses: Other Part	Shoulder Combinations	Total Errors	Dominant Responses: Shoulder	Dominant Responses: Other Part
Hand-FACE	71	7	64	Shoulder-FACE	79	14	65
Hand-GENITALS	88	9	79	Shoulder-genitals	56	28	28
Hand-SHOULDER	66	7	59	Shoulder buttock	67	25	42
Hand-BUTTOCK	72	5	67	Shoulder-foot	63	31	32
Hand-FOOT	72	9	63	SHOULDER-breast	77	56	21
Hand-BREAST	79	17	62	SHOULDER-back	84	55	29
Hand-BACK	85	15	70	SHOULDER-thigh	59	39	20
Hand-THIGH	76	27	49	SHOULDER-abdomen	74	48	26
Hand-ABDOMEN	86	15	71	SHOULDER-hand	66	59	7

Buttock Combinations	Total Errors	Dominant Responses: Buttock	Dominant Responses: Other Part	Foot Combinations	Total Errors	Dominant Responses: Foot	Dominant Responses: Other Part
Buttock-FACE	52	17	35	Foot-FACE	77	12	65
Buttock-GENITALS	65	20	45	Foot-GENITALS	87	9	78
Buttock-shoulder	67	42	25	Foot-shoulder	63	32	31
Buttock-FOOT	66	21	45	FOOT-buttock	66	45	21
Buttock-breast	59	30	29	Foot-breast	61	32	29
BUTTOCK-back	76	49	27	Foot-back	66	31	35
Buttock-thigh	66	31	35	FOOT-thigh	65	47	18
BUTTOCK-abdomen	56	40	16	FOOT-abdomen	57	40	17
BUTTOCK-hand	72	67	5	FOOT-hand	72	63	9

Breast Combinations	Total Errors	Dominant Responses: Breast	Dominant Responses: Other Part	Back Combinations	Total Errors	Dominant Responses: Back	Dominant Responses: Other Part
Breast-FACE	74	9	65	Back-FACE	74	19	55
Breast-GENITALS	74	28	46	Back-GENITALS	62	23	39
Breast-SHOULDER	77	21	56	Back-SHOULDER	84	29	55
Breast-buttock	59	29	30	Back-BUTTOCK	76	27	49
Breast-foot	61	29	32	Back-foot	66	35	31
BREAST-back	64	42	22	Back-BREAST	64	22	42
Breast-thigh	50	26	24	BACK-thigh	77	49	28
BREAST-abdomen	64	47	17	Back-abdomen	61	27	34
BREAST-hand	79	62	17	BACK-hand	85	70	15

Thigh Combinations	Total Errors	Dominant Responses: Thigh	Dominant Responses: Other Part	Abdomen Combinations	Total Errors	Dominant Responses: Abdomen	Dominant Responses: Other Part
Thigh-FACE	47	9	38	Abdomen-FACE	66	15	51
Thigh-GENITALS	81	16	65	Abdomen-GENITALS	81	16	65
Thigh-SHOULDER	59	20	39	Abdomen-SHOULDER	74	26	48
Thigh-buttock	66	35	31	Abdomen-BUTTOCK	56	16	40
Thigh-FOOT	65	18	47	Abdomen-FOOT	57	17	40
Thigh-breast	50	24	26	Abdomen-BREAST	64	17	47
Thigh-BACK	77	28	49	Abdomen-back	61	34	27
THIGH-abdomen	66	42	24	Abdomen-THIGH	66	24	42
THIGH-hand	76	49	27	ABDOMEN-hand	86	71	15

* One hundred tests done in each combination were analyzed statistically. The remaining 20 tests in each combination were of homologous body parts and did not lend themselves to this type of analysis.

† Capital letters indicate dominant part as evidenced by a *t* test value of 5% or less.

In testing normal subjects it was noted that they responded by mentioning the face as being the area touched and only when questioned further did they mention the hand. In other words, there was a preference for the face in the response.

In another series of simultaneous tests of 20 normal adults the following method was used. Twenty normal adults were informed that they were to be touched on two regions of the body and that they were to report only one of the two places stimulated. The eyes were closed during these tests. Ten tests were done in 8 body combinations in a random fashion (tests involving contralateral and homolateral parts of the body) in a manner similar to that used in working out the order of

TABLE 5.—*Response on the Initial Trial in Normal Adults Tested in a Single Body Combination*

Combination of Body Part		No. of Subjects	Correct	Responses Indicating Dominance of Body Part		Other Responses
A	B			A	B	
FACE *	Hand	160	77	78	5	..
FACE	Breast	94	58	29	2	5
Face	Shoulder	17	9	6	2	0
Face	Penis	30	25	4	1	0
Face	Back	31	22	6	1	2
Face	Foot	30	26	4	0	0
BREAST	Hand	76	40	31	3	2
Shoulder	Hand	30	24	2	2	2
Penis	Hand	30	17	11	2	0
Thigh	Hand	30	17	6	7	0
Foot	Hand	54	44	7	2	1
Thigh	Foot	30	16	2	9	3
Breast	Foot	30	23	6	1	0
Shoulder	Breast	32	19	7	4	2
Breast	Thigh	18	9	6	3	0

* Capital letters indicate dominant part as evidenced by a chi-square value of 5% or less.

TABLE 6.—*Simultaneous Touch Stimulations of Various Body Combinations* *

Body Combination	Choices Given			
Face-hand	Face	160	Hand	40
Face-thigh	Face	175	Thigh	25
Face-shoulder	Face	142	Shoulder	58
Face-foot	Face	167	Foot	33
Shoulder-hand	Shoulder	158	Hand	42
Hand-thigh	Hand	141	Thigh	59
Thigh-foot	Thigh	103	Foot	97
Hand-foot	Hand	114	Foot	86

* There were 200 tests for each combination.

dominance in Groups A and B. There were 200 tests in each combination. The genital regions were not investigated. The results are recorded in Table 6.

From an analysis of Table 6 it is obvious that the face is the part of the body which is chosen oftenest when it and other parts of the body are touched simultaneously. These findings support the results obtained by other methods. However, this method of selection, when the subject knows that two parts of the body are being touched, did not reveal the expected hand inferiority. This finding does not necessarily detract from observations obtained by the methods described above, where the subject was to report what he perceived after he was touched in two places without warning.

After this series of tests each of these 20 subjects was asked to indicate which part of the body they were the most and the least aware of during testing. The results are tabulated in Table 7.

Of significance in both sets of these experiments is the fact that the face shows a high dominance. However, it must be stressed again that the last two methods do not reflect the low order of hand dominance.

4. *Adults with Schizophrenia.*—When these patients made errors, the errors were similar to those obtained in normal adults under the age of 65. Each patient showed significant dominance of the face to the hand as well as to the foot, the breast to the hand and foot, and the penis to the hand and foot (Table 8).

The relationship of all the body areas has not been worked out so completely in these subjects as in the preceding groups. The difficulty in demonstrating the complete pattern in schizophrenic patients was the same as that encountered in normal adults. They showed fewer perceptual errors on simultaneous tests than did either patients with organic brain disease or children. These errors occurred only during the intial trials, so that one subject could be tested for only one body combination.‡

TABLE 7.—*Responses of Twenty Patients as to Areas of Greatest and Least Dominance*

Body Part Most Aware of	No. of Subjects	Body Part Least Aware of	No. of Subjects
Face	16	Thigh	10
Face and foot	1	Foot	4
Face and thigh	1	Hand	3
Hand	1	Shoulder and thigh	1
Foot	1	Foot and shoulder	1
		Not asked	1

TABLE 8.—*Response on the Initial Trial in Schizophrenic Adults Tested in a Single Body Combination*

Combination of Body Part		No. of Subjects	Correct	Responses Indicating Dominance of Body Part		Other Responses
A	B			A	B	
FACE *	Hand	72	24	46	2	..
Face	Breast	81	52	14	11	4
Face	Penis	30	23	3	2	2
Face	Back	42	29	7	4	2
FACE	Foot	37	25	12	0	0
Face	Shoulder	13	2	8	3	0
Shoulder	Hand	31	19	8	3	1
BREAST	Hand	77	29	44	1	3
PENIS	Hand	43	20	19	3	1
Thigh	Hand	30	9	11	9	1
Foot	Hand	31	15	8	6	2
Thigh	Foot	30	15	4	10	1
BREAST	Foot	30	9	19	1	1
PENIS	Foot	30	17	8	2	3
Shoulder	Breast	28	15	3	8	2

* Capital letters indicate dominant part as evidenced by a chi-square value of 5% or less.

‡ There were a number of patients with schizophrenia who presented bizarre responses. The touch stimuli were occasionally misidentified and were reported as "a burning" or "a fly crawling." At times the number of percepts were multiplied. Instead of perceiving the two applied stimuli, they reported three or more percepts in a variety of body parts. Similarly, a single stimulus was reported as two or more percepts, the locus of the original stimulus being occasionally omitted. Such patients usually persisted in the bizarre responses on repeated testing on subsequent days. Several of the paranoid patients refused to close their eyes but permitted examination provided they could see.

5. *Senile Adults.*—Studies of body combination tests in senile adults 65 to 96 years of age showed results similar to those found in patients with disease of the brain and in very young children.[4] The most dominant region was the face and the least dominant the hand. In plotting the errors on face-hand tests in normal subjects of all ages, we found that children under the age of 6 years and adults over the age of 65 show the greatest incidence.

6. *Supplementary Studies of Blind or Deaf Subjects.*—While we were conducting the foregoing experiments, we, naturally, tried to find an explanation for face dominance. One of the thoughts we entertained was that normal subjects developed the concept of the face being foremost in importance. It might be assumed that the earliest sensory image a subject experiences would be the sight of the mother during infancy. Therefore, the earliest memory of a person and his self-identification would be the visual image of a face. Moreover, young children who are asked to draw the picture of a man draw the face first and foremost, paying less attention to other parts of the body. Goodenough [15] made similar observations on the drawings of mentally retarded persons and patients with disease of the brain. Since visual memory and imagery of a face would seem to be important in one's sensory experience, it was thought that the congenitally blind might not respond as the normal subject does when he is tested with cutaneous stimulations. With this in mind, a series of congenitally blind children and another series of adults with an organic mental syndrome and long-standing acquired blindness were tested with double simultaneous stimulation of the face and hand. Results showed that there was no difference in the pattern of response between the blind and the normal subjects.

A. Blind Subjects: I. Children. Forty-two normal children (3 to 14 years of age) with congenital blindness were tested in face-hand and hand-foot combinations. Ten tests (heterologous and homolateral parts of the body) were done for each combination in a random order.

The results obtained were as follows:

1. Of all children 6 years of age or younger who were congenitally blind, 79% showed persistent errors after 10 trials of testing.

2. In the face-hand combination tests the following responses were obtained:

Face Only	Face-Face	Hand Only	Hand-Hand
202	34	2	1

3. In the foot-hand combination tests the responses were as follows:

Foot Only	Foot-Foot and Partial Displacement of Hand Stimulus	Hand Only	Hand-Hand
51	26	26	9

4. The pattern of all errors throughout the testing was the same as that for normal children without blindness.

II. Adults. Ten adults with an organic mental syndrome and blindness acquired after childhood were tested with multiple face-hand tests. All showed persistent errors. The analysis of all the errors are as follows:

Face Only	Face-Face	Hand Only	Hand-Hand
100	7	1	1

From this analysis it is obvious that preservation of vision in infancy is not essential for face dominance.

B. Deaf Subjects: We also thought of other causes for face dominance, namely, that the touch applied to the face was not only felt but reinforced by the sound stimulus produced by the touch on the face, which is so near the ear. To establish or exclude this possibility, we studied a series of deaf people.

Thirty-two adults with deafness acquired in early infancy or childhood were tested with multiple face-hand tests. These subjects were otherwise normal. They had no evidence of disease of the brain. The results are indicated in Table 9.

Again we found face dominance. Hearing did not seem to be a factor in face dominance.

COMMENT

From the foregoing studies it is obvious that we have been investigating perceptual functions from the standpoint of patterns. For many years Lashley § has been stressing the fact that the data obtained on neurologic examination should always be analyzed with reference to pattern of activity. We did this in the compilation of our own results. By clinical observation we learned that when the cutaneous sensory field is examined under conditions of simultaneous stimulation a distinct pattern is discerned. The pattern is most apparent in testing two non-

TABLE 9.—*Incidence of Errors for Deaf Subjects, Initial and Subsequent Trials*

Initial Trial				
Total No. of Subjects	Correct	Face Only	Face-Face	Hand Only
32	9	19	2	2

Initial and Subsequent Trials			
Face Only	Face-Face	Hand Only	Hand-Hand
86	1	4	0

symmetric regions, far removed from each other and situated along the longitudinal axis of the body. The resultant interaction between these two sensory stimuli yields a characteristic pattern. In studying the data, it was learned that the face is the most dominant region of the organism. The genital zone is next in the order of dominance, while other parts of the body follow in a gradient, with the hand manifesting the least dominance. Thus, the most conspicuous gradient is between the face and the hand. The pattern of response we obtained by testing with the method of double simultaneous stimulation has been found consistently on numerous occasions, under a variety of conditions, and in many groups of subjects.

In considering our results, we naturally ask what the organizing principle of this perceptual pattern might be, or with which neurophysiologic or psychophysiologic data it may be correlated. Why is the face the most dominant and the hand the least dominant? Why does the genital region show a high dominance? What determines such an order of dominance? Is it acquired by learning; is it inherent, or is it a product of each? If it is inherent, what role does the body image play?

Anatomic or Neuro-"Electrical" Studies.—In considering the anatomic substrate, we find no apparent correlation of findings elicited on electrical studies of the cerebral cortex with areas of the body which show dominance by our method of stimulation. Some aspects of tactile sensory interaction have been discussed by

§ References 16 through 18.

Marshall, Woolsey, and Bard [19] in their mappings of the cerebral cortex of the cat and monkey by the method of evoked action potentials. The map of the "sensory cortex" as determined by electrical stimulation or evoked action potentials does not serve to explain the order of dominance. It might be supposed that the degree of dominance found in a part of the body would be proportioned to the area in the cerebral cortex in which this part of the body is electrically represented. However, this is not the case. The face and the hand, the most and the least dominant areas, respectively, in our system of testing, have approximately equal representation in the homunculus of the human cortex as determined by the method of electric stimulation of the cerebrum.[20]

It is not certain whether electrical studies on neuron action will give us the answer, for, as Lashley has repeatedly pointed out, most studies are made on surgically isolated or anesthetized animals, and these are far from being in a physiologic state. Our own clinical studies show patterning of sensory interaction in the physiologic state of man, whether there is or is no disease of the brain. This is a physiologic fact. The meaning of this fact, however, is not as yet clear. This patterning of sensory interaction does not occur in any one region of the cortex. It is the result of integration of perceptual function, which takes place in the entire brain at the cortical, thalamic, and even lower levels of the nervous system. There is no doubt that sensory interaction occurs, but that this interaction is patterned and how it is patterned is still a mystery.

Psychophysiologic Studies.—Our own psychophysiologic data also fail to shed any light on our problem. Studies of thresholds of cutaneous sensations, types and nature of stimuli, and attention of subject and sensorimotor responses did not offer clues to a solution. Critchley,[21] in his interesting article on tactile functions in the blind, suggested that face dominance may be due to the sensitivity of the skin. It does not seem to be a matter of thresholds,[22] for we have been working with crude supraliminal stimulations. The stimuli we employed consisted for the most part of firm taps or scratching and slapping of the face and hand, or repetitive or moving stimulations, such as rubbing. Moreover, the tactile thresholds, as obtained in different regions of the cutaneous sensory field by use of the method of von Frey,[23] using von Frey's hairs (Table 10), or with a stimulus such as pinprick (Table 11), show no strict correspondence to the "dominance" values obtained by the method of simultaneous tactile or pinprick stimulations. The use of stronger or more noxious stimuli, such a pinpricks, will reveal a lower incidence of errors, but the pattern of dominance will be the same.

Nor is there any correlation between the acuity of the sense of two-point discrimination and the order of dominance. It will be recalled that the ability to discriminate two points at the finger tips or at the hand is much greater than that at many other parts of the body, excluding the lips and tongue; yet the hand shows the lowest order of dominance. This lack of correspondence is contrary to the hypothesis proposed by Denny-Brown, Meyer, and Horenstein, who studied patients with lesions of the parietal lobe.[24] In our studies of normal subjects and of patients with disease of the brain, including that of the parietal lobe, we find no correlation between incidence of errors as elicited by the method of double simultaneous stimulation and the two-point discriminative potentialities of a given cutaneous area.

Still another factor to consider is that of attention. Critchley,|| in a series of papers, claims that it is a lack of attention which causes the imperception of one of the two simultaneous stimuli in patients with lesions of the parietal lobe. As expected, this type of sensory defect is apparent only on the side opposite the cerebral lesion. It is especially pronounced in the hand and least manifest in the face, thus reflecting a pattern with an order of dominance similar to the one illustrated in normal children and in subjects with diffuse disease of the brain. If this pattern in the parietal lobe lesion is interpreted as due to a lack of atten-

TABLE 10.—*Stimulus Threshold for Pressure, in Grams per Square Millimeter, After von Frey*

Cornea	0.3	Hand, dorsum	12
Conjunctiva	2.0	Foot, dorsum	15
Tongue	2.0	Calf	16
Nose	2.0	Prepuce	16
Lip	2.5	Spinous processes	16
Finger tip	3.0	Medial edge of scapula	16
Eyelid (edge)	3.0	Deltoid muscle	17
Infraorbital area	3.0	Upper arm, extensor surface	26
Forehead	3.0	Abdomen	26
Hollow of palm	7	Orifice of urethra	26
Dorsum of fingers	5.0	Thigh, outer side	27
Upper arm, flexor surface	7	Areola of breast	27
Thigh, inner side	7	Undersurface of breast	27
Forearm, flexor surface	8	Sole, noncalloused part	28
Nipple	8	Tibia	28
Anterior edge of deltoid	9	Forearm, extensor surface	33
Anterior edge of axilla	11	Inguinal area	48
Xyphoid process	11	Glans penis	111
Mucosa of cheek	12	Sole, calloused part	250

TABLE 11.—*Stimulus Threshold for Pain, in Grams per Square Millimeter, After von Frey*

Cornea	0.2	Upper thigh	
Conjunctiva	2	Outer surface	30
Eyelid	10	Inner surface	30
Abdomen	15	Extensor surface	40
Forearm		Foot, dorsum	50
Flexor surface	20	Hand, dorsum	100
Extensor surface	30	Tibia	100
Upper arm		Internal malleolus	110
Flexor surface	30	Hand, palm	130
Outer condyle of humerus	30	Sole, calloused portion	200
Cheek	30	Finger tip	300
Calf	30		

tion, it must be that the inattention is only on one side of the body, and particularly in the hand. In other words, the term inattention becomes synonymous with defective perception produced by the parietal lobe lesion.

Nevertheless, attention tends to modify perceptual responses. According to William James, "when the things to be attended are small sensations and when the effort is to be exact in noting them it is found that attention to one interferes a good deal with the perception of the other."[46] But does this explain the pattern in dominance or in errors in perception as illustrated in Figures 1 and 2? It might be claimed that man pays most attention to the face because he is most interested

|| References 25 through 28.

in this part of the body. Such reasoning may explain face dominance, but it does not account for the frequent errors made in the hand stimulus. The latter finding would imply that man pays the least attention to the hand, less than to any other part of the body. Now, it is hardly likely that one pays less attention to one's hands than to one's back. Yet, according to our data, the back dominates over the hand, implying that man is more interested in his back than in his hand. This is contradictory, and it becomes obvious that attention does not account for the order of dominance as depicted in Figures 1 and 2. A defect in attention may crystallize but not determine the pattern of perception as elicited by the method of double simultaneous stimulation. Further evidence against the attention theory are the recent experiments by Hooker.[29] He found an order of dominance in sensation, using double simultaneous touch stimulations, in the human fetus. Even though the response to stimuli in his experiments involves an order lower than that implied in our results, there was a distinct pattern under his conditions of testing in which attention was not a factor. When there was simultaneous cutaneous stimulation of the face and hand, the dominant motor response was that typical of the face.

An important principle to consider in the study of patterns of response to sensory stimuli is that every sensation has a motor component. Thus, when we request the subject to report what is felt when the face and hand are touched simultaneously, there must be an efferent, or a motor, element. The patient replies verbally and tends to point to the spots touched. In a series of face-hand combination tests or in combinations involving the face and another body part, it was shown that the face is the first to be indicated, whether it is pointed to with the hand or announced verbally (Table 6). Since the hand is used in the pointing, it would be the last of the two (face and hand) perceived regions to which the subject would point. On the contrary, the face would be the first to be indicated. This, however, is not always the case, for when both stimuli are perceived, the hand is sometimes the first to be indicated. This is particularly evident in combinations which do not include the face. When both hands are stimulated, the incidence of errors is very low and the subject often uses either hand to point to the other.

Learned and Inherent Perceptual Organization.—Perceptual organization or sensory correlation may proceed along two lines: (1) learning or individual acquisition of perceptions and (2) inherited or genetically determined perceptual patterns. Acquired perceptions are organized in the course of experience by the postulated mechanisms of pattern identification, by a selective process, by symbolization, and by conceptual organization. As Nissen states, "Symbolization helps in perceptual organization also in connecting percepts with concepts to specific responses." [30]

1. Learning Factor: There are many who believe that all perceptions and perceptual patterns are acquired. Most perceptual reactions are learned during the maturation period or infancy. In our own studies of perceptual patterns under conditions of double simultaneous stimulation, we believe that awareness of the part of the body, such as the genital region, is an example of learning. Infants or children learn of and become aware of their genitals. Initially, when the pattern was demonstrated in adults with disease of the brain, the high dominance manifested in the genital region was not too surprising. The interpretation was that, due to its special sexual connotation acquired by learning, there is more "awareness" of

stimuli applied in this area. The question then arose as to what the pattern would be in very young children. If sexual "awareness" was not yet operative, that is, if the child had not yet learned of the social significance of the genital organs, one might assume that there might be less dominance of the genital zone than in adults. However, in our studies we found that young children were indeed "sensitive" about their genitals. Most of the children under 6 years of age, even the very youngest, who were just about able to cooperate in the perceptual tests, were reluctant to expose this area or showed some form of embarrassment or curiosity when their genitals were touched. Some refused to have more than a few tests done at one time. Evidently this increased "awareness" is learned prior to 3 years of age. Since we found a high dominance for the genital area in children, it might be inferred that this high dominance is related to a sexual awareness which was probably learned in the first two to three years of life.

Schilder ¶ pointed this out in his discussion of the principles concerning the libidinous structure of "the body image." # He stated:

> The attitude toward the different parts of the body can be determined by the interest the persons around us give to our body. We elaborate our body image according to the experiences we obtain through the actions and attitudes of others. The actions of others may provoke sensations when they touch and handle us. But they may influence us also by words and actions which direct our attention to particular parts of their body and our own body. . . . Early infantile experiences are of special importance in this connection but we never cease gathering experiences and exploring our own body.[31]

These principles of symbolization in perceptual organization apply to genital as well as to other regions of the body. From the psychoanalytic, or Freudian, point of view the face and the mouth participate in the oral stage of body image, or, more correctly, of body schema development. The same school emphasizes that the genital region plays a great role in the development of the organism. Therefore, it should not be surprising to find the face and genital regions almost on the same level of dominance as determined by double simultaneous stimulation.

¶ References 31 and 32.

Smythies,[33] in a philosophical paper, criticized the confusion and the loose use of the term "body image." Thus, (*a*) there is "the body image" which describes "a visual, mental, or memory image of a human body, one's own or someone else's." Body images are experienced. (*b*) Body schema should be used only in its original sense. It is part of the subconscious mind, and thus its presence is inferred, and not experienced. The experiments of Stratton are a good example of almost a pure disorder of the body schema. (*c*) Body concept is a conceptual constellation and depends largely upon the proper function of the relevant memory mechanisms. Anosognosia is an example of disorder of the body concept. (*d*) "The perceived body," or another name for it, "postural model of the body," a term to be applied to the somatic sensory field—directly experienced inside central consciousness. An example of this is the experience of having a phantom limb or autotopagnosia. The perceived body is identifiable with the "body image in the brain." (*e*) Actual physical body is a physical object and not the same as the perceived body. What one perceives as to body parts does not always correspond to the actual position of the physical body and vice versa. An example of this is found in the patient's experiences in mescaline intoxication, where the perceived body is not the same as the physical body. Also the postures assumed in some of the dyskinesias are not always perceived. (*f*) Body image in the brain of the physical body (theory of psychoneural identity). The homunculus as determined by electrical stimulation or destruction of brain tissues is an example.

While we agree with Smythies criticisms, it is sometimes extremely difficult to use his classification of "experiences and description of the human body." Nevertheless, in our subsequent discussions we shall try to use his terms wherever possible.

Even though Schilder * proposed these theories, there are no clear-cut experiments to show that the face is sensitized the most, and, for that matter, that the hand is sensitized the least, in the maturation of the normal infant or child. As a matter of fact, in the same book Schilder emphasized the importance of other structures in the construction of the "body image." In considering "sexual sensitization" of body parts in adults, one must compare such erogenous zones as the breast and buttock with the genital region. Yet analysis of our data reveals no undue dominance of the breast and buttock over nonerogenous regions, such as the foot or abdomen. Perhaps there would be no incongruity in dominance of erogenous zones if we interpreted our data from the standpoint of age, sex, personality, and social background of the subject. Under such conditions we might have found different gradients in each group and concluded that sensitizations of the body parts by learning are, after all, important, but not necessarily the principal factor in determination of the pattern.

In this connection the question of the development of the "body image" arises. How does the "body image" develop? Schilder admits that we have no reliable information as to how this development takes place. He said that there is "reason to believe that there is an inner development, maturation, . . . and there are inner factors, which are given in the organism and comparatively independent of experience which determines this development." He also believed that "the process of maturation gets its final shape through individual experience." Thus, there is a factor of maturation which forms the basic structure of the body image, whereas experience and learning influence the trends of the development. Maturation and learning are essential features of all types of development, whether it is body image, body schema, body concept, perceived body, or perception itself. These conclusions are partly supported by the experiments of Gesell.[34]

If this sort of reasoning, namely, development of the body image in infancy, accounts for face-genital dominance, what explains the inferiority of the hand, as determined by this series of tests? When the hand is considered in the spectrum of the "body image," there seems to be no prominent reason for its inferior position. According to Schilder, the hand is an important structure in the formation of the "body image." The "body image" is continuously influenced by the almost constant optic image of its hands. One sees his own hands more frequently than any other part of his own body. In fact, perceptually and from the motor standpoint the hand is one of the most important structures in the "perceived body." Katz [35] says that the hand makes the most vivid impression. Despite this, it is curious that the hand is least dominant when it is tested simultaneously with another body part.

2. Inherent Factor: Thus far we have discussed the factor of learning in perception as the basis for the pattern we obtained on double simultaneous stimulation. It is possible that "learning" during infancy might explain part of, but not the entire, pattern of sensory organization under conditions of double simultaneous stimulation. However, our results show that the factor of "learning" did not enter in our own tests. An analysis of the responses obtained on the first trial in many children showed that the face was most dominant and the hand was least dominant. In this situation there was no opportunity for learning; yet this pattern was found on the initial tests in most subjects. The same consistent initial response was obtained

* References 31 and 32.

in tests of combinations of other body regions, such as the hand and the thigh, etc. These findings strongly suggest that the patterns we obtained are not the result of a learning process during testing but may be due to inherent sensory organization. This theory is supported by the preliminary studies of Hooker.[29] Working with human fetuses, he found that double tactile simultaneous stimulation of the face and hand resulted only in the face reactions. When the hand and foot were tested, there was only the hand response. Thus, there was an order of dominance in which the face dominated over the hand and the hand over the foot. Although the pattern Hooker obtained in the fetus is not exactly the same as the one we obtained under our conditions of double simultaneous stimulation in young children, the fact remains that a pattern has been observed before the organism had an opportunity to learn. Carmichael,[36] after reviewing the available experimental data, concludes that there is only little evidence that learning modifies fetal behavior. If it is assumed that the pattern is determined inherently, one should consider the role the body image plays in organization of perception or in the order of perceptual dominance.

3. Organization of Perception in the Perceived Body, Body Image, and Body Concept: (*a*) Perceived body. In a discussion of the inherent properties of perception we must consider the role of the "perceived body." There is a theory that midline structures of the body dominate over the lateral or peripheral parts. In his monograph on the body image, Schilder emphasized the dominance of the midline structures. This theory considers the long axis of the body as being the dominant over other regions. Part of the same theory is that proximal parts of a limb dominate over distal regions. In our own experiments it is true that the face and the genital region, both midline or axial regions, are the most dominant parts of the perceived body. However, this axial theory does not account for the gradients as depicted in the graph we plotted from our data. There are some midline or axial structures which show no significant dominance over the lateral parts. Thus, the foot, a lateral area, is dominant or equal to the thigh, which is a proximal area, and to the buttock, which is an axial structure. Moreover, there is a differentiation of dominance along the longitudinal axis of the body itself. Thus, the face or the genital region is dominant over the abdomen, buttock, or midback.

A second hypothesis is the one proposed by Cohn.[37] This is similar to the first. Cohn proposed that the pattern of dominance, as elicited by the method of double simultaneous stimulation, is inherently organized on the basis of rostral dominance, i. e., the theory that the face is the most dominant part of the organism, while the remaining body areas show a descending gradient along the longitudinal axis. The rostral parts are dominant over the more caudal areas. This theory is consistent with the extensive observations on the development of the vertebrate nervous system, in which a rostral-caudal gradient is demonstrated in phylogenesis.[38] This gradient is manifest in the progressive differentiation of the rostrum until, in Mammalia, the cerebrum is fully differentiated. The gradient is also manifest in biochemical and physiologic reactions at each phylogenetic level. Similar gradients have been demonstrated for the musculoskeletal and gastrointestinal systems. A rostrocaudal order of sensory development has also been shown to exist in ontogenesis in studies of the fetus with single stimulations.[39] More recently, Hooker [29] found such an order in human fetuses when the face and hand, or hand and foot, were touched simultaneously. Our own data support this theory of rostrality only in part, inasmuch as there is face dominance. However, other facts tend to contra-

dict the theory of rostrality. There is no continuous downward gradient between the rostral and the caudal region. Even though the face is most dominant, there are caudal body parts which are dominant over some of the more rostral regions. For example, the foot is dominant to the hand and the thigh. Most significant is the dominance of the genital region to all more rostral areas except the face. From the foregoing data one must conclude that the concept of rostrocaudal order of sensory organization is not applicable beyond the fetal stage. There may be the factor of learning and maturity in the postnatal stage. More studies of double simultaneous stimulation in different parts of the body of the human fetus, particularly the genital region, may shed more light. Similar studies in the first year of life will help us in understanding the development and organization of perception in man.[40]

(*b*) Body image and body concept. Another theory can be evolved in considering the relation of the body to its inner self or that of the ego to its outer world. This concept implies that the ego has a center and a periphery region, just as the perceived body has an inside and an outside. We observe ourselves (inside) as we observe others (outside). When one thinks of himself, what Schilder called autoscopy,[32] there is an image of one's own face. This is a good example of what is meant by body image. Children in making drawings of a man indicate the face, while other parts of the body are less often illustrated.[15] Even congenitally blind children, in whom the hands and fingers are of especial importance, model the head as being too large [41] and the region of the mouth as being the most conspicuous.†

In expressing the concept of the ego in terms of body parts, the face is visualized or comes to the foreground more than any other structure. The face is the most distinguishing part of the organism itself. The face represents the most central or inner portion of the ego. In narcissism the self-interest in one's body is directed chiefly to the face. Claparède,[42] in his studies on localization of the self, concluded that the ego is conceived as being in the head. More specifically, he believed the center of the ego is situated between the eyes. As for the genital region, there are many, particularly the psychoanalysts, who would identify this area of the body with the inner part of the ego.

The part of the body which has to do with reproduction is probably just as "deeply in" or central in the organism's concept of the body as is the head, with its face, mouth, eyes, etc. In considering the genital region, it is not always easy to determine whether the importance attached to this part of the body is due to inherent or to acquired factors. There is a great deal of literature on this subject, but it is still difficult to ascertain what role the inherent factor plays as opposed to the learning factor.

Applying the theory of centrality, i. e., that the face-genital regions are innermost in the ego and in the body concept, we are faced with the problem of fitting the hand into this theory. In contrast to the concept of the face or genitals being central, the hand is mostly on the periphery. The hand is the medium with which we or our ego makes contact with the peripheral or outside world. The hand is on the periphery of our ego structure and, with the aid of vision, is the most important tool for exploration of the outer world. One might argue that the foot, although a distal structure, also makes contact with the outer world. However, in this task the

† von Stockert, F.: Quoted by Critchley.[21]

hand, in most instances, is used more than the foot. Moreover, the impression gained is that the foot is more inward—it seems more protected and hidden by shoes. In summary, it would appear that from the standpoint of body concept organization within the ego, the face and the genitals are the most inwardly situated, while the hand is least centrally or most peripherally situated in the conceptual organization of body parts within the ego. Now if we correlate the latter hypothetical pattern with the pattern we found in our perceptual tests, we create some sort of congruity between the two, namely, (*a*) face dominance as obtained on perceptual tests with face as the most inner portion of the ego, and (*b*) hand inferiority with hand as the most peripheral portion of the ego. From this it might be inferred that the ego may play a role in the determination of the perceptual pattern. We realize that this is a highly theoretical explanation. Obviously, the concept of the hand being the most distal, and the face the most central, portion in the organization of perception in body image needs testing. We also realize that our results may be colored by an obscure artifact, although we have checked our data by a variety of methods and conditions of testing.

If this concept is at all valid, it should be applicable to functions other than those of cutaneous senses. Thus, the concept of "central" portions dominating over the periphery may be found in studies of vision. Observations drawn from patients with mental changes consequent to diffuse brain disease show domination of central over peripheral vision. Goldstein ‡ and others have found that in these patients constricted fields of vision are not uncommon. When such a patient is instructed to fix at a central target and report whether he sees another target simultaneously in the periphery of the field, the response is that the central target is observed and not the one in the periphery.[45]

In studies of visual responses of these patients to rapid exposures of images with groups of figures, it was noted that they reported what they saw in the central portion of the field only, often not observing the peripheral figures. Similar results were obtained in tachistoscopic examinations of mentally defective persons. In all these cases the results were uniform, namely, the perception of the central, but not of the peripheral, figures. Thus, when the cutaneous sensory field is compared with the visuosensory field, the face seems to correspond to the macular region, and the hand, to the most peripheral part of the field of vision. On further comparison, it might be inferred that central vision is identifiable with the ego in the same manner as is the face. The optic image we have of ourselves or of others is situated in the central portion of the field of vision. Our ego is projected in the central regions of the perceptual field. In considering these patterns for perceptual function, we touched on the topic of conceptual functions. When the subject of the ego is discussed, a pattern for thinking becomes obvious. It is well known that most of our thoughts are pointed directly or indirectly toward ourselves, and we think least of what is most peripheral to or away from the ego. This subject has been amply discussed by William James in his "Principles of Psychology." The object of mentioning the parallel was to point out the principle that similar patterns exist in all types of perceptual functions, as well as in conceptual and motor functions.

‡ References 43 and 44.

SUMMARY

Tests of simultaneous tactile stimulation involving many different body combinations were applied to patients with an organic mental syndrome, normal children, normal adults, and schizophrenic adults. By the use of these simultaneous touch stimuli, a pattern in cutaneous perception was demonstrated in which the face, as well as the genital region, was the most perceptive or dominant body area, whereas the hand showed the least dominance. The remainder of the body regions fell between these two extremes in the form of a mild gradient. No one theory adequately explains the organization of this pattern. Learning and maturation are probably factors, but it appears to be mostly inherent. The pattern is found in the normal subject but is accentuated in the presence of disease of the brain.

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PATTERNS OF PERCEPTUAL ORGANIZATION WITH SIMULTANEOUS STIMULI

By Doctors: Morris B. Bender, Martin A. Green and Max Fink

Several series of normal adults, normal children, patients with organic mental syndrome and patients with schizophrenia were tested for their ability to perceive simultaneous tactile stimuli.

With his eyes closed, the subject was touched simultaneously on two different areas of his body and asked to report what he perceived and to localize the percepts. The responses to this method of testing in all subjects fell into two general groups. The subject either reported both stimuli correctly or reported only one correctly and either did not perceive the second stimulus (extinction) or mislocalized it (displacement). If the right face-left hand were tested, for example, the subject might report the face stimulus correctly and either not perceive the stimulus on the hand or mislocalize the hand stimulus to the left cheek and so report that he felt a single stimulus on each side of the face.

Twenty patients with organic mental syndrome and 20 normal children 3-6 years of age were tested in all possible combinations of two between the major body areas. Each subject received 540 tests in a random order. Testing was done with the subject completely nude.

When the incidence of errors in the different body areas was analyzed by statistical methods, a significant and similar relationship between these areas was found in both groups of subjects. Errors were least frequent in the face and genital zone. These were designated as the most dominant regions. Errors were most frequent in the hand when it was tested with any other body part. When all the body parts were thus compared, a gradient was established with the following order of dominance: the face and genital region, followed by abdomen, breast, buttock, foot, back, shoulder and thigh. Dominance was least apparent in the hand.

Three other groups consisting of 592 normal adults, 532 schizophrenic adults and 527 patients with organic mental syndrome were tested in various body combinations. In those combinations in which dominance was apparent, the order of dominance was similar to that found in the preceeding groups.

This order of dominance on simultaneous stimulation appears to be an inherent pattern of organization. It is present in normal children 3-6 years of age and in normal adults. The pattern is exaggerated and much more apparent in patients with disease of the brain.

Various theories explaining this pattern, particularly the closeness of the face and genital regions, will be discussed.

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