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Tests of Face and Hand

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PREVIOUSLY it was shown that examination of the cutaneous modalities by the method of double simultaneous stimulation elicited defects in perception which were not apparent on single stimulation. The defects, described as "extinction," "obscuration," "displacement," and "allesthesia," were observed in groups of patients with localized or diffuse disease of the central nervous system.¹ In each group the defects in cutaneous perception obtained on double simultaneous stimulation were most apparent in the hand and least in the face. The object of the present investigation was to determine the patterns of responses in normal subjects, adults and children to simultaneous stimulation of the face and hand—the "face-hand" test.² The observations on this normal group were then compared to some extent with the responses of patients with organic mental syndromes, aphasia, and schizophrenia.

MATERIAL

The "normal" subjects were children and adults. These subjects were persons attending hospital clinics in whom there was no evidence of disease of the brain, and school children, staff personnel, and students, in whom there was no manifest disorder of the central nervous system. None of them had been examined previously by the method of double simultaneous stimulation.

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1. (a) Bender, M. B., and Furlow, L. T.: Phenomenon of Visual Extinction in Homonymous Fields and Psychologic Principles Involved, *Arch. Neurol. & Psychiat.* **53**:29-33 (Jan.) 1945. (b) Bender, M. B.: Extinction and Precipitation of Cutaneous Sensations, *ibid.* **54**:1-9 (July) 1945; (c) The Phenomenon of Sensory Displacement, *ibid.* **65**:607-621 (May) 1951. (d) Bender, M. B.; Shapiro, M. F., and Schappell, A. W.: Extinction Phenomena in Hemiplegia, *ibid.* **62**:717-724 (Dec.) 1949. (e) Bender, M. B.; Wortis, S. B., and Cramer, J.: Organic Mental Syndrome with Phenomena of Extinction and Allesthesia, *ibid.* **59**:273-291 (March) 1948. (f) Bender, M. B.; Shapiro, M. F., and Teuber, H. L.: Allesthesia and Disturbance of Body Scheme, *ibid.* **62**:222-231 (Aug.) 1949. (g) Bender, M. B., and Nathanson, M.: Patterns in Allesthesia and Their Relation to Disorder of Body Scheme and Other Sensory Phenomena, *ibid.* **64**:501-515 (Oct.) 1950.

2. Bender, M. B.; Fink, M., and Green, M.: Patterns in Perception on Simultaneous Tests of the Face and Hand, *Tr. Am. Neurol. A.* **75**:250-252, 1950.

The subjects were divided into three groups according to age: children of 3 to 6, and 7 to 12 yr., and "adults" over 12 yr. of age.

For comparison with the normal group, we studied patients in the wards of the Bellevue Psychiatric Hospital. They were divided into three groups on the basis of their disease—schizophrenia, organic psychoses, and aphasia. No attempt was made to study separately the clinical types of schizophrenia. Most of the patients had the paranoid, mixed, or simple variety of schizophrenia. The patients with organic mental changes showed defects in memory, orientation, and calculation, as well as other signs and symptoms characteristic of diffuse disease of the brain. The clinical diagnoses for most of these patients was Alzheimer's' disease, arteriosclerotic encephalopathy, severe cerebral trauma, brain tumor, or toxic encephalopathy. The subjects with aphasia were those who showed characteristic difficulties in communication. Those who had concomitant hemiparesis or a hemisensory defect noticeable on single stimulation were not included in this series.

METHOD

The subject was instructed to close the eyes. When this was done, the face (cheek) and either the ipsilateral or the contralateral hand (any part of the hand or digits) were simultaneously touched or stroked with the examiner's fingers. The subjects reported either one or two sensations. When only one percept was reported, the subject was asked if there was still another and, if so, to indicate its location and quality.

After the initial trial, in each subject, the opposite cheek and hand were stimulated in the same manner. These tests were repeated and the results recorded, until the subjects consistently reported both stimuli correctly. In those subjects who failed to localize the two stimuli correctly after six or eight trials, other parts of the body were tested in such combinations as face-face, hand-hand, face-breast, or penis-hand, these stimulations alternating with the face-hand test.

In a second, separate series of studies, pinprick stimuli were used in a similar fashion. In both series, care was taken to apply the stimuli at the same time and with the same intensity. It was apparent that subjects who made consistent errors in reporting would be correct as soon as the stimuli were applied consecutively rather than simultaneously, even if the time lag between stimuli was that of one or two moments. It was also necessary to use naive normal subjects, since subjects previously tested did not show the patterns noted below.

RESULTS

The responses obtained on the face-hand test fell into four groups: (*a*) a touch sensation on the face and the hand, indicating the correct and expected perception; (*b*) a touch sensation on the face only, implying no sensation in the hand; (*c*) a touch sensation on both sides of the face, and (*d*) a touch sensation on the hand only, implying none on the face. When only one stimulus was reported, the subject was asked if there was any other sensation. The occasional reply was that there was another percept, and the subject correctly pointed to the second locus. Many subjects, however, reported that they had not perceived another stimulus, usually adding the statement: "I was not paying attention; do it again," or, "I'm not sure; maybe it was somewhere over here," and pointing in the direction of the side of the body of the poorly felt stimulus. In some instances, while correctly localizing the second percept, they volunteered the statement: "It was not as strong as the other one," or "It doesn't seem as sharp."

Before we proceed with the results, we must define the special terms used. In other communications the failure of the subject to report one of two simultaneously applied stimuli has been called "the phenomenon of sensory extinction," or "extinction."^{1a, b} The part of the body where the stimulus was perceived is said to be "dominant" to the part of the body where the simultaneous stimulus was not perceived, or perceived faintly. The latter diminution in the quality of a sensation was

termed "obscuration." When the subject reported two sensations, but mislocalized one of them, the "displacement" of a percept is said to have occurred.^{1c} Displacements are usually in the direction of the dominant stimulus and may be partial or complete. The displacements noted in this series were from the hand to the cheek of the same side. Rarely did the displacements occur to the neck or shoulder.

Initial Trial.—The results were analyzed from the standpoint of initial and subsequent trials. On the initial trial of the face-hand test with touch stimulation in normal subjects, face dominance was apparent in all age groups. More than half of such normal adults reported the sensation in the face and none in the hand. Three subjects mislocalized the sensation in the hand to the face. In the groups of normal children, 90% under the age of 6 yr. reported only the face percept or mislocalized the hand percept to the face. This pattern of face dominance is also seen in the children from 7 to 12 yr. of age, but to a less extent.

Of the normal subjects, five adults reported the hand stimulation only on the initial trial. No example of displacement from face to hand was noted.

This pattern of face dominance by hand extinction or by displacement of the hand percept to the face was even more apparent in the patients examined. It was most evident in patients with organic mental changes, 93% of whom did not report

TABLE 1.—*Response to Touch Stimulation on Initial Trial*

	Total	Correct Responses	Face Only	Face-Face	Hand Only
Normal adult	160	77	75	3	5
Normal child, 3-6 yr.....	56	10	28	18	0
Normal child, 7-12 yr.....	76	38	27	9	2
Schizophrenia (unclassified)	74	26	45	1	2
Organic mental syndrome.....	120	9	94	14	3
Aphasia	23	12	11	0	0

both stimuli correctly. In examinations of schizophrenic subjects and patients with aphasia, responses similar to those of the normal adult were observed in the initial trial.

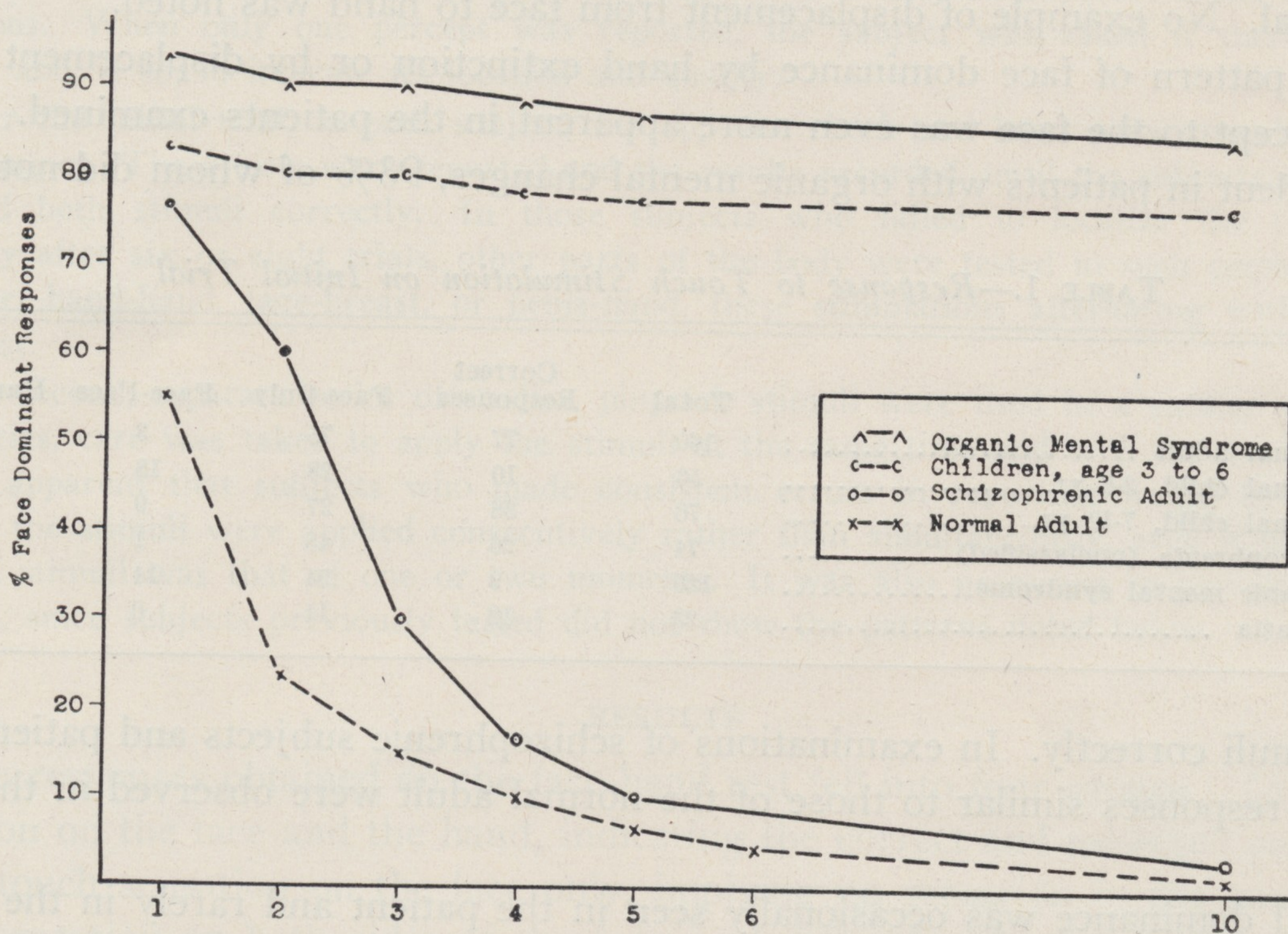
Hand dominance was occasionally seen in the patient and rarely in the normal subject. In cases of hand dominance the subject reported the hand, but not the face, percept. It was seen in the initial trial in five normal adults. These subjects reported both stimuli correctly on subsequent testing. In the patients with organic mental changes hand dominance was an inconstant response, and repeated testing the same day, or on subsequent days, demonstrated the more usual persistent pattern of face dominance.

Subsequent Trials.—Of the 83 normal adults who made errors on the initial trial, 43 made correct responses on the second trial and 12 on the third trial. In a few subjects, four, five, or six trials were necessary before the two stimuli were correctly localized. These subjects were assumed to be normal, although complete psychological tests were not made. It was noted that anxiety (tension during examination or a strong desire to please) interfered with the early correct recognition of the stimuli. In all normal subjects, including those with anxiety, once the correct response was obtained (even after many trials with errors), it was elicited on all subsequent testing. It seemed as though a number of trials was necessary for

the subject to get into the "set" of the examination, and that, once in the set, he reported the stimuli accurately, even after the lapse of many days.

In testing the normal young child, it was apparent that in most cases many trials were necessary before the correct response was consistently elicited. Also, the child did not always give a correct response on subsequent testing. Repeated testing over many days, however, elicited the same patterns of face dominance. This was noted in 36 of the 56 children tested. In a number of instances the child watched the application of the stimuli and thus reported the perceptions correctly. But as soon as the test was repeated with the eyes closed, the child again reported only one stimulus. It was evident that the child could not get into the "set" of the examination, even with visual cues.

This difficulty was not very apparent in all children. In the older group (ages 7 to 12 yr.) only 17 of the 76 failed to give the correct response after the initial few trials.



Responses to face-hand test on initial and subsequent trials.

The responses obtained on repeated trials of the face-hand tests in normal subjects also followed a consistent pattern. As on the initial trial, face dominance was prevalent in all subjects. It was manifest either by (a) extinction or obscuration of hand stimuli or (b) displacement of hand stimuli to the face, or, in several instances, in a direction toward the face.

In contrast to normal adults, patients with organic mental changes were unable to report the two stimuli correctly, even after many trials. When the patient reported the percept in one test correctly, he frequently failed on subsequent testing. It was also apparent that testing on subsequent days still elicited displacement and extinction of stimuli. This is in strong contrast to the responses of apparently normal subjects, who seldom made an error on subsequent trials, days after the initial examination. The responses obtained in this group demonstrated the patterns of face dominance in most of the tests. Displacement of the hand percept to

the face was frequent. In some instances displacement or extinction was present despite the fact that the patient watched the application of the stimuli to the face and hand. Extinction was very common on homolateral or heterologous testing, while displacement was apparent mostly on heterologous testing.

The schizophrenic and the aphasic patients gave reports which were similar to those of normal adults. After the first two trials percentage of error in hand sensation was slightly higher than in the normal group. Persistent bizarre responses were elicited from a number of the schizophrenic subjects. These reports included multiple responses to single or double stimuli, persistent displacements to one area from any other body area, and mirror reversals of localization. These were inconsistent during an examination and from day to day. As with the normal adults, testing the schizophrenic or aphasic subject on consecutive days failed to elicit extinction phenomena once the test had accurately been reported before.

A comparison of the responses of each of these groups to multiple testing is shown in the accompanying chart.

Pinprick Stimulation.—It is known that the type of stimulus applied influences the results in perception. To demonstrate the importance of this factor, similar groups of subjects were tested using two pinprick stimuli instead of two touch

TABLE 2.—*Response to Pinprick Stimulation on Initial Trial*

	Total	Correct Responses	Face Only	Face-Face	Hand Only
Normal adult	68	51	15	2	0
Normal child, 3-6 yr.....	45	16	26	2	1
Normal child, 7-12 yr.....	39	25	14	0	0
Schizophrenia	50	36	13	0	1
Organic mental syndrome.....	49	9	33	3	2

stimuli. With pinprick stimulation of the face and hand, face dominance was again manifest in all the groups. However, the incidence of error in perception of the pinprick in the hand was lower than that with a touch stimulus. The results are recorded in Table 2.

Repeated testing with two pins in the normal adult subjects elicited the correct responses in the initial three trials. Fewer of the children failed to report the test accurately after the initial trials. It was possible in a number of instances to alternate touch and pinprick stimulations and to demonstrate extinction to touch, but correct localization to pinprick. Moreover, with more intense pinprick stimulation, extinction and displacement were less frequently observed.

These phenomena, namely, extinction and displacement, were even more apparent in the patients with organic mental syndromes. Displacement of touch stimulation could be alternated with correct localization of pinprick stimulation. A combination of touch to the face and pinprick to the hand evinced the combination of displacement and obscuration, as the patient reported "a touch on the face, and a dull one on the other side (of the face)." Pinprick to the cheek and touch to the hand resulted in extinction of the hand percept, or, occasionally, the report of a pinprick on both the cheek and the hand.

The schizophrenic subjects were able to localize the pinprick stimulus accurately after the initial few trials, as had the normal adults.

COMMENT

By using the method of double simultaneous stimulation in tests of the face and the hand, a consistent pattern of responses has been observed in a variety of subjects. The stimulus to the face is more readily perceived than the one to the hand. Moreover, the face percept influences the hand percept, frequently causing the displacement of sensation. This pattern of responses has been repeatedly demonstrated in both the normal and the abnormal subjects and is manifest in extinction, obscuration, and displacement. Extinction is most, and displacement is least, frequent. In extinction, the face percept is correctly reported as to quality and locus, but the hand stimulus is not perceived at all. In all the foregoing tests of patient or normal subjects, whether the responses were accurate or not, it was noted that the subject almost invariably pointed to the face stimulus first. Occasionally the hand percept was perceived and correctly localized, but assumed a qualitative difference, always of diminution. In displacement the stimulus to the hand was mislocalized to the face, or in the direction of the face, e. g., to the shoulder or neck. In some instances if the face and the hand of the same side were stimulated, the subject occasionally reported two sensations in the face. None of these phenomena was haphazard. While the frequency with which any one of these effects was observed might be affected by attention, drugs, or variation in stimuli, its pattern was consistent.

These responses to the face-hand test are modified by many factors. Some of the influencing factors are (*a*) attention, (*b*) age of subject, (*c*) simultaneity of stimuli, (*d*) type of stimulus, (*e*) strength of stimulus, (*f*) locus of stimulation, and (*g*) internal state of organism. These factors may alter the frequency with which extinction and displacement appear, but they do not change the pattern of face dominance.

The subject's awareness of the test is a major factor in the appearance of the phenomenon of extinction. Both attention and previous experience can bring stimuli to awareness. In a series of 20 adults who were informed that two stimuli were to be applied, none showed extinction of percepts. Because previous experience can influence a response, it was necessary to record the findings on initial trial in naïve subjects. By this method the factor of previous experience was minimized. At the same time, the subject was not apt to be on the "alert" for the number of stimuli he was to receive. Consequently, one might say that the reason the subject perceived only one stimulus, or perceived one stimulus and displaced the percept of the other, is that he was not paying attention.³ This criticism may be valid, but the significant fact is that the error was always made in the hand and not in the face. If it were mere inattention, one would expect 50% of the single responses to double simultaneous stimulation to be in the hand and 50% in the face. But this type of chance error was not observed. Of the single responses to double simultaneous stimulation, 95% were of the face percept and 5% of the hand percept. This pattern of face dominance or hand extinction was further established during subsequent examinations. Moreover, when displacement was seen in normal subjects, it was to the face and not to the hand.

This pattern of face dominance to double simultaneous stimulation was found to be exaggerated in normal young children, of whom 83% demonstrated either hand extinction or displacement of the hand percept to the face on the initial trial.

3. Critchley, M.: The Phenomenon of Tactile Inattention with Special Reference to Parietal Lesions, *Brain* **72**:538-561, 1949.

Moreover, this high percentage of responses of face dominance persisted on subsequent trials. In the older children, also, face dominance was consistently demonstrable. It was noted that the younger the child, the more distinct was this pattern of face dominance.

Hand extinction might be attributed to an inability to perceive two stimuli at once. This particular defect has been noted in patients with severe mental changes by Goldstein.⁴ However, in patients with severe mental changes or in young children stimuli applied to both cheeks, or both hands, or any other two homologous body areas were correctly reported as two sensations. There was neither extinction nor displacement. Goldstein's observation, therefore, cannot be used as an explanation of hand extinction.

It is noted that face dominance was apparent no matter what type of stimulation was used. Simultaneous pinprick stimulations revealed the pattern of face dominance, although with a lower frequency than touch stimulations. Other cutaneous stimulation, such as application of two tuning forks or hot and cold tubes, repetitive rubbing, and repetitive pinprick stimulation, was used, and face dominance was manifest regardless of the cutaneous stimulation employed.

The importance of the simultaneity of the stimuli has already been alluded to. In subjects in whom extinction was persistent, consecutive application of the stimuli invariably resulted in the perception of two stimuli. In normal adults consecutive stimulation of the face and the hand, even on the initial trial, never resulted in extinction.

In these studies the stimuli were of equal intensity. This factor was important in eliciting the pattern in the normal subject, for unequal stimuli were seemingly more readily perceived than equal stimuli. After the first few trials the subject was able to perceive the two stimuli, even if one was painful and the other not. In patients with organic mental changes, however, extinction and displacement were manifest despite a wide discrepancy in the quality of the stimuli. By altering the strength of the stimuli, it was possible to alter the response from extinction of the hand percept (if the hand stimulus was weak) to displacement to the cheek (if the hand stimulus was strong). The change from extinction to displacement was also elicited by altering the quality of the stimuli, that is, from touch to pinprick. Nevertheless, the pattern of face dominance was always apparent.

The parts of the body being simultaneously stimulated is another consideration in studying these patterns. We have already alluded to the fact that extinction is commonest in the hand and least in the face. In testing other body areas, the incidence of extinction and displacement is less than in testing the face and the hand. That is, testing shoulder and thigh may not elicit extinction or obscuration, whereas the face-hand test may. Also, in patients with lesions of the brain or spinal cord, the pattern of relation of the body parts to simultaneous stimulation may be altered in a characteristic hemisensory or "level-lesion" syndrome. Further studies are necessary before the significance of the pattern can be interpreted. Any deduction made at this time would be purely speculative. For instance, nothing is gained by stating that face dominance implies a rostral order of sensory dominance.⁵ Such a

4. Goldstein, K.: The Mental Changes Due to Frontal Lobe Damage, *J. Psychol.* **17**:187, 1944.

5. Cohn, R., and Raines, G. N.: On Certain Aspects of the Sensory Organization of the Human Brain: A Study in Rostral Dominance as Determined by Ipsilateral Simultaneous Stimulation, *Tr. Am. Neurol. A.* **74**:162-168, 1949.

hypothesis is contradicted by at least one fact, namely, the observation that when the hand and foot are stimulated simultaneously the foot dominates over the hand. Perhaps after more data are accumulated a satisfactory theory may be obtained.

SUMMARY

A pattern in perception in tests of stimulation of the face and hand has been elicited in normal and abnormal subjects by the method of double simultaneous stimulation of cutaneous modalities.

Face dominance, manifest by extinction of the hand percept or by displacement of the hand percept to the face, is seen as a normal phenomenon, manifested in the normal adults and in the patients with schizophrenia and aphasia examined in the series. It is exaggerated in young children and in patients with diffuse disease of the brain, in whom extinction and displacement are persistent after multiple trials.

This pattern of face dominance is manifest regardless of the cutaneous modality tested, there being a change only in the frequency of extinction with change in type of stimulus.

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