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PATTERNS IN PERCEPTION ON SIMULTANEOUS TESTS OF FACE AND HAND

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In previous studies we found that the method of double simultaneous stimulation showed defects in sensation (extinction) which were not apparent on routine single stimulation. In testing two different regions of the body and various combinations it was found that extinction was apt to occur most often in the hand and least in the face. Conversely, "dominance" was greatest in the face and least in the hand. In the present communication we wish to report the results obtained on simultaneous stimulation of the face and the hand (the face-hand test) in groups of subjects with the following conditions: 1) aphasia without hemiparesis or hemisensory syndrome; 2) aphasia with severe mental changes; 3) organic mental syndrome; 4) schizophrenia; 5) no disease of the brain (normal adults) and 6) normal children between the ages of four to ten years. Patients in groups 2 and 3 showed severe memory defects, confusion, poor orientation, difficulties in calculation and other symptoms characteristic of diffuse disease of the brain.

Method: The subject was instructed to close his eyes. When this was done his face (cheek) and contralateral hand (any part of the hand or fingers) were touched simultaneously. Care was taken to make the two stimulations of equal intensity. As soon as the stimuli were applied the subject was asked to report what he felt, and following this, where he felt the sensation. Identical tests were carried out with light rubbing and pin prick stimulations.

Results: Under these conditions the subject gave either of the following responses on the first examination: a) a touch on the face only (face dominance), implying no sensation in the hand (extinction); b) a touch on both sides of the face (there being "displacement" from the hand to the ipsilateral face); or c) a touch on the face and contralateral hand. In the (a) response the subject was asked whether he felt still another stimulus. The reply was either in the negative, or there was uncertainty or vague approximation. This question suggested to the subject that there were two stimulations so that on subsequent tests he was expectant of more than one stimulus.

In the (b) type of response the subject mislocalized or displaced the sensation evoked in the hand toward the ipsilateral face. Since the mislocalization was towards the face it appeared as if the face determined the direc-

tion of the displacement. It might be said, therefore, that this was a type of face dominance. Response (b), or displacement, was less common than response (a) or extinction. Response (b) was seen most often in the patients with the organic mental syndrome, and persisted despite repeated testing. The (c) response was the expected normal and needs no special comment.

Extinction and displacement were also noted when the ipsilateral face and hand were simultaneously tested. In all the subjects tested, including those with aphasia, there was no difference between the right and left sides of the body.

Analysis of the results obtained in the various groups is shown in the following table:

Group	*Number of Subjects*	*Face Response Extinction or Displacement*	*Face and Head Response*	*Hand Response*
1	15	9	6	0
2	12	12	0	0
3	22	20	2	0
4	20	14	6	0
5	53	24	28	1
6	20	19	0	1

From the foregoing it is obvious that whenever there is dominance of one sensation over another it is apparent in the face. Dominance in the hand was noted only once. Face dominance was found almost uniformly in the subjects with severe mental changes (groups 2 and 3). These patients did not report sensation in the hand even after repeated testing. In a few instances, even after the patients were told there were two stimuli, or were asked to watch the application of the stimuli, they reported only one percept or displaced one. In these cases simultaneous stimulation of both sides of the face was reported correctly, thus excluding the objection that these patients were not able to do or perceive two things at once.

The incidence of face dominance in subjects with aphasia and in those with schizophrenia (groups 1 and 4) was less. In contrast to patients in groups 2 and 3, those in groups 1 and 4 reported both sensations correctly on the second, third or fourth trials, if they had not done so on the first trial. In the group of normal adults (group 5) the incidence of face dominance was least, but still significant, even though it was found only on the first trial. In a series of normal children the incidence of face dominance was almost the same as in groups 2 and 3. In young children face dominance was present even several trials after the first examination.

When the face and parts of the body other than the hand were tested simultaneously in groups 2 and 3, face dominance was still apparent. The order of dominance was face, shoulder, trunk (breast), penis, thigh, calf, foot, arm and hand.

Conclusion

In a wide variety of subjects the phenomena of extinction and displacement on double simultaneous stimulation were demonstrated. A consistent pattern of perception was established in which the face was most dominant and the hand the least. These findings were noted in both the abnormal and the normal subjects. In the abnormal subjects with severe mental changes, face dominance and hand extinction were so consistent that they may be used as a sign of diffuse disease of the brain, but only when found to persist after repeated examinations.

The pattern of dominance, as well as the phenomenon of extinction, which are so prominent in patients with diffuse brain disease, appear to be exaggerations of the patterns found in the normal subjects, especially children.

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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) (2) (3). 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.(4) The observations in 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 previously examined by the method of double simultaneous stimulation. The subjects were classified into three groups according to age: children of 3 to 6 and 7 to 12 years, and "adults" over 12 years.

For comparison with the normal group we studied patients on the wards of the Bellevue Psychiatric Hospital. There were three groups - schizophrenia, organic psychoses and aphasia. No attempt

was made to separately study each of the clinical types of schizophrenia. Most of the patients were of the paranoid, mixed or simple varieties 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 in most of these cases 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 a 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 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.

Following 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 as face-face, hand-hand, face-breast, penis-hand, etc., alternating with the face-hand test.

In a second separate series of studies pin prick stimulations 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 on the face and the hand, indicating the correct and expected perception; (b) a touch on the face only, implying no sensation in the hand; (c) a touch on both sides of the face; and (d) a touch 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 vdunteered 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" (1). 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 (2). 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 six 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 7-12 years of age but to a lesser extent.

Of the normal subjects, five adults reported the hand stimulus 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 both stimuli correctly. In examinations of schizophrenic subjects and patients with aphasia responses similar to those of the normal adult were observed on the initial trial.

Hand dominance was occasionally seen in the patient and rarely in the normal subject. In cases of hand dominance the individual reported the hand but not the face percept. It was seen in the initial trial on five different normal adults. In these instances, the subject 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.

TABLE I

Touch Stimulation
Response on Initial Trial

	Total	Correct	Face Only	Face-Face	Hand Only
Normal Adult	160	77	75	3	5
Normal child, 3-6	56	10	28	18	0
Normal child, 7-12	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

Subsequent Trials: Of the 83 normal adults who made errors on the initial trial, 43 were correct on the second 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 done. 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 if a number of trials were necessary for the subject to get into the "set" of the examination, and 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 was not always correct 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 7-12) only 17 of the 76 failed to give the correct response after the initial few trials.

The reports 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) by displacement of hand stimuli to the face, or in several instances the displacement was 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 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 test. 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 tests.

The schizophrenic and the aphasic patients gave reports which were similar to normal adults. After the first two trials the 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 adult, testing the schizophrenic or aphasic subject on consecutive

days failed to elicit extinction phenomena once the test had been accurately reported before.

A comparison of the responses of each of these groups to multiple testing is shown in Fig. 1.

Pin Prick 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 pin prick instead of two touch stimulations. With pin prick stimulation of face and hand, face dominance was again manifest in all the groups. However, the incidence of error in perception of the pin prick in the hand was lower than with a touch stimulus. The results are recorded in Table II.

TABLE II

Pin Prick Stimulation
Response on Initial Trial

	Total Correct	Face Only	Face-Face	Hand Only
Normal Adult	68	51	15	2	0
Normal child, 3-6 years	45	16	26	2	1
Normal Child, 7-12 years	39	25	14	0	0
Schizophrenia	50	36	13	0	1
Organic Mental Syndrome	47	9	33	3	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 pin prick stimulations, and demonstrate extinction to touch, but correct localization to pin prick. Moreover, with

more intense pin prick 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 stimuli could be alternated with correct localization of pin prick stimulation. A combination of touch to the face and pin prick 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)." Pin prick to the cheek and touch to the hand resulted in extinction of the hand percept; or, occasionally, the report of a pin prick both on the cheek and hand.

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

DISCUSSION:

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 in the hand. Moreover, the percept in the face influences the one in the hand, frequently causing the displacement of sensation. This pattern of responses has been repeatedly demonstrated in both the normal and 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 of 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 is perceived and correctly localized, but assumes a qualitative difference, always of diminution. In displacement the percept in the hand is mis-localized to the face, or in the direction of the face, such as to the shoulder or neck. In some instances if the face and the hand of the same side are stimulated, the subject occasionally reports two percepts in the face. None of these phenomena is haphazard. While the frequency with which any one of these effects is observed may be affected by attention, drugs, variation in stimuli, etc., its pattern is 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.(5) In a series of twenty 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 naive 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 and displaced the percept of the other stimulus is that he was not paying attention.(5) 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.

(5)

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. Moreover, this high percentage of face dominant responses 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 (6). 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 for hand extinction.

It is noted that face dominance is apparent no matter what types of stimulation was used. Simultaneous pin prick stimulations revealed the pattern of face dominance, although with a lesser frequency than touch stimulations. Other cutaneous stimulation such as two tuning forks, hot and cold temperature tubes, repetitive rubbing and repetitive pin prick stimulation were applied and face dominance is manifest regardless of the cutaneous stimulation used.

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 was important in eliciting the pattern in the normal, 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 alternate the response from extinction of the hand percept (if the hand stimuli were weak) to displacement to the cheek (if the hand stimuli were strong). The change from extinction to displacement was also elicited by altering the quality of the

stimuli, that is from touch to pin prick. Nevertheless, the pattern of face dominance was always apparent.

The parts of the body being simultaneously stimulated are another consideration in studying these patterns. We have already alluded to the fact that extinction is most common 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, where the face-hand test will. Also, in patients with lesions of the brain or spinal cord, the pattern of relationship of the body parts to simultaneous stimulation may be altered in a characteristic hemisensory or "level lesion" syndrome. As for the significance of the pattern further studies are necessary before the proper meaning 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 (7). Such 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 might be obtained.

SUMMARY:

A pattern in perception in tests 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 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 only a change in the frequency of extinction with change in type of stimulus.

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