

## EXOSOMESTHESIA OR DISPLACEMENT OF CUTANEOUS SENSATION INTO EXTRAPERSONAL SPACE

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AMONG phenomena that may be apparent during examination of patients with disease of the sensory pathways is mislocalization of a sensory stimulus. It has long been known that a person with a sensory defect, as seen in the common varieties of cerebral hemiplegia, may inaccurately localize stimuli applied on the paretic side.

Such point mislocalizations are apparent in examinations using a single stimulus and have been described in detail by Head.<sup>1</sup> These mislocalizations can be accentuated by the use of double simultaneous stimulation techniques.<sup>2</sup> In addition, when these techniques of examination are employed, other varieties of mislocalization, such as displacement,<sup>3</sup> become apparent. Displacement is the patterned mislocalization of one of two stimuli simultaneously applied to different body areas. The direction of displacement is in a definite pattern, which is dependent upon the parts of the body stimulated.

Characteristic of mislocalization so far reported has been the fact that their extent was within the limits of the patient's body. In the course of studies of cutaneous perception, we observed a new form of displacement in which the patient consistently and in a predictable fashion mislocalized stimuli into extrapersonal space. This type of displacement we have termed "exosomesthesia."<sup>4</sup>

Exosomesthesia is not a commonly observed phenomenon. More than 400 patients with brain disease were examined at Psychiatric Pavilion of Bellevue

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1. Head, H.: *Studies in Neurology*, London, Oxford University Press, 1920, Vol. 2.

2. Bender, M. B.; Shapiro, M. F., and Schappell, A. W.: Extinction Phenomenon in Hemiplegia, *Arch. Neurol. & Psychiat.* **62**:717-724 (Dec.) 1949. Bender, M. B.: The Advantages of the Method of Simultaneous Stimulation in the Neurological Examination, *M. Clin. North America* **32**:755-758 (May) 1948.

3. Bender, M. B.: The Phenomenon of Sensory Displacement, *A. M. A. Arch. Neurol. & Psychiat.* **65**:607-621 (May) 1951.

4. The term was derived by Dr. Judah A. Joffe (Hinsie, L. E., and Shatzky, J.: *Psychiatric Dictionary*, New York, Oxford University Press, 1940) from the Greek έξω, out of; σώμα, body, and αίσθησις, perception by the senses.

Hospital Center by routine and specialized sensory tests. Exosomesthesia was observed in only 15 cases, an incidence of about 3%.<sup>5</sup> The following case reports illustrate the phenomenon and demonstrate some of the conditions under which it was observed.

#### CASE REPORTS

CASE 1.—H. M., a man aged 64, was admitted to the Psychiatric Pavilion of Bellevue Hospital with a history of progressive mental changes of six years' duration. The first four years of illness were marked by slowly progressive impairment of memory, concentration, and other intellectual functions and by increasing apathy to his environment. In the last two years there was rapid exacerbation of this condition, resulting in the loss of his job as a store manager. During this period his speech became increasingly garbled and stammering. He vacillated between irritability and complete apathy. He was occasionally incontinent, ceased bathing, had difficulty in dressing, and was sometimes so forgetful and confused as to wander into the street without his trousers.

*Routine Neurologic Examination.*—In walking, the trunk was tilted to the right, and there was a tendency to drag the right lower extremity. However, there was no significant motor weakness, reflex change, or tonus abnormality. Coordination tests were well performed. The cranial nerve functions were intact. Vibration sense was correctly perceived only in the clavicles and the head, while position sense was lost in the fingers, wrists, toes, and ankles bilaterally. Temperature differences were poorly perceived except in the face area. His responses to touch and pinprick stimulation will be described later. A mild degree of "mixed aphasia" was present. This speech difficulty was evident only by special testing or when the patient was fatigued by prolonged examination. There was a fluctuating dyspraxia of moderate severity. Occasionally he had difficulty in dressing, being unable to handle buttons and sleeves. However, he could perform such functions as feeding himself, combing his hair, and other routine daily tasks. He was usually unable to mimic the more complicated patterns of the hand-praxis tests.

An electroencephalogram showed bilateral diffuse abnormality, with decrease in amplitude and intermittent suppression of activity over the parietal regions. A pneumoencephalogram disclosed bilaterally dilated ventricles and moderate "cortical atrophy," particularly in the left temporal lobe.

*Psychiatric Status.*—Although the patient was oriented for place and situation, he made errors as to date and time of day. There were defects in recent memory, concentration, calculation, and ability to assume the abstract attitude. He usually sat placidly staring into space or wandered aimlessly about the ward. He did not mix with other patients. When approached by members of the staff, he was friendly and passively cooperative. Testing procedures were approached with cheerful indifference. When, however, he was pushed into test situations greater than his capacity, he reacted with increasing irritability and tension, eventually culminating in a "catastrophic reaction." At such times he would become red in the face, shout that he knew the answers but did not want to continue, and suddenly begin to weep.

*Body Scheme.*—He was able to distinguish the right side of his body from the left, but was unable to make this distinction on the examiner's body. He had no difficulty either in locating midline structures of his body, such as the nose, mouth, chin, umbilicus, and penis, or in pointing to his eyes. With eyes open he readily found both ears; but when his eyes were closed he groped about his face for several seconds before locating them. He could point to his thighs, knees, ankles, and toes but could not point to any specific toe other than the big toe.

He frequently had difficulty in locating portions of his upper extremities. If asked to point to his shoulders, he correctly located one shoulder but then groped behind his neck looking for the other. This defect was even more noticeable in trying to find the "other" elbow and wrist, and greatest in trying to find the "other" hand. His search for the "other" hand or wrist was bizarre. He would look under the pillow or rummage under the mattress, becoming tense and

5. Fink, M.; Green, M., and Bender, M. B.: The Face-Hand Test as a Diagnostic Sign of Organic Mental Syndrome, *Neurology* 2:46-58 (Jan.-Feb.) 1952.

insisting it was lost. It should be emphasized that, despite the great difficulty in locating parts of his body, the patient was able to name the body parts, except the fingers and toes. This was true whether the part pointed to was on the patient's or on the examiner's body.

*Sensory Status.*—(a) Single Stimulation: He had difficulty in differentiating between the sharp and the dull end of a pin. This defect was present throughout the body, although he made significantly fewer errors in the face and hands. Touch stimulation was poorly perceived. Usually he could not state whether or not he had been touched. Again, there seemed to be relatively better preservation of this modality in the hands and face.

Except under special conditions of examination of the hands, to be described later, the patient was able to locate the site of a pinprick by pointing. However, if the pin was repetitively and rapidly applied to one region, or if the prick was steadily maintained at that one place, he could not locate the point of stimulation. He would make frantic, random searching movements over his body, and not infrequently around the bedclothes, grimacing as though in pain and exclaiming that he was trying to remove the pin. If asked where he was being pricked, he disregarded the question and continued to try to remove the stimulus. This phenomenon occurred on stimulation of any portion of the body but was most apparent when the hand was tested.

(b) Double Simultaneous Stimulation: The phenomena of extinction and displacement were frequently observed in tests of different body areas by simultaneous tactile stimulation. On stimulation of the face and hand, stimuli to the hand were not perceived or were mislocalized to the cheek. In tests of homologous body areas (as hand-hand) extinction of one percept was common. The side on which the stimulus was not perceived fluctuated, so that at one moment only a right-sided stimulus was perceived and a few moments later only a left-sided stimulus was perceived.

*Exosomesthesia.*—Whenever his palm was in contact with a portion of his body or any other object, and the dorsum of that hand was pricked with a pin, the patient consistently mislocalized the stimulus. This mislocalization was to whatever object the palmar surface of the hand was touching. For example, if the patient's hand was resting on his thigh and the dorsum of the hand was pricked, he insisted that the thigh had been touched, and not the hand. This mislocalization—exosomesthesia—occurred to the thigh, abdomen, leg, or face and was present with stimuli to either hand. It was observed even when the patient was urged to look at the hand during the application of the pin. Exosomesthesia could not be elicited, however, by stimulation of the palm or palmar surface of the fingers when the dorsum of the hand was resting on a portion of the body. Furthermore, localization of stimuli to the dorsum of the hand was correct if the hand was held in space.

Mislocalization also occurred to objects external to his body. If his palm was resting on a table or on his bed, and the dorsum of the hand was pricked with a pin, he would point to these objects and state that the pin had been applied "there." When questioned, he stated that the hand had been touched but continued to point to the bed or table. Frequently, however, he insisted that it was the bed or table that had been touched, and not his hand. If asked how he could feel the bed being pricked with a pin, he would become tense, avoid the question, and insist, "You touched the bed, not me."

Displacement into extrapersonal space was not eliminated by simultaneous stimulation, even when extinction of one of the percepts occurred. For example, if pins were simultaneously applied to the dorsa of the hands while the palms were resting on a table, he would report feeling only one pinprick, that on the left (or right, as dominance fluctuated) and point to the place where the left hand had been resting, saying, "You touched the bed there."

This phenomenon of displacement into extrapersonal space occurred daily during a period of more than two months.

*Comment.*—In this patient a requisite to displacement into space was that the palm of the hand be in contact with an external object. In other words, there were two cutaneous stimuli simultaneously in operation, namely, the pinprick on the dorsum of the hand and the pressure of the object in contact with the palm or fingers. A single stimulus, such as pricking the dorsum of a hand held in space, did not elicit the displacement.

Exosomesthesia was elicited only on stimulating the hands. This occurred even though single pinprick was perceived more sharply in the hands than in any other area except the face.

Although this patient showed inability to locate correctly parts of his own and the examiner's body, it does not necessarily mean that exosomesthesia is determined by this particular type of disorder in body scheme. The following case illustrates the phenomenon of exosomesthesia in the presence of the patient's ability to locate body parts.

CASE 2.—E. K., a woman aged 52, was admitted to the neurologic service of the Mount Sinai Hospital in August, 1950, with a history of grand mal seizures. She had been in good health until 1947, when there appeared sporadic, momentary sensations of "blacking out." About two years before admission she began to suffer monthly grand mal seizures. There was no aura.

Routine examination on admission showed that her status was within normal limits except for anosmia in the right nostril. There was no organic mental syndrome. X-ray studies revealed evidence of a subfrontal neoplasm. On August 12 a craniotomy was done, and after amputation of a portion of the right frontal lobe, a large bilateral subfrontal meningioma was excised.

Her postoperative course was stormy. For two weeks she was semistuporous. She responded only to massive, painful stimulation, and these responses were limited to vague, ineffective attempts to push away the stimulus. In this period she lapsed several times into coma and showed Cheyne-Stokes respiration. The Babinski response was obtained bilaterally. Her pupils did not react to light.

From about Aug. 23, 1950, the patient improved slowly and steadily. She began to respond verbally, and contact could be maintained for short periods. Vision, which had apparently been absent, began to return, although right homonymous hemianopsia remained for some time. A marked organic mental syndrome characterized by confusion, disorientation, and anosognosia, was present.

*Routine Neurologic Examination.*—Neurologic examination in September, 1950, disclosed right homonymous hemianopsia, severe impairment of visual acuity with bilateral secondary optic nerve atrophy, nystagmus in all directions of gaze, a bilateral Babinski sign, and a mild degree of aphasia. Position sense, vibration sense, and temperature perception were unimpaired. There were difficulties in perception of touch and pinprick stimuli, as described below.

*Psychiatric Status.*—The patient was usually friendly and cooperative. However, she was frequently irritable and would not permit examination. She was disoriented as to time and occasionally to situation, but not to place. There were defects in retention and recall, covered by confabulation. She was euphoric and displayed little self-restraint or concern in social situations. Usually she would lie with her body fully exposed. Not infrequently she soiled herself or wet the bed. Anosognosia was prominent.

*Body Scheme.*—On command, the patient was able to identify and locate correctly parts of her own and the examiner's body, such as the ears, eyes, feet, and parts of the upper extremities. She exhibited some confusion about the right and the left side of the body.

*Sensory Status.*—(a) Single Stimulation: The patient perceived single pinprick stimuli well, although she made occasional nonpatterned errors in localization. These errors were more frequent on the left side.

(b) Double Simultaneous Stimulation: On simultaneous application of pinprick to the two sides of the body, except the hands, extinction on the left or displacement on the left toward the level of the right-sided stimulus was the usual response. Homolateral simultaneous stimulation on the right side of the body showed no extinction, but stimulation on the left side elicited frequent extinction and displacement.

*Exosomesthesia.*—Displacement into extrapersonal space occurred when the left hand was pricked at the same time that either the right hand or the right cheek was stimulated. The phenomenon could also be elicited when the left hand and any other area of the left side of the body were simultaneously stimulated.

Under these conditions the patient mislocalized the stimulus to the left hand into space near that hand, or to the object on which the hand was lying. For example, if pinpricks were

simultaneously applied to the right cheek and the left hand, the patient indicated she had been pricked on the right cheek and the arm of the chair on which her left hand had been resting. As a rule she answered by pointing. If asked to verbalize, she would say, "The right cheek and about here," (pointing to the chair arm or into space near her left hand). If asked directly, "Was your hand touched?" she would avoid the question, responding only, "Here," pointing at the same time to the left chair arm or into space. It is to be noted that, except under the special condition of simultaneous stimulation, the patient was always able to point to or to name her left hand on demand.

If pricked simultaneously on the dorsa of the left and right hands, she correctly localized only the stimulus on the right, both by pointing and by stating, "My right hand." The stimulus on the left, however, was localized only by pointing to the chair arm and saying, "Here." If asked whether the chair arm and not her left hand, had been touched, she answered, "No, here," pointing to the chair arm.

When pinpricks were applied to the left hand and, at the same time, to another area on the left side of the body, a similar displacement into space was evident. Usually the stimulus to the left hand was mislocalized onto whatever structure the hand was resting or else into contiguous space. The other stimulus on the left side was usually correctly localized, though this stimulus, too, was occasionally displaced into space. When this double displacement occurred, the patient would state that she felt two stimuli and would point into space to the left of the arm, stating, "Here and here."

These mislocalizations were repeatedly observed during a period of a month and were not always limited to the left side. They were occasionally observed to occur on the right side. At these times localization on the left was always correct, as indicated by pointing and by verbalization.

*Comment.*—Exosomesthesia was elicited in this patient only under the condition of multiple simultaneous stimulation. It could not be elicited by single-stimulation methods. Also significant is the fact that exosomesthesia was apparent even though there was no gross disorder in body scheme on routine testing. Furthermore, it is evident that her errors in localization were not simply inability to point to or identify parts of her body by name, as ordinarily she experienced no difficulty in doing this on command.

Both patients mislocalized percepts to parts of the body, to objects, or into space contiguous with the area stimulated. Occasionally, we have also observed displacement of a stimulus to the person of the examiner. Usually such percepts are mislocalized to a homologous portion of the examiner's body; e. g., a stimulus applied to the patient's hand is reported by him as though it had been applied to the examiner's hand. Rarely, the mislocalization is to any part of the examiner's body. This type of displacement is illustrated in the following case.

CASE 3.—R. M., a man aged 52, was admitted to the Psychiatric Pavilion of Bellevue Hospital with the complaint that he had become confused and depressed. For about a year he had been disoriented and confused as to date and his relationship to people and had wandered about the city aimlessly. He had been admitted to the Farm Colony about a half-year before and had worked as a barber until the week before his admission to the hospital.

*Routine Neurologic Examination.*—Neurologic examination showed normal gait and station. Coordination tests were well performed. The reflexes were active bilaterally, with normal plantar and abdominal responses. Cranial nerve functions were normal. The sensory status showed changes, but only with special methods of testing. A pneumoencephalogram demonstrated moderately dilated ventricles, without shift or deformity, and some dilated cerebral sulci.

*Psychiatric Status.*—A severe organic mental syndrome was evident. In the ward he sat quietly for hours by his bedside, taking little interest in his surroundings. When approached by members of the staff, he appeared perplexed but was affable. During the testing procedures he was cooperative unless confronted by a test situation in which the examiner demanded tasks

beyond his ability. At such times he showed a "catastrophic" reaction, became excited, and discontinued his efforts in the examination.

He was disoriented for time, place, and situation. However, he was able to find his way about the ward, locating his bed, the nurses' desk, the doctor's office, and the lavatory. Severe difficulties in intellectual function were observed. He was unable to give an adequate history. He could not recall the examiner's name or the events of several hours before but did not confabulate. Calculation and symbol-identification tests were poorly performed.

Severe aphasic difficulties were evident. He was unable to name common objects, clothing, or most parts of the body. He could not comprehend written commands, nor could he write, but he was able to follow simple verbal commands.

Mild dyspraxia was demonstrated in his attempts to imitate finger and mouth movements. However, he was able to dress, feed, and otherwise care for himself.

*Body Image.*—He had difficulty both in naming body parts and in locating them by pointing. The defects were severest in the fingers, wrists, and elbows, and occasionally the feet. There was difficulty in right-left orientation.

*Sensory Status.*—(a) Single Stimulation: Routine sensory studies of touch, pinprick, and vibration stimuli showed no consistent impairment. These stimuli were usually correctly localized and described. Occasionally a single stimulus to the hand or forearm was displaced to a contiguous object or to space about the upper extremity.

(b) Double Simultaneous Stimulation: On double simultaneous [touch] stimulation the patient displayed extinction and displacement of tactile stimuli. This was most evident in trials of the face-hand test<sup>6</sup> but was seen in tests of other body parts as well. For example, on simultaneous stimulation of the cheek and the opposite hand, he would either report only the stimulus to the cheek (extinction of the hand stimulus) or report a stimulus to each cheek (displacement of the hand stimulus). The pattern of sensory dominance was that usually seen in diffuse cerebral disease, the face being most dominant, the hand least.<sup>5</sup> There was no lateral dominance.

*Exosomesthesia.*—Displacement into extrapersonal space was occasionally observed on single stimulation. This displacement was from the hand, forearm, or elbow to space contiguous to the part touched. Exosomesthesia was, however, markedly exaggerated when double simultaneous stimulation was employed. Again, the areas from which the phenomenon was most frequently observed were the hands, forearms, and elbows. For example, when stimuli were applied to the dorsa of the hands as they were lying on the patient's lap, he pointed to space in front of his knees. If asked to state where he had been touched, he would say, "The hands," but would continue to point to the space in front of his knees. Exosomesthesia was rarely noted when other body parts, such as the cheeks or shoulders, were simultaneously stimulated.

Occasionally it was found that on tests with double simultaneous stimulation the patient mislocalized a stimulus from his body to the homologous region of the examiner's body. For instance, when the hands were simultaneously touched, he would grasp the examiner's hands and affirm he had been touched "there." Despite the examiner's insistence that the stimulus had been to the patient's hands, the patient would persist in pointing to the examiner's hands. When asked to name the parts touched, he would say "There, there." The same phenomenon was occasionally observed on simultaneous stimulation of the two elbows or cheeks. It was significant that this mislocalization to the examiner's body occurred even when the patient was urged to look at the stimulations.

It was observed that emotional tension, increase in the rate of testing or undue prolongation of the examination increased the incidence of exosomesthesia. For example, to initial application of pinprick to the right hand and the left cheek, the patient reported only the face percept, omitting the hand stimulus. Later, he localized the two stimuli to the cheeks. As the examination progressed and the physician speeded up the testing, the patient became tenser. He then localized the face percept correctly but insisted that the hand stimulation was into space in front of the hand. Finally, both stimuli were displaced into space or to the examiner's body.

These phenomena were observed daily over a period of 2½ months.

6. Bender, M. B.; Fink, M., and Green, M.: Patterns in Perception on Simultaneous Tests of Face and Hand, *Tr. Am. Neurol. A.* **75**:250-252 (June) 1950; Patterns in Perception on Simultaneous Tests of Face and Hand, *A. M. A. Arch. Neurol. & Psychiat.* **66**:355-262 (Sept.) 1951.

*Comment.*—While single stimulation occasionally produced exosomesthesia in this patient, the phenomenon was more pronounced under conditions of double simultaneous stimulation. This patient also mislocalized stimuli to the examiner's body. Emotional tension, prolonged examination, or increase in the rate of testing exaggerated the phenomenon of exosomesthesia.

#### GENERAL COMMENT

On consideration of these cases, it is immediately apparent that exosomesthesia is associated with a severe organic mental syndrome. Therefore, it might be argued that exosomesthesia is merely a manifestation of the patient's mental confusion; that the patient simply points into space because he is confused. However, we have examined many severely confused patients and found exosomesthesia only rarely. Moreover, exosomesthesia is a patterned phenomenon, demonstrable in each patient under defined conditions, predictable as to the area from which it will occur and the extrapersonal spatial region to which the sensation will be projected. For example, in Case 1 exosomesthesia could be elicited only from the hand, and only when the dorsum was stimulated at the same time that the palm or fingers were in contact with another object. Displacement under these circumstances was usually not haphazard. As a rule it occurred to the object touching the palm or fingers. In Case 2 exosomesthesia could be elicited only by double simultaneous stimulation. It was seen most clearly in the hand and could be elicited only unilaterally at any one examination. Again, the displacement was not haphazard; the stimulus as a rule was localized to extrapersonal space contiguous to the area actually stimulated. In Case 3 the phenomenon was observed again under conditions of double simultaneous stimulation, and the displacements were either to space contiguous to the stimulated area or to homologous areas of the examiner's body. It is significant that these displacements could be elicited even when the patient was urged to look at the application of the stimuli. Moreover, even when the examiner pointed out the error in localization and emphasized the implausibility of the response, the patient characteristically insisted on the correctness of the mislocalization.

*Factors Influencing Exosomesthesia.*—Many factors influence the appearance of exosomesthesia. Except in children under special conditions, it has been observed exclusively in patients with severe mental changes resulting from disease of the brain. It is influenced by the type of stimulus used and the rate of stimulation, as well as by the element of simultaneity of stimuli. Moreover, the emotional state of the patient has a significant effect on the phenomenon, as does the part of the body stimulated. In some cases exosomesthesia has been made apparent by administration of small doses of amobarbital sodium. These factors will be discussed.

(a) *Bilateral Cerebral Disease:* The symptom background in every case of exosomesthesia is an organic mental syndrome secondary to bilateral cerebral disease. We have not been able to demonstrate exosomesthesia in an adult unless there were severe mental changes. But, as previously noted, it is a rare phenomenon, and only a few patients with severe organic mental syndrome show it. In 400 patients with organic cerebral disease, of varying severity, exosomesthesia was observed in approximately 3%.<sup>5</sup> Even in these patients it was not manifest in every examination, and its frequency was readily altered by changes in the conditions of testing. It is therefore evident that severe bilateral cerebral disease in itself is not sufficient to produce exosomesthesia.

(b) Effect of Simultaneous Stimuli: That simultaneous stimulation may elicit sensory phenomena not apparent on single stimulation has previously been demonstrated.<sup>2</sup> For example, a hemisensory syndrome in a hemiplegic patient may not be discernible except under conditions of double simultaneous stimulation. Thus, single stimulation may be well perceived and localized by the patient, but the addition of a second stimulus simultaneously applied may so affect integration that the phenomena of extinction, obscuration, and displacement become apparent.

Similarly, simultaneous stimulation elicited exosomesthesia when it was absent on single-stimulus examination, or exaggerated it when it was occasionally manifest on routine stimulation. In Cases 1 and 2 simultaneous stimulation was a necessary condition for eliciting the phenomenon. It could not be demonstrated by single stimulation. In Case 3 exosomesthesia could occasionally be elicited on single stimulation, but with simultaneous stimulation the phenomenon was demonstrated with much greater frequency.

(c) Type of Stimulus Most Effective: Of the various stimuli used in these examinations, such as single touch, single pinprick, repetitive touch, and repetitive pinprick, it was noted that repetitive touch stimuli were most effective in eliciting exosomesthesia. This was especially true on double simultaneous stimulation.

(d) Effect of the Patient's Emotional State: Exosomesthesia was exaggerated by alterations in the test situation which made performances more difficult. Increasing the rate of stimulation or unduly prolonging the examination increased the displacements to extrapersonal space. If the examiner was deliberately critical of the patient's errors, the phenomenon also appeared with greater frequency. These factors increased the emotional tension of the patient and if carried further produced a "catastrophic" reaction.

(e) Effect of Drugs: It has previously been demonstrated that difficulties in perception may be exaggerated by barbiturate intoxicants.<sup>5</sup> Amobarbital sodium was administered intravenously in doses of 3 to 7 grains (0.2 to 0.45 gm.) to patients with diffuse cerebral disease. Prior to administration of the drug, these patients manifested the phenomena of extinction and displacement of percepts on simultaneous tests, but not exosomesthesia. While under the influence of the barbiturate, three patients showed exosomesthesia, in addition to extinction and displacement. In two other patients, in whom exosomesthesia had been elicited only after a protracted testing period, the administration of amobarbital sodium elicited exosomesthesia at the onset of testing and exaggerated the phenomena of extinction and displacement.

*Relation of Exosomesthesia to Extinction, Obscuration, and Displacement.*—In our experience, whenever exosomesthesia has been observed, the phenomena of extinction, obscuration, and displacement are also present. Exosomesthesia, however, is a rare phenomenon, whereas extinction, obscuration, and displacement are commonly observed. Moreover, whereas extinction, obscuration, and displacement are frequently seen in adult patients with mild cerebral dysfunction,<sup>5</sup> displacement into extrapersonal space is present only in cases of severe mental changes due to disease of the brain. It may therefore be concluded that exosomesthesia in adults represents a severer type of cerebral dysfunction than other simultaneous stimulation phenomena.

*Relation of Exosomesthesia to Body Image.*—It might be said that exosomesthesia is a pathologic extension of the body image. The normal person is continually extending the boundaries of this image. For example, Head cites the examples of the woman with a feather in her hat who “feels” when the feather is touched, and the surgeon who handles his probe as though it were an extension of his fingers.<sup>1</sup> In the normal person, however, these extensions of the body image are fluid, immediately reversible, and clearly recognized by the subject as artificial. The surgeon, for example, is able at any moment to redefine correctly his body image. He “knows” that the probe is not his finger. In the group of patients described above, however, the extension of the body image seems to operate in a pathologic, rigid form. Under certain conditions these patients lose the ability to maintain a realistic definition of the limits of their body. They behave as though portions of the contiguous external world are concretely incorporated into the inner image of their body’s extent.

Although we may consider exosomesthesia as a specialized body-image disturbance, it should be noted that patients who do not show difficulties in identification and location of body parts still may show mislocalization into extrapersonal space. On the other hand, patients with an inability to identify or locate their body parts on command do not necessarily manifest exosomesthesia.

In similar fashion, there is no necessary relationship between exosomesthesia and position-sense difficulties. A patient (Case 3) who manifested displacement of sensation into extrapersonal space did not make errors in routine tests of position sense in the extremities. This is consistent with observations previously made by Head<sup>1</sup> that localization of single stimuli is not functionally related to sense of position of the extremities.

*Role of the Hand.*—Although displacement into extrapersonal space has been elicited from various areas of the body, it has been observed to occur most frequently from the hand. Moreover, in no case has it been elicited from another area and been absent from the hand.

This predilection for the hand is consistent with the manner in which other dysfunctions of the nervous system are reflected. As a rule, when the functioning of one side of the body is impaired through cerebral disease, the disorder is most manifest in the hand. Thus, in the usual hemiplegia resulting from a capsular lesion the paresis, body-image disturbance, and sensory loss are most prominent in the hand and fingers.

In these patients, and in others with diffuse cerebral disease, the phenomena of extinction, obscuration, and displacement are also best elicited when the hand is tested. Furthermore, studies of the order of sensory dominance of various areas of the body demonstrate that the hand is in the lowest rank. This is true of the dominance order of patients with cerebral disease,<sup>5</sup> and also of normal subjects, both adults and children.<sup>6</sup>

Similarly, when allesthesia is observed, it is seen most clearly in the hand. Bender and Nathanson<sup>7</sup> described a case in which the clinical course was reflected in a

7. Bender, M. B., and Nathanson, M.: Patterns in Allesthesia and Their Relation to Disorder of Body Scheme and Other Sensory Phenomena, *Arch. Neurol. & Psychiat.* **64**:501-515 (Oct.) 1950.

waxing and waning allesthesia. As this patient improved, the areas from which the phenomenon could be elicited diminished, until finally allesthesia was demonstrable only in the hand.

In autotopagnosia the hands are more profoundly affected than other regions. Finger agnosia, possibly the earliest sign of body-image disturbance, is frequently seen in the absence of other gross disturbances of the body schema. Furthermore, phantom limb, anosognosia, causalgia, and synesthesia are phenomena in which the role of the hand is especially prominent.

Just as these pathologic phenomena are manifest in tests of other body parts, but are most clearly demonstrable in the hand, so, too, exosomesthesia, though occasionally demonstrable elsewhere, is most apparent in examination of the functions of the hand.

*Exosomesthesia in the Normal Child.*—It has been observed that sensory phenomena which occur in patients with cerebral dysfunction may be found in the normal young child.<sup>6</sup> Similarly, exosomesthesia, which we have never found in adults except when there is severe cerebral disease, can be readily observed in children up to the age of 4 years. In examination of a large series of normal children it was noted that the initial responses of children to double simultaneous stimulation frequently included exosomesthesia, although the commoner responses were extinction and displacement. Exosomesthesia was rare, however, after the initial few trials.

The frequency with which exosomesthesia may be seen in children up to the age of 4 years suggests that it may represent, in the child, a "normal" developmental stage in the organization of perception. Its appearance in adults with severe brain disease may possibly be, as with other pathologic phenomena, a regression in function to a previous level of sensory integration.

#### SUMMARY

The patterned mislocalization of tactile stimuli into extrapersonal space is described and termed exosomesthesia.

Exosomesthesia is observed in patients with severe organic mental syndromes. It is apparent only rarely on single tactile stimulation and is more readily elicited by the technique of double simultaneous stimulation. It is exaggerated by fatigue, rapid testing, and increased emotional tension. Barbiturate intoxication also may elicit or exaggerate the phenomenon.

Exosomesthesia is most apparent in stimulation of the hand but has been observed in tests of other body parts. While it may be considered a pathologic extension of the body image, it is not dependent upon concomitant body-image disturbances.

Although exosomesthesia has been observed chiefly in patients with severe mental changes, it is not a manifestation of confusion, but is a patterned, predictable phenomenon. It may be a regression, in patients with cerebral dysfunction, to a previously "normal" stage in sensory development, as suggested by the fact that it is readily observed in simultaneous tactile tests of young children.

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EXOSOMESTHESIA OR DISPLACEMENT OF CUTANEOUS  
SENSATION INTO EXTRA-PERSONAL SPACE\*

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Among phenomena that may be apparent during examination of patients with disease of the sensory pathways is mislocalization of a sensory stimulus. It has long been known that an individual with a sensory defect, as seen in the common varieties of cerebral hemiplegia, may localize inaccurately stimuli applied on the paretic side.

Such point mislocalizations are apparent in examinations using a single stimulus, and have been described in detail by Head (1). These mislocalizations can be accentuated<sup>by</sup> the use of double simultaneous stimulation techniques (2). In addition, when these techniques of examination are employed, other varieties of mislocalization, such as displacement (3), become apparent. Displacement is the patterned mislocalization of one of two stimuli simultaneously applied to different body areas. The direction of displacement is in a definite pattern, which is dependent upon the parts of the body stimulated.

Characteristic of mislocalization so far reported has been the fact that their extent was within the limits of the patient's body. In the course of studies of cutaneous perception we observed a new form of displacement in which the patient consistently and in a predictable fashion mislocalizes stimuli into extra-personal space. This type of displacement we have termed "exosomesthesia".\*

FN:\*The term was derived by Dr. Judah A. Joffe, Editor of the Psychiatric Dictionary, Oxford University Press, 1940, from the Greek "exo", out of; "soma", body; "aisthesis", perception by the senses. END FN:

Exosomesthesia is not a commonly observed phenomenon. More than 400 patients with brain disease were examined at Bellevue Psychiatric Hospital by routine and specialized sensory tests.

Exosomesthesia was observed in only 15 cases - an incidence of about 3% (5). The following case reports illustrate the phenomenon and demonstrate some of the conditions under which it was observed.

Case 1: H.M., a 64 year old male, was admitted to Bellevue Psychiatric Hospital with a history of progressive mental changes of six years duration. The first four years of illness were marked by slowly progressive impairment of memory, concentration and other intellectual functions, and increasing apathy to his environment. In the last two years this condition exacerbated rapidly, resulting in the loss of his job as a store manager. During this period his speech became increasingly garbled and stammering. He vacillated between irritability and complete apathy to his environment. He was occasionally incontinent, ceased bathing, had difficulty in dressing, and was sometimes so forgetful and confused as to wander into the street without his trousers.

Routine Neurologic Examination: In walking the trunk was tilted to the right and there was a tendency to drag the right lower extremity. However, there was no significant motor weakness, reflex change or tonus abnormality. Coordination tests were well performed. The cranial nerve functions were intact. Vibration sense was correctly perceived only in the clavicles and the head, while position sense was lost in the fingers, wrists, toes and ankles bilaterally. Temperature differences were poorly perceived except in the face area. His responses to touch and pin prick stimulation will be described later. A mild degree of "mixed aphasia" was present. This speech difficulty was evident only by special testing or when the patient was fatigued by prolonged examination. There was a fluctuating dyspraxia of moderate severity.

Occasionally he had difficulty in dressing, being unable to handle buttons and sleeves. However, he could perform such functions as feeding himself, combing his hair and other routine daily tasks. He was usually unable to mimic the more complicated patterns of the hand-praxis tests.

Electroencephalogram showed bilateral diffuse abnormality, with decrease in amplitude and intermittent suppression of activity over the parietal regions. Pneumoencephalogram disclosed bilaterally dilated ventricles and moderate "cortical atrophy", particularly in the left temporal lobe.

Psychiatric Status: Although the patient was oriented for place and situation, he made errors as to date and time of day. There were defects in recent memory, concentration, calculation and ability to assume the abstract attitude. He usually sat placidly staring into space or wandered aimlessly about the ward. He did not mix with other patients. When approached by the staff he was friendly and passively cooperative. Testing procedures were approached with a cheerful indifference. When, however, he was pushed into test situations greater than his capacity, he reacted with increasing irritability and tension, eventually culminating in a "catastrophic reaction." At such times he would become red in the face, shout that he knew the answers but didn't want to continue and suddenly begin to weep.

Body Scheme: He was unable to distinguish the right side of his body from the left, but was unable to make this distinction on the examiner's body. He had no difficulty either in locating midline structures of his body, such as the nose, mouth, chin, umbilicus and penis, or in pointing to his eyes. With eyes open he readily found

both ears, but when his eyes were closed he groped about his face for several seconds before locating them. He could point to his thighs, knees, ankles and toes but could not point to any specific toe other than the big toes.

He frequently had difficulty in locating portions of his upper extremities. If asked to point to his shoulders, he correctly located one shoulder, but then groped behind his neck looking for the other. This defect was even more noticeable in trying to find the "other" elbow and wrist, and greatest in trying to find the "other" hand. His search for the "other" hand or wrist was bizarre. He would look under the pillow, or rummage under the mattress becoming tense and insisting it was lost. It should be emphasized that despite the great difficulty in locating parts of his body, the patient was able to name the body parts, except the fingers and toes. This was true whether the part pointed to was on the patient's or on the examiner's body.

Sensory Status:

(a) Single Stimulation: He had difficulty in differentiating between the sharp and dull end of a pin. This defect was present throughout the body, although he made significantly fewer errors in the face and hands. Touch stimulation was poorly perceived. Usually he could not state whether or not he had been touched. Again, there

seemed to be relatively better preservation of this modality in the hands and face.

Except under special conditions of examination of the hands, to be described later, the patient was able to locate the site of a pin prick by pointing. However, if the pin was repetitively and rapidly applied to one region, or if the prick was steadily maintained at that one place, he could not locate the point of stimulation. He would make frantic, random searching movements over his body and not infrequently around the bed clothes, grimacing as though in pain and exclaiming that he was trying to remove the pin. If asked where he was being pricked, he disregarded the question and continued to try to remove the stimulus. This phenomenon occurred on stimulation of any portion of the body, but was most apparent when the hand was tested.

(b) Double Simultaneous Stimulation: The phenomena of extinction and displacement were frequently observed in tests of different body areas by simultaneous tactile stimuli. On stimulating the face and hand, stimuli to the hand were not perceived, or mislocalized to the cheek. In testing homologous body areas (as hand-hand) extinction of one percept was common. The side on which the stimulus was not perceived fluctuated, so that at one moment only a right-sided stimulus was perceived and a few moments later, only a left-sided stimulus was perceived.

Exosomesthesia: Whenever his palm was in contact with a portion of his body or any other object, and the dorsum of that hand was pricked with a pin, the patient consistently mislocalized the

stimulus. This mislocalization was to whatever object the palmar surface of the hand was touching. For example, if the patient's hand was resting on his thigh and the dorsum of the hand was pricked, he insisted that the thigh had been touched, and not the hand. This mislocalization - exosomesthesia - occurred to the thigh, abdomen, leg or face, and was present with stimuli to either hand. It was observed even when the patient was urged to look at the hands during the application of the pin. Exosomesthesia could not be elicited, however, by stimulation of the palm or palmar surfaces of the fingers when the dorsum of the hand was resting on a portion of the body. Furthermore, localization of dorsal hand stimulation was correct if the hand was held in space.

Mislocalization also occurred to objects external to his body. If his palm was resting on a table or on his bed, and the dorsum of the hand was pricked with a pin, he would point to these objects and state that the pin had been applied "there." When questioned, he stated that the hand had been touched, but continued to point to the bed or table. Frequently, however, he insisted that it was the bed or table that had been touched and not his hand. If asked how he could feel the bed being pricked with a pin he would become tense, avoid the question and insist "you touched the bed, not me".

Displacement into extra-personal space was not eliminated by simultaneous stimulation, even when extinction of one of the percepts occurred. For example, if pins were simultaneously applied to the dorsa of both hands while the palms were resting on a table, he would report feeling only one pin prick, that on the left (or right, as dominance fluctuated) and point to the place where the left hand had been resting, saying "you touched the bed there."

This phenomenon of displacement into extra-personal space occurred daily during a period of over two months.

Comment: In this patient a requisite to displacement into space was that the palm of the hand be in contact with an external object. In other words, there were two cutaneous stimuli simultaneously in operation, namely the pin prick on the dorsum of the hand and the pressure of the object in contact with the palm or fingers. A single stimulus, such as pricking the dorsum of a hand held in space, did not elicit the displacement.

Exosomesthesia was elicited only on stimulating the hands. This occurred even though single pin prick was perceived more sharply in the hands than in any other area, excepting the face.

Although this patient showed an inability to correctly locate parts of his own and the examiner's body, it does not necessarily mean that exosomesthesia is determined by this particular type of disorder in body scheme. The following case illustrates the phenomenon of exosomesthesia in the presence of the patient's ability to locate body parts.

Case 2: E.K., a 52 year old woman, was admitted to the Neurologic Service of the Mount Sinai Hospital in August 1950 with a history of grand mal seizures. She had been in good health until 1947 when there appeared sporadic, momentary sensations of "blacking out." About two years before admission she began to suffer monthly grand mal seizures. There was no aura.

Routine examination on admission was within normal limits, except for anosmia in the right nostril. There was no organic mental syndrome. Special x-ray studies revealed evidence of a subfrontal neoplasm. On August 12th a craniotomy was done and following amputation of a portion of the right frontal lobe, a large bilateral

sub-frontal meningioma was excised.

Her post-operative course was stormy. For two weeks she was semi-stuporous. She responded only to massive, painful stimulation, and these responses were limited to vague ineffective attempts to push away the stimulus. In this period she lapsed several times into coma and showed Cheyne-Stokes respiration. Bilateral Babinski responses were present. Her pupils did not react to light.

From about August 23, 1950 the patient improved slowly and steadily. She began to respond verbally and contact could be maintained for short periods. Vision, which had apparently been absent, began to return, although a right homonymous hemianopsia remained for some time. A marked organic mental syndrome characterized by confusion, disorientation and anosognosia was present.

Routine Neurologic Examination: Neurologic examination in September 1950 disclosed a right homonymous hemianopsia, marked impairment of visual acuity with bilateral secondary optic atrophy, nystagmus in all directions of gaze, bilaterally positive Babinski signs, and a mild degree of aphasia. Position sense, vibration and temperature perception were unimpaired. There were difficulties in perception of touch and pin prick stimuli as described below.

Psychiatric Status: The patient was usually friendly and cooperative. However, she was frequently irritable and would not permit examination. She was disoriented as to time and occasionally to situation, but not to place. There were defects in retention and recall covered by confabulation. She was euphoric and displayed little self restraint or concern in social situations. Usually she would lie with her body fully exposed. Not infrequently she soiled

herself or wet the bed. Anosognosia was prominent.

Body Scheme: On command the patient was able to identify and locate correctly parts of her own and the examiner's body, such as ears, eyes, feet and parts of the upper extremities. She exhibited some confusion about the right and left sides of the body.

Sensory Status:

(a) Single Stimulation: The patient perceived single pin prick stimuli well, although she made occasional non-patterned errors in localization. These errors were more frequent on the left side.

(b) Double Simultaneous Stimulation: On simultaneous application of pin pricks to both sides of the body (excluding the hands) extinction on the left, or displacement on the left toward the level of the right-sided stimulus were the usual responses. Homolateral simultaneous stimulation on the right side of the body showed no extinction, but stimulation on the left side elicited frequent extinction and displacement.

Exosomesthesia: Displacement into extra-personal space occurred when the left hand was pricked at the same time as either the right hand or right cheek were stimulated. The phenomenon could also be elicited when the left hand and any other area of the left side of the body were simultaneously stimulated.

Under these conditions the patient mislocalized the stimulus to the left hand into space near that hand, or to the object on which the hand was lying. For example, if pin pricks were simultaneously applied to the right cheek and the left hand, the patient indicated she had been pricked on the right cheek and the arm of the chair on which her left hand had been resting. As a rule she answered by pointing. If asked to verbalize she would say, "the right cheek and about here," (pointing to the chair arm or into space near her left

hand). If asked directly, "was your hand touched," she would avoid the question responding only, "here," pointing at the same time to the left chair arm or to space. It is to be noted that except under the special condition of simultaneous stimulation the patient was always able to point to or to name her left hand on demand.

If pricked simultaneously on the dorsa of the left and right hands, she correctly localized only the stimulus on the right, both by pointing and stating, "my right hand." The stimulus on the left, however, was localized only by pointing to the chair arm and saying, "here." If asked whether the chair arm, and not her left hand had been touched, she answered, "no, here" pointing to the chair arm.

When pin pricks were applied to the left hand, and at the same time, to another area on the left side of the body, a similar displacement into space was evident. Usually the stimulus to the left hand was mislocalized onto whatever structure the hand was resting or else to contiguous space. The other stimulus on the left side was usually correctly localized, though this stimulus too was occasionally displaced into space. When this double displacement occurred, the patient would state she felt two stimuli and would point into space to the left of the arm, stating "here and here".

These mislocalizations were repeatedly observed during a period of a month, and were not always limited to the left side. They were occasionally observed to occur on the right side. At these times localization on the left was always correct as indicated by pointing and verbalization.

Comment: Exosomesthesia was elicited in this patient only under the condition of multiple simultaneous stimulation. It could not be elicited by single stimulation methods. Also significant is

that exosomesthesia was apparent even though there was no gross disorder in body scheme on routine testing. Furthermore, it is evident that her errors in localization were not simply an inability to point to or identify parts of her body by name, as ordinarily she experienced no difficulty in doing this on command.

In both cases percepts were mislocalized to parts of the body, to objects, or into space contiguous with the area stimulated. Occasionally, we have also observed displacement of a stimulus to the person of the examiner. Usually such percepts are mislocalized to a homologous portion of the examiner's body, e.g., a stimulus applied to the patient's hand is reported by him as if it had been applied to the examiner's hand. Rarely, the mislocalization is to any part of the examiner's body. This type of displacement is illustrated in the following case.

Case 3: R.M., a 52 year old male, was admitted to Bellevue Psychiatric Hospital with the complaint that he had become confused and depressed. For about a year he had been disoriented, confused as to date and relationships of people, and had wandered about the city aimlessly. He had been admitted to the Farm Colony about a half year before, and had worked as a barber until the week before his admission to the hospital.

Routine Neurologic Examination: Neurological examination showed normal gait and station. Coordination tests were well performed. The reflexes were active bilaterally with normal plantar and abdominal responses. Cranial nerve functions were normal. Sensory status showed changes, but only by special methods of testing. A pneumoencephalogram demonstrated moderately dilated ventricles without shift or deformity, and some dilated cerebral sulci.

Psychiatric Status: A marked organic mental syndrome was

evident. On the ward he sat quietly for hours by his bedside taking little interest in his surroundings. When approached by the staff he appeared perplexed but was affable. During the testing procedures he was cooperative unless confronted by a test situation in which the examiner demanded tasks beyond his ability. At these times he showed a "catastrophic" reaction, became excited and discontinued the examination.

He was disoriented for time, place, and situation. However, he was able to find his way about the ward, locating his bed, the nurses desk, the doctors office and the lavatory. Severe difficulties in intellectual function were observed. He was unable to give an adequate history. He could not recall the examiner's name nor the events of several hours before, but did not confabulate. Calculation and symbol identification tests were poorly performed.

Severe aphasic difficulties were evident. He was unable to name common objects, clothing or most body parts. He could not comprehend written commands nor could he write, but he was able to follow simple verbal commands.

Mild dyspraxia was demonstrated in his attempts to imitate finger and mouth movements. However, he was able to dress, feed, and otherwise care for himself.

Body Image: He had difficulty both in naming body parts, and in locating them by pointing. The defects were most severe in the fingers, wrists and elbows, and occasionally feet. There was difficulty in right-left orientation.

Sensory Status:

(a) Single Stimulation: Routine sensory studies of touch, pin prick and vibration showed no consistent impairment. These

stimuli were usually correctly localized and described. Occasionally a single stimulus to the hand or forearm was displaced to a contiguous object, or to space about the upper extremity.

(b) Double Simultaneous Stimulation: On double simultaneous touch stimulation the patient displayed extinction and displacement of tactile stimuli. This was most evident on trials of the face-hand test (6), but was seen in tests of other body parts as well. For example, on simultaneously stimulating the cheek and the opposite hand he would either report only the stimulus to the cheek (extinction of the hand stimulus) or would report a stimulus to each cheek (displacement of the hand stimulus). The pattern of sensory dominance was that usually seen in diffuse cerebral disease, the face being most dominant, the hand least (5). There was no lateral dominance.

Exosomesthesia: Displacement into extra-personal space was occasionally observed on single stimulation. This displacement was from the hand, forearm, or the elbow to space contiguous to the part touched. Exosomesthesia was however markedly exaggerated when double simultaneous stimulation was employed. Again the areas from which the phenomenon was most frequently observed were the hands, forearms and elbows. For example, when stimuli were applied to the dorsa of both hands as they were lying on the patient's lap he pointed to space in front of his knees. If asked to state where he had been touched he would say, "the hands" but would continue to point to the space in front of his knees. Exosomesthesia was rarely noted when other body parts, such as cheeks or shoulders were simultaneously stimulated.

Occasionally it was found that on tests with double simultaneous stimulation the patient mislocalized a stimulus from his body to the homologous region of the examiner's body. For instance, when both hands were simultaneously touched he would grasp the examiner's

hands and affirm he had been touched "there." Despite the examiner's insistence that the stimulus had been to the patient's hands, the patient would persist in pointing to the examiner's hands. When asked to name the parts touched, he would say "there, there." The same phenomenon was occasionally observed on simultaneous stimulations of both elbows or cheeks. It was significant that this mislocalization to the examiner's body occurred even when the patient was urged to look at the stimulations.

It was observed that emotional tension, increasing the rate of testing or unduly prolonging the examination, increased the incidence of exosomesthesia. For example, to initial application of pin prick to the right hand and left cheek, the patient reported only the face percept, omitting the hand stimulus. Later, he localized the two stimuli to the cheeks. As the examination progressed and the physician speeded up the testing, the patient became more tense. He then localized the face percept correctly, but insisted that the hand stimulation was into space in front of the hand. Finally both stimuli were displaced into space or to the examiner's body.

These phenomena were observed daily over a period of two and a half months.

Comment: While single stimulation occasionally produced exosomesthesia in this individual, the phenomenon was more pronounced under conditions of double simultaneous stimulation. This patient also mislocalized stimuli to the examiner's body. Emotional tension, prolonged examination, or increasing the rate of testing exaggerated the phenomenon of exosomesthesia.

Discussion: In considering these cases it is immediately apparent that exosomesthesia is associated with a severe organic

mental syndrome. Therefore, it might be argued that exosomesthesia is merely a manifestation of the patient's mental confusion; that the patient simply points into space because he is confused. However, we have examined many severely confused patients and found exosomesthesia only rarely. Moreover, exosomesthesia is a patterned phenomenon, demonstrable in each patient under defined conditions, predictable as to the area from which it will occur and the extra-personal spatial region to which the sensation will be projected. For example, in Case I, exosomesthesia could be elicited only from the hand and only when the dorsum was stimulated at the same time as the palm or fingers were in contact with another object. Displacement under these circumstances was usually not haphazard. As a rule it occurred to the object touching the palm or fingers. In Case 2, exosomesthesia could be elicited only by double simultaneous stimulation. It was seen most clearly in the hand and could be elicited only unilaterally at any one examination. Again the displacement was not haphazard; the stimulus as a rule was localized to extra-personal space contiguous to the area actually stimulated. In Case 3 the phenomenon was observed again under conditions of double simultaneous stimulation, and the displacements were either to space contiguous to the stimulated area, or to homologous areas of the examiner's body. It is significant that these displacements could be elicited even when the patients were urged to look at the application of the stimuli. Moreover, even when the examiner pointed out the error in localization and emphasized the implausability of their response, the patients characteristically insisted on the correctness of the mislocalization.

#### Factors Influencing Exosomesthesia:

There are many factors which influence the appearance of exosomesthesia. Except under special conditions in children, it

has been observed exclusively in patients with severe mental changes resulting from disease of the brain. It is influenced by the type of stimulus used, the rate of stimulation, as well as by the element of simultaneity of stimuli. Moreover, the emotional state of the patient has a significant effect on the phenomenon as does the part of the body stimulated. In some cases exosomesthesia has been made apparent by administration of small doses of amobarbital sodium. These factors will be discussed.

(a) Bilateral Cerebral Disease: The symptom background in every case of exosomesthesia is an organic mental syndrome secondary to bilateral cerebral disease. We have not been able to demonstrate exosomesthesia in an adult unless there were severe mental changes. But, as previously noted, it is a rare phenomenon and only few of the individuals with severe organic mental syndrome show it. In 400 patients with organic brain disease of varying severity, exosomesthesia was observed in approximately 3% of the cases (5). Even in these patients, it was not manifest in every examination, and its frequency was readily altered by changes in the conditions of testing. It is therefore evident that severe bilateral cerebral disease, in itself, is not sufficient to produce exosomesthesia.

(b) Effect of Simultaneous Stimuli: That simultaneous stimulation may elicit sensory phenomena not apparent on single stimulation has been previously demonstrated (2). For example, a hemisensory syndrome in a hemiplegic patient may not be discernible except under conditions of double simultaneous stimulation. Thus, single stimulation may be well perceived and localized by the patient, but the addition of a second stimulus simultaneously applied may so affect integration that the phenomena of extinction, obscuration and displacement become apparent.

Similarly, simultaneous stimulation elicited exosomesthesia when it was absent on single stimulus examination, or exaggerated it when it was occasionally manifest on routine stimulation. In cases 1 and 2, simultaneous stimulation was a necessary condition for eliciting the phenomenon. It could not be demonstrated by single stimulation. In case 3, exosomesthesia could occasionally be elicited on single stimulation, but simultaneous stimulation demonstrated the phenomenon with much greater frequency.

(c) Type of Stimulus Most Effective: Of the various stimuli used in these examinations, such as single touch, single pin prick, repetitive touch and repetitive pin prick, it was noted that repetitive touch stimuli were most effective in eliciting exosomesthesia. This was especially true on double simultaneous stimulation.

(d) Effect of the Patient's Emotional State: Exosomesthesia was exaggerated by alterations in the test situation which made performances more difficult. Increasing the rate of stimulation, or unduly prolonging the examination increased the displacements to extra-personal space. Also, if the examiner was deliberately critical of the patient's errors, the phenomenon appeared with greater frequency. These factors increased the emotional tension of the patient, and if carried further, produced a "catastrophic" reaction.

(e) Effect of Drugs: It has been previously demonstrated that difficulties in perception may be exaggerated by barbiturate intoxicants (5). Amobarbital sodium was administered intravenously in dosages of 3 to 7 grains to patients with diffuse cerebral disease. Prior to drug administration, these patients manifested the phenomena of extinction and displacement of percepts on simultaneous tests, but not exosomesthesia. While under the influence of the barbiturate,

three patients showed exosomesthesia, in addition to extinction and displacement. In two other patients, in whom exosomesthesia had been elicited only after a protracted testing period, the administration of amobarbital sodium elicited exosomesthesia at the onset of testing and exaggerated the phenomena of extinction and displacement.

Relation of Exosomesthesia to Extinction, Obscuration and Displacement: In our experience, whenever exosomesthesia has been observed, the phenomena of extinction, obscuration and displacement are also present. Exosomesthesia, however, is a rare phenomenon, whereas extinction, obscuration and displacement are commonly observed. Moreover, whereas extinction, obscuration and displacement are frequently seen in adult patients with mild cerebral dysfunction (5), displacement into extra-personal space is only present in cases of severe mental changes due to disease of the brain. It may therefore be concluded that exosomesthesia in adults represents a more severe type of cerebral dysfunction than other simultaneous stimulation phenomena.

Relation of Exosomesthesia to Body Image: It might be said that exosomesthesia is a pathologic extension of the body image. The normal individual is continually extending the boundaries of this image. For example, Head cites the examples of the woman with a feather in her hat who "feels" when the feather is touched, and the surgeon who handles his probe as though it were an extension of his fingers (1). In the normal individual, however, these extensions of the body image are fluid, immediately reversible and clearly recognized by the individual as artificial. The surgeon for example, is able at any moment to redefine correctly his body image. He "knows" that the probe is not his finger. In the group of patients

described above, however, the extension of the body image seems to operate in a pathologic, rigid form. Under certain conditions these patients lose the ability to maintain a realistic definition of the limits of their body. They behave as though portions of the contiguous external world are concretely incorporated into the inner image of their body's extent.

Although we may consider exosomesthesia as a specialized body image disturbance it should be noted that patients who do not show difficulties in identification and location of body parts still may show mislocalization into extra-personal space. Conversely, patients with an inability to identify or locate their body parts on command, do not necessarily manifest exosomesthesia.

In similar fashion, there is no necessary relationship between exosomesthesia and position sense difficulties. A patient (Case 3) who manifested displacement of sensation into extra-personal space, did not make errors in routine tests of position sense in the extremities. This is consistent with observations previously made by Head that localization of single stimuli is not functionally related to sense of position of the extremities (1).

Role of the Hand: Although displacement into extra-personal space has been elicited from various areas of the body, it has been observed to occur most frequently from the hand. Moreover, in no case has it been elicited from another area and been absent from the hand.

This predilection for the hand is consistent with the manner in which other dysfunctions of the nervous system are reflected. As a rule when the functioning of one side of the body is impaired through cerebral disease the pathology is most manifest in the hand.

Thus in the usual hemiplegia resulting from a capsular lesion the paresis, body image disturbance and sensory loss are most prominent in the hand and fingers.

In these patients and in others with diffuse cerebral disease the phenomena of extinction, obscuration and displacement are also best elicited when the hand is tested. Furthermore, studies of the order of sensory dominance of various areas of the body demonstrate the hand in the lowest rank. This is true in the dominance order of patients with cerebral disease (5), and also normal subjects, both adults and children (6).

Similarly, when allesthesia is observed, it is seen most clearly in the hand. Bender and Nathanson (4b) described a case in which the clinical course was reflected in a waxing and waning allesthesia. As this patient improved, the areas from which the phenomenon could be elicited diminished, until finally allesthesia was demonstrable only in the hand.

In autotopagnosia the hands are more profoundly affected than other regions. Finger agnosia, possibly the earliest sign of body image disturbance, is frequently seen in the absence of other gross disturbances of the body schema. Furthermore, phantom limb, anosognosia, causalgia and synesthesia are phenomena in which the role of the hand is especially prominent.

Just as these pathologic phenomena are manifest in tests of other body parts, but are most clearly demonstrable in the hand, so too, exosomesthesia, though occasionally demonstrable elsewhere, is most apparent in examination of the functions of the hand.

Exosomesthesia in the Normal Child: It has been observed that sensory phenomena which occur in patients with cerebral dysfunction

may be found in the normal young child (6). Similarly, exosomesthesia, which we have never found in adults except when there is marked cerebral disease, can be readily observed in children up to the age of four. In examining a large series of normal children it was noted that the initial responses of children to double simultaneous stimulation frequently included exosomesthesia, although the more common responses were extinction and displacement. Exosomesthesia was rare, however, after the initial few trials.

The frequency with which exosomesthesia may be seen in children up to the age of four suggests that it may represent, in the child, a "normal" developmental stage in the organization of perception. Its appearance in adults with severe brain disease may possibly be, as with other pathologic phenomena, a regression in function to a previous level of sensory integration.

#### SUMMARY:

The patterned mislocalization of tactile stimuli into extra-personal space is described and termed exosomesthesia.

Exosomesthesia is observed in patients with severe organic mental syndromes. It is apparent only very rarely on single tactile stimulation and is more readily elicited by the technique of double simultaneous stimulation. It is exaggerated by fatigue, rapid testing and increased emotional tension. Barbiturate intoxication also may elicit or exaggerate the phenomenon.

Exosomesthesia is most apparent in stimulation of the hand, but has been observed in tests of other body parts. While it may be considered a pathologic extension of the body image, it is not dependent upon other concomitant body image disturbances.

Although exosomesthesia has been observed chiefly in patients with severe mental changes, it is not a manifestation of confusion, but a patterned predictable phenomenon. It may be a regression, in patients with cerebral dysfunction, to a previously "normal" stage in sensory development, as suggested by the fact that it is readily observed in simultaneous tactile tests of young children.

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