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ORAL AND MANUAL STEREOGNOSIS AND TWO-POINT TACTILE DISCRIMINATION OF THE TONGUE

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INTRODUCTION

Tactile perception in man has been reported to be most accurate in the lips, the tip of the tongue and the finger tips. This has been observed in two-point discrimination tests i.e. by determining the minimum distance between two separately perceptible points of contact. *Hensel* (1966) thus mentioned 1 mm as the interval perceived by the tip of the tongue, while *Greisheimer* (1963) reported an interval of 1.4 mm for the tongue and 2 mm for the finger tips. In mapping the receptive fields on the surface of the sensory receiving areas in the cerebral cortex, it has been noted that the facial and intra-oral tissues are prominently represented in proportion to their size (*Penfield* and *Rasmunssen*, 1950).

In recent years, attention has also been drawn to oral stereognosis, i.e. the perception of form in the mouth; the matter has gained particular significance after it was discovered that people with deficiencies in their oral sensory functions were afflicted by speech and mastication disorders, too (*Bosma*, 1967). *Grossman* (1964) has found that healthy subjects were capable of perceiving 70 per cent of a series of ten test pieces. Even when the palate was covered with a prosthesis, the results were not affected. *Molnar et al.* (1968) found, on the other hand, that covering the palate with a denture

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plate decisively weakened the perception of form and the three-dimensional localization capability.

The present authors have previously observed, applying the test series of *Berry* and *Mahood* (1966), that there was no regular correlation between parodontal sensory appreciation and shape recognition (*Siirilä* and *Laine*, 1967) and that the stereognosis of young, healthy individuals, both oral and manual, was slightly more accurate that that of aged wearers of complete dentures (*Siirilä* and *Laine*, 1968). It was likewise noted that no significant differences existed in a group of subjects aged 41 to 78 years between the mouth and the fingers as far as form perceiving aptitude was concerned. On the other hand, in the group of younger subjects, 20 to 25 years of age, the manual perception of form seemed to be slightly superior to the oral ($P < 0.01$).

Tactile perception has been reported to be more sensitive in the tip of the tongue than in the tips of the fingers (*Grossman et al.*, 1965). In contrast, the previous observations of the present authors have indicated that the manual perception of form was more accurate than the oral perception. Accordingly, the aim of this study was

1) to obtain information by means of an enlarged test series with respect to the range of forms whether the manual stereognosis of young adults was more accurate than the oral;

2) to ascertain whether any correlation existed between the oral perception of form and the threshold of the two-point tactile discrimination of the tongue;

3) to determine whether any correlation existed between the size and form of the area of contact of the experimental pieces and the threshold of two-point tactile discrimination.

METHOD AND MATERIALS

In the stereognostic test, two series of 15 pieces of different shapes were used (Fig. 1), the previous five-piece series being extended by the addition of ten new test pieces developed of the shapes. The edge or diagonal of the pieces in one series was 10 mm and that of the other series 5 mm. The pieces were cut out of a sheet of acrylic resin 1.5 mm thick.

The shortest interval in two-point tactile discrimination was determined with sharp-pointed (0.15 mm) dividers on the tip of the tongue, on top of the fore part and on the side at the point of contact with the premolars. This was done by first placing the tips of the dividers sufficiently far apart to make it certain that the subject sensed the contact at two separate points. After that

Fig. 1. The 15 different-shaped test pieces used in the stereognostic test.

the distance between the points was shortened 1 mm at a time, until the subject declared that he felt the touch of only a single point. The minimal value thereby obtained was checked by repeating the test thrice, applying in random order the minimal value obtained, a value 1 mm below that and contact with only one point. If the subject did not respond unerringly to the minimal value, the test was continued by using an 0.5 mm higher limit.

The effect of the size and form of the contact area in two point discrimination was tested with ten special pieces of metal ($15 \times 15 \times 3$ mm), each of which had four sharp points (0.15 mm) or four sharp edges projecting 1.5 mm over the base and situated in each given instance 1.25, 1.50, 1.75, 2.00 or 3.00 mm apart (Fig. 2). The subject was supposed to be able to tell the number of points or edges correctly, the object being to determine whether he was capable of perceiving the contacts separately. Each subject received all the pieces of acrylic resin prepared for the stereognostic test as well as the metal pieces for tactile discrimination first in the mouth and then in the fingers in random order without being able to see them. The subject was allowed to explain the form of the acrylic test pieces either verbally or by means of a drawing. As for the pieces of metal, the subject was told that they had one or more tips of edges and that the task was to determine how many there were.

In the stereognostic test, 2 points were scored for the correct response and 1 point for an approximately correct response. The maximum score in the series of 30 test pieces was thus 60 points. The result in the discrimination of metal test pieces, was determined by the distance in millimeters,

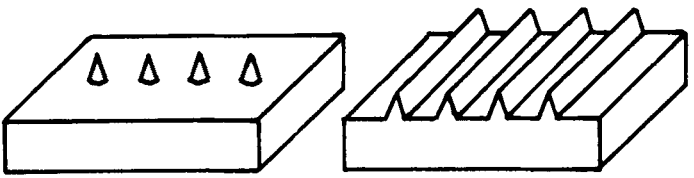

Fig. 2. The test pieces used in the task of estimating the numbers of points and edges.

between the tips or edges starting with the value the subject was able to count correctly.

The material consisted of ten dental students.

RESULTS

The perception of form proved to be distinctly surer in the fingers than in the mouth ($P < 0.001$). The mean score in the case of the fingers was 49.5 and that of the mouth 39.5. The three most easily recognized forms in the stereognostic test were the triangle, the semicircle and the circle. The greatest uncertainty involved test pieces 11, 12, 14, 15, which deviated from simple geometric figures.

The mean value for the threshold of two-point tactile discrimination was 1.25 mm at the tip of the tongue (range of variation: 1 to 2 mm), 4.0 mm on top of the fore part of the tongue (variation: 3 to 6.5 mm), and 8.2 mm on the side of the tongue (variation: 3 to 28 mm). No correlation could be detected between the values obtained and the point scores registered in the oral stereognostic test.

The results obtained in the task of estimating the number of the points and edges are given in Table I. Unless a subject was able to count correctly the points of edges situated at a distance of three millimeters apart, he was left scoreless in the application of this measuring unit.

Table I

Interval in mm between points or edges when their number was estimated correctly. If the estimation was not correct even in maximum distance (3 mm), score 0 was recorded.

Subject	Points		Edges	
	Oral	Manual	Oral	Manual
1	0	1,75	2,00	1,75
2	3,00	3,00	3,00	2,00
3	0	1,50	0	2,00
4	0	3,00	2,00	2,00
5	0	1,25	3,00	1,25
6	0	0	0	0
7	3,00	3,00	0	3,00
8	0	0	3,00	3,00
9	3,00	3,00	0	2,00
10	3,00	1,25	3,00	2,00

The counting of points and edges was distinctly surer when using the fingers than when using the mouth ($P < 0.001$). No correlation could be observed between the results obtained in the counting of points and edges and the threshold of two-point tactile discrimination. The counting of the edges, with their 15 mm length of contact surface, did not prove to be significantly easier than the counting of points.

DISCUSSION

The series of test pieces used in the stereognostic test represented an adequate level of difficulty, judging by the fact that not one of the subjects achieved a maximum point score even when using the fingers. For practical reasons, the testing of the pieces was performed in the case of each subject first in the mouth and then with the fingers. This sequence could scarcely have affected the results, for in previous investigations (*Bosma*, 1967) the identification of forms in the mouth had not yielded better results even when the subjects had first been allowed to feel the test pieces in their fingers.

The use of the dividers in the determination of the threshold of two-point tactile discrimination cannot be considered an altogether exact method in the study of tactile perception. It was difficult to maintain the tactile pressure at a constant level, and it was likewise difficult to achieve simultaneous contact, although the differences between simultaneous and successive contacts are comparatively slight — for example, according to *Schriever* and *Gehlert* (1933), the difference in the case of the tip of the tongue was only 0.1 mm.

In the task of counting the points and edges, the estimation of the number of edges with a 15 mm long contact surface did not prove to be easier than the counting of the number of points, although one might suppose that the simultaneous stimulation of several tactile receptors would facilitate the recognition of the edges. Evidently, in the tactile sensation, whether oral or manual, several impulses from the receptors of the muscles and joints in addition to the tactile sensations form a combined basis for the perception of the whole structure. The fundamental differences between individuals probably occur on this level.

The present findings indicate that the appreciation of tactile stimuli of a more complicated nature than mere touch, and the perception of form are distinctly weaker in the mouth than in the fingers. On the other hand, it has been noted in nylon-filament-aesthesiometric tests (*Grossman et al.*, 1965) that the lips and the tip of the tongue are more sensitive than the finger

tips. This discrepancy can probably be explained by the fact that the tongue and the lips are not used in the identification of forms as frequently as are the fingers. Thus is lacking practice and along with it the development of reflexes. In contrast, the tactile sensivity of the lips and the tongue may be assumed to be of significance in the functions associated with the production of speech sounds.

SUMMARY

In the stereognostic test, two series of fifteen test pieces of acrylic resin cut in different shapes from a sheet 1.5 mm thick were used. The edge or diagonal of the pieces in one series was 10 mm and that of the other series 5 mm. The shortest interval in the two-point tactile discrimination on the tongue was determined with sharp-pointed (0.15 mm) dividers.

The effect of the size and form of the contact area of each test piece was tested with ten pieces of metal ($15 \times 15 \times 3$ mm), each of which had four sharp points (0.15 mm) or edges projecting 1.5 mm over the base and situated at varying from 1.25 to 3.00 mm. The task of each subject was to estimate the number of points and edges. The subject first took the test pieces in the mouth to try out and then in the fingers in random order without being allowed to look at them. The experimental group consisted of ten dental students. The perception of form was distinctly surer in the fingers than in the mouth ($P < 0.001$).

No correlation could be discovered between the values obtained in the determination of the threshold of two-point tactile discrimination and the point scores registered in the oral stereognostic test. The estimation of the numbers of points and sharp edges was distinctly more accurate manually than orally ($P < 0.001$). No correlation could be discerned between the results obtained in the counting of points and edges and the threshold of two-point tactile discrimination. The counting of the edges, which had a 15 mm length of contact surface, was not significantly more accurate than the counting of the points.

RÉSUMÉ

STÉRÉOGNOSIE MANUELLE ET ORALE ET PERCEPTION DISTINCTE DE DEUX POINTES SUR LA LANGUE

Dans le test de stéréognosie, on a utilisé deux séries de 15 objets de résine acrylique taillés de différentes formes à partir d'une plaque de 1,5 mm d'épaisseur. Le rebord ou la diagonale des objets de l'une des séries était de 10 mm, et dans l'autre série il était de 5 mm.

La distance minima de perception distincte des deux pointes sur la langue a été déterminée au moyen d'un compas à pointes aiguës (0,15 mm).

L'influence de la taille et de la forme de la zone de contact de chaque objet a été testée au moyen de 10 objets de métal ($15 \times 15 \times 3$ mm), ayant chacun 4 pointes aiguës (0,15 mm) ou des rebords surplombant la base de 1,5 mm et situés à différentes distances (1,25—3,00 mm). Chaque sujet devait estimer le nombre de pointes et de rebords. Le sujet prenait d'abord les objets dans la bouche pour les examiner et ensuite entre les doigts dans un ordre aléatoire et sans pouvoir les regarder. Le groupe expérimental se composait de 10 étudiants en art dentaire.

La perception des formes était nettement plus certaine avec les doigts que dans la bouche ($P < 0{,}001$).

Aucune corrélation n'a pu être mise en évidence entre les valeurs obtenues dans la détermination de la distance minima de perception distincte de deux pointes d'une part et les valeurs obtenues dans le test de stéréognosie orale d'autre part.

L'estimation manuelle du nombre de pointes et de rebords aigus a été nettement plus précise que l'estimation buccale ($P < 0{,}001$). Aucune corrélation n'a pu être notée entre le comptage des pointes et des rebords d'une part et la distance minima de perception distincte de deux pointes d'autre part. Le comptage des rebords, qui avaient une surface de contact de 15 mm de longueur, n'était pas significativement plus précis que le comptage des pointes.

ZUSAMMENFASSUNG

DIE FORMERKENNUNG IM MUND UND MIT DEN FINGERN UND DIE WAHRNEHMUNGSGENAUIGKEIT BEI DER DOPPELBERÜHRUNG DER ZUNGE

Im Formerkennungstest wurden 2 Serien von 15 verschiedengeformten Versuchsstücken verwendet, die aus einer 1,5 mm dicken Akrylplatte hergestellt wurden. Die Kante oder Diagonale der einen Versuchsstück-Serie war 10 mm, die der anderen 5 mm lang. Der kürzeste Abstand zweier gesondert wahrnehmbarer Berührungen (= Raumschwellenwert) auf der Zunge wurde mit einem spitzen (0,15 mm) Zirkel ermittelt. Die Wirkung von Flächeninhalt und Form der Berührungsgebiete des Versuchsstückes wurde mit Hilfe von 10 metallenen Versuchsstücken ($15 \times 15 \times 3$) getestet. Auf jedem der Stücke befanden sich 4 scharfe Spitzen (0,15 mm) oder Kämme von 1,5 mm Höhe und einem Abstand voneinander, der bei beiden Probestückarten zwischen 1,25—3 mm schwankte. Den Probanden

oblag es, die Anzahl der Spitzen und Kämme zu zählen. Dem Probanden wurden die Probestücke in zu fälliger Reihenfolge und ohne dass er sie sehen konnte zum Ertasten zunächst in den Mund dann in die Finger gegeben. Die Testpersonen-Gruppe bestand aus 10 Studenten der Zahnheilkunde. Die Formerkennung war mit den Fingern entschieden sicherer als das Ertasten im Mund ($P < 0{,}001$).

Zwischen den bei der Raumschwellenbestimmung erhaltenen Werten und denen des oralen Erkennungstestes konnte keine Korrelation festgestellt werden. Das Zählen der Spitzen und Kämme war mit den Fingern markant sicherer als im Mund ($P < 0{,}001$). Zwischen den Ergebnissen, die beim Zählen der Spitzen und Kämme und bei der Ermittlung des Raumschwellenwertes erhalten wurden, konnte keine gegenseitige Abhängigkeit festgestellt werden. Das Zählen der Kämme mit einer Brührungsfläche von 15 mm war nicht signifikant sicherer als das Zählen der punktförmigen Spitzen.

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