What Does Your "Homunculus" Look Like?

Mapping Your Brain

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Purpose:
We will determine the density of touch receptors in various parts of the body on the right hand side. Using these data, we will draw a picture of the " homunculus" of the experimental subject.

Background:
Human skin possesses several different sense receptors that can be differentiated from one another when a cross-section of skin is placed under the microscope. These different receptors respond to mechanical, chemical and thermal stimuli so that we can explore and determine the characteristics of our environment. Each receptor carries information to the brain where the information is processed and interpreted.

Most of the activity in the cerebrum of the human brain is centered in a thin convoluted surface layer only a few mm thick. Different regions of this cortex have different functions. For example: the somatosensory cortex straddles the foremost portion of the parietal lobe. Each point on this band of densely packed nerve cells represents sensory receptors from a different part of the body. In addition, due to the crossing over of nerve tracts, the right half gets input from the left side of the body and vice-versa. The specific amount of space in the brain dedicated to sensing each body part is proportional to the density of the sensory receptors in that area. For example: the fewer the receptors in the upper arm, the smaller the upper arm sensory area in the brain. So, you can map the entire body as it is "sensed" by the cortex. The "picture" of the body on the brain is called the "homunculus" ("little person").

Materials:
- 2 straight pins (or round tooth picks), paper scissors, glue stick, adhesive tape, cardboard (or a 5X7 inch file card), blindfold, graph paper. (Optional: appropriate clothing for the experimental subject: shorts and a tank top shirt.)

Procedure I: Construction of a measuring tool.
1. Cut out the pattern on the attached sheet and glue it to the cardboard. Place a weight such as a book, on top and wait a minute for it to dry.
2. Cut the lettered sections apart along all the lines making 6 pieces, A through F.
3. Glue B and C on top of A, leaving space in the middle for F.

4. Glue D and E to B and C only, leaving the center spaces under D and E open.
5. After the glue has had time to dry, slide F in under D and E so that it is parallel with B and C but free to slide back and forth.
6. Using adhesive tape, tape one pin along the far left edge of of D, with its top reaching only as high as the top of D. This will be the fixed point. Be sure the tape does not prevent F from sliding.
7. Tape a second pin to the inside edge of the perpendicular arm of F. Be certain that the points of the two pins are aligned.
8. The completed tester should look like the diagram on the attached page.

Procedure II: Experiment.
Your team should consist of an experimental subject (blindfolded) and an experimenter/recorder. Starting from the head and working down to the feet, measure the distance between touch receptor fields in specific parts of the right hand side of the body using the following method:

1. Spread the pins apart and press the points lightly on the skin of the subject. The subject should detect two points of contact. If he feels only one, repeat the process , moving the pins farther apart.
2. Move the 2 pins closer together, 0.5 cm at a time, until the subject will no longer be able to distinguish 2 separate pins. Measure this distance in cm. At this point, both pins are within the same receptive field of one sensory receptor, and so the 2 points cannot be identified separately.
3. Repeat this measurement 2 times in the same general area . Average these measurements, and record the mean in the data table.
4. Measure as many parts of the body as possible. See the data table for suggested areas.

Procedure III: Calculations.

1. The number recorded for each body part represents the distance between each sensory receptor field, so the distance measured is inversely proportional to the cortical area dedicated to that body part. That is: the closer the receptor fields, the larger the area on the cortex. To calculate the inverses, divide each mean into the number 1. For example: Distance = 0.25 cm. 1/0.25 cm divides out to be 4.0. Calculate the inverses for each body part and record on the data sheet.

2. Draw a proportional picture of the homunculus on graph paper. If the inverse is 4.0, then the body part occupies 4 boxes on the graph paper, approximating the normal body shape. To enlarge the scale, for example, just multiply all values by the enlarging factor. For example, to make the drawing 5 times larger, multiply the inverses by 5.

Analysis:

1. Which side of the brain's sensory cortex did you map? Explain.
2. How does your group's "homunculus" compare with those drawn by other groups? Discuss the similarities and differences.
3. Is there any adaptive or evolutionary value to the amount of space dedicated to each body part? Explain.

Sensitivity Data Chart

Site	Distance in cm	Inverse Values
Scalp		
Forehead		
Cheek		
Lips		
Tongue		
Chin		
Nose		
Neck		
Upper Arm		
Lower Arm		
Palm		
Elbow		
Back of Hand		
Fingertips		
Chest		
Back		
Abdomen		
Thigh		
Kneecap		
Calf		
Heel		
Sole		
Toes		

References:

Hooper, Judith and Dick Teresi. 1986. **The 3-Pound Universe.** New York: Macmillan Publishing Co.

Ornstein, Robert and Richard F. Thompson. 1984. **The Amazing Brain.** Boston: Houghton Mifflin Co.

Perigee Book, A. 1982. **The Brain: A User's Manual.** New York: G. P. Putnam's Sons.

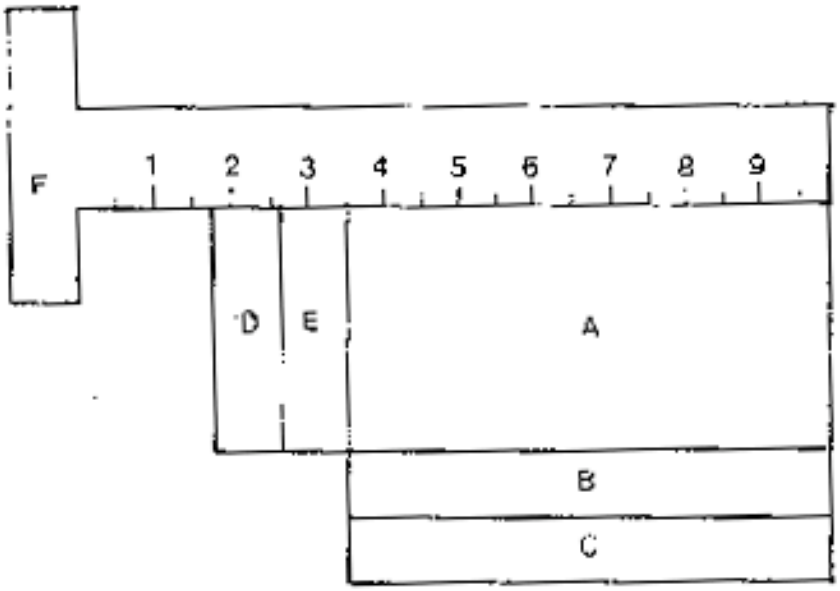
Sample data and map for homunculus / right cerebral cortex mapping lab:

Each unit in the inverse column equals one square on the graph paper.

Body area (left)	Two point threshold (cm)	Inverse
chin	0.55	1.82
above upper lip	0.3	3.33
scalp	5.4	0.19
forehead	1.9	0.53
nose (bridge)	0.9	1.11
eyelids	0.65	1.54
cheek	1.60	0.63
lower lip	0.3	3.3
upper lip	0.25	4.00
ear	2.40	0.42
back neck	1.35	0.74
side neck	1.85	0.54
front neck	2.55	0.39
top shoulder	4.4	0.23
outer upper arm	16.3	0.06
inner upper arm	5.2	0.19
outer forearm	5.2	0.19
inner forearm	4.6	0.22
back of hand	1.7	1.25
second finger front	0.25	4.00
second finger back	0.25	4.00
thumb back	0.75	1.33
thumb front	0.3	3.33
back	4.2	0.24
chest	3.8	0.26
thigh outer	3.65	0.27
thigh inner	3.35	0.30
lower leg front	4.0	0.25

foot top	4.6	0.22
foot bottom	3.3	0.3
middle toe top	3.05	0.33
big toe top	2.6	0.38

Measuring Tool Template



Finished Tool