A Study of Sensory Field Sizes and Handedness
Nerves and Stimuli

- Bundles of nerve cells called neurons
- Nerves receive and transmit signals
- Stimuli signal changes in the environment
- Types of stimuli:
  - Chemical
    - Odorants and tastants
    - Particles that are smelled or tasted
  - Thermal
    - Changes in temperature
    - Hot → Cold or Cold → Hot
  - Mechanical stimuli
    - Touch
    - Pain
    - Vibration
    - Movement
Nervous Systems

- Central Nervous System (CNS)
  - Brain and Spinal Cord
  - Stimuli received from and sent to the PNS
- Peripheral Nervous System (PNS)
  - Nerves throughout body
  - Stimuli received from the environment and the CNS
Types of Neurons

- **Interneurons** -
  - Found in CNS
  - Responsible for processing and responding to stimuli

- **Sensory neurons** -
  - Found in PNS
  - Pick up and translate stimuli

- **Motor neurons** -
  - Found in PNS
  - Carry signals that cause movement
Neuron Structure

- Dendrites- Receive stimuli
- Cell body- Houses the nucleus
- Axon- Relays signals to the next neuron
Sensory Receptors and Stimuli Transport

- Found on the end of dendrites
- Detect and transport stimuli to CNS
  - Stimuli travels through the neuron
  - Stimuli are passed from one neuron to the next
  - Stimuli are transported to the CNS
Touch Receptors

- Allow us to detect mechanical stimuli
- Types of Touch Receptors
  - Merkel’s Discs
  - Meissner’s Corpuscles
  - Krause’s End Bulbs
  - Ruffini Endings
  - Pacinian Corpuscles
  - Hair follicle receptors
  - Free nerve endings
Somatosensory Cortex

- Headband shaped region of the brain
- Stimuli from touch receptors processed
- Neurologist mapped out the cortex
  - Electrically stimulating spots on cortex
  - Causing illusions of stimulation
- Area in the cortex is proportional to number of touch receptors
  - Lips have a large area on the cortex
  - Trunk of body has very small area on the cortex
- Motor neurons carry the response away from the brain
Sensory Fields

- Area in which any one neuron detects stimuli
- Dendrite branches extend across this area
- Dendrite branches have sensory receptor that detects stimuli in its sensory field
Density and Sensory Field Size

- Small, dense sensory fields
  - More densely packed neurons
  - More sensitive to stimuli

- Large, less dense sensory fields
  - Less densely packed neurons
  - Less sensitive to stimuli
Measuring Sensory Fields

- Two-Point Touch Discrimination Tests
- Medical test used to determine extent of nerve damage
- Measures distance between two sensory fields
**Two-Point Discrimination Test**

- Caliper with two blunt needles
  - Measured distance between needles
  - Needles placed simultaneously against skin
- Subject may feel 1 or 2 points
  - Feels 1 point - activated 1 sensory field
  - Feels 2 points - activated 2 sensory fields
- Two-Point Discrimination Threshold is the minimum distance between two sensory fields
Preliminary Findings

- Two-Point Touch Discrimination Lab
  - Test regions included fingers, palms, forearm, neck and shins
  - Smaller two-point threshold sizes on fingertips
  - Smaller, more dense sensory fields on fingertips
- Findings match the Somatosensory Cortex map developed by neurologist
Research on Hands and Stimuli

- Sathiamoorthy et al. (1994)
  - Fingertips to push machine buttons
  - Visual and auditory stimuli reaction time measured
  - Left handed women responded faster to auditory stimuli

Since left handed females responded faster to auditory stimuli, how does handedness relate to other stimuli such as touch?
Handedness

- Preferred use of left or right hand
- Dominant hand is the preferred hand
- Often the hand used to write
- 10% of population is left handed
Dominant Hands

- Preferred use
- Are faster, stronger, and more precise for manual tasks
  - Writing
  - Cutting with scissors
  - Screwing lids on a jar
  - Hammering nails
Purpose

- Determine if sensory field sizes differ on dominant and non-dominant hands.
Hypotheses

- Null: Sensory field sizes are the same on both dominant and non-dominant hands
- Alternate: Sensory field sizes will differ between dominant and non-dominant hands
Study Site and Subjects

- Frostburg State University
- July 1, 2015
- Two test groups
  - Left Handed- 9 individuals
  - Right Handed- 9 individuals
- Males and females in each group
- Ages ranged from 13-50 years old
Calipers

- Plastic Calipers (General/National No. N-141 me)
- Measured in millimeters
- Modified- hot glued metal blunt sewing needles to caliper prongs
Using the Calipers

- Needles glued in slightly different places
- Rulers were used to measure distance between needle points
Finding Two-Point Thresholds

- Calipers were opened and needles separate
- Needles placed simultaneously against skin
- Subject would state if they felt 1 or 2 points
  - 1-increase distance between needles
  - 2-slightly decrease distance between needles
- Measured distance with a ruler
- Sample multiple locations in a region
- Recorded the two-point threshold
Caliper Sample Sites

- Sampled Left and Right arms of each subject
- Found minimum two-point threshold in five regions
  - Tip of index finger
  - Tip of thumb
  - Palm
  - Forearm
  - Upper arm
Data Analysis

- Microsoft Excel
- Calculate averages for both groups
  - Average Two-Point Threshold
  - 95% Confidence Intervals
- For the five regions

<table>
<thead>
<tr>
<th>Regions</th>
<th>Left Arm</th>
<th>Right Arm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Index Fingertip</td>
<td>4mm</td>
<td>5mm</td>
</tr>
<tr>
<td>2. Thumtib</td>
<td>4mm</td>
<td>6mm</td>
</tr>
<tr>
<td>3. Palm</td>
<td>12mm</td>
<td>18mm</td>
</tr>
<tr>
<td>4. Forearm</td>
<td>16mm</td>
<td>25mm</td>
</tr>
<tr>
<td>5. Upperarm</td>
<td>33mm</td>
<td>31mm</td>
</tr>
</tbody>
</table>
Results
Right Handed Group

- Smaller thresholds on left thumb, forearm, and upper arm
- Smaller thresholds on right index fingers
- Same size thresholds on palms
- All 95% confidence intervals overlapped
- Averages between left and right hands are not different

![Graph showing average 2-point discrimination threshold (mm) for different arm regions for right-handed group. The graph compares left and right thresholds for index, thumb, palm, forearm, and upper arm regions. The error bars indicate the 95% confidence intervals.](image-url)
Left Handed Group

- All 5 regions had smaller thresholds on left hands
- All 95% confidence intervals overlapped
- Averages between the left and right hand are not different

![Graph showing average 2-point discrimination threshold (mm) for different arm regions (Index, Thumb, Palm, Forearm, Upper Arm) between left and right hands. The graph includes error bars indicating the 95% confidence intervals.]
Discussion & Conclusions
Left and Right Handed Groups

Both had overlapping 95% confidence intervals for all regions with no difference between dominant and non dominant hands.
Hypotheses

- Accept Null: Sensory field sizes are the same on both dominant and non-dominant hands
- Reject Alternate: Sensory field sizes will differ between dominant and non-dominant hands
Purpose Revisited

Do sensory field sizes differ on dominant and non-dominant hands?

- Sensory field sizes did not differ between dominant and non-dominant hands
Right Handed Group

- All averages were very similar
- Sensory field sizes, density and sensitivity were not different between left and right hands
- Both hands may have similar neuron density and space on the somatosensory cortex
Left Handed Group

- Larger difference between averages, but overlapping CIs.
- Sensory field sizes, density and sensitivity were not different between left and right hands.
- Both hands may have similar neuron density and space on the somatosensory cortex.
Left Handed Group

- Trend - left hands consistently had smaller thresholds on all five regions
- Implications - difference may exist if we could improve upon limitations of our study
Sample Size Limitations and Improvements

- Low sample size in groups, N=9
- Number too low for statistical analysis
- Number of subjects in each group should be increased
Gender Limitations and Improvements

- Gender of subjects varied
- Only 2 left handed females
- Number of left handed females should be increased
- Comparisons can be made between genders
Equipment Limitations and Improvements

- Calipers were imprecise due to being homemade
- Medical grade equipment is very expensive
- Future studies could use medical grade equipment
Sampling Method Limitations and Improvements

- Sampling regions lacked consistency
- Lack of practice and experience
- Regions for sampling should be more specific
- Researchers should have more training or checks to see if they are measuring the same
Test Environment Limitation and Improvements

- Location of testing varied from lab, hallway, and cafeteria
- Cold room temperatures may impact results
- Select one location with comfortable temperature for testing
New Questions

- What are the normal size ranges for sensory fields in various body locations?
- Do sensory field sizes differ between genders?
- Does temperature impact two-point touch discrimination thresholds?
Special Thanks

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Questions