Excerpt from

LABORATORY MANUAL

PRINCIPLES OF PSYCHOLOGY: EXPERIMENTAL FOUNDATIONS

PSYCHOLOGY 122
2001

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Experiment 3

Neuropsychology: Handedness

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Neuropsychology: Handedness

Bonnie S. Sherman

Introduction

It is a curious fact that, in spite of social pressures to conform and an environment in which most people become what we call "right-handed," some people insist on being "left-handed." Even our language conveys the notion that "left" is less valued than "right." We use expressions like "out in left field" and we borrow words from other languages like "gauche," "sinister," and "maladroit" to suggest the negative, while "all right," "right on," and sitting at "the right-hand of God" imply the positive. So why would some children seemingly choose the awkward, difficult path of being left-handed?

Perhaps the choice is not simple; left-handers may be responding to strong genetic pressures. Yet interestingly there is no known simple genetic code for handedness, and monozygotic twins with identical genetic make-up are not especially likely to be concordant for handedness (Halpern and Coren, 1990).

Perhaps the left-handed path is chosen early, too early to be in response to these cultural factors. Michel (1981), for example, has noticed that newborns in the first couple of days after birth lie with their heads turned mostly in one direction. About two-thirds of them choose turning to the right. Five months later those same infants who had turned their heads to the right were reaching for things with their right hands, while the infants who had turned mostly to the left were reaching with their left hands.

This and other behaviors interacting with genetics may result in different cortical organizations for right- and left-handers. If so, researchers then ask what the difference is and how that difference might show up in brain anatomy. There are a number of studies that show anatomical differences; these differences are small, but they provide a few pieces of a yet unsolved puzzle.

Below are some facts (Springer and Deutsch, 1993) about handedness that may provide starting points for discussion.

1. About 90% of humans use their right hands for skilled, one-handed activities such as writing, drawing or cutting. This has been true since prehistoric times. About 10% of human beings, however, become left-handed in a right-handed world.

2. The incidence of left-handedness is lower in females than in males.

3. A child born to two left-handed parents has a probability of 0.46 of being left-handed. If only one parent is left-handed, the probability is 0.17. If neither parent is left-handed, the chance of having a left-handed child is 0.02.

4. Hemispheric asymmetry: 95% of right-handers have speech localized to the left hemisphere, and 70% of left-handers have speech localized to the left hemisphere. The remaining 30% of left-handers often have bilateral speech representation; there

seems to be less asymmetry in left-handers. There is also a higher incidence of stuttering in strongly left-handers than in strong right-handers.

5. Some clinical data suggest a relationship between handedness and birth trauma or early brain damage. In one study, most of the left-handers who showed evidence of early damage to the left hemisphere also showed evidence of carrying language in the right hemisphere, whereas left-handers with no signs of early brain damage had left-hemisphere language.

6. Left-handers have a better prognosis for recovery from aphasia after a stroke than do right-handers. Strong left-handers show a higher incidence of migraine and dyslexia than strong right-handers.

7. The rate of immune disorders is 2.5 times greater in strongly oriented left-handers than in right-handers.

8. More than 2.5% of right-handers live to the age of 90, whereas fewer than 0.5% of the left-handers reach 90. The mean age for death of right-handers is 75.34 years; for left-handers, it was 66.2 years.

Objectives

- To consider ways of defining and testing handedness
- To discriminate between functional and structural asymmetry
- To learn some of the basic anatomy of the human brain and look for differences between individuals
- To examine some sensitivities in brain development
- To investigate the relationship of handedness and brain structure

Terms

The following terms are described in detail in the **Methods** section:

Brain stem

Cerebellum

Cerebral cortex

Corpus callosum
Isthmus of corpus callosum: **posterior 1/3** minus **posterior 1/5**

Fissure(s):
Sylvian or lateral fissure

Longitudinal fissure--right and left cerebral hemispheres

Frontal lobe

Gray matter

Gyrus / gyri

Lateral ventricles--occipital horns of lateral ventricle

Motor cortex of the precentral gyrus

Occipital lobes

Parietal lobe– Parietal operculum

Pyramidal system

Somatosensory cortex of the postcentral gyrus

Spinal cord

Sulcus / sulci

- Precentral sulcus
- Central sulcus
- Postcentral sulcus

Temporal lobe

White matter

Method

Materials

- Edinburgh Handedness Inventory
- Handedness Scale
- human brain tissue
- dissection trays
- dissection kits
- latex gloves
- lab coats
- rulers
- graph paper
- 1500 mL beakers
- 1000 mL graduated cylinders
- masking tape
- video (The Mind: Development)

PART 1

What Does It Mean to Be Functionally Asymmetrical?

<u>DT</u>	**What constitutes handedness? How would you define it and measure it?**

A number of tests have been written to measure handedness. Complete the following tests, score your individual results, and then put your data on the board so the results of the entire group can be viewed.

1. Edinburgh Handedness Inventory (at the end of this lab unit)

2. Handedness Scale (to be given to you by your preceptor)

<u>DT</u>	**In comparing your handedness tests, do you find the scores for individuals the same on both tests? Why might you expect to find differences? How does the definition of handedness determine your results?**

<u>DT</u>	**Looking at the results of your lab colleagues, where does your score fall? What might the reasons for this be? Was there an overall trend in the scores?**

PART 2

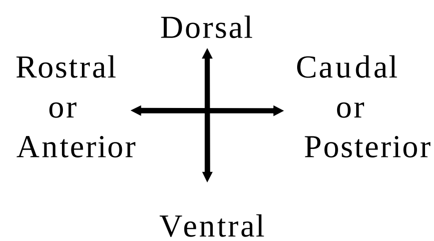
Basic Brain Anatomy and Individual Differences

1. You will be examining human brain tissue. These brain specimens are from people who donated their remains to the medical school at the University of Minnesota. The brains were dissected by first-year medical students, and we have them this year for study. Treat them with respect; they are gifts to us for our education.

2. Select latex gloves that fit your hands and put them on. You will be working with the brain that is on a tray at your research group's station.

3. Some helpful directional terms to aid in your dissection (you <u>do not</u> have to memorize these):
   <u>Dorsal</u> refers to the top or back of the nervous system.
   <u>Ventral</u> refers to the front or bottom.
   <u>Lateral</u> means toward the side or away from the midline.
   <u>Medial</u> means toward the middle or the midline.
   <u>Anterior</u> means toward the head (words with the same meaning are <u>rostral</u> and <u>cephalic</u>).

Posterior means toward the tail (same as caudal)
Superior refers to something that is located above.
Inferior refers to something that is located below.
Unilateral indicates involvement of only half of the brain.
Bilateral indicates the involvement of both hemispheres.
Ipsilateral refers to the same side of the brain.
Contralateral refers to the opposite side of the brain.



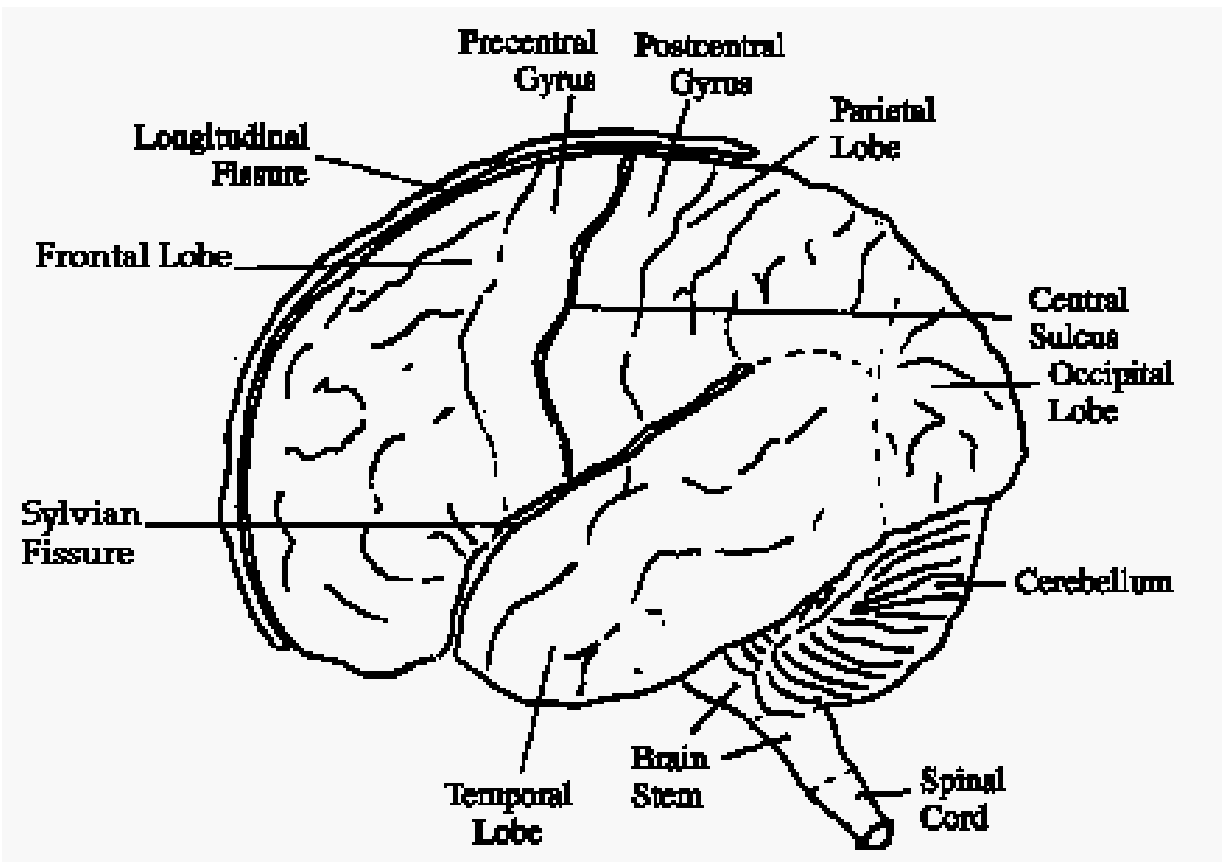


Figure 1. Structural landmarks and functional areas of the human brain

4. Note that the brain is narrower at the front (or rostral portion) and at the back (or caudal portion). Attached at the base is a structure called the CEREBELLUM. This "little brain" is involved in the maintenance of equilibrium and coordination.

5. Place the brain with its right side resting against the tray. Most of the brain seen from this view is the left cerebral hemisphere (Figure 1). Both the left and right cerebral hemispheres are composed of a superficial layer of GRAY MATTER (called the CEREBRAL CORTEX) that covers a core of WHITE MATTER. Note that the tissue may not

look very gray because the preservation may have changed it somewhat in color and texture. You should, however, be able to distinguish gray matter from white matter as the white matter is still rather white.

6. Examine some of the sections of the two brains that have been “sliced” and are available at the front of the lab. The outer bark, or gray matter, (the cortex) is quite thin. The gray matter consists of the cell bodies of the neurons. Most of the inner tissue is white matter, the neural fibers or axons that make the connections within the nervous system.

7. Note that the gray matter of the cortex is thrown into many convolutions and depressions, the result of which is to make GYRI or ridges (GYRUS, singular) and SULCI or clefts or grooves (SULCUS, singular). The total surface area of the cortex is about a square meter. The average thickness is about 2.5 mm; however, it is usually thicker in the gyri of the convolutions than in the sulci. It is thickest (4.5 mm) in the MOTOR CORTEX of the PRECENTRAL GYRUS and thinnest in the visual cortex of the OCCIPITAL LOBE (1.5 mm).

8. The deepest and longest grooves are called FISSURES. These are grooves that are deep enough to indent the ventricles beneath the cortex; this distinguishes them from sulci. Note that the RIGHT and LEFT CEREBRAL HEMISPHERES are separated by a very deep indentation called the LONGITUDINAL FISSURE. Find this fissure. Now locate the SYLVIAN FISSURE or LATERAL FISSURE, which begins in a cleft on the anterior, inferior surface of the cortex. (This has been named for François Sylvius, a seventeenth century anatomist.) Place your probe or your gloved finger in this fissure and notice its depth.

9. Now find the TEMPORAL LOBE. Lobes are not functional regions but convenient anatomical regions. They are named after skull bones under which they are found. The temporal lobe is just beneath, or inferior to, the Sylvian fissure, which you have found. Check the location on the diagram.

10. Now locate the FRONTAL LOBE at the anterior part of the brain. To expose the sulcus that forms the posterior boundary of the frontal lobe, note that there are three somewhat parallel sulci that run from the upper, or superior, surface of the brain around almost to the Sylvian fissure. Locate these three sulci on your brain specimen. These are the PRECENTRAL, CENTRAL, and POSTCENTRAL SULCI. The CENTRAL SULCUS forms the posterior boundary of the frontal lobe. It curves toward the posterior part of the brain as it moves medially across the superior surface of the cortex. It is just visible on the medial view.

11. These three sulci enclose two gyri, the PRECENTRAL and POSTCENTRAL GYRI. The PRECENTRAL GYRUS is the gyrus farthest back on the frontal lobe; it is the MOTOR CORTEX of the brain (and is the thickest part of the cortex). Hand movements originate here. The POSTCENTRAL GYRUS is the somatosensory cortex, the area that receives sensory input from the skin including the hands.

12. When you find these gyri on your brain specimen, stop and look at these same features on another brain. Interestingly, like the rest of our bodies, different brains tend to look somewhat different. There is <u>some</u> variation between the location of these features on the two sides of a single individual's brain and <u>substantial</u> variation in both the location and the size and exact structure of the gyri and sulci in the brains of different individuals. Sometimes it is difficult to locate features on a different brain.

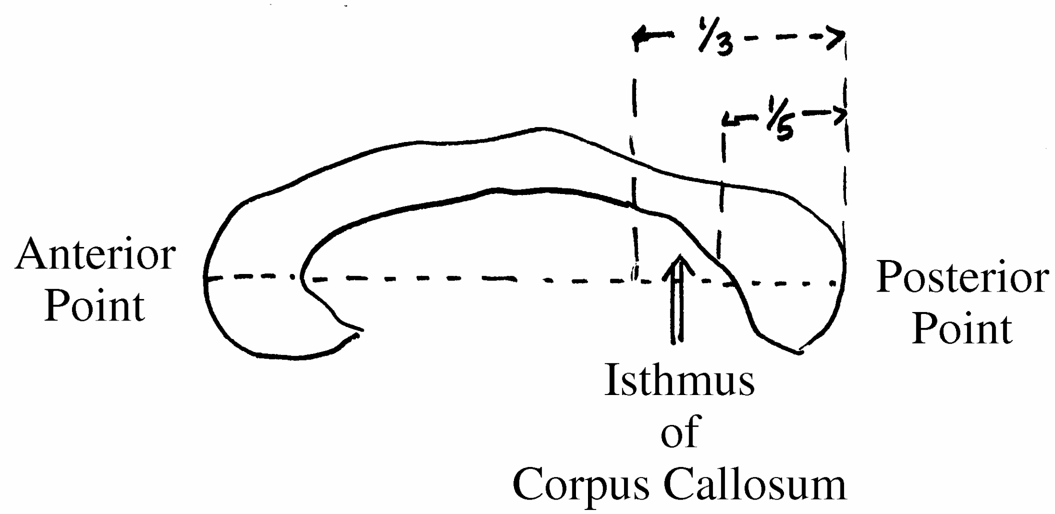
    Make note of some of the differences you observe in the space below.

13. The lobe directly behind the frontal lobe is the PARIETAL LOBE. The most anterior gyrus of the parietal lobe is the POSTCENTRAL GYRUS that you have located in #10 above. The parietal lobe is bounded anteriorly by the frontal lobe, posteriorly by the occipital lobe, and inferiorly and laterally by the temporal lobe. Note that where the parietal lobe meets the Sylvian fissure, its cortex turns under a bit; this area is the PARIETAL OPERCULUM. Much of the border between the parietal, occipital, and temporal lobes is indefinite. These are called transition areas because definite boundaries are lacking.

14. The OCCIPITAL LOBES are posterior to the parietal lobes and form the most caudal portion of the cortex. The extreme posterior end of the occipital lobe of the cortex is often referred to as the occipital pole. The occipital lobe is involved in vision. Remember the cortex is thinnest in the occipital lobe.

15. Examine a brain that has been cut along the longitudinal fissure. The tissue that has been cut is the CORPUS CALLOSUM, a stout band of fibers or axons that connect the two cerebral cortices. Look at the cross-sectional diagram of the corpus callosum to locate the ISTHMUS of the corpus callosum. The isthmus has no clear anatomical boundaries; it is defined by the following formula:

    caudal 1/3 minus **caudal 1/5** of the corpus callosum



16. Now note that all the structures you have been examining are in the uppermost region of the brain. There is also tissue in the center of the brain and in a narrow column that extends down from the brain (the SPINAL CORD). Just above the cut end of the spinal cord, the cord widens. Here major neural fibers descending from the brain to the hands and other body areas cross from one side of the body to the other. The crossing enlarges the cord. There are two longitudinal fiber bundles that resemble narrow elongated pyramids; they make up the PYRAMIDAL SYSTEM.

17. Finally note in the National Geographic article diagrams that within each of the cerebral hemispheres there are open spaces that are filled with a cerebral fluid. These are called VENTRICLES. There is a model of the ventricles in the front of the lab for you to examine. The posterior portions of these are the OCCIPITAL HORNS. Note that this model was cast from a particular brain; it is not a stylized model. Thus you can see the asymmetry in the horns.

PART 3
Investigating the Relationship of Handedness and Brain Structure.

Below are some findings from research literature. Read and discuss the information in your research groups.

A. Variations in Anatomical Asymmetry

"A general pattern of hemispheric specialization, in which linguistic-sequential and spatial tasks are more accurately processed in the left and right hemispheres, respectively, exists for most people, but the pattern may vary in both direction and degree" (Witelson, 1985, p. 665).

Following are some variations found by researchers investigating this topic:

1. Variation in the corpus callosum
   a. In a study of 300 cases, the cross-sectional (or midsagittal area, the cross-section along the longitudinal fissure) of the corpus callosum was 11%, (0.75

cm^2) greater in left-handed and ambidextrous subjects than in right handed subjects (Witelson, 1985). If the difference were due to the number of fibers, it would represent some 25 million fibers. (Kolb & Whishaw, 1990; Blinkov & Glezer, 1968). (Recall that the corpus callosum develops its shape and position before birth.)

b. The overall size of the corpus callosum is larger in men than in women; this is proportionate to the overall larger brain size of men. In contrast the area of the isthmus is larger in women; this difference is accentuated when the isthmus is considered relative to the overall area of the corpus callosum. In males, the size of the corpus callosum is correlated with handedness; the isthmus is smaller in right-handed men than in non-right-handed men. Handedness and the size of the corpus callosum are not correlated in women (Witelson, 1989).

2. Variation in the Sylvian fissure on the left and right side of the brain
   Ratcliffe (1980) and his colleagues found that left-handers and right-handers with left hemisphere speech had an average right-left difference of 27° in the angle with which blood vessels (the middle cerebral arteries) leave the lateral, or Sylvian fissure. For left- or right-handers with speech in the right hemisphere, or with bilateral speech, the mean difference was 0°. This is one datum that suggests that left-handers have reduced asymmetry compared to right-handers.

3. Variation in gray matter and blood flow
   In regional blood flow studies, Gur (1982) found more gray matter in left-handers than in right-handers. The total blood volume in the right hemisphere is greater than in the left hemisphere in 62% of right-handers. However, the total blood volume of the left hemisphere is greater than in the right hemisphere in 64% of left-handers (Carmon et. al., 1972).

4. Variation in lateral ventricles
   The occipital horns of the lateral ventricles were longer on the left side than on the right in 87% of right-handed subjects. (In left-handers, the occipital horns tend to be equal or to have an equal chance of the right or left horn being longer) (Witelson, 1980).

5. Variation in relative size of hand-brain connections
   a. Volumetric measurements show that right-handed individuals have larger right hands than left hands. In contrast, the hands of left-handers are much more nearly symmetrical (Purves, White and Andrews, 1994).
   b. Yakovlev and Rakic (1966) found that in 80% of the cases the pyramidal tract descending to the right hand contains more fibers than does the same tract going to the left hand.
   c. Note the histological (tissue) asymmetry was discussed in your required lab reading (White et. al., 1994). This is a difference in motor and somatosensory (body sensation) cortex, that is in regions that may move the hand, or bring in sensations from the hand.

B. Variations in Functional Asymmetry

1. Bihemispheric representation
   Left-handers, as a group, have greater bilateral representation of cognitive functioning than do right-handers (Bryden, 1982). Right-handers are more likely to carry out tasks such as speaking, writing, solving a spatial puzzle, etc. in a single hemisphere (either right or left), while left-handers may carry out a test with input from both hemispheres.
2. Other factors
   Different patterns of hemispheric functional organization may be related to handedness, but also to other variables, such as sex, brain damage, or cognitive disorders.

PART 4
Investigating the Relationship between Handedness and Anatomical Structure

As illustrated by the preceding findings, considerable effort has been made to discover systematic differences in handedness that might accompany specific patterns of handedness. In this part of the laboratory investigation you are asked to develop a procedure that investigates one of these anatomical differences. You may design your own method, or utilize one of the following. **Record all data and answers to questions in your lab notebook.**

Example 1: Corpus Callosum size vs. Handedness and Gender

Part b in finding 1 under "Variations in Anatomical Asymmetry" describes discrepancies in corpus callosum size between genders. It states that in males the size of a portion of the corpus callosum is correlated with handedness (the isthmus is smaller in right-handed men). Therefore, if you know you are investigating a male brain, you may be able to ascertain the handedness of the individual. The area of the isthmus can be effectively measured with a ruler and graph paper, in a brain that has been cut along the longitudinal fissure.

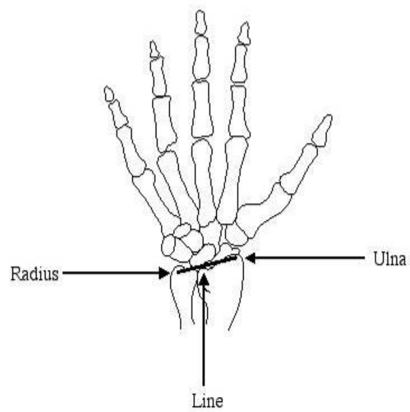
- Trace the outline of the corpus callosum onto a piece of scrap paper.
- Determine which section of the trace corresponds to the isthmus (see diagram on page for details)
- Trace the isthmus area onto a piece of graph paper.
- Using the graph paper, estimate the area of the isthmus. Be sure to specify units.

Measure the area of the isthmus of all brains present and make a chart listing the data obtained for each one. What preliminary conclusions can you draw from the data?

Example 2: Left and Right Hand Volume vs. Handedness

Part a in finding 5 under "Variation in relative size of hand-brain connections" describes asymmetry in hand size in right handed individuals. An easy way to measure the volume of an object is to submerge it in water and measure the amount of water displaced by it. Volume measurements must be made with a high degree of precision to ensure that any difference will be observable. This can easily be accomplished by following this procedure:

1. Locate the ends of your radius and ulna (the two bones of your forearm). This feels like a rounded bump on both sides of each wrist (one bump for each bone). Draw a line with a pen connecting them.



Left Hand

2. Fill a large graduated cylinder (at least 1000 mL) with an exact amount of water. Try to aim for a volume between 580 and 620 mL. Record the amount of water added to the nearest mL. You can do this by approximation based on the existing gradations.

3. Add the water from the cylinder to a large beaker (at least 1000 mL). Place a piece of masking tape longitudinally along the upper half of the beaker.

4. Place the hand (record if it is the right or left) into the beaker. Submerge the hand up to the line on the wrist. Spread your fingers slightly to ensure that water comes in contact with all of the hand. Make a mark on the masking tape at the level the water reaches while the hand is submerged. Remove your hand.

5. With the graduated cylinder, or another beaker, add water to the mark on the masking tape.

6. Pour the water from the beaker (it should now be at the level of the mark on the tape) into the empty graduated cylinder. Record the resulting volume.

7. Subtract your initial volume (step 2) from the final volume (step 6). This is the volume of the hand that was submerged.

8. Repeat steps 1-7 for the other hand.

9. Divide the volume for the right hand by that obtained for the left. Subtract this number from 1 and multiple by 100. Take the absolute value of this percent. This is the percent increase in volume of the right hand over the left.

Also subtract the volume of the left hand from the volume of the right hand and divide that by the sum of the two volumes. This is either negative or positive depending on the larger hand. Compare this number with your handedness scores.

10. Was your result what you expected based on the researcher's findings?

Example 3: Develop your own scientific investigation

Using information from the introduction or *part 3*, develop your own scientific investigation of handedness variation as a function of anatomical differences. You must then carry out the investigation using materials that are available to you in the laboratory. Be sure to define the procedure, record your data, and compare your findings with previous research.

PART 5

Sensitivities in Brain Development

The video segment on development shows some dramatic effects on fetal brain development resulting from (1) radiation and (2) a chemical insult, (alcohol). As you watch the video, notice how the neurons respond to these insults.

Discussion Questions

1. Consider the relationship between nature, nurture, and development. Looking back on the statistics about left-handers, variations in anatomy, and neural development, how might these factors contribute to the handedness of an individual?

2. You have been examining the biological foundation for the aspect of mental life and / or behavior that we call handedness. What does it mean to look at non-mental processes (anatomy) that effect mental processes?

References

Required Lab Reading

White, L.E., Lucas, G., Richards, A. & Purves, D. (1994). Cerebral asymmetry and handedness. Nature, 368, 197–198.

Additional reference article to read and bring to lab (in Rolvaag Library on three-day reserve):

Swerdlow, J.L. (1995, June). Quiet miracles of the brain. National Geographic, 187, 2–41.

Suggested Readings

Gardner, H. (1974). The shattered mind: The person after brain damage. New York: Vintage Books. [Howard Gardner explains and illustrates through case narratives of brain-damaged patients the relationship of mind and brain. Of particular interest here is Gardner's first case, Peter Franklin, the non-right-hander who suffered a stroke.]

Springer, S.P., & Deutsch, G. (1993). Left brain, right brain (4th ed.). New York: Freeman. [A highly readable text that considers differences, similarities, and interactions between the cerebral hemispheres. Chapter 5 presents data on left-handedness and the brain.]

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Witelson, S.F. (1985). The brain connection: The corpus callosum is larger in left-handers. Science, 229, 665-668.

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Yakovlev, P.I., & Rakic, P. (1966). Patterns of decussation of bulbar pyramids and distribution of pyramidal tracts on two sides of the spinal cord. Transactions of the American Neurological Association, 91, 366-367.

Web Links

Genetics of handedness

http://duke.usask.ca/~elias/left

A short article discussing the ways in which left-handedness may be under genetic control.

Primate handedness and brain lateralization

http://www.indiana.edu/~primate/index.html

This site gives research on a thorough hand-preference questionnaire. It also gives discussion on a definition of handedness.

Handedness Scale

The instructions are: " I want to see how well you can follow directions. Listen carefully and make sure you do exactly as I say. If you don't understand something, or if you want me to repeat it; just ask."

1. Fold your hands like this. (Demonstration of folding with interlocking fingers, dominant hand indicated by outermost thumb. One measurement)

2. Draw a circle…Now do it with your other hand…Now do it with both hands at the same time." (Record which hand was used first, and which circle was more accurately drawn. Two measurements.)

3. Stand up. Now hop on one leg. (Record which leg was used. One measurement.)

4. Hold your pencil (or pen) in your hand right here. (10" directly in front of S's nose). Now close one eye. Now open that eye and close the other. When did the pencil look like it was higher? (Record which hand was used, and which eye was closed when the pencil seemed higher. Two measurements.)

5. Stand up. Close your eyes and put your feet together. Now lift up your arms and hold them straight out in front of you. (Record which arm was higher. One measurement.)

6. Fold your arms like this. (Demonstrate. Record which arm was uppermost. One measurement.)

7. Write your name. Do the best penmanship you can. (Note the direction of the head tilt. Record opposite eye as dominate. One measurement.)

8. Kneel down on one knee. (Record which knee. One measurement.)

9. Hold your pen at arms length in front of your nose. Hold it so that it covers the vertical line drawn on the board. Now bring the pen slowly toward your nose always keeping it covering the line on the board. I know that you may see two images but keep the pen covering the line with the one that covers it best. Keep moving the pen toward your nose until it touches your face. (Record the side of the nose (which eye) to which the pen is brought.

10. Take three full steps forward and stop with your feet together. Do not turn around. Now take three steps backwards to your original position. (Record foot used first walking forward and foot used first walking backwards. Two measurements.)

11. Take one of the sticks and pretend it is a rifle. Aim it and pretend you are going to shoot me. (Record which hand was used for the trigger and which eye was used for sighting. Two measurements.)

12. Write your name. Now do it with the other hand. Now do it with both hands together. (Record which hand was used first, and which hand was better controlled. Two measurements.)

13. Take a sheet of paper. Roll it into a tube like this. Now hold the tube up to your eye with one hand so you can see the red spot on the board. (Record which hand was used and which eye was used. Two measurements.)

14. Drop a paper clip to the floor and cover it quickly with your foot. (Record which foot was used and which hand was used to drop the paper clip.) Take one of the sticks and pretend (only pretend) to swing it as a bat, or use it as a handle of a mop or broom. (Record which hand was used as the power hand for the swing. One Measure.)

Handedness Scale
Recording Sheet

1.	________________	
2.	________________	________________
3.	________________	
4.	________________	________________
5.	________________	
6.	________________	
7.	________________	
8.	________________	
9.	________________	
10.	________________	________________
11.	________________	________________
12.	________________	________________
13.	________________	________________
14.	________________	________________
15.	________________	

Edinburgh Handedness Inventory *

M. R. C. Speech and Communication Research Unit

Name: Date of Birth: Sex:

Have you ever had any tendency to left-handedness? YES NO

Please indicate your preferences in the use of hands in the following activities by putting **+** in the appropriate column. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, put **++**. If in any case you are really indifferent, put **+** in both columns.

Some of the activities require both hands. In these cases, the part of the task or object, for which hand-preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		Right	**Left**
1.	Writing	______	______
2.	Drawing	______	______
3.	Throwing	______	______
4.	Scissors	______	______
5.	Comb	______	______
6.	Toothbrush	______	______
7.	Knife (without fork)	______	______
8.	Spoon	______	______
9.	Hammer	______	______
10.	Screwdriver	______	______
11.	Tennis Racket	______	______
13.	Cricket bat (lower hand)	______	______
14.	Golf Club (lower hand)	______	______
15.	Broom (upper hand)	______	______
16.	Rake (upper hand)	______	______
17.	Striking match (match)	______	______
18.	Opening box (lid)	______	______
19.	Dealing cards (card being dealt)	______	______
20.	Threading needle (needle or thread according to which is moved)	______	______
40.	Which foot do you prefer to kick with?	______	______
41.	Which eye do you use when using only one?	______	______

Note: The numbering in this questionnaire reflects the numbering in the original test. Questions 21 through 39 were not included in the final scale.