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PSYC 270 LAB SYLLABUS – Winter 2018 Term 1

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Contacting the TAs: The TAs do not have regular office hours, but are available by appointment. If you have content-related questions, please ask your classmates (via Connect), or discuss with the TAs in person. Please only email TAs to schedule meetings or for administrative issues.

Course Time and Location
Lab 1: Tuesdays 5:00 – 8:00; Center for Brain Health (DMCBH) 3402A-C
Lab 2: Thursdays 5:00 – 8:00; Center for Brain Health (DMCBH) 3402A-C
Exceptions: The labs involving the sheep brain (Sept 18/20 and Sept 25/27) and animal handling (Date TBD) will be held in different facilities due to chemicals, animals, etc. For those classes, please refer to specific instructions that will be given to you by the TAs.

Expectations
The laboratory section of this course is meant to be informative, to encourage scientific and logical thinking, and to be fun! To get the most out of each laboratory class, you should come to each class prepared and willing to participate. You will be presented with a lot of new material, information and directions in this course, so expect it to be a challenge! We will be expecting a lot from each of you.

You will be required to follow directions provided in the lab manual and by your TAs. The TAs reserve the right to override anything written in the lab manual (by either verbal instructions in class or via email). We expect you to plan for each laboratory session in advance and come prepared with any additional materials you may need for that session. We expect you to work and think independently. If you are unsure of something, turn first to your lab notes and to your classmates for information, rather than to your TA’s.

Lab evaluation (25% of your PSYC 270 mark)
- Homework (7%)
- Sheep Brain Quiz (5%)
- Scientific Paper (13%)

Missed Labs and Late Assignments:
You are responsible for attending all labs, and will not receive credit for content that you have missed. The only exception is for validated medical reasons, in which case you must email your TAs within 24 hours of the missed lab and provide medical documentation. If you missed the sheep brain quiz due to medical reasons, the make-up evaluation will consist of an oral exam. Late papers will be deducted 10% of the total paper grade per day late. Late homework assignments will not be accepted.
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<td>Sept 18/20</td>
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<td>STUDY FOR QUIZ&lt;br&gt;Lab manual, Chapters 2</td>
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<td>Paper Q&amp;A&lt;br&gt;How to make a research poster&lt;br&gt;Finish scoring if needed</td>
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Chapter 1: LAB INTRODUCTION and FINDING AND READING AN ONLINE JOURNAL

Lab Introduction

Please refer to the lab syllabus page in this manual for this section of the lab

How to Find and Read an Online Journal

Your teaching assistants will show you how to use online tools for querying scientific databases and how to find scientific articles online and in UBC libraries.

During the class, we will locate the primary scientific article from the secondary news article posted on Connect under “Course Content”

Secondary news article from The Atlantic: “How Brain Scientists Forgot That Brains Have Owners”

At home, you will task with finding the following primary journal article and completing the homework posted on Connect briefly after the class ends.


By exploring this article, you will gain a better sense of how to navigate online journal databases and how to orient yourself in a complex scientific paper.

Links to Online Databases

These links use the UBC proxy so you can access full-text articles from home

Google Scholar - https://scholar-google-ca.ezproxy.library.ubc.ca/

Chapter 2: NEUROANATOMY and DISSECTION OF THE SHEEP BRAIN

Other resources
Online guides to the sheep brain:
- http://www.gwc.maricopa.edu/class/bio201/brain/1neuro.htm

Youtube video series about human neuroanatomy by UBC Med:
- http://goo.gl/BkQEgp

Anatomical Directional Terms

Anterior – from Ante (before). Towards front or head. Synonymous with rostral (means beak)
Posterior – from Post (after). Towards back or tail. Synonymous with caudal (means tail)

Dorsal – from Dorsum (back). Think of a shark’s dorsal fin. Up or on top of. Synonymous with superior
Ventral – from Venter (belly). Down, below, or on the bottom. Synonymous with inferior

Medial – from Medius (middle). Towards the midline. Synonymous with nasal (means nose)
Lateral – from Latus (side). Away from midline. Synonymous with temporal (means temple)

Ipsilateral – from Ipsi (self or same). On the same side of the body (e.g., right eye and right ear)
Contralateral – from Contra (against, opposite to) on the opposite side of the body (e.g., right eye and left eye)
For practice, fill out the anatomical direction terms for a human. Keep in mind how a human body is configured compared to a rat (and compared to most other vertebrate animals).
Sheep Brain Sectioning and Visualization

Brains are often sectioned in order to look at different structures within the brain. These sections can be done in one of three ways.

1. **Sagittal sections** divide the brain parallel to the midline. The image below shows a central sagittal section, which cuts directly through the midline.

   ![Central Sagittal Section](image1.png)

2. **Coronal (from corona, “crown”) sections** divide the brain perpendicular to the midline.

   ![Coronal Section](image2.png)

3. **Horizontal sections** divide the brain parallel to the anterior-posterior axis. These are often seen in CT and MRI scans.

   ![Horizontal Section](image3.png)
Notice the similarities between the sheep brain and the human brain in these sections. Many regions have clear similarities because during evolution we shared a common ancestor.

What might we learn about the human brain from studying the sheep or the rat brain?
**Parts of the Nervous System**

**Tract** – a set of axons *within* the CNS, also known as a **projection**. (e.g., if axons extend from the cell bodies in the Ventral Tegmental Area (VTA) to the Prefrontal Cortex (PFC), we would say that fibers “**project**” from the VTA to the PFC).

**Nerve** – a set of axons that connect *between* the periphery and the CNS. (e.g., a nerve may connect between the CNS to a muscle gland, or from sensory organs to the CNS)

**Nucleus** (*pl. nuclei*) – a cluster of neuron cell bodies *within* the CNS (ex. The Caudate “Nucleus” is a region in the brain that is part of the dorsal striatum).

**Ganglion** (*pl. ganglia*) – a cluster of neuron cell bodies, usually *outside* the CNS, as in the sympathetic nervous system.

**Gyrus** (*pl. gyri*) – a protuberance (bump, peak) on the surface of the brain.

**Sulcus** (*pl. sulci*) – a fold or groove that separates one gyrus from another.

**Fissure** – a long deep sulcus.

*Note that these terms are not always used consistently in the historical naming conventions for some brain regions. For example, the basal ganglia, despite using the term **ganglion/ganglia**, refer to a set of structures within the brain. We are unfortunately stuck with these names and exceptions today.*

**Sheep Brain Dissection**

*You must wear latex gloves during this laboratory period. We will supply one pair of gloves for you to use.*

**Procedure**

Pick up the brain. Don't worry, it won’t squish around in your hands, the brain is covered by a tough, durable membrane called the **meninges**.

When identifying lobes and regions on the cerebral cortex, remember that these are general areas. Don't spend too much time looking for clear delineating marks – know the general areas.

Notice that the two cerebral hemispheres are convoluted. The convolutions (bumps) are called gyri. Sulci or fissures separate the gyri. Blood vessels (the thin squiggly, brown-black lines) running through the meninges can sometimes obscure your vision of various sulci. When this occurs, carefully remove the membrane from that area.

Some of the brains will have “glitches” (cuts, nicks, etc.) in the cortex. As long as the glitches aren’t bad or are only on one side, it doesn't matter much for our purposes, since the hemispheres are roughly symmetrical.
Look at the underside (ventral portion) of the brain. At the anterior end you may see two relatively flat, whitish floppy structures, one per hemisphere. These are the olfactory bulbs. (The round cords below them are the olfactory tracts.) They are often lost during processing, but you should be able to see the base of them still attached to the rostral end of the brain.

 Locate the optic chiasm. Posterior to the optic chiasm, you'll find the pons. Identify the portion of the cerebral cortex posterior and anterior to the optic chiasm.

 Posterior to the cerebral cortex, seen in dorsal view, is the cerebellum.

 **Identification of Brain Structures**

 The **cerebral cortex** may be divided into four lobes: the **frontal, temporal, occipital, and parietal**. First inspect the dorsal surface of the brain. Identify the four lobes as well as the **central** and **lateral sulci** (fissures). The central sulcus separates the motor and the somatosensory cortical fields. It traverses the ventral surface of the brain laterally, and is directed at about 60 degree angle to the lateral fissure. The **frontal lobe** is the portion of cortex that lies anterior to the central sulcus and superior to the lateral fissure. The **precentral gyrus** lies directly in front of the central, fissure, and the **postcentral** just behind it.

 Next identify where the **occipital lobe** and the **temporal lobes** are located. The occipital lobe is the most posterior area of the brain. The temporal lobe can be identified as that cortical region lying ventral to the lateral fissure.

 Inspect the dorsal surface of the **corpus callosum** by gently separating the two hemispheres. Be sure you have identified all of the structures in **figure 1** before continuing.

 Ask one of your TAs to section your sheep brain. Your TA will make a **sagittal section** directly through the middle of the corpus callosum. Then, through one half of your sheep brain, your TA will make two **coronal sections**, cutting once several millimetres posterior to the sylvian sulcus, through the middle of the anterior commissure, and again farther posterior in the brain, about midway through the temporal lobe. Even when done correctly, your sections may not reveal all of the structures listed, so check around and examine the sections belonging to other people, or ask a TA.

 Once the sagittal section has been made it will be possible to identify the **corpus callosum**. The cortical gyrus lying above the corpus callosum (including the downward turn of the genu) is the **cingulate gyrus** (cingulum).

 Note that the **precentral** and **postcentral gyr**i extend onto the medial surface of the hemisphere. Identify the **hypothalamus**. A large prominent nucleus, the **mammillary body**, defining the posterior extent of the hypothalamus, can be easily seen. Locate the **optic nerve** and **optic chiasm**. The posterior end of the optic chiasm defines the anterior extent of the hypothalamus.
Identify the primary divisions of the brain stem. The medulla, pons and midbrain can be seen clearly on the medial surface although the divisions between them are not always well defined. The sensory and motor components of the third to twelfth cranial nerves exit and enter. Very careful inspection will allow the interested student to identify most of these nerve roots.

Note the superior and inferior colliculi on the dorsal surface of the midbrain. Identify the rest of the structures seen in figure 2.

Identify the structures seen in figure 3 (a-e). Discuss where the pathways see in figure 4 (a-c) would travel in your sheep brain.

**Functions of major brain structures**

You should know the functions of all the structures listed below.

**Lobes of the cerebral cortex** – Each of the four lobes of the cortex have a wide variety of functions, which include but are not limited to:

- **Frontal lobe** – Impulse control, cognitive flexibility, risk/reward processing, judgment, language, memory, motor function, problem solving, sexual behavior, socialization and spontaneity, attention
- **Parietal lobe** – Integrating sensory information and manipulation of objects
- **Occipital lobe** – Processing of local orientation, spatial-frequency and color properties.
- **Temporal lobe** – Speech/language functions (predominantly in left hemisphere), audition, episodic memory, visual processing, object recognition, face recognition

**Specific regions of the cerebral cortex**

- **Pyriform cortex** – Critical role in olfaction. Analogous to association cortex of the other senses. Links olfactory components with other brain functions.
- **Prefrontal cortex** – Critical role in regulation of cognitive processes such as working memory, cognitive flexibility, and inhibitory control.
- **Entorhinal cortex** – Involved with the medial temporal lobe memory system. Has many reciprocal connections with cortical and subcortical regions.
- **Cingulate cortex (cingulate gyrus)** – Involved in the generation of emotional responses. In the past this was a common target area for lobotomy in psychiatric patients.
- **Motor cortex** – Divided into primary motor cortex, premotor cortex and the supplementary motor area. These areas work together to plan and execute movements.

**Commissures** – Allow for communication between left and right hemispheres

- **Corpus callosum** – The main bridge for communication between hemispheres
- **Hippocampal commissure** – A small portion of each fornix crosses here
- **Posterior commissure** – Made up of fibers originating mainly from thalamic nuclei
- **Anterior commissure** – Part of the olfactory tract crosses here.
**Ventricles** – Interconnected fluid-filled cavities that produce cerebrospinal fluid, which then act to cushion and protect the brain and spinal cord

- **Lateral ventricles** – Found in forebrain. Neurons are produced here during development and in adulthood
- **Third ventricle** – Found in midbrain.
- **Fourth ventricle** – Found in hindbrain.

**Cerebrum (Telencephalon) structures**

- All of the **cerebral cortex** is part of the cerebrum
- **Olfactory bulb** – Important component of olfactory system. Analogous to primary cortex of the other senses. Extracts different components of odors. This information is passed on to the pyriform cortex.
- **Hippocampus (Hippocampal formation)** – A memory centre in the brain. Responsible for spatial memory and navigation, and some types of non-spatial memory such as contextual memory and episodic memory. Damage to this structure produces both retrograde and anterograde amnesia. The hippocampal formation is composed of the following sub-regions:
  - **Dentate gyrus** – Primarily made up of granule cells (excitatory) and basket cells (inhibitory). One of few regions that adult neurogenesis (birth of new neurons) occurs. Neurogenesis in this region has been suggested to play a role in depression.
  - **Cornu ammonis (CA1, CA2, CA3)** – primarily pyramidal cells
  - **Subiculum** – Mostly pyramidal cells
  - Each region may play a different role in memory processing, and their unique functions are an area of active research in neuroscience.
- **Basal ganglia** – A set of nuclei crucial for voluntary motor functions, behavioural routines (including procedural learning and addiction), and plays a role in cognition and emotion. Some of the specific structures include:
  - **Caudate nucleus** – Together with the putamen, forms the dorsal striatum. This region is important for voluntary movement.
  - **Putamen** – Receives input from sensory and motor areas and projects to globus pallidus. Important for some types of reinforcement and motor learning.
  - **Nucleus accumbens** – Receives lots of dopaminergic input from the ventral tegmental area. Involved in motivation and reward processing.
  - **Globus pallidus** – Main inhibitory output from the basal ganglia to thalamus. Also important for posture control.
- **Amygdala** – Responsible for the production of fear and anger related behaviours and involved in fear memories.
**Diencephalon structures**

- **Thalamus** – Relay and integration station for all sensory inputs (except olfactory input) before continuing to cerebral cortex. Sensory and motor inputs are also processed here.
  - *Lateral geniculate nucleus* – One of the many nuclei of the thalamus. It receives visual information from the retina (perhaps cancelling out redundant or unnecessary information) and relays it to primary visual cortex.
- **Hypothalamus** – Responsible for maintaining homeostasis of factors such as blood pressure, body temperature, electrolyte balance, body weight.
  - *Mammillary nuclei* – Appear to play a role in memory formation as their damage produces anterograde amnesia but the exact role is unknown.
  - *Posterior pituitary gland* – Made of axons directly projecting from the hypothalamus, and releases oxytocin and vasopressin into the bloodstream.
  - *Anterior pituitary gland* – Separate gland connected to the hypothalamus by blood vessels, and known as the “master gland” due to its regulation of other endocrine functions. Releases into the bloodstream a range of hormones that regulate the activity of gonads, adrenal glands, thyroid, and adipose tissue.
- **Pineal body** – A small endocrine gland. Contains photoreceptors, and is stimulated by darkness to produce melatonin and this process is inhibited by light. Melatonin plays an important role in maintenance of the circadian rhythm.

**Midbrain (mesencephalon) structures**

- **Superior colliculus** – Part of the visual and auditory system that helps to orient the head to something that is seen or heard.
  - *Inferior colliculus* – Part of the auditory system that integrates sound localization information from different dimensions.
- **Cerebral peduncle** – Descending fiber pathway from the brain to the spinal cord.
- **Substantia nigra** – Neurons here contain the pigment melanin, which gives this region a dark appearance. The substantia nigra synthesizes the neurotransmitter dopamine.
- **Ventral tegmental area (VTA)** – Medial to substantia nigra and rich in dopamine neurons, the VTA is important for cognition, motivation and reward processing.

**Hindbrain (rhombencephalon) structures**

- **Medulla** – Controls vital reflexes (e.g., heartbeat, respiration, vomiting).
- **Cerebellum** – Important for motor coordination and procedural memory.
- **Pons** – Consists of fibers from the cerebellum crossing from left to right hemispheres.
- **Reticular formation** – A distributed set of numerous small nuclei. Involved in maintaining wakefulness and sleep. One sub-region is the *raphe nuclei* (dorsal raphe), which releases serotonin to other regions of the brain.
Fiber Tracts

- **Optic chiasm** – Location where part of each optic nerve crosses to the other side of the brain. This cross means the left visual field is processed in the right side of the brain and the right visual field in the left.
- **Optic tract** – Segment of the optic nerve that connects the optic chiasm and the lateral geniculate nucleus. Carries visual information from the retina.
- **Olfactory tract** – Responsible for transmission of olfactory information from the olfactory bulbs to primary olfactory cortex.
- **Fornix** – Fibre bundle that connects the hippocampus with the mammillary nuclei and the septal nuclei.
**Figure 1a:** Outer surface of the sheep brain, dorsal view

- Lateral (Sylvian) sulcus
- Cruciate fissure (Central sulcus)
- Occipital lobe
- Parietal lobe
- Temporal lobe
- Frontal lobe
- Superior Frontal Sulcus
- Longitudinal fissure

**Figure 1b:** Outer surface of the sheep brain, ventral view

- temporal lobe of the cerebral cortex
- optic chiasm
- cerebral peduncle
- cerebellum
- pons
- medulla
- abducens nerve (6th CN)
- trigeminal nerve (5th CN)
- parahippocampal gyrus
- pituitary gland
- frontal lobe of the cerebral cortex
- olfactory tubercle
- olfactory bulb
Figure 2: Inner surface of the brain, mid-sagittal view

Figure 3: Coronal sections of the brain, from anterior to posterior end

Figure 3a: Most anterior view
Figure 3d: 

Figure 3e: Most posterior view
Chapter 2-Part 2: HUMAN BRAIN ANATOMY

Figure 1a: Outer surface of the human brain, dorsal/superior view
Figure 1b: Outer surface of the human brain, ventral view

Figure 2: Inner surface of the brain, mid-sagittal view
Figure 3: Coronal sections of the brain, from anterior to posterior end

Figure 3a: Most anterior view

Figure 3b:
Figure 3e: Most posterior view

- Lateral Ventriles
- Cerebellum
- Dentate Nucleus
- Tonsil
- Medulla
- Inferior Vermis

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Chapter 3: PARTS OF A SCIENTIFIC PAPER

Scientific Writing

While there are many different formats used to write a scientific paper manuscript (such as the APA style, which you will learn about later), all of these formats follow basic rules for scientific writing. Below is the typical order for a research paper:

- Title Page
- Abstract
- Body
  - Introduction
  - Methods (Subjects/Participants, Materials, Procedure, Data analysis)
  - Results
  - Discussion
- References
- Tables
- Figures and Figure Captions

Title Page

A title should indicate the general research problem area, include some clue about the research method, and give direction of the effect. For example, "Estradiol increases neuron production in the hippocampus of adult rats" (Ormerod & Galea, 1999). A title should also be short and concise. For Psyc 270, the title of your lab paper should be 12 words or less.

Abstract

The abstract is a short summary of the paper. This lets others read the abstract in order to determine whether the paper contains any information that may be useful to them. The abstract should provide the following information:

1) Kind of problem being investigated
2) Hypothesis
3) Subjects (species, age, sex, strain, number)
4) Description of the experimental procedure
5) Major results and whether they reached significance
6) Major conclusions drawn from the research

For Psyc 270 the abstract of your lab paper should be 200 words or less.
Introduction

The introduction makes a logical argument for performing the study. It describes past studies and existing knowledge in the area, and how past research led to the present hypothesis. The introduction starts with a general idea to engage the reader and ends with a precise statement of the hypothesis and specific predictions.

Flow is very important, not just in this section, but throughout your paper. The introduction should logically show how the described study evolved from previous knowledge in the area. This is usually done either by addressing a knowledge gap that exists in the literature, OR highlighting a methodological problem with a type of study done in the past. Ensure your points are connected and your argument is a logical flow of ideas.

All of the information included in your introduction must relate to your research question. Avoid unrelated and redundant tangents, but make sure to provide enough information to your audience.

Methods

The methods allows other people to understand and replicate the experiment. This lets scientists to verify the results, compare the experiment with others that may have produced conflicting findings, and develop new studies based on the current one. All of the relevant details of the procedure should be described.

The method section is divided into subsections, usually with the subheadings 'subjects', 'materials', and 'procedures' (though other configurations are also seen). Some of the required information include:

Subjects
- Species, strain
- Sex, age or weight
- Sample size
- Housing conditions (container, bedding, food and water, light cycle, etc.)
- Prior research experience (exposure to drugs/hormones, testing/training, surgeries)
- Statement about ethical treatment of animals

Materials
- Drugs and hormones (include supplier)
- Testing chambers or apparatuses (include supplier)
- Equipment in surgeries, injections, and other treatments
- Other equipment and supplies used

Procedures
- Description of surgeries, injections, and other treatments
- Description of testing (including timing of testing relative to manipulations)
- Any other details about data collection
Data Analysis:
- Any data manipulations done post data collection (ie. any calculations done or composite scores created)
- All statistical tests used
- Alpha level used for assessing significance

The methods section should also contain information about how subjects were organized into groups, why the drugs and tests used were selected (if not already covered in the introduction), details about the experimenters (where they trained, blind to study conditions, etc.), and how the behaviours of interest were measured (“operationalized”).

Results

The results describe what was found in the experiment. The description should be complete enough to allow the reader to examine the data and draw their own conclusions.

One possible format:
1. Describe or summarize the data using descriptive statistics. Tables, figures, and/or descriptive statistics should be referred to.
2. Provide the results of inferential analyses. Name and present the calculated values of any statistical tests, indicating whether the results were significant and the probability levels obtained.
3. Report any important observations that were not captured by the numerical results.

Statistically significant findings should be reported before non-significant findings, but all statistical comparisons regardless of significance should be reported. Tables and figures should be used to support, rather than duplicate, any information presented in the text. In comparison with tables and figures, the results narrative can be the most useful for describing the direction and significance of key comparisons and analyses. The results section should not provide any theoretical interpretations or any other discussion/evaluation of the data.

Discussion

The discussion fits the results of the experiment into the bigger picture by interpreting and evaluating the results of the research. It allows the experimenter to select, emphasize and interpret the findings in the way that he/she feels is most informative. This section starts specific (i.e. the described experiment) and ends broad (including suggestions for future experiments).

One possible organization:
1) Very briefly review the experiment and results.
2) Describe whether the results supported the hypothesis.
3) Compare the current results to previous studies.
4) Discuss if your study has any implications for our broader understanding of this topic.
5) Discuss the implications of the study to solve real-world problems.
6) Describe potential confounds and limitations in the current study.
7) Suggest future studies or research questions that have arisen from your findings.
References

The references list the full information of all the citations made in the paper. It lets readers know where the background information can be found, allows verification of any claims you make, and provides acknowledgement to researchers who you based your work on.

Tables and Figures

Tables and figures visually organize and display results to facilitate communication of the results. All tables and figures should aid in the presentation of the data but **should not be redundant** with the results section.

Tables

Tables are useful for providing a large volume of information quickly. It is often useful for presenting information that can be skimmed fairly quickly, but can make the most important findings harder to identity. If tables are used, they should be given an informative title and have clear labels for columns and rows. Enough lines/dividers in the table should be used so that the reader does not get lost, but avoid using too many lines as that reduces readability.

Figures

Figures are useful for proving a visualized presentation of findings. They are often useful for communicating the most important aspects of your results (your primary dependent variables), though figures take up a lot of space and too many detracts from their impact. If figures are used, they should be clearly labeled (groups, axes names and increments), have easily distinguishable lines/bars, and provide information on central tendency and variability.

Each figure should have a figure caption (or legend). Figure captions should provide information on the subjects (species, strain, sex), sample size, test/apparatus used, and group treatment conditions. Captions should also note if a reported effect is statistically significant.
Chapter 4: APA STYLE for CITATIONS AND REFERENCES

All academic journals have guidelines that must be followed for a paper to be considered for publication. In this lab, we will follow the American Psychological Association (APA) format. Note that we do not necessarily think that the APA format is the end all, be all of publishing style. Rather, the goal is to teach you how to following a standardized format. As you go on to do more research, you will find that journals will differ in the specific style they require, but all of them will require that you are able to follow instructions on style carefully and effectively.

We will present the most important aspects of APA style below; however, the information may not necessarily be exhaustive. You should refer to the Purdue University Online Writing Lab (https://owl.english.purdue.edu/owl/resource/560/01/) and the Sixth Edition of the Publication Manual by the American Psychology Association for more information. The APA Manual is available at the UBC Library, and the TAs have a copy that can be used for reference when you are in class (please let TAs know ahead of time).

Page Layout

Title Page
  - (Running head (max 50 characters), Title, Name, Affiliation)
Abstract (started on a new page)
Body (started on a new page)
  - Introduction
  - Methods (Participants, Materials, Procedure)
  - Results
  - Discussion
References (started on a new page)
Table(s) and Figure(s) (started on a new page)
Table and Figure Caption(s) (use a separate page for each figure)

Spacing and Font

All text on your manuscript must be typed, double-spaced, and with 1 inch (2.5cm) margins on all sides. The text should be in 12 pt. Times New Roman.

Writing Tense

In general, your writing should be in third person and in past tense. However, there are a few exceptions and further details. Note that we didn’t come up with these rules.

1. When discussing generally well-known or general findings, particularly in the introduction and discussion, you should use present tense. E.g., “The hypothalamus is involved in fight or flight responses.”
2. When discussing recent findings or specific results, you should use past tense. E.g., “The previous study found that THC exposure reduced depression symptoms.”
3. Methods and results should be in past tense. E.g., “There was a significant difference between males and females in depressive behaviours at baseline.”

4. When you present your research approach, hypothesis, and predictions, you should use future tense. E.g., “The current study will use the forced swim test to examine depression-like behaviours.”

Abbreviations

You may use abbreviations for terms that appear three or more times in the text of the manuscript. The first time you use a term, it must be written out in full with the abbreviation in parentheses. From that point on, use the abbreviation. E.g., “Subjects received 10 g of estradiol benzoate (EB)... In the second experiment, subjects were given 5 g of EB.”

Running Head and Page Numbering

The running head is a capitalized shortened version of your title (limited to 50 characters or less). It is written in the upper left hand corner of every page. Only on the title page proceeded by “Running Head:”

Page numbers are put in the upper right hand corner. All pages, including the title page, must be numbered.

Subtitles

The subtitle for the introduction should be the title of the paper, in italics (i.e., not “Introduction”). Subtitle for other body sections should be bolded and centered on the page. Second level subtitles such as Participants, Materials, Procedure should be bolded and aligned with the left margin.

References

In the reference section, references are listed in alphabetical order. Each reference follows the format below:


(Note: Make sure to note the spacing and italics. The italicized “7” refers to the volume number and the 3 in the brackets is the issue number)


If there are greater than 7 authors write the first 6 names, then use an ellipses, then end with the last author’s name.

Citations

You must also cite information throughout your text (known as in-text citations). These can either be written into the sentence or tact on the end. Please refer to the examples below:

It has been shown that X prevents Y when you have Z in the J (Abtruse, 1983; Obscure, Marvelous, & Odd 1976).

(Note: if you have multiple sources list them in alphabetical order and separate them by semicolons)

According to Obscure, Marvelous, and Odd (1980), two Z’s in the J do not make a Y.

Obscure et al. (1980) neglected to investigate that two Z’s in the X do make a Y.

Our findings do not support previous research, which indicates that two Zs cannot make a Y (Obscure et al., 1980).

If an article has 2 authors, every time you cite the article you must name both authors. If an article has between 3-5 authors the first time it is cited all authors must be named. However, all subsequent citations you write the first authors name followed by “et al.”

Perverse et al. (1980) have provided evidence that you can J a Y.

If there are greater than 5 authors, only include the first author with “et al.” followed by the date, even if it is the first time citing that source.

Tables and Figures

Do not insert your tables and figures into the body of your paper, but place each figure/table each on a separate page after the reference section. When talking about them in the body of the paper, refer to them by their figure/table number (E.g., Figure 1, Table 1, etc.). All figures and tables you include must be cited in the body of the manuscript.
Tables: Follow the general format below that was retrieved from Purdue OWL:

<table>
<thead>
<tr>
<th>Breed</th>
<th>Male</th>
<th>Female</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dachshund</td>
<td>123</td>
<td>234</td>
<td>17.6</td>
</tr>
<tr>
<td>Terrier</td>
<td>456</td>
<td>567</td>
<td>31.1</td>
</tr>
<tr>
<td>Siberian Husky*</td>
<td>789</td>
<td>891</td>
<td>51.3</td>
</tr>
<tr>
<td>Totals ($N=3060$)</td>
<td>1368</td>
<td>1692</td>
<td></td>
</tr>
</tbody>
</table>

Note. Average score = 150. No animals were harmed during testing.

*Three huskies (one male, two female) escaped before testing was completed and are therefore not included in the table.

Figures: It is important to choose the best type of graph for conveying the type of data (line graphs for continuous, bar graphs for groups, etc.). The graph should be easily readable, clearly show central tendency and variability (i.e., error bars), labeled axes, and highlight any significant differences. There should be a minimum of other lines and borders not required to convey this information.

Figure captions: Figure captions go on a separate page and describe the figure fully so that others can understand the figure without needing to go to the rest of the paper. This means stating the variables measured in the graph, meaning of lines and bars, subjects and manipulations, significance of effects, and key for any symbols used.
Chapter 5: STATISTICAL TESTING

Statistics

In a “real” animal study, you might have upwards of 100 subjects with tens of variables. In a “real” human study, you might have hundreds to thousands of subjects with hundreds of variables. That’s a lot of information! It is certainly more than most people can figure out from a visual inspection. Therefore, the first role of statistics is for us to describe our data quickly in a way that’s easily understood — this is known as descriptive statistics.

After you have described your data, you might be interested in the patterns in your data and whether those patterns can be generalized to the population. For this, you will need inferential statistics.

Descriptive statistics

Central tendency
One thing you might be interested in when you look at a set of numbers is the “average” of those numbers. For example, your course grades might range from C- to A+, but people (e.g. the med school entrance committee) will need a single number to describe your academic standing. This is what a measure of central tendency is — some representation of the “average” of your data. Here are the common measures of central tendency:

Mode – The mode is the most common value in your data set.

Median – The median is the numerical central value of your data set.

Mean – The mean is the value that has the minimal overall distance from all data points in your data set.

Equation for the mean:

\[
x = \frac{1}{n} \sum_{i=1}^{n} x_i
\]

For example, in the following data set:

1, 3, 3, 3, 5, 5, 7, 8, 9, 9

Mode = 3, Median = 5, Mean = 5.3

For reasons that are beyond the scope of this course, the mean is the most commonly used measure of central tendency. All the other measures and tests we will discuss in this section are based on using the mean as the measure of central tendency. For Psyc 270, you should use the mean as the measure of central tendency.
Variability

After you know the central tendency of your data, you might be interested in the “spread”. For example, if you scored 80%, 65%, and 95% on the exams in this class, that is different from someone who scored 80%, 80%, and 80% (even though the means are the same). Here are the common measures of variance:

**Standard deviation** – The standard deviation is the average difference from each data point to the mean of your data set.

Equation for the standard deviation of a sample:

\[ S = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2} \]

**Variance** – Variance is the standard deviation squared.

**Standard error of the mean (SEM)** – SEM is the standard deviation divided by the square root of the sample size.

Equation for the SEM:

\[ SEM = \frac{S}{\sqrt{n}} \]

Each measure of variability is conceptually important and are needed in different situations, but a discussion of that is beyond the scope of this course. For Psyc 270, you need the standard deviation for your statistical tests, while the SEM should be reported to tables and figures.

Inferential Statistics

Inferential statistics makes use a variety of tests, which are useful for different types of data and for uncovering different types of patterns. For Psyc 270, we will focus on one of the most basic patterns – mean differences between two groups. Specifically, we are interested in whether or not there is a consistent difference between the means of two groups.

Hypothesis testing

To conduct statistical tests for differences between two groups, first we need to have a basic understanding of hypothesis testing.

Let’s say we are interested in whether Science students (group 1) differ on average in intelligence (IQ scores) compared Arts students (group 2). First, we’ll need to create our statistical hypotheses:

**Null hypothesis** – \( H_0 \): “Science and Arts students have the same mean on IQ”

**Alternate hypothesis** – \( H_1 \): “Science and Arts students have different means on IQ”
In traditional statistical tests, we are trying to find evidence to disconfirm the null hypothesis, which would therefore lend evidence to the alternate hypothesis. We cannot directly confirm or “prove” the alternate hypothesis.

Once we have our hypotheses, we collect data and calculate descriptive statistics. Their means and standard deviations are:

Science students: 115 ± 10  
Arts students: 110 ± 15

What we see is that not all Science students have the same IQ, and not all Arts students have the same IQ. There is variability in IQ within each group. We also find that there is a small difference in IQ between the two groups.

Given that there is variability *within* each group, how do we know if there is a mean difference *between* the two groups? In other words, is the difference between Science and Arts students because Science students are actually more intelligent than Arts students, or because of random chance (e.g., we accidently sampled the smart people in Science and the not-smart people in Arts)?

We can *never* know for certain whether the difference we see is due to chance or because it reflects a real difference between the two populations. We can only determine the *probability* that the difference we see in our sample reflects a true difference between Science and Arts students, versus being due to random chance.

In science, we tend to reject the null hypothesis if we think that there is a 95% (or greater) chance that a difference between groups in our sample is due to a real difference in the populations. In other words, when we do reject the null hypothesis, there is a 5% (or less) chance that the two populations means are actually the same and we have rejected the null hypothesis incorrectly. This is known as setting the *alpha level* to .05. To find if in our analysis there would be a less than 5% chance of it being incorrect to reject the null hypothesis (in other words, if the difference we see has a $p < .05$), we can use the independent samples *t*-test.
Independent samples t-test

Equation for the independent samples t-test:

\[
t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left( \frac{\sum x_1^2}{n_1} + \frac{\sum x_2^2}{n_2} - \frac{(\sum x_1)^2}{n_1} - \frac{(\sum x_2)^2}{n_2} \right) \left( \frac{1}{n_1} + \frac{1}{n_2} \right)} \sqrt{n_1 + n_2 - 2}}
\]

We also need the degrees of freedom, which is calculated as:

\[df = n_1 + n_2 - 2\]

Note that the concept of degrees of freedom is complex and beyond the scope of this course.

Once we have both \(t\) and \(df\), we can use the \(t\) to \(p\) conversion table. Since we set the alpha level to .05, use the \(p < .05\) column of the table. If the calculated \(t\) value is greater than listed \(t\) value, then we can state for our analysis, there is only a 5% (or less) chance that rejecting the null hypothesis would be incorrect. Therefore, we can state that we have a significant difference, that we can reject the null hypothesis, and that we have provided support for the alternate hypothesis.
### t-test t to p conversion table:

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>Probability, p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>1</td>
<td>6.31</td>
</tr>
<tr>
<td>2</td>
<td>2.92</td>
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<td>1.66</td>
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<tr>
<td>∞</td>
<td>1.65</td>
</tr>
</tbody>
</table>
Effect size & Cohen’s $d$

So now that we know there is a significant difference between the two means and we can reject the null hypothesis. But we might ask whether that difference is a big difference. This is what is characterized by effect size.

Equation for the Cohen's $d$ effect size for t-tests:

$$d = \frac{x_1 - x_2}{s}$$

where:

$$s = \frac{n_1s_1^2 + n_2s_2^2}{n_1 + n_2}$$

This statistic describes the mean difference with standard deviation as units. For example, $d = 2$, it means that the difference between group 1 and group 2 is two standard deviations in size. Generally, in animal behavioural research, $d > 1$ is generally considered a large effect size, while in human research, $d > .6$ is generally considered large. However, these are more or less arbitrary, and the how “big” is “important” depends entirely on context.

Reporting statistics

When we report statistics in APA style for t-tests:

If significant difference:
$$t(df) = t_{calc}, p < .05, d = d_{calc}$$

If non-significant difference:
$$t(df) = t_{calc}, p > .05, d = d_{calc}$$

Example:
Science students had significantly higher mean scores on IQ than Arts students, $t(18) = 2.14, p < .05, d = 1.5.$
Chapter 6: EXPERIMENTAL DESIGN

Goals of science
There are many goals in science. They include:
1. Description (e.g., what behaviours are associated with stress?)
2. Prediction (e.g., what stimuli will make lab rats become more stressed?)
3. Explanation (e.g., what is the functional purpose of stress behaviours?)
4. Manipulation (e.g., what can we do to help people reduce their stress levels?)

Scientific method
The scientific method is the way through which science achieves the above goals. A basic outline of the process is below (image from Wikipedia).
Ask a question
Science starts with a question. This question can be profound (e.g., how does consciousness work?), or idiosyncratic (e.g., how does yawning work?). It can be focused on understanding the world (e.g., why do humans like psychoactive drugs?) or solving a practical problem (e.g., how can we effectively treat drug addiction?). You might draw inspiration for questions from all sources, like previous research, a practical problem, a mandate given by an employer, a situation you encountered in your life, or your own curiosity.

Do background research
Background research is crucial in allowing the scientist to understand what has already been explored within an area of research in order to make a meaningful hypothesis. There must always be a logical train of thought that bridges what is known about the question, to the unknown, which you are testing. Isaac Newton said it best: “If I have seen further, it is by standing on the shoulders of giants.”

Construct a hypothesis
Constructing a hypothesis means taking the big picture question you started with and creating a smaller, testable question. You’ll often have to narrow things down to one specific facet. You will also have to understand the existing literature so that your hypothesis addresses a topic that is still not fully understood, but also not so far from what has been done that it has no connection with anything else. A good hypothesis should also be clear, so that it can be unambiguously discriminated from alternative hypotheses.

Create the experiment
There are several factors to consider when you design the experiment that will test your hypothesis.

Participants/subjects
You first must decide what is the most appropriate population to sample from. This can include deciding between animal versus human studies. If you decide on an animal study, you’ll need to think about which laboratory animal (e.g., rat, mouse, finch, nematode, etc.) is most relevant to the phenomenon you are interested in, and is more easy to use for the independent and dependent variable you are interested in. You must also think about how to divide your subjects into groups, so that they can receive different levels of the independent variable.

Independent variable
The independent variable is the one that you are manipulating in your experiment. All other variables should be same between groups. For example, if your hypothesis is that new Drug X will be effective for treating schizophrenia, your independent variable will be what drug a group receives, such as Drug X, an existing drug, or a placebo. All other variables, such as age and gender, should be the same between all groups.
**Dependent variable**
The dependent variable is the outcome variable that you are interested in. It should be easily measured in an objective and precise manner, so that it can be interpreted with less bias. Selecting the best dependent variable depends on the goal and hypothesis of your study. In the above example, your dependent variable might be a psychiatrist’s rating of schizophrenia symptom severity, the patient’s rating of quality of life, an fMRI scan of brain function, etc.

For animal studies, the dependent variable is often in the form of a specific test or activity. For example, in this lab, your paper will be based on the Morris Water Maze (MWM), a test of memory. Within this larger test, there are individual dependent variables to be examined. For example, the MWM measures of “latency”, which is a measure of how quickly the animal finds its target, and path length, which is how far the animal travelled in the test. Each of these dependent variables are interpreted differently and tell us different things about the subject.

**Control groups**
A control group allows you to tell that any differences you see (in the dependent variable) are due to differences in the independent variable, as opposed to other factors. A control group is almost identical to an experimental group, but it does not receive the “treatment”. In the above example, if both the group receiving Drug X and placebo are of the same age and gender, then you know that any differences in schizophrenia symptoms between the two groups are not due to the effects of age or gender but probably due to the drug. In this way, age and gender are “controlled for” by your study design.

**Interpretation**
Once you have designed and conducted your study, and analyzed the results, you can interpret the findings and decide if the data do or do not support your hypothesis. When designing your study, it is important to think about how you might interpret any findings you receive and make sure you are able to answer if your hypothesis is supported based on this.

**Iteration**
If your hypothesis was not supported by your findings, it is important to revisit your hypothesis and think about what happened. Was your hypothesis incorrect, or in need of some revision? Perhaps a new hypothesis needs to be made and tested in the future. It is also possible that the study you designed had weaknesses or flaws that caused it to produce unexpected results. If your finding did support your hypothesis, it is important to think about whether your findings generalize to all situations. For example, a different group of subjects (e.g., rats vs humans, men vs women, Canadians vs Japanese) might show different patterns. It is also important to think about whether there are any limitations (i.e., anything that is still unknown or cannot be addressed by the study) or confounds (i.e., anything that you failed to control for that might have made a difference).

Hypotheses which are repeatedly supported by data from experiments and other scientific studies may come be regarded as a “theory” or “law”. This ultimately helps with describing, explaining, predicting, and manipulating the universe.