# LABS 4 & 5: CLASSICAL CONDITIONING

## BACKGROUND

Classical conditioning is the form of learning that results when two stimuli occur reliably in sequence so that the first stimulus predicts the occurrence of the second. Usually, the stimuli have differing degrees of biological importance to the organism, with the less important stimulus coming before the more important stimulus. Many of the phenomena of classical conditioning were first described by the Russian physiologist Ivan Pavlov and his associates, who were the first to systematically explore this form of learning (Pavlov, 1927).

In classical conditioning, the stimulus that comes first in the temporal sequence has the potential to develop into what is called the **conditioned stimulus (CS)**, and the stimulus that comes second is called the **unconditioned stimulus (US)**. The US initially possesses the capacity to elicit an obvious, easy-to-measure response called the **unconditioned response (UR)**. The CS is a novel/neutral stimulus that initially elicits little or no response at all, but after being paired with the US, it comes to elicit a response.

The **classical conditioning *acquisition* procedure** consists of repeatedly presenting the CS shortly before the US. As a consequence of this repeated pairing of the two stimuli, the CS gradually acquires the capacity to elicit a new learned response, which is called the **conditioned response (CR)**. Often, but not always, the CR resembles the UR in the sense that the CR consists of certain components of the UR. When a response component that occurs in both the CR and UR is measured quantitatively, the response magnitude in the CR is usually smaller.

In their early experiments, Pavlov and his associates used food placed in the mouths of food-deprived dogs as the US. Food in a hungry dog's mouth elicits salivation, chewing and swallowing as a UR. Pavlov's group used various medium-intensity sounds, lights, and tactile stimuli as CS's, *none of which had any initial tendency to elicit a response resembling the UR to food*. When repeatedly paired with food presentation, all these CS's gradually acquired the capacity to elicit salivation. During the more than 90 years since Pavlov first reported his findings, thousands of classical conditioning experiments have been performed, employing dozens of different species and a wide variety of different stimuli as US and CS.

## THE CONDITIONED EMOTIONAL RESPONSE (CER)

Sniffy Pro simulates a form of classical conditioning called the **conditioned emotional response (CER) or conditioned suppression,** which was first described by Estes and Skinner (1941). In this procedure, a rat is first trained to bar-press for food reinforcement on a schedule of reinforcement that produces steady responding (such as a moderate-sized Variable Ratio schedule). The rat's steady response rate is then used as a baseline against which to measure the effects of presenting stimuli. Thus, the defining feature of CER is that it is a comparison of the animal's pre-stimulus behavior to its post–stimulus behavior.

Sudden, very loud sounds and electric shocks delivered to a rat's feet are stimuli that intrinsically possess the capacity to *interrupt* a rat's steady bar pressing. The rat jumps when the loud sound or shock occurs and then freeze (remaining very still). Thus, loud sounds or shock can be used as US's to produce freezing as the UR. In contrast, less intense sounds and lights initially have little or no effect on a rat's bar press behavior. For this reason, these stimuli can be used as the CS's.

The **conditioning procedure** consists of turning on the stimulus that is serving as the CS for a period of time before briefly presenting the US. Usually, the CS and US terminate simultaneously. In different experiments, the period of time during each trial when the CS is presented by itself typically ranges between 30 and 120 seconds (Domjan, 1998; Mazur, 1998). The duration of the US is usually 1 second or less. As a consequence of pairing the CS with the US, the CS gradually acquires the capacity to suppress bar-pressing on its own. That is, even without the US, the rat eventually stops bar-pressing in response to the CS.

Over the past 20 years or so, the CER has become the form of classical conditioning that North American psychologists most commonly study. There are probably two main reasons for this popularity. First, the CER provides an experimental preparation for studying the acquisition of a very important and interesting response - fear. Second, because the entire process of presenting stimuli and collecting data can be fully automated, the CER is a very convenient form of classical conditioning to study.

**THE SUPPRESSION RATIO AS A MEASURE OF THE CONDITIONED RESPONSE**

To measure the CR to the CS in CER experiments, psychologists employ a response measure called the **suppression ratio**. The basic idea behind the suppression ratio is to compare the rate of bar pressing (the number of bar presses per minute) during the CS (Rate During CS) to the rate of bar pressing during the period of time immediately preceding presentation of the CS (Rate Pre CS). If the CS elicits no fear response, the number of bar presses during these two time periods (During CS and Pre CS) should be about equal. However, if the CS suppresses bar pressing (i.e., if there IS a conditioned response), then bar presses *during* CS will be less than bar presses *pre-CS*.

To get a quantitative measure of suppression of bar pressing in response to the CS, the suppression ratio is expressed as the ratio between the Bar Presses During CS and the sum of Bar Presses During CS plus Bar Presses Pre CS.

Written as an equation, the suppression ratio is defined as:

$$\textbf{Suppression ratio} = \frac{\textbf{Bar Presses During CS}}{\textbf{Bar Presses During CS + Bar Presses Pre-CS}}$$

Here is how this equation works: If presenting the CS *does not affect* the animal's bar pressing (if Bar Presses During CS = Bar Presses Pre-CS), then the denominator of the fraction will be twice as large as the numerator; and the suppression ratio will be 0.5. However, if the CS suppresses bar pressing so that the rat presses less during the CS than during the Pre-CS period, the suppression ratio will be less than 0.5; and if the rat doesn't press the bar at all during the CS, the suppression ratio will be zero.

In a CER experiment where the CS is being paired with an *aversive US*, Bar Presses During CS should never (except by chance) be greater than Bar Presses Pre-CS, so that the suppression ratio should generally be less than or equal to 0.5. On the first training trial (before the animal has experienced the US), the Suppression Ratio should be about 0.5. Then as conditioning proceeds, the value of Suppression Ratio should decline until it eventually levels off at an average value less than 0.5.

In sum:

- Baseline responding (1st trial) → suppression ratio = 0.5
- no effect of CS (Pre CS = CS) → suppression ratio = 0.5
- CS suppresses bar pressing (Pre CS > CS) → suppression ratio < 0.5
- no bar pressing (maximum suppression) → suppression ratio = 0.0

The suppression ratio should always be 0.5 or less in a CER experiment with an aversive US.

With real rats and in the Sniffy Pro program, CER conditioning is rather rapid. The suppression ratio usually levels out at a minimal value after 10 or fewer CS/US pairings. The Sniffy Pro program compares the number of responses that Sniffy makes during the 30 seconds preceding each CS presentation with the number of responses that he makes during the 30 seconds that each CS lasts.

The US that the Sniffy Pro program simulates is electric foot shock delivered through the parallel metal bars that form the floor of Sniffy's operant chamber. Shock duration is always 1 second. Shocking Sniffy immediately interrupts his bar-pressing performance. He jumps and then freezes. When he begins to move around again, bouts of freezing are interspersed with bouts of grooming and exploratory behavior. After a few minutes, the effect of the shock wears off, and he returns to bar pressing.

**Unconditioned Stimulus**

In the Sniffy Pro program, the shock **US** has **three levels of intensity**: low, medium, and high. Sniffy's initial reaction to shocks of these three intensities is the same. The first time he is shocked, Sniffy will not take any longer to return to bar pressing after receiving a high-intensity shock than after receiving a low-intensity shock. In every case, after receiving an initial shock, Sniffy will require about 2 minutes before his rate of bar pressing returns to its normal, pre-shock level. However, his reaction (measured as the duration of suppression) to *repeated* stimulation is different for the three shock levels:

- Sniffy's UR to the low-intensity shock is likely to habituate. As the number of shocks that he has received increases, his reaction to the low-intensity shock may gradually decrease. (After receiving about 25 low-intensity shocks, Sniffy may no longer react to them at all. He may just keep pressing the bar.)

- The duration of Sniffy's UR to the medium-intensity shock likely never changes no matter how many shocks he has received. Therefore, the medium setting is the one you should use except in experiments where you *want* Sniffy's UR to change.

- Sniffy's UR to the high-intensity shock is likely to sensitize. As the number of shocks he has received increases, his reaction (duration of suppression of bar-pressing) to the high-intensity shock may gradually increase. (After receiving about 25 high-intensity shocks, Sniffy will take about twice as long to return to bar pressing at the normal rate.)

  **Important:** ***note that the above refers only to the reaction to the US. These are not meant to describe your experimental hypotheses.***

**Conditioned Stimulus**

The Sniffy program simulates **three different kinds of CS**: a light, a tone, and a bell. The light and tone can be presented at **three different intensity levels**: low, medium, and high. The duration of the CS is always 30 seconds. On trials when the CS is paired with the US, the US (shock) occurs during the final second of the CS (short delay conditioning procedure). In other words, the onset of the CS always precedes the onset of the US by 29 seconds. (All of these times refer to Sniffy Pro program time).

***None of the CSs initially has any effect on Sniffy's bar-pressing performance*.** Neither the tone, the light, nor the bell is intense enough to have any tendency to act as a US capable of suppressing bar pressing. However, when a CS is paired with the shock US, the CS gradually acquires the capacity to suppress bar pressing as a CR. When he is fully conditioned, Sniffy will begin showing bouts of freezing, grooming, and exploratory behavior soon after the CS comes on.

**SET UP A CLASSICAL CONDITIONING EXPERIMENT**

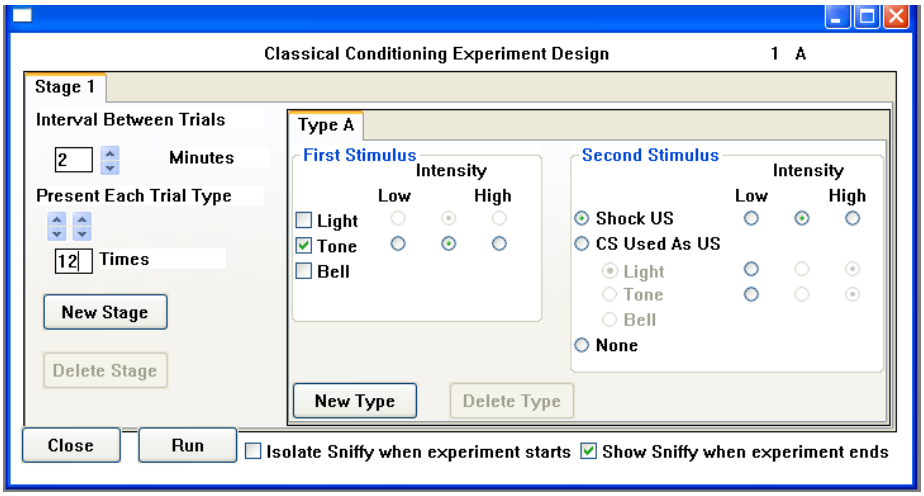
As noted earlier, one of the reasons for the CER's popularity with North American researchers is the fact that all aspects of CER experiments can be automated. A computer controls the presentation of stimuli, records the rat's bar-pressing responses, and computes the suppression ratio. The Sniffy Pro program provides you with a simple interface that enables you to set up and run a wide variety of classical conditioning experiments. Like a psychologist in a research lab, you will set up the experiment and then let your computer perform the experiment and collect the data.

Classical conditioning experiments consist of one or more **stages** (made of trials), and there may be one or more **trial types** within a stage.

- ❖ A stage is a group of trials
- ❖ There is no overlap of stages – a new one does not begin before the preceding stage is complete.
- ❖ Each stage may have one or more trial types
- ❖ A trial type defines a stimulus event – a trial type is denoted by the type of stimulus used. A trial is one CS/US pairing (i.e., one presentation of the tone and one presentation of the shock).
- ❖ Within a stage with multiple trial types, the trials occur in random order during the stage; each trial occurs an equal number of times.

In other words, imagine that you run an experiment in which Sniffy gets 10 trials during which the tone CS is paired with the shock US and 10 trials during which the tone CS occurs without the US. If you define the two kinds of trials as belonging to different stages of the experiment, Sniffy will receive a block of 10 trials of one kind followed by a block of 10 trials of the other kind. If you define the two kinds of trials as different trial types within the same 20-trial stage, the two kinds of trials will be randomly intermixed with each other.

THE DESIGN CLASSICAL CONDITIONING EXPERIMENT DIALOGUE BOX




**OVERVIEW OF THE CLASSICAL CONDITIONING PROCEDURE**

The following is an overview of how the classical conditioning procedure works. Specific instructions for our lab procedure are included later in this doc. Please refer to the section titled "Specific Settings for Labs" page during lab.

- In the **Stage section of the dialogue box**, the highlighted number after Stage indicates which stage of the experiment you are currently viewing. The default setting is Stage 1. We are only using Stage 1. You should not use Previous Stage or Next Stage.

- You specify the *average* time between trials for the current stage by typing a number into the Interval Between Trials text box. Intervals between trials are measured in minutes. Remember that you are specifying the *average* interval between trials. The actual intervals vary from trial to trial so that Sniffy cannot learn to anticipate when the next CS is going to occur.
    - *For these labs, we will be using a 2-minute between-trial interval.*

- The number that you type into the box labeled Times is the number of times that each trial type will be presented in the stage of the experiment that you are currently editing. We will have 12 trials in each experiment, so enter 12 in this box.

- **Trial Types** are specified in sequence by letters: A, B, C, and so on. The highlighted letter that appears after Type tells you which trial type you are currently viewing or editing. Remember that trial types occur and are defined within stages. *Do not* edit or change the trial types**.** *Do not* click on any of the following: Previous Type, Next Type, New Type, or Delete Type buttons.

- The panels labeled **First Stimulus** and **Second Stimulus** enable you to specify CS and US conditions respectively for the experiment that you are currently editing.

**General Information and Instructions (Read and follow first)**

- First make certain that the bar press response will be reinforced. Open the Design Operant Conditioning Experiment window located under the *Experiment* tab, select Press Bar from the *Record Behavior* menu, and click *Apply* to save the setting.

- Open the Design Classical Conditioning Experiment window located under the *Experiment* tab.

- You **must unclick** (i.e., remove the check in) the box next to *Isolate Sniffy when experiment starts*. It is **important that you watch what happens during the experiment**. You will be explaining the behavior patterns in the lab summary

- You must define a first stimulus (CS) and second stimulus (US) for each trial type in each stage of an experiment.

- When the first stimulus (CS) is paired with the shock US, the duration of the first stimulus is always 30 seconds. Duration of a shock US is 1 second, and the shock occurs during the last second that the first stimulus is turned on.

- To choose the tone (which is the CS we will use) as the First Stimulus, click on the box just to the left of the word "Tone". You must also specify a stimulus intensity (Low, Medium, or High) by clicking on the appropriate button. In this lab we will use the tone set on the Medium intensity.

- The second stimulus settings are in most ways analogous to the first stimulus settings except that only one kind of second stimulus can be chosen for each trial type.
    - The default value for the shock US is Medium. We will be using the 3 intensities of the US in Week 1 of this lab project, and only the medium intensity shock US in Week 2.

- *Save As* the experimental design that you have created (or any changes that you have made to the design) as a part of the current Sniffy file, click on Close. The setting will be preserved as long as the Sniffy program is open and running.

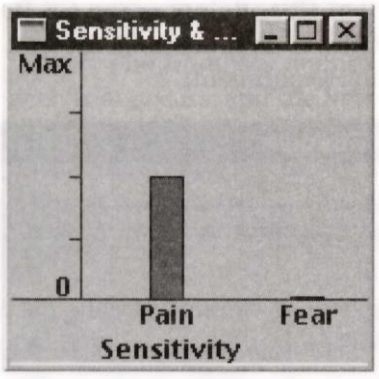
- Important! To run (execute) a classical conditioning experiment, click on Run in the Design Classical Conditioning Experiment window.

- Once the Run command has been executed, the Sniffy Pro program will run the experiment. *Be sure that the experiment is designed the way you want it before you execute the Run command.*

- If you *Exit* the program or *Open* another Sniffy file after executing the Run classical conditioning experiment command, you will be asked whether you want to save the file. If you save it, the program will begin running the classical conditioning experiment exactly where it left off when you open the file the next time.

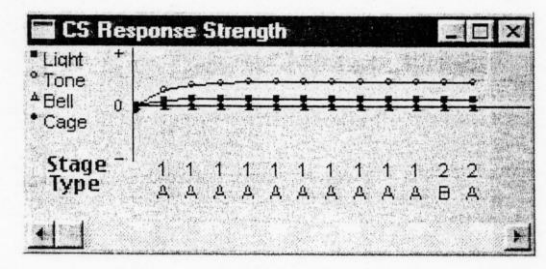
- If you realize that you have made a mistake in setting up a stage of the experiment that has not already started to execute, you can choose the Design Classical Conditioning Experiment command and change the experiment only if it has not begun running. Once you have started running it, it cannot be changed and you must start over.

THE SENSITIVITY AND FEAR MIND WINDOW




- The column labeled **Pain Sensitivity** depicts Sniffy's sensitivity to the shock US and predicts the strength of his UR the next time the US occurs. This column will always be at its midpoint at the beginning of a classical conditioning experiment, and it will remain at the midpoint throughout experiments that employ the medium-intensity shock. If you are employing the high-intensity, sensitizing US, the height of the column will rise as Sniffy's UR becomes more intense as a result of repeated presentations of the US. If you are using the low-intensity, habituating US, the height of the column will decrease as Sniffy habituates to repeated presentations of the US.
- The column labeled **Fear** shows the current intensity of Sniffy's fear. Remember that this is not a measure of Sniffy's behavior; it is a measure of an internal psychological process. However, *the more intense Sniffy's fear, the less likely he is to press the bar*.

THE CS RESPONSE STRENGTH MIND WINDOW




In Sniffy Pro experiments, the light, tone, and bell can be used as CS's. The cage (the general operant chamber environment or background) can also function as a CS. The CS Response Strength mind window displays the strength of each possible CS's capacity to elicit a bar-press suppressing CR as a function of trials. In other words, it shows the predicted change in the rat's reaction to the CS over trials (see below for further explanation).

When you execute a classical conditioning experiment, you will see the following features of the CS Response Strength mind window:

- The CS Response Strength window is a mind window, which means it measures a psychological state, not Sniffy's behavior. The psychological state depicted takes the form of a prediction about each

possible CS's capacity to elicit a CR at the end of each trial. CS Response Strength thus predicts how strongly Sniffy will respond to a CS the next time it is presented.

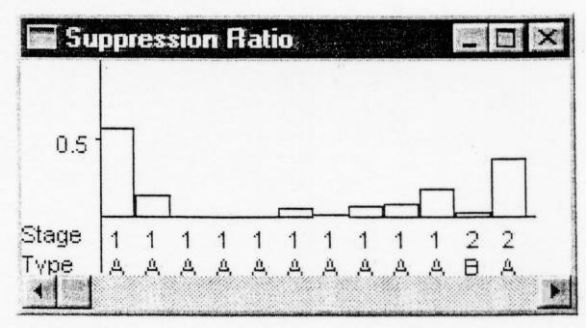
- At the left-hand margin is the graph legend, which displays the data-point shapes associated with the light, tone, bell, and cage stimuli *(we only use the tone).*

- The vertical axis of the graph indicates whether the CS response strength is excitatory or inhibitory. If a CS has an excitatory, positive tendency to elicit a bar-press suppressing CR, its response strength will be greater than zero. If a CS has an inhibitory, negative tendency to prevent the occurrence of a CR, its response strength will be less than zero. A response strength of zero means that a stimulus has no capacity either to elicit or inhibit a CR.

- Beneath the horizontal axis of the graph and to the right of the words "Stage" and "Type," respectively, are a row of numbers and a row of letters. The numbers denote the stage of the experiment in which each trial occurs, and the letters denote the trial type for each trial.

## THE SUPPRESSION RATIO WINDOW

Here is an example of a Suppression Ratio window:




- This window displays a measure Sniffy's behavior (not a hypothesized psychological state).

- At the bottom of the graph, the row of numbers that appears to the right of the word "Stage" denotes the stages of the experiment; and the row of letters that appear to the right of the word "Type" denotes the trial types.

- The suppression ratio is about 0.5 on the first trial. After Trial 1, the suppression ratio decreases and then levels out at or just above 0 for the remainder of Stage 1. Thus, during Stage 1, the CS acquires the capacity to elicit a strong CER.

## PUTTING EVERYTHING TOGETHER TO UNDERSTAND CLASSICAL CONDITIONING

During a classical conditioning experiment, you can observe four things:

- *Occurrences of the CS and US.*
- *Changes in Sniffy's Psychological States*. These changes are visible in the Sensitivity & Fear and in the CS Response Strength mind windows.
- *Sniffy's Responses to the CS and US,* and especially how his response to the CS changes as a function of experience. You can observe Sniffy's responses to these stimuli by simply watching Sniffy's behavior during and after their presentation.
- *Response Measures:* The Cumulative Record contains raw data about Sniffy's bar-pressing behavior throughout the experiment, shows when the different stimuli occur, and enables you to view the ways in which the stimuli affect Sniffy's bar pressing. The Suppression Ratio window contains the classical conditioning response measure that psychologists typically employ in CER experiments.

- Being able to see how stimulus events produce psychological changes, that in turn produce behavior changes, that in turn are reflected in behavioral measurements should enable you to develop a thorough understanding of the way in which psychologists believe classical conditioning works.

Specific Settings for Labs

*Remember, the CS is the tone, and the US is the shock.*

| | TONE | SHOCK |
|---|---|---|
| WEEK 1 – SETTINGS | | |
| ❖ Experiment 1: | CS – medium | + US - low |
| ❖ Experiment 2: | CS – medium | + US – medium |
| ❖ Experiment 3: | CS – medium | + US - high |
| WEEK 2 – SETTINGS | | |
| ❖ Experiment 5: | CS – low | + US – medium |
| ❖ Experiment 6: | *Use the data from week 1 Experiment 2* (CS – medium | + US – medium) |
| ❖ Experiment 7: | CS – high | + US – medium |

## Classical Conditioning – Procedure

**WEEK ONE**

I. Now that the program has been set-up properly, you will begin the classical conditioning training procedure. Your folder contains a sample file of a rat that has been trained on VR-25 schedule (file is called Original VR25). This file will serve as your baseline for these experiments, so the first thing you will do today is open this file from your folder. Immediately save this file under a new name "Low intensity US". (The next two files you will create today will be called "Medium intensity US" and "High intensity US" and you will again use the Original VR-25 for these.)

II. Next you will set up your first experiment. You will be setting up 3 different Experiments and you will run these one at a time. Therefore you will need to create a new file (as named above) for each experiment.

1. Choose the "Design Classical Conditioning Experiment" command from the Experiment menu. You have seen this window before in your lab instructions.

2. Set up the Design Classical Conditioning Experiment dialogue box as follows:

   a. In the Stage section, set the Interval Between Trials to 2 minutes.

   b. Type 12 in the box next to the words "Present Each Trial" (each trial type will be presented 12 times).

   c. In the First Stimulus (CS) panel of the dialogue box, make sure Medium Intensity is selected.

   d. Pick Tone as your first stimulus.

   e. In the Second Stimulus panel, select Low Intensity.

   f. Make sure "Shock US" is selected.

   g. Make sure that there is *no* check in the box next to Isolate Sniffy when experiment starts.

   h. If all of your settings are correct, click on Run.

3. After your experiment is complete, be sure to save your file

4. Re-open the Original VR25.sdf file from your folder.

5. Immediately re-save this file under the appropriate new name "Medium intensity US".

6. Set up another single-stage experiment (Experiment 2) using the Medium Intensity US paired with the Medium CS. Follow steps 1 through 3, above.

7. Again re-open the Original VR25 file, you will set up an experiment (Experiment 3) using the High Intensity US. Immediately re-save this file under the appropriate new name "High intensity US". Follow steps 1 through 3, above.

**WEEK TWO**

I. You will begin this lab with the Original VR25.sdf file you began with last week (not the classically conditioned Sniffy that you saved last week). This original file will serve as your baseline for these experiments, so the first thing you will do today is open this file from your folder. Immediately save this file in your folder under the name "Low Intensity CS". (The next file you create today will be called "High Intensity CS".)

II. Next you will set up your first experiment. You will be setting up 2 different Experiments and you will run these one at a time. Therefore you will need to create a new file (as named above) for each experiment.

1. Choose the "Design Classical Conditioning Experiment" command from the Experiment menu. You have seen this window before in your lab instructions.

2. Set up the Design Classical Conditioning Experiment dialogue box as follows:

   a. In the Stage section, set the Interval Between Trials at 2 minutes.

   b. Type 12 in the box next to the words "Present Each Trial" (each trial type will be presented 12 times).

   c. In the First Stimulus (CS) panel of the dialogue box, make sure Low Intensity is selected.

   d. Pick Tone as your first stimulus.

   e. In the Second Stimulus panel, select Medium Intensity.

   f. Make sure "Shock US" is selected.

   g. Make sure that there is no check in the box next to Isolate Sniffy when experiment starts.

   h. If all of your settings are correct, click on Run.

3. After your experiment is complete, be sure to save your file

4. Re-open the "Original VR25.sdf" file from your folder.

5. Immediately re-save this file under the appropriate new name "High Intensity CS".

6. Set up another single-stage experiment (Experiment 2) using the medium intensity US paired with the high intensity CS. Follow steps 1 through 3, above.

7. Remember that you can use the same data from week 1 for the Medium CS and Medium US condition, instead of running the experiment again. Create a copy of the "Medium Intensity US" file and rename the copy "Medium Intensity CS."

DATA PREPARATION FOR LAB SUMMARY 2
EFFECTS OF STIMULUS INTENSITY IN CLASSICAL CONDITIONING

In order to see how differing levels of tone or shock affect the Suppression Ratio (inhibit bar-pressing), you will compare the 3 levels of US intensity to each other, and you will compare the 3 levels of CS intensity to each other. To obtain a clear picture of the effect of manipulating CS and US intensity, you will export your results to an Excel spreadsheet and plot the results on line graphs. You will create 6 data export files from the experiments, open those files with a spreadsheet program, copy the relevant information into one or two spreadsheet files, and finally draw four graphs:

1. One graph that shows the effect of manipulating US intensity on the Suppression Ratio
2. One graph that shows the effect of manipulating CS intensity on the Suppression Ratio
3. A column (bar) graph depicting the *average Suppression Ratio* per US group (Low, Medium, and High Intensity Shock).
4. A column (bar) graph depicting the *average Suppression Ratio* for each CS group (Low, Medium, and High Intensity Tone).

CREATE DATA EXPORT FILES

1. The first step is to create six data export files (three for the varying US intensities, three for the varying CS intensities) that you will later open with the Excel spreadsheet program. To create each of the data export files:

    a. Open one of your classical conditioning Sniffy files.
    b. Display the Suppression Ratio window. You can make it visible by selecting it from the Response Measures section of the Windows menu.
    c. Point the cursor at the Suppression Ratio window, and click your (left) mouse button once to make sure that the window is selected.
    d. Choose the Export Data command from the File menu.
    e. In the file-saving dialogue box that appears, save your export file in your folder. The name must end in ".dat". The file names are as follows:

        Low US export.dat
        Medium US export.dat
        High US export.dat

        Low CS export.dat
        Medium CS export.dat
        High CS export.dat

    *** VERY IMPORTANT: The extension ".dat" at the end of the file name tells the computer to save the file as just numbers (raw data) rather than as a regular Sniffy file. Excel can only read a raw data file saved this way.

2. Repeat this process to create a data export file for each of the other classical conditioning experiments. Save each of these files in your folder. You should end up with 6 files containing the exported data from your 6 classical conditioning experiments.

3. Exit the Sniffy Pro program.

CREATE TWO TEMPLATE FILES IN EXCEL (one for US and one for CS)

4. Start your Excel spreadsheet program. To do this, click on the Start button in the lower left hand corner of the screen, click on Programs, and click on Microsoft Excel.

5. As soon as the program opens, enter row and column headings to create a group of cells that look something like the table below. This table will be used to display the data you just transferred.

6. Save the file under the appropriate name "US Intensity Data.xls". The .xls ending saves it as an Excel file. Remember the US is the Shock. This will contain the data showing the effects on the Suppression Ratio of the varying Shocks, with the Tone (the CS) remaining constant at medium.

| Trials | Low US | Medium US | High US |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |

7. Start a new spreadsheet in Excel by clicking on File and then New on the Excel toolbar.

8. Label this spreadsheet exactly like the one above, but change "US" to "CS" in the column headings. Save the file under the appropriate name "CS Intensity Data.xls". This is where you will display the data showing the effects on the Suppression Ratio of the varying Tones (CS).

MODIFY THE SIX NEW FILES IN EXCEL

Now you will open one of your Sniffy classical conditioning data (*.dat) files and move the Suppression Ratio data to the file you created in the previous steps (the template file). To open one of these files in Excel:

a. Choose the Open command from the File menu.

b. In the dialogue box that appears, go to the location where you saved the Sniffy Pro data export files (which should be your folder under Guest2). If you do not see your file, please read the next set of instructions before you ask the Lab Instructor.

c. If the Sniffy Pro data export files are not visible, click on *Files of Type* and select the *All files (*.*)* option in the file-opening dialogue box. Then Click on the file that you want to open.

d. A dialogue box will appear and ask you to choose the import file settings. Do not change the settings, just click "Finish".

Each of the data export files will look something like this:

| Stage | Trial | S/R | Light | Tone | Bell | Background | BP During CS | BP Pre CS |
|---|---|---|---|---|---|---|---|---|
| 1 | A | 0.5306 | 0 | 0.3 | 0 | 0.0149 | 52 | 46 |
| 1 | A | 0.3333 | 0 | 0.506 | 0 | 0.0252 | 19 | 38 |
| 1 | A | 0.4705 | 0 | 0.646 | 0 | 0.0323 | 16 | 18 |
| 1 | A | 0.1785 | 0 | 0.743 | 0 | 0.0371 | 5 | 23 |
| 1 | A | 0.1639 | 0 | 0.809 | 0 | 0.0404 | 10 | 51 |
| 1 | A | 0.05 | 0 | 0.300 | 0 | 0.0426 | 3 | 57 |
| 1 | A | 0.0312 | 0 | 0.506 | 0 | 0.0442 | 1 | 31 |
| 1 | A | 0.0909 | 0 | 0.646 | 0 | 0.0453 | 3 | 30 |
| 1 | A | 0.13 15 | 0 | 0.743 | 0 | 0.046 | 5 | 33 |
| 1 | A | 0.5306 | 0 | 0.809 | 0 | 0.0465 | 0 | 32 |
| 1 | A | 0.3333 | 0 | 0.450 | 0 | 0.0149 | 52 | 46 |
| 1 | A | 0.4705 | 0 | 0.691 | 0 | 0.0252 | 19 | 38 |
| 1 | A | 0.1785 | 0 | 0.820 | 0 | 0.0323 | 16 | 18 |
| 1 | A | 0.1639 | 0 | 0.888 | 0 | 0.0371 | 5 | 23 |
| 1 | A | 0.5306 | 0 | 0.925 | 0 | 0.0404 | 10 | 51 |

The column labeled Stage lists the stage of the experiment for each trial. This experiment had one stage of 12 trials. The column headed Trial lists the trial type for each trial. Because this experiment had only one trial type, the letter A appears for every trial.

The column labeled S/R provides the suppression ratio for each trial.
*** This is the column of data you will be moving to the file you created. ***

The columns labeled Light, Tone, Bell, and Background show the CS Response Strength values respectively for the light CS, tone CS, bell CS, and background (cage) CS for each trial. Since Tone was the selected CS type, only the tone column contains data.

The column labeled BP During CS indicates how many times Sniffy pressed the bar while the 30-second CS was on during each trial. The column labeled BP Pre CS shows how many times Sniffy pressed the bar during the 30-second period immediately before the CS came on during every trial.

## COPY DATA FROM THE EXPORT FILE TO THE US OR CS INTENSITY FILE

To draw a single graph in which you compare Suppression Ratios as a function of the three different US intensities, you need to copy the S/R data from each data export file and paste those data into the spreadsheet file that you created for that purpose (the “template” file).

1. The columns in your US Intensity spreadsheet are labeled Trials, Low US, Medium US, and High US. First, you will copy some of the data from the classical conditioning Low Shock (US) exported data file into the column called Low US on the spreadsheet. To do this:

    a. Go to your “Low US export.dat” data file.

    b. Select the 12 numbers in the column labeled S/R.
    You can select a group of numbers in a column by pointing the cursor at the top number, clicking your (left) mouse button and then keeping the button depressed while dragging down to the last desired number. When all the numbers have been selected, release the mouse button.

c. Go to the Edit menu and choose the Copy command (or right click the mouse and select Copy).

d. Move back to the spreadsheet file into which you want to paste the numbers. To move back to the spreadsheet file, select it from the Windows menu.

e. Select the cells for Trials 1 through 12 under the heading Low CS. To select these cells, click on the cell for Trial 1, drag down to the cell for Trial 12 while holding down the (left) mouse button, then release the mouse button. (Or just click in the first cell of the column into which you want to place the data.)

f. Select the Paste command from the Edit menu.

2. The numbers that you copied from the CS Export data export file should appear in the spreadsheet so that your spreadsheet should now looks something like this:

| Trials | Low US | Medium US | High US |
|---|---|---|---|
| 1 | 0.150 | | |
| 2 | 0.275 | | |
| 3 | 0.380 | | |
| 4 | 0.467 | | |
| 5 | 0.540 | | |
| 6 | 0.601 | | |
| 7 | 0.652 | | |
| 8 | 0.694 | | |
| 9 | 0.730 | | |
| 10 | 0.759 | | |
| 11 | 0.790 | | |
| 12 | 0.833 | | |

3. Repeat the copy-paste process just outlined to copy the rest of the data from each US data export file into the spreadsheet columns labeled Medium US and High US, respectively.

4. Your spreadsheet should now look something like this:

| Trials | Low US | Medium US | High US |
|---|---|---|---|
| 1 | 0.150 | 0.300 | 0.450 |
| 2 | 0.275 | 0.506 | 0.691 |
| 3 | 0.380 | 0.646 | 0.820 |
| 4 | 0.467 | 0.743 | 0.888 |
| 5 | 0.540 | 0.809 | 0.925 |
| 6 | 0.601 | 0.854 | 0.945 |
| 7 | 0.652 | 0.885 | 0.956 |
| 8 | 0.694 | 0.906 | 0.961 |
| 9 | 0.730 | 0.921 | 0.964 |
| 10 | 0.759 | 0.93 1 | 0.966 |
| 11 | 0.790 | 0.942 | 0.969 |
| 12 | 0.833 | 0.963 | 0.971 |

5. Save As the file and print the spreadsheet.

6. *Repeat the entire process for the CS intensity experiment* and name the files Low CS export.dat, Medium CS export.dat, and High CS export.dat. Use the Excel spreadsheet template you created and cut and paste the S/R columns from each (high, medium and low) CS exported data file.

# Classical Conditioning - Review

A few things about the US, CS, UR, and CR:

- The US on its own has different effects on the UR, depending on the intensity of the US.
- The CS on its own (in the Sniffy program) does not affect Sniffy's performance — none of the CS intensities is strong enough.
- Paired with the US, the CS acquires the ability to produce the CR (as suppressed bar-pressing).
- The CR is a new response that *resembles* the UR (inhibited-bar pressing). The CR is the degree of inhibition or suppression of bar-pressing produced by the tone (CS), and we measure it with the Suppression Ratio.

## Hypotheses - Classical Conditioning

Hypothesis: *Sniffy's acquisition of the CR is more affected by different intensities of the US (shock) than by different intensities of the CS (tone).*

Predictions to test the hypothesis:

1. The stronger the US, the faster the conditioning (CR acquisition).*
2. The stronger the US, the greater the level of conditioning.

   (US intensity affects the speed* (rate) of acquisition – it is acquired faster. And US intensity affects the level of conditioning.)

3. The stronger the CS, the faster* the CR (as measured by the suppression ratio) is acquired.

   a. The curves level off at the same level — that is, the eventual level of conditioning is the same across CS intensities.

   b. Changing the CS only affects the speed* (rate) of conditioning.

*The rate or speed is shown by the change in slope of the lines.

The purpose of this experiment was to test how the rate of learning (i.e., conditioning) and how response strength (magnitude of response) are affected by different levels of stimulus intensity. Both factors will be assessed by examining the Suppression Ratio data from your six experiments.

To obtain a clear picture of the effect of manipulating US (shock) and CS (tone) intensity, you will compare the 3 levels of US intensity and the 3 levels of CS intensity with regard to their effects on the suppression ratios.

**PART 1 - Graphs (There are a total of four graphs.)**

1. Effect of US Intensity on the Suppression Ratio

    a. On a line graph plot the suppression ratio data from the three experiments that manipulated US intensity.
        - Your graph should contain 3 lines: one line represents the low US, the second line represents the medium US, and the third line represents the high US.
        - Clearly identify the 3 different US intensities by using different symbols or lines or colors, and include a legend.
        - Trial number goes on the x-axis and suppression ratio goes on the y-axis.

    b. Draw a column (bar) graph depicting the *average suppression ratio* for each US group (Low, Medium, and High Intensity).
        - Using the 12 low US trials, calculate the average suppression ratio for the low US and plot on the bar graph. Do the same for the medium and high US's.
        - Your graph should contain 3 columns (bars) with the level of each column indicating the average suppression ratio for each US condition.
        - Clearly identify the 3 different US groups on the x-axis by using different bar fills or colors, and include a legend.
        - Optional: you may combine this graph with graph 2b. Your graph would then show three pairs of bars.

2. Effect of CS Intensity of the Suppression Ratio

    a. On a line graph plot the suppression ratio data from the three experiments that manipulated CS intensity.
        - Your graph should contain 3 lines: one line represents the low CS, the second line represents the medium CS, and the third line represents the strong CS.
        - Clearly identify the 3 different CS intensities by using different symbols, lines or colors, and include a legend.
        - Trial number goes on the x—axis and suppression ratio goes on the y-axis.

    b. Draw a column (bar) graph depicting the *average suppression ratio* for each CS group (Low, Medium, and High Intensity).
        - Using the 12 low CS trials, calculate the average suppression ratio for the low CS and plot on the bar graph. Do the same for the medium and high CS's.
        - Your graph should contain 3 bars with the level of each bar indicating the average suppression ratio for each CS condition.
        - Clearly identify the 3 different CS groups on the x-axis by using different bar fills or colors, and include a legend.

    - Optional: you may combine this graph with graph 1b. Your graph would then show three *pairs* of bars.

**PART 2 – Written Description of the Experiment and the Data**

1. Explain in one sentence each of the four factors that have an impact on the rate of learning and response (or associative) strength. *(Hint: Refer to your lecture notes as this was discussed in class).*

2. Clearly explain the basic classical conditioning procedure.
    - In this description you should give a general *definition and explanation* of each of the following components: CS, US, UR, and CR.
    - Be sure to clearly describe each component of the procedure and how they relate to one another. This should take from one to three sentences per component.

- State the different stimulus intensities that were compared for each stimulus condition (CS and US) in your experiment. Be sure to state which stimuli we used and to specify the different CS-US pairings.

3. In your own words, state and carefully explain the hypothesis and its predictions (i.e., what do you expect will happen with each stimulus manipulation and *why* do you expect it?)

4. By looking at the graphs, did the results support the hypothesis or not? *Explain your conclusion*. Be sure to report the average suppression ratios.