LABORATORY 9

Concept Learning, or
Penguin Picaresque

Purpose

- to introduce standard methods in the analysis of learning, such as **training to a criterion**, using **transfer tests** to assess what is learned, and constructing a **learning curve**;
- to illustrate the notions of **stimulus dimensions** and **factorial combinations**;
- to give you practice with using the **t-test** as a statistical procedure;
- to illustrate the differences between *rule-based* learning and *exemplar-based* learning in the study of concept learning.

Introduction

The study of concept formation has long been an important area of psychological research, reflecting the importance of our ability to form concepts. We are only capable of functioning in the world in the ways that we do because of our capacity to classify objects and events into conceptual groups. Suppose, for example, a child burns its fingers on a lit match. In order to learn from this experience, the child must be able to form such concepts as those of "matches", "flame", "pain", etc., so that he or she will treat any lit match with proper respect. Language itself presupposes the use of concepts, because words usually refer to concepts, not to particular objects. The word "dog", for instance, refers not to a particular dog but to a class of animals as different as Chihuahuas and Saint Bernards.

In view of the importance of concepts, it is not surprising that psychologists have investigated many aspects of concept formation, for example, what sorts of concepts are easy to learn and what sorts are difficult to learn, what is the best way to teach a concept, and what kinds of strategies people use to learn concepts.

This lab focuses on the way in which different methods of learning can influence the speed with which we acquire a concept as well as how those methods influence the content of what we learn.

Getting Started

Materials

For this exercise, you will need a set of 16 stimulus cards, each card having a different penguin drawing on it; a training sheet with a series of randomized presentations for each trial block for the learning phase and for the transfer test phase; and a stimulus coding key.

Organization

Students will work in pairs during the lab, with one person acting as teacher and the other as learner for the first part of the lab, then reversing these roles in the second part of the lab. Thus, each member of the pair will have a chance to be a teacher and a chance to be a learner. The specific conditions for learning will be different for the first and second parts of the lab, and the members of a pair must get the new set of learning conditions before starting the second part.

Collecting Data

The experiment consists of two phases – a learning phase and a transfer test phase. The learning phase consists of a series of trial blocks during which the learner attempts to learn how to classify the penguins. In each trial block, the learner will be shown 6 different penguins, one at a time, and will try to learn the correct classification for each penguin. This phase will continue until the learner is able to classify all 6 penguins correctly on two successive trial blocks, or until 20 trial blocks have been completed (whichever comes first). Limiting the learning phase in this way is known as ***training to a criterion***; in this case, the criterion is 2 successive trial blocks. The completion of the learning phase will be followed by a transfer test involving all 16 penguins.

The learning phase has two forms of training (Form A and Form B), with each form having two conditions. Your instructor will indicate the form and the condition a particular teacher-learner pair is to follow.

Form A

Select the 6 penguins corresponding to the numbers for your condition (these are shown on your stimulus coding key). Put the remaining penguins to one side face down in a pile to use later for the transfer task.

When ready to begin, the teacher should instruct the learner as follows: "This is a concept learning task. I would like you to learn simply from experience the concepts of two kinds of penguin, Peruvian penguins and penguins of the Galapagos Islands. I am going to show you examples of each kind of penguin, and I will ask you to indicate for each example whether you think it is a Peruvian or a Galapagos penguin. On the first trial, of course, you will have to guess about what to say. After you state your choice, I will tell you whether or not you are correct. If you are incorrect, I will tell you what the correct answer is. Then I will show you another penguin, ask you to classify it, and indicate whether or not you are correct. We will continue in this way with 6 different examples.

When I have shown you all 6 penguins, we will have completed one *trial block*. I will shuffle the cards, and then we will do another trial block, following the same procedure. This process will continue until you correctly classify all the penguins on two successive trial blocks. Once you can do this, I will show you a larger group of penguins and ask you to classify them."

On each trial, show the learner the penguins, one at a time, and ask for a classification. (For the first trial, the learner will have to guess). Record the learner's response next to the trial indicator on the recording sheet, and tell the learner whether the answer is correct or incorrect. The learning criterion is being correct on two successive trial blocks (that is, classifying all 6 penguins correctly twice in a row.)

Transfer Testing

When acquisition is complete, administer a transfer test. For this test, instruct the learner as follows: "I am going to present all 16 penguins one at a time. For each penguin, I want you to indicate, first, the kind of penguin (Peruvian or Galapagos), second, whether it is "Old" (one seen in training) or "New" (one not seen in training), and third, how confident you are of your recognition. The confidence rating scale is -3 (very sure new), -2 (sort of sure new), -1 (think new), 0 (guess), +1 (think old), +2 (sort of sure old), +3 (very sure old). After I have shown you all 16 penguins, I will ask you to tell me, if you can, whatever rule or rules one can follow to classify the penguins correctly."

When learning and testing are completed for part one, bring your penguins to the instructor for relabeling, get the new learning conditions, and do part two. When part two is completed, go on to the Data Analysis.

Form B

Select the 6 penguins corresponding to the numbers for your condition. Put the remaining penguins aside in a pile to use later for the transfer task.

When ready to begin, the teacher should instruct the learner as follows: "This is a concept learning task. I would like you to learn simply from experience the names of 6 different types of penguins. These penguins are all either Peruvian penguins or penguins of the Galapagos Islands, but your task is to learn the name of each penguin. The names are on the paper in front of you, so you only have to learn which name goes with which penguin. I will show you a penguin, and I will ask you to tell me its name. On the first trial, of course, you will have to guess at the name. I will tell you whether or not you are correct, and, if you are incorrect, I will also tell you what the correct answer is. Then I will show you another penguin, ask for its name, and indicate whether your response is correct or not. We will continue in this fashion with all 6 penguins.

When I have shown you all 6 penguins, we will have completed one *trial block*. I will mix up the 6 penguins, and then we will do another trial block, following the same procedure. This process will continue until you correctly name all the penguins on two successive trial blocks. Once you can do this, I will show you a larger group of penguins and ask you to classify them."

On each trial, show the learner the penguins, one at a time, and ask for a name. (For the first trial, the learner will have to guess). Record the learner's response next to the trial indicator on the recording sheet, tell the learner whether the answer is correct or incorrect, and, in case of an error, tell the learner the correct name. The learning criterion is two successive trials correct (that is, naming all 6 penguins correctly twice in a row).

Transfer Testing

When acquisition is complete, administer a transfer test. For this test, first tell the learner which of the 6 penguins were Galapagos penguins and which were Peruvian (this is indicated on your coding key). Then, instruct the learner as follows, "I am going to present all 16 penguins one at a time. For each penguin, I would like you to tell me first, what kind it is (Peruvian or Galapagos), second, whether it is "Old" (one seen in training) or "New", and third, how confident you are of your recognition. The confidence rating scale is -3 (very sure new), -2 (sort of sure new), -1 (think new), 0 (guess), +1 (think old), +2 (sort of sure old), +3 (very sure old). After I have shown you all 16 penguins, I will ask you to tell me, if you can, whatever rule or rules one can follow to classify the penguins correctly."

When learning and testing are completed for part one, bring your penguins to the instructor for relabeling, get the new learning conditions, and do part two. When part two is completed, go on to the Data Analysis.

Data Analysis

The purpose of the data analysis is to determine whether one method of concept learning is easier than the other and to determine what you have formed in memory when you learn a concept.

Step 1. Determine the dimensions and attributes of the stimulus set

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The first step is to define the dimensions (and the attributes for each dimension) that were used to construct the stimuli. The full set of 16 stimuli represent a **factorial combination** of the stimulus dimensions. A stimulus dimension is a characteristic that can vary, like hair color, and the particular variations of the dimension are its attributes. For people, "hair color" is a dimension, with "blonde", "brunette", and "red" as 3 attributes of that dimension, and "eye color" is another dimension, with "blue" and "brown" as 2 attributes of that dimension. A factorial combination of *hair color* and *eye color*, based on those attributes, would produce 6 distinct descriptions: blond hair - blue eyes, blond hair - brown eyes, brunette hair - blue eyes, brunette hair - brown eyes, red hair - blue eyes, and red hair - brown eyes.

This step requires examining all 16 penguins with the goal of finding a way to describe each penguin as a unique combination of attributes from a small number of stimulus dimensions. When you can do this, you will have figured out the *structure* of the stimulus set.

Step 2. Determine the experimenter's classification rule

After the structure of the stimulus set has been figured out, determine what rule or rules were used to define the two kinds of penguin (Galapagos and Peruvian). The solution is a rule that correctly classifies each of the 16 penguins. Using the example of hair color, for instance, the rule might have been "All people with red hair and blue eyes are from the Galapagos, and everyone else is Peruvian."

Step 3. Make a **learning curve** for each learner

Set up a section of a spreadsheet so that you have 10 columns, labeled from "Block 1" to "Block 10", and 2 rows, labeled "Learner 1" and "Learner 2". For each learner, determine from the response sheet used in training the number of correct responses in pairs of trial blocks (e.g., in Trial Block 1 and 2, Trial Block 3 and 4, etc.). Convert these *numbers* of correct responses to *proportions* of correct responses by dividing the numbers by 12. (Why 12?) Enter the proportions into the appropriate cells of the matrix you have created.

Select all the cells in your matrix, including the cells with the row and column labels, and click on the Chart Wizard to make a graph that plots the proportion of correct responses as a function of 2 Trial-Blocks. Use the "Scatter" option and select "symbols with straight lines" as the form for making the graph.

Note: If one of the learners reached criterion before completing all 20 trial blocks, assume that the learner would have continued to get all responses correct for the remaining trials. Thus, you will have data for all 20 trial blocks for both learners, regardless of when they reached the

learning criterion.

Step 4. Determine the difficulty of learning individual penguins

Examine the learning trials and find the total number of errors for each specific penguin. For example, if penguin #4 was one of the penguins used in training, examine all the learning trials and count the number of times the learner made an error on penguin #4. Repeat this for all the penguins used in training, separately for each learner. Looking at the errors, does it appear that all penguins are equally difficult to learn? If not, think about what might be the source of variations in learning difficulty (your answer to this question will be part of your discussion).

Step 5. Compare the two learners using a **t-test** for independent samples

Enter the errors from Step 4 in a spreadsheet, set up as follows: Label two adjacent columns "Learner 1" and "Learner 2", and label the rows with the ID numbers of the penguins used in training (e.g., #4, #6, #7, etc.). Put the errors in the appropriate cells of this matrix.

In the row immediately below the penguin ID numbers, enter the label "Average Errors". In the cells next to this label, calculate the average errors for each learner, using the function

=average(FirstPenguin:LastPenguin)

where you enter the cell addresses for errors for the first and last penguins in your matrix.

In the row below these averages, enter the Excel formula for the TTEST function

=ttest("data for Learner 1", "data for Learner 2", 2, 2)

where you enter the cell addresses for the data for Learner 1 and Learner 2. The first "2" after the data for Learner 2 is a code that indicates you want a *two-tailed t-test* and the second "2" is a code that indicates you want to perform a *t-test for independent samples* (these numbers are just Excel's arbitrary codes).

In the cell immediately below the cell in which you entered the TTEST function, enter the TINV function

=tinv(t-test, df)

where, for *t-test*, you enter the address of the cell containing the TTEST function and, for *df*, you enter the degrees of freedom for your comparison. The degrees of freedom for an independent sample t-test is equal to the size of sample 1 plus the size of sample 2 minus 2. Is there a reliable difference between the two learners? (The answer to this question will go in the Results section of your lab report)

Step 6. Compare the two learners using a **t-test** for dependent samples

Compare the two learners a second time, but using only those 4 penguins that were exactly the same for the two learners. The data for these penguins have to be in adjacent cells. In a cell to the right of the ones used for *t-test* and *tinv* in Step 5, enter the TTEST function again,

but with a change in the last number, from a "2" to a "1" (again, this is an arbitrary code in Excel, to indicate a dependent t-test).

=ttest("data for learner 1", "data for learner 2", 2, 1)

and enter the TINV function, but with a change in the degrees of freedom to equal the size of sample 1 minus 1.

=tinv(ttest, df).

Are these differences statistically significant?

Step 7. Compare the recognition and classification accuracy of the two learners.

For each learner, calculate the proportion of correct recognition judgments in the transfer test (a *correct recognition judgment* is to call an "Old" item *old* and to call a "New" item *new*), then compare the two. Was one learner more accurate in recognition? If so, which one?

Next, calculate the proportion of correct classification judgments in the transfer test (a *correct classification judgment* is to call a "Peruvian" penguin *Peruvian* and a "Galapagos" penguin *Galapagos*. Was one learner more accurate in classification? If so, which one?

Finally, for each learner, compare all the confidence judgments for "Old" penguins against all the confidence judgments for "New" penguins using a t-test to determine if the learner showed a reliable ability to distinguish old penguins from new penguins.

Lab Report

Your report of this lab will consist of

1) a title page;
2) a table that lays out the structure of the set of penguins
3) a statement as to what classification rules applied to each learner, and what classification rules each learner used;
4) the learning curve from Step 3 of the Data Analysis and the results of your analysis in Steps 5, 6, and 7;
5) a statement as to which form of learning seems to have worked better.

In your report, be sure to label your graphs correctly, and be sure to explain the reasoning behind your conclusions.