

20170906 - Friend or Foe

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Introduction

Do children who are less than a year old recognize the difference between nice, friendly behavior as opposed to mean, unhelpful behavior? Do they make choices based on such behavior? In a study reported in the November 2007 issue of *Nature*, researchers investigated whether infants take into account an individual's actions towards others in evaluating that individual as appealing or aversive (Hamlin, Wynn, and Bloom, 2007).

In one component of the study, 10-month-old infants were shown a “climber” character (a piece of wood with “google” eyes glued onto it) that could not make it up a hill in two tries. Then they were alternately shown two scenarios for the climber's next try, one where the climber was pushed to the top of the hill by another character (“friend”) and one where the climber was pushed back down the hill by another character (“foe”). The infant was alternately shown these two scenarios several times. Then the child was presented with both pieces of wood (representing the friend and the foe) and asked to pick one to play with. Videos of this study are available at websites for the UBC Center for Infant Cognition Lab (<http://cic.psych.ubc.ca/example-stimuli/>) and the Yale Infant Cognition Center (<https://campuspress.yale.edu/infantlab/>).

Objectives

This lab will introduce you to 3 Big Ideas that we'll come back to throughout this class:

1. The importance of *experimental design*
2. We can quantify *random variability*
3. We can quantify the *strength of evidence* an experiment provides

Along the way, we'll also get a first look at R, the statistical programming language we'll use in this class.

Evaluation

You will not be turning this lab in for a grade.

Section 1: Introducing the Study

a) Identify the observational units and variable in this study. Is the variable categorical or quantitative?

b) The Methodology section states that for the 10-month-olds, the climber was a yellow triangle; helper and hinderer were a red square and a blue circle (counterbalanced). Also counterbalanced were which event (helping or hindering) they observed first and the positions of helper and hinderer when presented to the infants (on left or right). Why are these important considerations?

c) Researchers found that 14 of the 16 infants in the study selected the nice toy. Suggest two possible explanations for this result that the researchers observed.

d) Suppose for the moment that the researchers' conjecture is wrong, and infants actually have no preference for either type of toy. Would it be possible to have obtained a result as extreme as the researchers found?

e) If infants have no preference, how many of the 16 would you have expected to select the nice toy? Would you always expect to see that many of the 16 infants select the nice toy? How many of the 16 infants would have to select the nice toy in order for you to be fairly well convinced that the researchers' conjecture is correct, that infants really do have a tendency to prefer the nice toy? Explain.

f) In your judgment, how many infants, out of the 16, would have to select the nice toy in order for you to fairly well convinced that the researchers' conjecture is correct, that infants really do have a tendency to prefer the nice toy? Explain.

Section 2: A Simulation Study

The key question here is to determine what results would occur in the long run under the assumption that infants actually have no preference. (We will call this assumption of no genuine preference the null model or null hypothesis.) We will answer this question with by simulating (artificially re-creating) the selection process of 16 infants over and over, assuming that infants actually have no genuine preference.

g) Describe how we could use a common device to simulate the infants' selection process.

h) Flip a coin 16 times. Record the number of heads that you obtain, which represents the number of your 16 hypothetical infants who choose the nice toy.

i) Combine your simulation results with your classmates. Produce a well-labeled dotplot.

j) Where is the distribution of number of heads in 16 tosses centered? Explain why this makes sense.

k) Looking at this dotplot, does it seem that the result obtained by the researchers would have been surprising if in fact the infants had no preference? What does this suggest about whether the researchers' result provides much evidence that the infants do genuinely prefer the nice toy? Explain.

Section 3: Automating the Simulation using R

We really need to simulate this random selection process hundreds, preferably thousands of times. This would be very tedious and time-consuming with coins, so we'll turn to technology.

Open a web browser and sign in to <https://rstudio.mtholyoke.edu/> using your Mount Holyoke user name and password. You'll see a page like this:

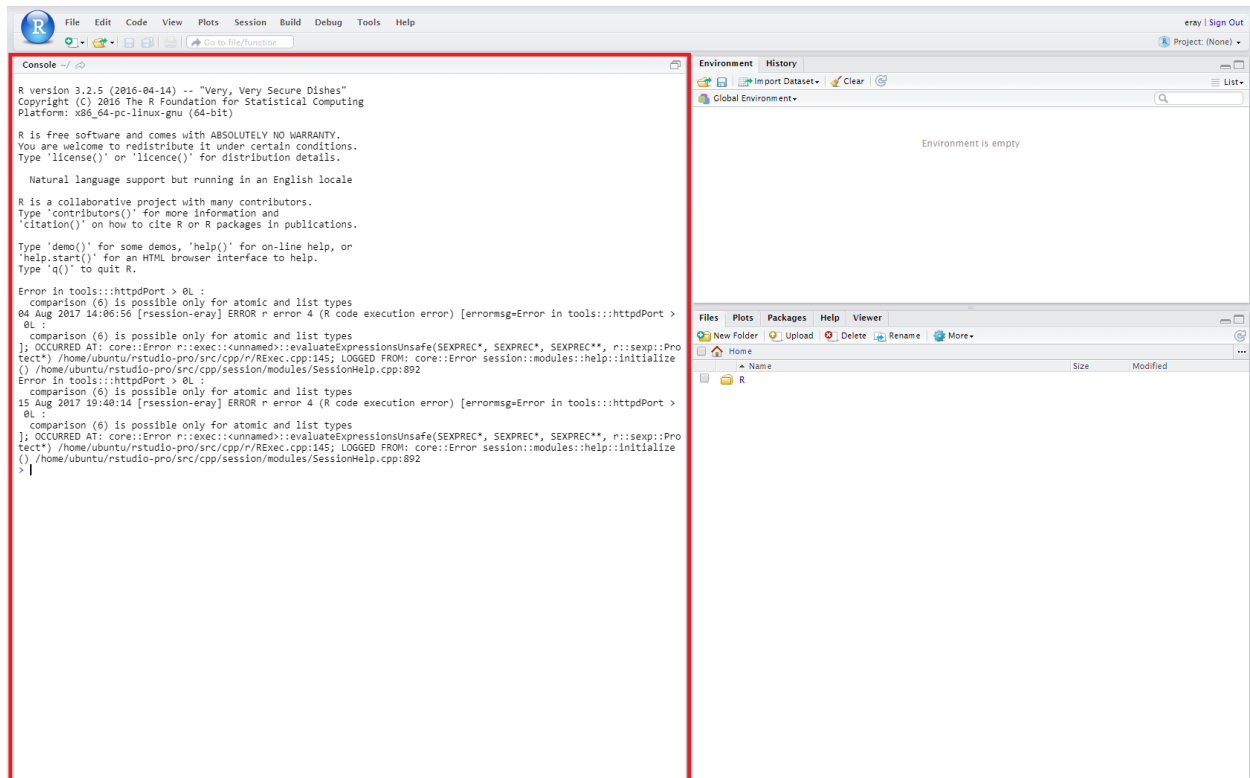


Figure 1: RStudio

We'll talk about the different areas on this screen in future classes, but for today we'll just use the Console, which I've outlined in red. You can type in R commands into the console to run them.

1) Enter the following command into the R Console to simulate the random process of 16 infants making this toy choice, still assuming the null model that infants have no real preference and so are equally likely to choose either toy.

```
experiment_results <- rbinom(n = 1, size = 16, prob = 0.5)
experiment_results
```

Here's a breakdown of what's going on in just the first line of R code:

- The `rbinom` function simulates flipping a coin 16 times and counts the number of heads that came up. The name of this function describes the fact that it randomly generates values from a **binomial** distribution. The binomial distribution is just the name statisticians have given to describe how often different numbers of heads come up when you flip a coin a certain number of times. We'll talk about this distribution more later in the class.
- The `rbinom` function has three *arguments*, describing how the coin flipping should be done:

1. `n` tells R how many times to repeat the experiment (how many times we ask 16 babies to choose a toy – just once for now)
 2. `size` tells R how many babies are included in each run of the experiment – 16
 3. `prob` tells R how likely each baby is to choose the friendly toy – we set this to 0.5 because we’re working under the null model where babies are equally likely to choose either toy.
- We store the results of this simulation in a *variable* called `experiment_results`. The `<-` (a less than symbol followed by a minus sign) is called the *assignment operator*. It tells R, “take the result of the computation on the right and store it in the variable on the left”.

Finally, in the second line we look at the results of the experiment by seeing what was stored in the `experiment_results` variable.

m) The whole point of using R was to make it easy to repeat the simulation many times. Modify the code you entered above to perform 1000 simulations of the experiment, all under the null model that infants have no preference for either toy. (Hint: in the console, you can press the up arrow key to go back to and edit earlier commands.)

n) It’s not too helpful to just look at the list of simulated numbers. You can use the commands below to make a histogram of the simulated experimental results, and to calculate the number of hypothetical experiments resulting in a certain number of babies choosing the friendly toy:

```
library(ggplot2)
ggplot() +
  geom_histogram(aes(x = experiment_results), binwidth = 1)

table(experiment_results)
```

We’ll talk about making plots in R in much more detail starting in the next class, so don’t worry too much about the details of this command. In case you’re curious, here’s a brief description (but you can also feel free to skip over this description for now):

- We’re using the `ggplot2` package to make plots. (The `gg` stands for *grammar of graphics*; this is a way of thinking about building up plots in a structured way... but we’ll get to that more next class). The first thing we have to do is load the `ggplot2` package into R so that all of the plotting capabilities it provides are available to use. We do that with the `library(ggplot2)` line.
- You begin a new plot with the `ggplot()` function.
- You then *add* layers to the plot with different types of *geometry*. In this plot, there is only one layer, and its *geometry* type is a *histogram*.
- `aes(x = experiment_results)` specifies that we’re going to use the `experiment_results` variable for the `x` (horizontal) axis of the plot. `aes` stands for *aesthetics*: this function lets us specify how variables get used for different *aesthetic* attributes of the plot. Again, we’ll discuss this in much more detail next class!
- `binwidth = 1` specifies that the horizontal axis bins used to create the histogram have width 1.

o) Describe the shape of the histogram, and comment on whether it is centered where you expected. Based on your simulation results, would you say that it would be very surprising, if infants actually have no genuine preference, that 14 out of 16 infants in the study would have chosen the nice toy just by chance? Explain.

p) Report how many of your 1000 repetitions produced 14 or more infants choosing the friend toy. Also determine the proportion of these 1000 repetitions that produced such an extreme result.

This proportion is called an approximate p-value. A p-value is the probability of obtaining a result as extreme as the one observed, assuming that there is no genuine preference/difference. A small p-value casts doubt on the null model/hypothesis used to perform the calculation (in this case, that infants have no genuine preference).

- A p-value of .10 or less is generally considered to be some evidence against the null model/hypothesis.
- A p-value of .05 or less is generally considered to be fairly strong evidence against the null model/hypothesis.
- A p-value of .01 or less is generally considered to be very strong evidence against the null model/hypothesis.
- A p-value of .001 or less is generally considered to be extremely strong evidence against the null model/hypothesis.

q) Is the proportion you got in part o) small enough to consider the actual result obtained by the researchers surprising, assuming the null model that infants have no preference and so choose blindly between the two toys?

r) In light of your answers to the previous two questions, would you say that the experimental data obtained by the researchers provide strong evidence that infants in general have a genuine preference for the friend toy over the foe toy? Explain the reasoning process behind your answer.

s) In a follow-up study, the researchers repeated this protocol but without the googly eyes on the helper. In this study, they found that 10 of the 16 infants chose the helper toy. How does this change your p-value and conclusions? [Hint: Use your earlier simulation results but explain what you are doing differently now to find the approximate p-value.] Explain why your answers make intuitive sense. Explain how this result contributes to the theory that infants are reacting to the social interaction of the toys.