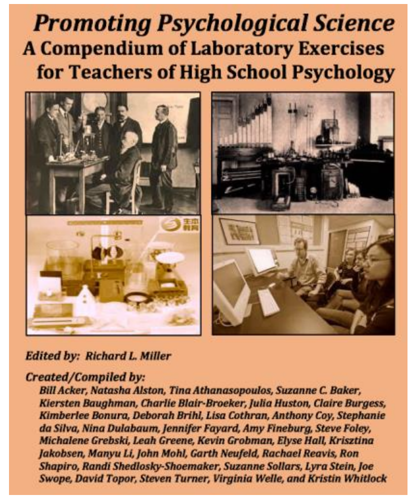
Confirmation Bias and the 2-4-6 Game:
How do we Test our Perspectives?

Grobman, K. H. (2018). Confirmation bias and the 2-4-6 game: How do we test our perspectives? In R. L. Miller (Ed.) *Promoting Psychological Science: A Compendium of Laboratory Exercises for Teachers of High School Psychology,* (pp. 286-290), Washington, DC: American Psychological Association Society for the Teaching of Psychology, Retrieved from http://teachpsych.org/ebooks/index.php



Abstract:

The confirmation bias, our natural inclination to interpret ambiguous information and seek validation in ways conforming with our existing beliefs, plays a significant role in shaping our understanding of the world. This class activity builds on Peter Cathcart Wason's (1960) 2-4-6 Hypothesis Rule Discovery task, highlighting the importance of falsifiability in research methodology and demonstrating the role of construal shaping our social perception and choices. By introducing the confirmation bias through an engaging experience, students discover even sophisticated thinkers are prone to reasoning errors. This understanding helps us recognize the confirmation bias in various aspects of life, such as social media interactions and news consumption, and encourages critical thinking, open-mindedness, and better-informed decision-making. Ultimately, students appreciate the value of well-designed experimental tasks in explaining complex real-world phenomena, fostering a deeper understanding of the intricacies of human cognition and behavior.

Katie Hope Grobman
Associate Professor of Psychology
Department of Psychology
California State University – Monterey Bay
kgrobman@csumb.edu
Copernican Revolution

Confirmation Bias and the 2-4-6 Game:

How do we test our perspectives?

Adapted from: Original classroom activity by Katie Grobman, adapted from original experiment by Peter Wason.

Wason, P. C. (1960). On the failure to eliminate hypotheses in a conceptual task. *The Quarterly Journal of Experimental Psychology, 12,* 129-140.

Grobman, K. H. (2003). *Confirmation Bias: A class activity adapted from Wason's 2-4-6 Hypothesis Rule Discovery Task.* Retrieved from: http://www.DevPsy.org/teaching/method/confirmation_bias.html

Section 1: Performance Expectations

What will the student be asked to do?

- *Plan and carry out a scientific investigation* using Wason's 2-4-6 task.
- *Formulate a scientific question* such as testing if individual differences predict differences in performance on the task, or if variations of the task impact performance. Alternatively, the instructor may simply have students replicate the original result.
- *Analyze data* to determine if participants show the confirmation bias. Instructors can set expectations for data analysis. The results of a replication are typically strong enough where a graph (e.g., pie chart) and descriptive statistics (e.g., percentages) clearly show the confirmation bias. Alternatively, instructors may have students conduct inferential statistics (details below).

Main Idea/Concept Demonstrated or Taught by Lab:

By demonstrating the confirmation bias, students discover that even those capable of sophisticated reasoning are nevertheless prone to reasoning errors. Students hopefully recognize how the confirmation bias plays a role in the world around them, such as how people share information on social media, and why people like to watch news sources with particular political leanings. Ideally, students start to appreciate how understanding the complexities of everyday life can be informed by carefully designed experimental tasks, even when those tasks do not look like everyday life experiences.

Key Terms and Psychologists Associated with Main Idea/Concept:

Confirmation Bias, Peter Cathcart Wason

Materials:

2-4-6 task, a PDF of the handout is available at: http://DevPsy.org/teaching/method/confirmation_bias.pdf

Pencil or pen for participant; pencil or pen for experimenter.
Additional materials may be necessary if students generated a hypothesis beyond replication.

Instructions:

It is helpful if the teacher demonstrates the 2-4-6 game in class with all their students acting as participants before the students design their labs. Complete instructions for the class activity, PowerPoint slides, and the 2-4-6 handout are available at http://www.DevPsy.org/teaching/method/confirmation_bias.html . For the classroom activity to work well, the teacher needs to be especially clear when giving instructions. By demonstrating to the class, the teacher is helping students recognize the need for precision when collecting their data. Most importantly, once students know the answer, it seems obvious. They are unlikely to believe they would have been prone to this reasoning error (i.e., confirmation bias). But they would have: about 80% show the bias, even very capable students who enroll in classes like AP Psychology. Ironically, this lack of realization is due to an additional common reasoning error called the "hindsight bias." Because we are all subject to these biases, I recommend that teachers view the webpage and provide their first sequence in response, before continuing to read these instructions.

Students in class act as the experimenter in a one-on-one session with each participant. Allot about 5 minutes to administer the 2-4-6 task to each participant. The experimenter should be deliberate when explaining the task to participants and, to avoid extraneous variables, the directions should be written in advance and spoken consistently to each participant. Here are recommended standard instructions:

> A sequence of numbers has an order to it. For example, 1-2-3 is a different sequence from 3-2-1. Some sequences of 3 numbers make me incredibly happy; other sequences of 3 numbers make me very sad. Your goal is to figure out the rule for what sequences make me happy. But you can't simply ask me my rule. Instead you can conduct experiments on me. You can make up a 3 number sequence and I'll tell you if it makes me happy. Then you can make up another sequence, I'll tell you again, and we'll keep going until you're mostly confident you know the rule inside my head. Let's do the first sequence together. 2-4-6 (gesture to the pre-written cell on the handout). After you write a sequence I'll write a happy or sad face for you in the "fits my rule" column (gesture to the pre-written cell on the handout). It turns out this sequence makes me very happy! Now that you have feedback from me, you should make your best guess for the rule that makes me happy. For example, you might guess, "counting up by 2's." If that's your guess write it in this blank (gesture to cell), or you can feel free to write another hypothesis (wait for participant to write hypothesis). To finish the row, you should make a rough estimate for how certain you are that the rule you guessed really is the rule for sequences that make me happy (gesture to cell). If you have absolutely no confidence and your guess is basically random, write 0%. On the other hand, if you are totally sure you have it, write 100%. You can also write anything in between, such as 50% (wait for participant to write percent). Now let's continue. Write a sequence of 3 numbers to test. Once I give you feedback with a happy or sad face, write your hypothesis. If it's the same as before, feel free to put ditto marks. Say how sure you are with a percent. Then make another sequence to test what rule makes me happy, and so forth. Once you're nearly 100% confident we'll stop.

Generally participants are 100% confident in about 5 trials. Nevertheless, experimenters should have a clear rule for when to stop. You might also say that once a participant is more than 90% confident, the experimenter asks at each trial if the participant would like to continue or stop there. If a participant writes 100%, you stop without asking.

For each trial, the experimenter needs to determine if the sequence fits the rule. The rule is, "any increasing sequence," so this normally requires little thought. Sequences that fit the rule include: {1,2,3}, {2,4,6}, {-20, π , 3000}, and {⅛, ¼, ½}. Sequences that do <u>not</u> fit the rule include: {3,2,1}, {7,4,7}, and {42,42,42}.

Experimenters should retain the handouts as their raw data, as well as keep any additional information that will be analyzed (e.g., demographics like school grade, other tasks for comparison).

If students go beyond a replication, there will either be additional information recorded (e.g., for individual differences) or additional tasks. The opportunity to generate hypotheses for onesself are important experiences for budding scientists, so I recommend not sharing examples with students at first. But the teacher may benefit from having some examples in mind to help nudge students toward their own. Here are some examples:

> There may be group or individual differences. For example, perhaps one gender is hypothesized to perform better on the 2-4-6 task than another. Perhaps seniors perform better than sophomores, or teachers perform better than students, or students who take AP classes perform better than other students, or students whose favorite subject is science perform better. Generally these hypotheses will not be supported by the data. This is okay because being wrong, and being okay with being wrong, is an important part of science. Moreover, since the confirmation bias is a basic part of human cognition, we should not expect much variation.
>
> There may be correlates with naturally occuring variations. For example, maybe those who complete the task right before a class or catching the bus (i.e, rushed) perform worse than those who participate during study hall. Perhaps those who take longer to complete the task perform better. To test these hypotheses, students will need to collect additional information with each handout (e.g., timing for each participant, time of day, location).
>
> Performance on other tasks might predict performance on the 2-4-6 task. For example, those who are better at solving logical syllogisms might perform better. To test these hypotheses, students will need to find or create an additional task.
>
> Finally, the 2-4-6 task itself might be changed. For example, rather than trying to find the rule for sequences that make me happy, you might find a rule for sequences that make me bop my head to the left or right. What if the directions caution participants that most people do not get the right answer? What if particiants are first taught about the confirmation bias before playing the game? To test these hypotheses, students will need to rewrite the handout, alter the directions, or write something to tell particpants beforehand (e.g., teach about the confirmation bias versus a control). Be especially sure to remind students that they need to record the condition with each participant's handout. Afterall, condition is a variable.

Follow-up and Discussion:

- I recommend most class discussion precede the design of the lab (see first paragraph of *Instructions*).
- To understand and appreciate this lab, students benefit from prior knowledge of the scientific method (especially hypothesis testing) from their science classes, as well as knowledge of current events and historical group polarization from their social studies classes. Students' knowledge of media (e.g., 'bubbles' on Facebook and Twitter, Fox News vs. MSNBC) may help them appreciate the importance of the topic.
- Students might be hindered by lay-person beliefs about intelligence and the expectation that being smart means you won't fall prey to cognitive biases. However, having "common sense" lay theories challenged by data is an especially powerful lesson.
- Especially thoughtful students might consider how it could be adaptive that we make reasoning errors like the confirmation bias (*Next Generation Science Standard LS2D*). Teachers might highlight that the world in which our reasoning evolved is quite different from modern-day schooling. What helps students do well in school and in science today (e.g., careful, methodical thinking) is not necessarily the same as what helped our species survive in the distant past (e.g., quick decisions for survival).

Section 2: Crosscutting Concepts

- *Stability & Change*: Just like an ecosystem, a person is a complex dynamic system. The confirmation bias is one mechanism by which we maintain stability.
- *Structure & Function*: By observing how people function when completing the 2-4-6 task we can infer something about the overall structure of cognition.
- *Cause & Effect*: Different lab groups may choose to test different hypotheses. Those who experimentally manipulate the 2-4-6 task can infer a cause & effect relationship whereas those who correlate performance with something else may not.

Section 3: Lab Report (written, verbal, or recorded)

Students' lab reports might follow the standard science lab report format. The *Introduction* begins by defining the confirmation bias and it closes with the hypothesis. The *Method* describes the participants, materials, and procedure. The *Results* summarize the pattern of results found in the study. It is <u>not</u> the same thing as the raw data (i.e., handouts); however the handouts might be included in an appendix. More details about the results section follow. The *Discussion* restates the conclusion from the results, discusses the implications of the confirmation bias, and notes any limitations (e.g., correlation does not imply causality, how the sample of participants may differ from persons broadly, and therefore may not generalize).

Students' prior knowledge of statistics might vary widely, as might teachers' expectations for the results section. Generally, only about 20% of participants figure out the rule on the 2-4-6 task. This descriptive finding is dramatic enough to illustrate the confirmation bias, so teachers might expect students to summarize the results with descriptive statistics like this. Students might provide more detail by summarizing the proportion of participants with each final hypothesis (i.e., count up by 2's, count up by multiples, a formula combing the first two numbers for their third, or any increasing sequence).

This lab provides a nice learning opportunity for basic inferential statistics. To be likely to have statistically significant results, I recommend each lab group collect data from at least 15 participants. Each participant's handout can be classified as "inclined toward confirmation" or "inclined toward falsification" based on what sequences participants generate after they make hypotheses. Two students can "code" each participant handout and resolve disagreements through discussion. If participants show no bias, they should be just as likely to confirm versus falsify. Students can set up a table like this:

Response to 2-4-6 Task	Observed Outcome	Expected Outcome
Falsification Bias	3	50%
Confirmation Bias	12	50%

The numbers students put in their "observed outcome" column are from their actual data (i.e., observed) and they should sum to their total number of participants. To test if participants have a confirmation bias, you compare the results to the null hypothesis. That is, participants being just as likely to confirm as falsify (i.e., expected outcome column). The appropriate statistic to determine if the proportion found by students' observations differs from the null hypothesis is a Goodness-of-Fit Chi Square. Many online calculators will complete that statistic for you, such as this one: https://www.graphpad.com/quickcalcs/chisquared1.cfm . If you enter the sample data above into this calculator, you would write the results like this: $\chi^2(1) = 5.400$, $p = .020$. From the p-value we can infer that there is only a 2% chance these results would differ from chance (i.e., the null hypothesis) by a fluke. Since this is less than 5%, by convention we say that we can reject the null hypothesis because our result is, "statistically significant."

If lab groups formed hypotheses beyond a replication, the statistics may be more complicated. I recommend at least 15 participants per condition / kind of person. For example, maybe students hypothesized that different proportions of teachers and students show the confirmation bais. To compare the proportions you would conduct a Chi Square Test of Independence with an online calculator such as: https://www.graphpad.com/quickcalcs/contingency1/ . Your students' table might look like this:

Response to 2-4-6 Task	Students	Teachers
Falsification Bias	6	3
Confirmation Bias	9	12

Though it looks like teachers have a greater tendency to use the confirmation bias than students (80% vs. 60%) the statistic is $\chi^2(1) = 1.429$, $p = .232$. The p value shows there is a 23.2% chance the result was just a fluke, so we cannot reject the null hypothesis. That is, teachers and students probably have similar cognitive biases. For a brief summary of basic inferential statistics with common ways of showing the results graphically, please see this one-page summary:

http://PerplexingQuestions.org/science_fair/science_fair_statistics.pdf

Authors Note: The copy of record links to the handout, but I attach it as the next page for your convenience. Since publication, I have refined my websites, so if you would like slides and a detailed guide to playing the 2-4-6 game as a class activity, please see: **CopernicanRevolution.org**

Name: ____ ________ ________ ________

Let's Do Science! What Sequences Make Me Happy?

A sequence of numbers has an order. For example, 1-2-3 is a different sequence from 3-2-1. Some sequences of 3 numbers make me happy. Your goal is to figure out the rule for what sequences make me happy. You can make up a 3 number sequence and I'll tell you if it makes me happy. Then you can make up another sequence, I'll tell you again, and we'll keep going until you're mostly confident you know the rule inside my head. Let's do the first sequence together. 2-4-6. It turns out the sequence makes me happy! Now that you have feedback from me, make your best guess for the rule making me happy (e.g., "counting up by 2's."). Estimate roughly how certain you are the rule you guessed really is the rule for sequences making me happy (i.e., 0% to 100%). Now it's your turn. Write your own sequence of 3 numbers to test me. ***Wait until I give you a happy or sad face.*** Once I give you feedback, write your hypothesis. Say how sure you are. Make another sequence. And repeat until you're confident you know the rule in my mind for sequences making me happy.

Sequence	Fits My Rule?	Guess What Rule Makes Me Happy	How Sure?
2, 4, 6	☺		