Warped Words and the Stroop Effect

Abstract

The Stroop effect describes an experiment about the time it takes to name the color of printed words. When you try to name the color in which color words are printed, it takes longer when the color word differs from the ink color than when the color word is the same as the ink color. This project is an interesting variation: what happens if you 'warp' the words into a curved shape that is harder to recognize as a word? Will the Stroop effect still happen? How 'warped' do the words have to be in order to negate the Stroop effect?

Objective

The goal of this project is to determine if manipulations of words (e.g., rotation, mirror reversal, bending into circles), can eliminate the Stroop effect.

Introduction

The Stroop effect describes an experiment about the time it takes to name the color of printed words. When you try to name the color in which color words are printed, it takes longer when the color word differs from the ink color than when the color word is the same as the ink color.

To give you an idea of how the Stroop effect works, here is a task for you to try:

1. Following this list of instructions are two gray boxes that each contain a list of words.
2. The words appear in color on your screen.
3. The task is to name the color of the letters of each word (*not* to read the words).
4. Try to the name each color as quickly as possible.

red green blue yellow black white yellow blue black green white red

white black yellow green blue red black yellow white blue green red

Naming the colors was much harder for the second box, right? You may even have felt like you were fighting back an urge to read the color word out loud, rather than naming the color of the letters. This phenomenon was described in 1935 in a now-famous paper by John Ridley Stroop, and is known in experimental psychology as the Stroop effect. One explanation for the Stroop effect is called *interference*. From the earliest years of school, reading is a task that people practice every day. We become so good at it that we read words automatically. When we are asked to name the color *of* the word instead of reading the word, somehow the automatic reading of the word interferes with naming the color of the word.

This experiment explores what you can do to change the presentation of the word in order to eliminate the Stroop effect. For example, if you print the words in the shape of a circle, does it make reading the word slow enough so that the interference effect is reduced or canceled? Does it make a difference if the letters are in clockwise order or counterclockwise order? Figure 1 below has examples to show what we mean, and the Experimental Procedure section has a pdf file that you can download and print (requires Adobe Acrobat).

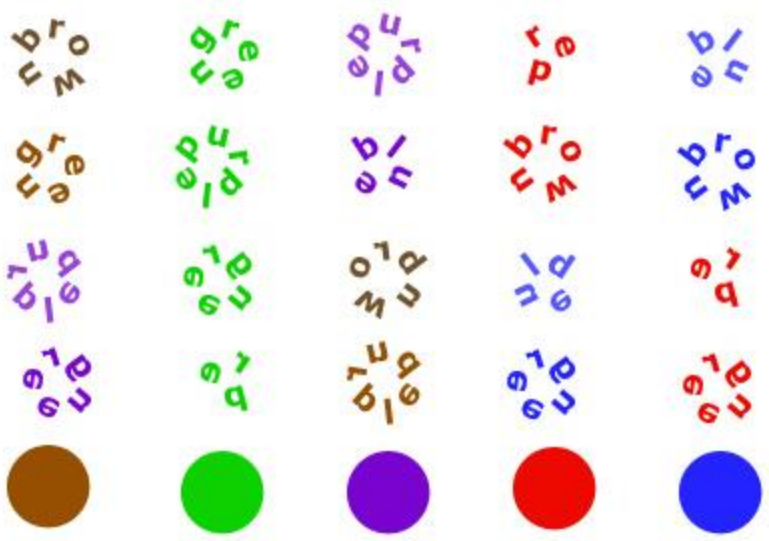

Figure 1. Examples of the five different 'warped' words test stimuli. The first line has clockwise words that match the ink color. The second line has clockwise words with non-matching ink color. The third line has counterclockwise words with matching ink color. The fourth line has counterclockwise words with non-matching ink color.

Will warping the words into a circle prevent automatic reading and the interference effect that goes with it? Does it matter if the letters are arranged in clockwise vs. counterclockwise order? Try this experiment to find out!

Terms, Concepts, and Questions to Start Background Research

To do this project, you should do research that enables you to understand the following terms and concepts:

- Attention
- Perception
- Interference
- Anterior cingulate gyrus
- Cognitive psychology
- Experimental bias

Questions

- How does the concept of interference help to explain the Stroop effect?

Bibliography

- Try these webpages for background information on the Stroop effect:
    - Chudler, E. et al., 2006. "Neuroscience for Kids: Stroop Effect," Neuroscience for Kids, University of Washington, Seattle [accessed May 1, 2007] http://faculty.washington.edu/chudler/words.html.
    - APA, 2007. "Interference: The Stroop Effect," American Psychological Association

[accessed May 1, 2007] http://www.apa.org/science/stroop.html.

- This article from *Science News* shows how Stroop's experimental work from 1935 has had a lasting influence on experimental psychology. You may be able to find it at your local library, or it can be purchased from *Science News* archives online for a modest fee:
  Bower, B., 1992. "Brother Stroop's Enduring Effect: A Mental Task Devised Nearly 60 Years Ago Still Intrigues Psychologists," *Science News* 141: 312–314.
- This is the original paper, from which the Stroop effect gets its name:
  Stroop, J.R., 1935. "Studies of Interference in Serial Verbal Reactions," originally published in *Journal of Experimental Psychology* 18: 643–662, available online from Classics in the History of Psychology, York University, Toronto, Ontario [accessed May 1, 2007] http://psychclassics.yorku.ca/Stroop/.

Materials and Equipment

To do this experiment you will need the following materials and equipment:

- Computer with a color printer
- Five sheets of cardstock (available at an office-supply store or stationer)
- Five envelopes
- Stopwatch
- Volunteers to take a simple color-naming test
  - To see how many volunteers you need, check out the Science Buddies resource Sample Size: How Many Survey Participants Do I Need?.
  - For ISEF-affiliated science fairs, studies involving human subjects require prior approval. For more information, see Projects Involving Human Subjects.

Shop for Supplies at Science Buddies Online Store

Science Buddies has compiled some suggestions for harder to find items in our Amazon store. The store does not include every item for every project, but it does include items that we feel work for the projects on our website. If you have comments or would like us to add items to the store, please contact us at scibuddy@sciencebuddies.org.

Experimental Procedure

Note: for ISEF-affiliated science fairs, studies involving human subjects require prior approval. For more information, see Projects Involving Human Subjects.

Experiment Overview

This science fair procedure calls for two different experiments, a *positive control experiment* and an *interference test*. Details for each are discussed below. Please note that the same volunteers can participate in both experiments. But, to ensure that you are not introducing **experimental bias**, randomly assign volunteers to two groups. Group one will do the positive control experiment first and the interference test second. Group two will do the interference test first and the positive control experiment second.

Positive Control Experiment: Demonstrating the Stroop Effect

1. Do your background research so that you are knowledgeable about the terms, concepts, and questions, above.
2. Click here for a pdf file (requires Adobe Acrobat) with four pages of color words that you can use as a positive control for this project. Each page has the 20 sequences of five color words (red, blue, green, brown, purple) printed in pseudo-random order.
    a. Page one in the file has color words printed in matching color ink.
    b. Page two in the file has color words printed in different color ink (five examples of each different color).
    c. Note: pages three and four have the color words printed in black ink. These are not needed for this experiment.
    d. Print the pages you need on card stock (for sturdiness), then cut them into horizontal strips.
    e. Lightly label the backs of the strips, and keep the two sets in separate envelopes.
    f. Your volunteers will call out the ink colors as they read through the strips.
3. For each volunteer, instruct them on what they are supposed to do in the test:
    a. You will be given cards containing a sequence of words printed in colored ink.
    b. The ink colors used are red, blue, green, brown, and purple.
    c. The task is to call out the ink color of each word as quickly as possible without making a mistake.
4. Time how long it takes for the volunteer to name the colors of the non-matching words.
5. Time how long it takes for the volunteer to name the colors of the matching words.
6. For half of the volunteers, reverse the order and have them name the colors of the matching words first.
7. Calculate the average time to name the colors for each word list.
8. Calculate the time *difference* for each volunteer (i.e., non-matching word time minus the matching word time). Then calculate the average difference for the group of volunteers.
9. Make bar graphs to illustrate your results.

Interference Test: Does "Warping" the Color Words Block the Stroop Effect?

1. Click here for a pdf file (requires Adobe Acrobat) with five pages of circular test stimuli that you can use for this project.
    a. Page one in the file has clockwise color words printed in matching color ink. (Each color word appears twenty times.)
    b. Page two in the file has clockwise color words printed in different color ink. (Each color word appears in each of the four non-matching colors five times.)
    c. Page three in the file has counterclockwise color words printed in matching color ink (five examples of each different color).
    d. Page four in the file has counterclockwise color words printed in different color ink (five examples of each different color).
    e. Page five has solid colored circles of the same size as the circular words from pages 1–4.
    f. Print the file on five separate pages of card stock (for sturdiness), then cut them into

horizontal strips.

g. Lightly label the backs of the strips, and keep the five sets in separate envelopes.

h. Your volunteers will call out the ink colors as they read through the strips.

2. For each volunteer, instruct them on what they are supposed to do in the tests:
    a. You will be given cards containing a sequence of words printed in colored ink, or circles printed in color ink.
    b. The ink colors used are red, blue, green, brown, and purple.
    c. The task is to call out the ink color of each word (or circle) as quickly as possible without making a mistake.
3. Time how long it takes for the volunteer to name the colors of each test set.
4. Mix up the order of presentation of the sets for different volunteers.
5. Calculate the average time to name the colors for each set.
6. Calculate the time differences for each volunteer between the time to name the clockwise non-matching color word set and the clockwise matched color word set.
7. Calculate the time differences for each volunteer between the time to name the counterclockwise non-matching color word set and the counterclockwise matched color word set.
8. Calculate the time differences for each volunteer between each of the four word sets and the solid color circles. Is this time difference close to zero for any of the four sets? If so, what can you conclude about interference for that word set?
9. Make bar graphs to illustrate your results.

Variations

- For a basic project on the Stroop Effect, see the Science Buddies project What Conflicting Mental Tasks Reveal About Thinking: The Stroop Effect.
- Does interference still occur if the test words are turned upside down or rotated 90°? Design an experiment to find out.
- For an alternative experiment that investigates whether the Stroop effect occurs with shapes, see the Science Buddies project Shaping Your Thoughts?
- **Advanced.** Does practice make any difference with this experiment? For example, you may find little interference when reading the 'warped' words, and you might expect the interference to increase with practice as people become more accustomed to reading them. On the other hand, you might expect interference to decrease with practice as people become more accustomed to calling out the ink color. Design an experiment to find out what happens with practice. For a super-advanced project, can you figure out different practice routines to push the result one way or the other?
- For more science project ideas in this area of science, see Human Behavior Project Ideas.

Credits

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Sources

- Chudler, E. et al., 2006. "Neuroscience for Kids: Stroop Effect," Neuroscience for Kids,

University of Washington, Seattle [accessed May 1, 2007] http://faculty.washington.edu/chudler/words.html.

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- Stroop, J.R., 1935. "Studies of Interference in Serial Verbal Reactions," originally published in *Journal of Experimental Psychology* 18: 643–662, available online from Classics in the History of Psychology, York University, Toronto, Ontario [accessed May 1, 2007] http://psychclassics.yorku.ca/Stroop/.

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