www.sciencemag.org/cgi/content/full/science.1207745/DC1

# Supporting Online Material for

## Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips

Betsy Sparrow,* Jenny Liu, Daniel M. Wegner

*To whom correspondence should be addressed. E-mail: sparrow@psych.columbia.edu

Published 14 July 2011 on *Science* Express
DOI: 10.1126/science.1207745

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## Supporting Online Material

### *Experiment 1: Method*

*Participants.* Forty-six undergraduate students (28 female, 18 male) at Harvard University were tested in a within subjects experiment, with two counterbalanced blocks between participants. They received partial course credit or payment for participating. No sex effects were found in this or any of the following four experiments, and thus will not be mentioned in the analyses.

*Materials.* Participants answered 16 easy and 16 hard questions (see Appendices A and B). Participants completed a Modified Stroop Task (*10*) after each block of questions. A Modified Stroop replaces the usual color words with words of interest, for which you would expect interference due to priming. In this case, we expect participants to have computer terms in mind, because they desire access to the information which would allow them to answer difficult questions. Participants are presented with words in either blue or red, and were asked to press a key corresponding with the correct color. At the same time, they were to hold a 6 digit number in memory, creating cognitive load. This color naming contained 8 target words related to computers and search engines (e.g., Google, Yahoo, screen, browser, modem, keys, internet, computer), and 16 unrelated words (e.g., Target, Nike, Coca Cola, Yoplait, table, telephone, book, hammer. nails, chair, piano, pencil, paper, eraser, laser, television) which were matched for frequency to the target words (*11*) and presented in random order. No explicit mention was made of the difficulty of the questions, nor to the types of words that were included in the Stroop. An increased reaction time is the outcome measure, demonstrating interference, due to the salience of the word, in naming the color.

*Design & Procedure.* Participants first answered a block of either easy or difficult questions, then performed a Modified Stroop Task, all presented in Direct RT (*12*), answered the second block, then took a second Modified Stroop. No order effects were found, $F(1,66) < 1$. As a manipulation check, correctness levels were assessed for both blocks. As we intended, participants indeed found the easy questions to be answerable (M=.98), but appeared to guess the answers to the difficult questions (M = .47), a difference that was significant, $t(68) = 31.45$, $p < .001$.

*Results*. Taking out the 4 terms (Google/Yahoo and Target/Nike) which yielded an interaction with easy/hard questions ($F(1,66)$ 5.52, $p < .03$), the interaction between computer and general terms and easy/hard questions remains significant $F(1,66)$ 9.49, $p < .004$.

*Experiment 2: Method*

*Participants.* Sixty undergraduate students (37 female, 23 male) at Harvard University were tested in a between subjects experiment, with four conditions. They received partial course credit or payment for participating.

*Materials.* Participants read and then were asked to type forty trivia statements into Medialab (see Appendix C). Participants then completed a recall task on paper, then a recognition task in Medialab (*13*).

*Design & Procedure.* Participants were given instructions on the computer screen to create four conditions. Participants were told they would be presented trivia statements one by one on the computer screen. They were asked to read the statements, and then type what they read into a dialog box which appeared below the statement. Half of the participants were told to press the spacebar to save what they typed to the computer, and that they would have access to what they typed at the end of the task. The other half were told to press the spacebar in order to

erase what they just typed so that they could type the next statement. In addition, half of those who expected the information to be saved and half of those who believed it would be erased were asked explicitly to try to remember what they typed. Thus saved, saved/remember, erased, and erased/remember conditions were created between subjects. After typing, participants were given a sheet of paper on which to recall as many of the statements as they could remember in ten minutes. Participants were given a half point for remembering some of the statement, and one point if they remembered it perfectly. Participants were then given a recognition task. They saw all 40 statements, half of which had been altered slightly (names or dates altered). Participants had to judge yes or no whether the statement they were now presented with were exactly what they were asked to type.

*Results*. Overall, participants recalled a small proportion of statements, but those who believed that the computer erased what they typed had the best recall. The explicit remember instruction had no significant effect. It may be that all subjects made the assumption that there would be a memory test. However, memory instructions did interact with save/erase beliefs in the recognition task. Here, there were no main effects, but the remember instruction caused greater memory for erase participants (M = .87), and the least recognition for saved participants (M = .78), with the other two, no explicit memory instruction groups falling in between (Save M = .83 and Erase M = .81), $F$ (3, 56) = 3.21, $p < .03$. In the case of recognition, the explicit remember instruction only improved the performance for those who did not expect to have access to the information later. Those who were asked to remember, but believed they would have a cheat sheet, because they would have the information available to them, were least concerned about explicitly remembering.

## *Experiment 3: Method*

*Participants.* Twenty-eight undergraduate students (20 female, 8 male) at Columbia University were tested in a within subjects experiment with three factors. They received partial course credit or payment for participating.

*Materials.* Participants typed thirty trivia statements into Medialab (see Appendix C, first 30 statements). Participants then completed a recognition task in DirectRT, where they were asked three questions: 1) Is this statement the exactly the one you were previously asked to read? 2) Was the original statement saved or erased? And 3) Which folder, if any, was the statement saved into?

*Design & Procedure.* Participants were given instructions on the computer screen to create three within-subject conditions. For one-third of the questions, participants were shown "Your entry has been saved." For a second third, participants were shown "Your entry has been saved into the folder FACTS" (or DATA, INFO, NAMES, ITEMS, POINTS, these folders were named to be interchangeable and the trivia statements were previously randomly assigned to them), and for the final third, participants were told "Your entry has been erased." The order that each statement was presented was randomly generated by Medialab. Thus generically saved, saved in a specific folder, and erased trials were created for all participants. Participants were then given a recognition task. They saw all 30 statements, half of which had been altered slightly (names or dates altered). Participants had to judge yes or no whether the statement they were now presented with were exactly what they were asked to type, whether the statement was saved or erased, and finally if the statement was saved to a folder, they had to recognize which folder the statement was saved into (they were given the folder names, they also had "no specific folder" and "erased" as answer options to this last question).

## *Experiment 4: Method*

*Participants.* Thirty-four undergraduate students (16 female, 18 male) at Columbia University were run in a within subjects experiment with three factors. They received partial course credit or payment for participating. Two participants were missing data, yielding a final sample of 32.

*Materials.* Participants read and then typed thirty trivia statements into Medialab (see Appendix C, first 30 statements). Participants then completed a recall task on paper and in DirectRT.

*Design & Procedure.* Participants were given instructions on the computer screen to create one condition. Participants were shown "Your entry has been saved into the folder FACTS" (or DATA, INFO, NAMES, ITEMS, POINTS). Participants were given the expectation that they would have access to what they saved, through a pretend practice trial where they had access to the file folders during a "recall" task. The order that each statement was presented was randomly generated by Medialab. Participants were then given a recall task, where they were given ten minutes to write down as many of the statements as they remembered. Participants were then given an identifying feature of the statement that they read then typed (and had been saved), and they had to answer with the folder in which it was saved. For example for the statement "An ostrich's eye is bigger than its brain" the question would be "What folder was the statement about the ostrich saved?" Participants had to type into a dialog box "Items" to recall correctly. The folder names were purposefully generic sounding, and each of the 30 saved statements was randomly assigned to a folder before the experiment began. Participants were not reminded of the folder names before the recall task began.

## Appendix A: Easy Questions Presented on Computer Screen

1. Are dinosaurs extinct?
2. Was Moby Dick written by Herman Melville?
3. Is the formula for water H20?
4. Is a stop sign red in color?
5. Are there 24 hours in a day?
6. Is the current president of the United States Ronald Reagan?
7. Does 8 plus 8 equal 16?
8. Was John F. Kennedy assassinated in 1994?
9. Is oxygen a metal?
10. Are there 15 months in a year?
11. Is ketchup made with tomatoes?
12. Does 5 plus 7 equal 30?
13. Was Romeo and Juliet written by William Shakespeare?
14. Do all countries have at least two colors in their flags?
15. Was Cat in the Hat written by J.D. Salinger?
16. Does a triangle have 3 sides?

## Appendix B: Hard Questions Presented on Computer Screen

1. Does Denmark contain more square miles than Costa Rica?
2. Did Benjamin Franklin give piano lessons?
3. Does an Italian deck of card contain jacks?
4. Did Alfred Hitchcock eat meat?
5. Are more babies conceived in February than in any other month?
6. Do all countries have at least two colors in their flags?
7. Was Czar Nicholas II executed in 1917?
8. Is Krypton's atomic number 26?
9. Is the average age of a human eyelash 150 days?
10. Was Pompey defeated by Julius Caesar in 48 B.C.?
11. Were family names first used in Roman times?
12. Is myrmecophobia fear of ants?
13. Is Jones the most common name in America?
14. Do insects feel hunger?
15. Was Pepin king of the Franks from 482 to 511 A.D.?
16. Is a quince a fruit?

## Appendix C: Trivia Statements Typed Into Computer

1. Saddam Hussein has been executed.

2. Greenland is the world's largest island by area.

3. The Tsunami disaster in Asia occurred in December 2004.

4. A cow produces nearly 200,000 glasses of milk in her lifetime.

5. Bluebirds cannot see the color blue.

6. Michael Jackson was acquitted of molestation charges.

7. Only two countries border three oceans, the United States & Canada.

8. There was a terrorist bombing in the subways of London in July 2005.

9. There have been 43 presidents of the United States.

10. Ingrown toenails are hereditary.

11. ABC news anchor Peter Jennings was a high school dropout from Canada.

12. Pope Benedict XVI deserted the German Army during World War II.

13. The highest point in Pennsylvania is lower than the lowest point in Colorado.

14. Europe is the only continent without a desert.

15. The collapse of the Larsen B ice shelf in Antarctica began in January 2002.

16. The space shuttle Columbia disintegrated during re-entry over Texas in Feb 2003.

17. The international telephone dialing code for Antarctica is 672.

18. A quarter has 119 grooves around the edge.

19. Rubber bands last longer when refrigerated.

20. French Fries are originally from Belgium, not France.

21. Al Capone’s business card said he was a used furniture dealer.

22. Without glasses, John Lennon was legally blind all of his life.

23. The Atlantic Ocean is saltier than the Pacific Ocean.

24. The Dominican Republic has the only national flag with a bible in it.

25. The Live 8 concerts took place in the G8 nations and South Africa in July 2005.

26. The NATO bombing of Yugoslavia began in March 1999.

27. There are an average of 178 sesame seeds on a McDonald's Big Mac bun.

28. In Chinese script, there are more than 40,000 characters.

29. An ostrich's eye is bigger than its brain.

30. A person burns more calories when sleeping than when watching television.

31. Babe Ruth earned the nickname The Sultan of Swat for his home run hitting ability.

32. Albert Einstein's first job after graduation was evaluating patent applications for electromagnetic devices.

33. The Himalayan mountains continue to grow due to the collision of tectonic plates.

34. The great Pyramids of Giza are the only one of the Seven Wonders of the Ancient World that still exists.

35. North Korea announced that it had conducted a successful nuclear test in Oct 2006.

36. Chechen separatists in Southern Russia took a school hostage in Sept 2004.

37. The longest classical composition would take 639 years to perform.

38. A person will shed over 40 pounds of skin in their lifetime.

39. Peanuts are one of the ingredients of dynamite.

40. A shrimp's heart is in its head.

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