Assignment 1: The Cognitive Revolution

What is cognitive psychology, and where did it come from? The materials for this assignment focus on the cognitive revolution, which began in the 1950s and can be viewed as the birth of cognitive psychology. There are three assigned resources:

1. The video and short article available here:

   http://news.harvard.edu/gazette/story/multimedia/the-cognitive-revolution

   This resource provides a good introduction to the cognitive revolution, but be aware that it is a little Harvard-centric– there were researchers at places other than Harvard who made fundamental contributions to the cognitive revolution, including Newell and Simon at CMU.

2. Anderson textbook, pp 7 – 12

   An introduction to behaviorism, cognitive psychology, and information-processing approaches

3. Gardner, The Mind's New Science: A history of the Cognitive Revolution, pp 89 – 96

   This extract describes three influential lines of research that helped to launch the cognitive revolution.

Questions 3 and 4 relate to the Sternberg search task, which is one of the first assigned CogLabs. You will probably find it useful to complete this CogLab before answering Questions 3 and 4.

Each question will be graded by a different person. Please take this into account and make sure that your answers to each question stand alone.

You may discuss the assigned materials with other students, but should provide your own answers to each question. More precisely, your answers should represent your own ideas, and your own way of organizing and explaining these ideas. Please put your ideas in your own words— you may quote key phrases from the article if you like, but as a rule of thumb any direct quote should be at most a few words long.

A FAQ for this assignment will be maintained on Blackboard. Please check the FAQ before contacting us with questions.

SUBMISSION INSTRUCTIONS

Please type your answers in the box below each question. Don't feel that you need to use the entire space provided for each question: full credit can often be earned for carefully constructed responses that use half of the space or less. When you are finished:

1. Print out a copy of your answers and turn it in before the end of class on the due date. Make sure that you fill in and include the cover sheet that appears on the next page. Important: **please put your name on top of each page** and **print out your answers single-sided**. We will separate your packet and distribute different pages to individual graders.
2. Upload the file to the course website on Blackboard. The file should be uploaded via the Assignments page. The uploaded file will give us a permanent copy of your assignment (in case of query or loss of the paper copy). If you're having trouble submitting your file, try using a different browser before contacting us. Note that submitting an electronic copy alone is not sufficient – **if you do not submit a hard copy, then you will not receive any credit for this assignment.**
3. Questions 3 and 4 ask you to draw flow diagrams and sketch graphs. If you choose to submit hand-drawn diagrams for these questions, it's fine to leave the corresponding boxes on the electronic copy blank.

PLEASE FOLLOW THE ABOVE INSTRUCTIONS CAREFULLY. To encourage you to do so, 10 % of your assignment grade will depend on following the instructions correctly.

- If you do not print out your answers single-sided and write your name on each page, you will lose 5% of your grade.
- If you do not upload an electronic copy of your assignment to the Assignments page on Blackboard, you will lose 5% of your grade.

Turn in this homework in class on Thurs September 5 or earlier to Rony's mailbox (BH 336D).

COVER SHEET

Honor code:

“My responses to these questions represent my own ideas and I have not received undue assistance from any source”

Your signature: _____

Please choose one of the following options:

☐: I would like to pick up my graded assignment at the end of class. The final grade will be written on the underside of the first page, but I understand that others may see my graded work.

☐: I prefer that my graded assignment not be distributed at the end of class, and understand that I will need to collect it during Rony’s office hour .

Your signature: _____

1) Miller wrote a paper called “The magical number seven, plus or minus two.”

(a) Explain what memory researchers are referring to when they talk about the “magical number seven.”

Memory researchers use the “magical number seven” to refer to an apparent limit in most individuals' working memory capacity. In a variety of experiments, individuals reasoning abilities decreased sharply when the number of items about which they had to concurrently reason increased beyond a certain number, typically in the range of five to nine (i.e., seven plus or minus two).

(b) Explain in your own words why the magical number seven is relevant to the debate between behaviorism and cognitive psychology.

The “magical number seven” result reflected an interest in studying the internal mechanisms of behavior (in this case, a finite memory capacity), rather than simply regarding behavior as a function of external stimuli, as behaviorists had done.

The quantitative nature of the result also differentiated cognitive psychology from introspectionism, or other approaches the behaviorists criticized as not scientifically rigorous. In particular, in quantifying memory capacity, the result evidenced the new computational and information theoretic tools on which the rigorous approach of cognitive science was based.

2) Page 92 of the Gardner reading shows what may be the first flow chart developed by cognitive psychologists. Don't worry about the details of this chart – we'll discuss similar charts later in class.

(a) Why do you think that cognitive psychologists found flow charts useful when formulating their theories?

One of the primary goals of cognitive scientists was to describe behavior in terms of information processing in the brain. Flow charts are a convenient means for illustrating information flow between different physical regions or processing steps. Indeed, flow charts are commonly used in both communications theory and computer science, fields which inspired many of the methods of cognitive psychology.

(b) Why might a behaviorist be uncomfortable with flow charts like the one on p 92?

Cognitive psychologists use flow charts to illustrate models of information processing in the brain. The behaviorist approach avoided any discussion of internal processes on the basis that internal processing was inessential to understanding cognition and behavior and could not be studied rigorously.

3) The Sternberg study described on p 10 – 12 of the textbook is a classic example of how cognitive psychologists use behavioral data to draw conclusions about psychological processes. Sternberg used the data in Fig 1.1 to argue for an underlying process that might be called “exhaustive serial search”—exhaustive because the probe is compared to all digits in the memory set, and serial because these comparisons are carried out one by one. Consider two alternative processes:

“Self-terminating serial search:” The comparison process terminates as soon as a match is found.

“Parallel search:” The probe digit is compared to all of the memorized digits simultaneously.

Draw flow diagrams like Fig 1.2 to illustrate the steps involved in the following cases:

(a) Process = self-terminating serial search, test set = “3 9 7”, probe digit=9

(b) Process = self-terminating serial search, test set = “3 9 7”, probe digit=4

(c) Process = parallel search, test set = “3 9 7”, probe digit = 9

(d) Process = parallel search, test set = “3 9 7”, probe digit = 4

4) Sketch diagrams like Fig 1.1 that show the response times predicted by the alternative processes mentioned in question 3 (i.e. self-terminating serial search and parallel search). Fig 1.1 shows points of different colors for “targets” and “foils” – instead of plotting individual points, you should join them up to form a “target curve” and a “foil curve.” In other words, each sketch should include a “target” curve for cases where the probe digit is present in the test set and a “foil” curve for cases where the probe digit is not present in the test set. Make sure that you clearly label the two curves

On any given trial, the response time for a “present” trial may depend on whether the probe digit appeared near the start or the end of the test set. Please plot target curves which show what you'd expect if you averaged across many experiments where the location of the probe digit (e.g. first,third, etc) was randomly chosen each time.

The x axis for each plot should run from 1 to 7 – don’t worry about what happens when the size s is zero. For each plot, you can assume that the y value for the “present” curve is 400 ms when s = 1, and that each comparison step takes 40 ms.

(a) self-terminating serial search

(b) parallel search

(c) In your sketch for (a), are the target and foil curves the same? If so, explain why – if not, explain why these curves differ.

The target curve has half the slope of the foil curve. Since the target search terminates after querying, on average, half of the digits, the target response time increases about half as much per digit as does the foil response time.

(d) In your sketch for (b), are the target and foil curves the same? If so, explain why – if not, explain why these curves differ.

The curves are identical. Since the parallel search is necessarily exhaustive, the target search does not benefit from self-termination, and the only difference between the two search processes is the final output.

5) Explain in your own words how the development of the computer contributed to the cognitive revolution.

Most fundamentally, the development of the computer inspired an interest in studying abstract information processing and representation. Many fields, including information theory, algorithms, and artificial intelligence were inspired by abstract problems in computer science, but were adapted by cognitive scientists to answer questions about human behavior.

Since computers solve many of the same problems as the brain and had been analyzed extensively by computer scientists, computers gave cognitive scientists an established language in which to phrase their understanding of cognition (for example, the linear response time found in the Sternberg Search Task suggests that the brain stores certain numeric information in an unsorted linear structure, as opposed to, say, a tree-like structure).

Finally, more recently, the computer has allowed cognitive scientists to compute models with large amounts of data and to simulate complex cognitive models, allowing the use of much more powerful analyses.