International selection
Cognitive Studies

June 2013

1 Short term visual memory

1.1 First study

In a study of 1997, ("The capacity of visual working memory for features and conjunctions", *Nature*, 390, 279–281), Luck and Vogel show an array of 1 to 12 colored squares during 0.1 second, followed by a blank of 0.9 sec. and finally a test array for 2 sec. In half of the trials, the test array is identical to the sample array, in the other half one individual square has a different color. Performance is measured with a binary decision "identical" / "change".

The authors do the following variations on the base task:

1. With or without verbal interference (in which case participants are required to recall two digits given at the beginning of the trial and say them out loud at the end of the trial): Figure 1, left;
2. A frame is present or not present to cue participants with respect to the square that has potentially changed. Presentation time of the first screen is increased: Figure 1, right;
3. Stimuli are now oriented, colored bars, and the task is about one or the other aspect (it is fixed within a block of trials); or it is on both aspects (in which case participants do not know in advance of each trial which feature is susceptible to change): Figure 2, left;
4. Stimuli vary on color, orientation, size, presence or absence of a gap. Participants are tested on each feature separately or on their conjunction: Figure 2, right;

1.2 Questions

1. What are the roles of the "verbal interference" and "cue" controls (1 and 2 above);
2. Compare the amount of information stored in the critical variations (3 and 4 above); which model of memory could account for these results?

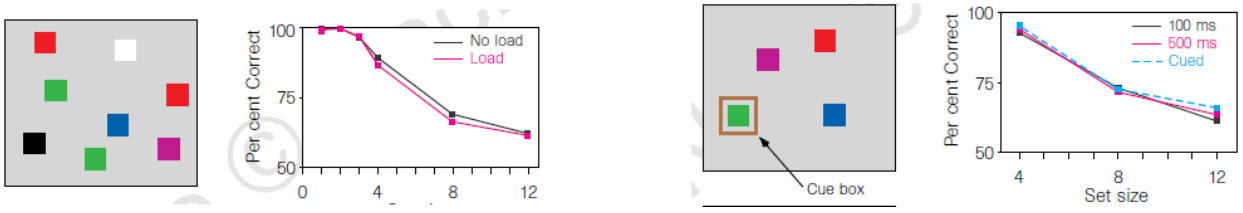

Figure 1: Stimuli and performances in Luck and Vogel study. In all the graphs, percent correct responses is shown as a function of the number of items in the display (set size). Left: "no load": without verbal interference; "load": with verbal interference. Right: with a variation of duration for the to be memorized array (.1 or .5 sec.) and with a frame cue indicating which square has potentially changed.

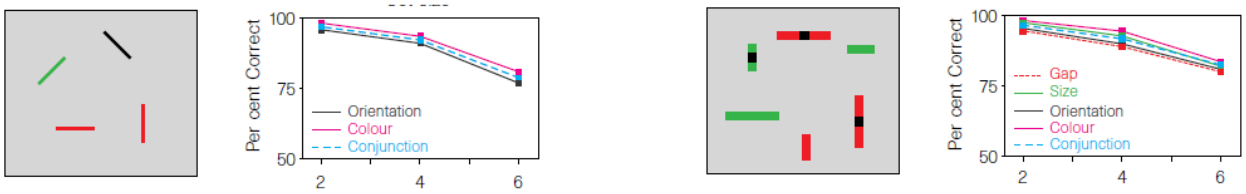

Figure 2: Left: the task is about color, or orientation or their conjunction. Right: the task is about color, orientation, size or gap presence, or about their conjunction.

1.3 Deuxième étude

In a later study Alvarez and Cavanagh (*Psychological Science*, 2004) use two tasks per participant, with the same set of stimuli (see Figure 3): 1- a **change detection** task similar to the one of Luck and Vogel: 1, 3, 5, 7, 9, 11, 13 ou 15 items within one stimulus class are presented for 0.5 sec. After a blank screen (0.9 sec), a second test screen is presented: in half of the trials this second screen is identical to the first, in the other half one of the object has been replaced by another object of the same class. Subjects were instructed to respond by *same* or *different*.

As an estimation of memory capacity, the authors use the number of items for which performance is at 75% (75% threshold), and halve it.

2- A **visual search task**: each trial consisted in the presentation of a target for 0.5 sec., followed by a blank interval (0.9 sec.) and the presentation of an array of 4, 8 or 12 objects from the *same* stimulus class. Subjects were instructed to search for the target as quickly as possible, and press one button if it was present, another one if it was absent. The target was present on half of the trials.

Visual search rate (or processing rate) was estimated by calculating the slope of the line relating target-present response times to the number of objects in the display. Thus, if the response times do not change as a function of the number of presented items, this gives a slope of $0 sec/items$ (0 sec. by item); if the number of distractors slows the search, this number will increase.

Combined results for the two experiments are presented on Figure 4.

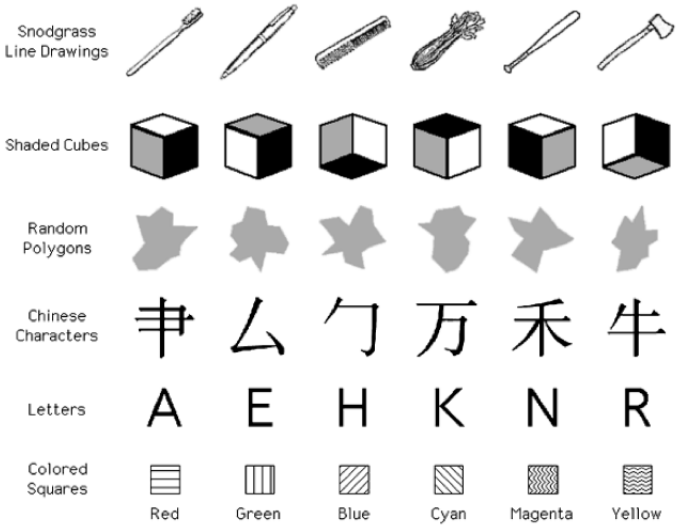

Figure 3: Stimulus set in Alvarez and Cavanagh, 2004

1.4 Questions

1. In the visual search task, if the processing rate is 0 $sec/item$, what is the subjective impression? If it is 1 $sec/item$? From a psychological perspective, what does this rate correspond to? What does it purport to measure that was not estimated by Luck and Vogel?
2. Why do the authors divide the 75% threshold by 2 to obtain an estimate of visual short term memory? What are the limits of such an estimation?

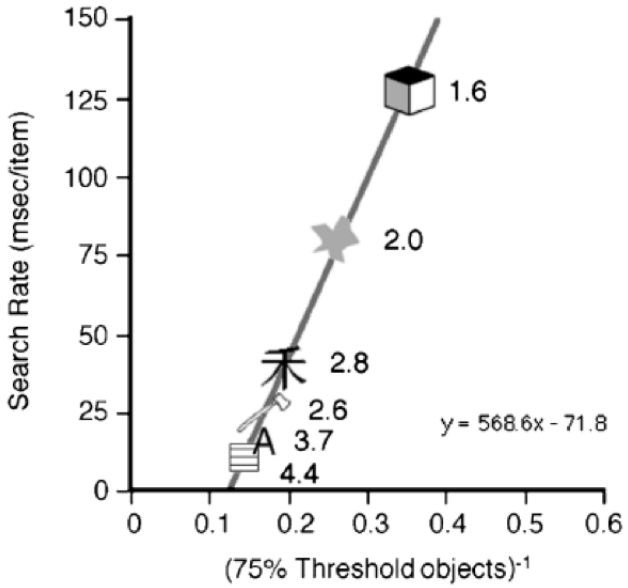

Figure 4: Results of both tasks in (Alvarez and Cavanagh, 2004). The numbers next to the category cartoons are the working memory capacity estimates for each category. The $(75\% thresholdobjects)^{-1}$ corresponds to the inverse of the 75%-threshold number of objects in change detection for each stimulus class in the change detection experiment.

3. What does the intersection of the regression line and the x-axis represent?
4. Which model of short term visual memory does this experiment seem to favor?
5. Explain why these results would seem to contradict those of Luck and Vogel. Discuss this contradiction.

2 Unconscious emotions in decision making

Read Bechara *et al.* (1997) Deciding advantageously before knowing the advantageous strategy, *Science*, 275, 1293–5.

Note: "Skin Conductance Response" (SCR) is the measure of the electrical conductance of the skin — which increases with humidity. This is directly linked to arousal of the sympathetic nervous system. For this reason, SCR is used as a measure of the level of emotional response.

Discuss this article, with the help of the following questions and supplements. **You are encouraged to expound on any other point that you feel is important.**

1. Is there a reason for the use of four decks rather than one good and one bad?
2. In Figure 1, one can see that the total number of cards of the "pre-hunch" period is much more important in patients than in controls. Why?
3. Compare the temporal unfolding of SCR in patients and controls.
4. In Figure 2, draw the cerebral structures corresponding to the various components of the model.
5. The authors note that three patients who reach the "conceptual stage" still chose the "bad" decks. Why?
6. What is the definition of consciousness that the authors use? Discuss.
7. Even if one has a perfect mastery of the situation, to what extent could it be optimal to chose a "bad" deck?

In an article of 2004, Maia and McClelland (*Proceedings of the National Academy of Sciences, USA*, 101, 16075–16080) criticize the methodology and the conclusions of Bechara *et al.*. They re-use the exact same task, but replace the two consciousness questions with a questionnaire (Figure 5), and they obtain the results shown on Figure 6. Maia and McClelland conclude that there is no "unconscious knowledge".

1. What would be the responses to the questionnaire at each of the three stages of Bechara *et al.*?
2. Compare and discuss the use of the questionnaire and of the two questions of Bechara *et al.* as measures of consciousness. What are their merits and limits?

3. Could there be a form of consciousness not captured in any of the two methods?
4. Bechara *et al.* contend that there are two parallel routes in the decision process. Is this hypothesis disproved by Maia and McClelland's results?
5. Maia and McClelland do not measure SCRs. Why?
6. Explain how one could reconcile the results of Bechara *et al.* and of Maia and McClelland. Do we need to suppose that there are two separate routes in the decision process?

Q1. Rate, on a scale of –10 to +10, how good or bad you think deck 1 is, where –10 means that it is terrible and +10 means that it is excellent.

Q2. Okay; why did you rate deck 1 with …?

[Repeat questions Q1 and Q2 for decks 2 through 4.]

Q3. In answering the questions that follow, consider the following definitions. Your "winning amount" for a trial is the amount you won on that trial. Your "loss" on a trial is the amount you lost on that trial. Your "net result" for a trial is the amount you won minus the amount you lost on that trial. Do you understand these definitions and the differences between the three terms? [If not, explain again using examples.]

Okay, now suppose you were to select 10 cards from deck 1.

Q3.1. What would you expect your average net result to be?
Q3.2. What would you expect your average winning amount to be?
Q3.3. In how many of the 10 trials would you expect to get a loss (not necessarily a net loss)?
Q3.4. For those trials in which you would get a loss, what would you expect the average loss to be?

[Repeat question Q3 for decks 2 through 4.]

Q4. Okay, now tell me, on a scale of 0 to 100, how much you think that you know what you should do in this game in order to win as much money as possible (or, if you can't win, to avoid losing money as much as possible). 0 means that you have no idea of what you should do and feel that you still need to explore the game more and 100 means that you know exactly what you should do and have no doubts that that would be the best strategy.

Q5. Now suppose I told you that you could only select cards from one of the decks until the end of the game, but that you were allowed to choose now the deck from which you would draw your cards. Which of the four decks would you pick?

Figure 5: Questionnaire of Maia and McClelland.

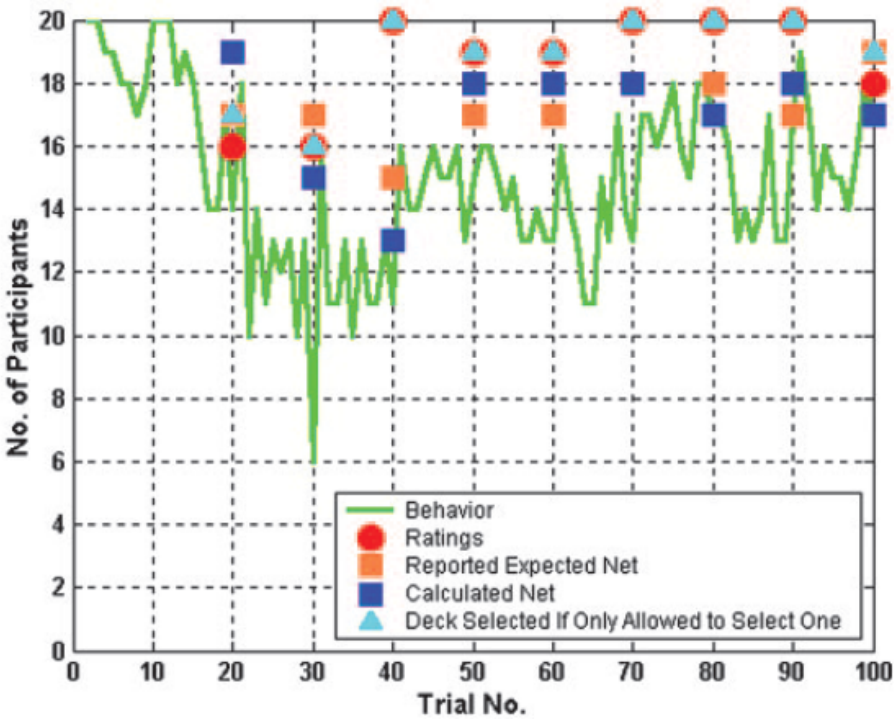

Figure 6: Main results of Maia and McClelland (2004). On the x-axis: trial number. y-axis: Number of participants for the following behaviors and reports: green line: chose one of the "good" decks; red circles: higher rating for one of the good decks; light blue triangle: would choose one of the good decks if needed till the end of the experiment; squares: one of the good decks is preferred, according to expected net estimates.