Hypermnesia and the Primitive Processes of Cognition

by

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My talk this morning is about hypermnesia. Hypermnesia is an increase in memory over time after the study phase has ended. Hypermnesia is measured by repeated testing. In many of the studies of recognition memory all of the studied items are shown during repeated testing. This is not a problem with recall studies because you don't have to show people studied items, they just recall whatever the can. But in recognition there is the potential for a confound if you show people the same pictures three times in a row. Maybe they are just learning these pictures during repeated exposure. Maybe they're just getting more familiar. This is one of the issues that I will deal with in the talk this morning.

In the study I used 27 simple line drawings. These are eight exemplars, taken from Ballard (1913). So, there is a black screen with a line drawing in the foreground. Drawings were presented one at a time.

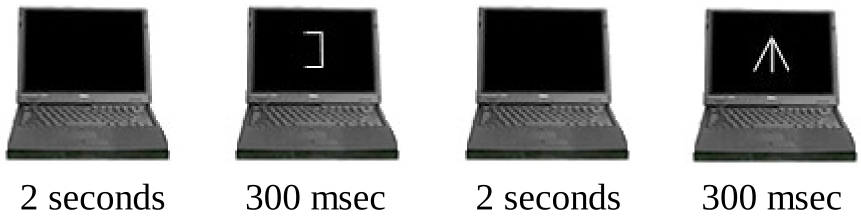
Figure 1. A representative sample of eight line drawings used in the experiments (After Ballard 1913).

There were nine study items and eighteen lures in this experiment. During the study session participants saw the nine study items. During test one they saw three studied items and six of the lures. During test two they saw three studied items and six lures. And, again in test three the same thing.

There are a lot of explanations of hypermnesia.   But the explanation that I am following and trying to apply and develop is based upon item-specific processing and relational processing. Item-specific processing deals with individual items, and it is thought that if you do item-specific processing then you develop more distinctiveness in the mind for the individual items. In contrast, relational processing helps to organize the items in the mind. That would be between-item relational processing.

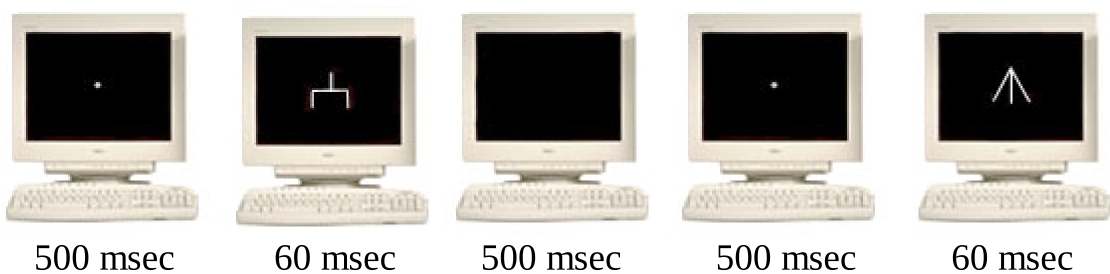
What varied in this study was the amount of time that an image was presented, and then the time between the study session and the first test session. I started out presenting items for 300 milliseconds, and then dropped back to 80 milliseconds, and eventually ended up with about a 60 millisecond presentation of items at study.

Experiment 1



Experiment 2

Experiment 3



In the first study people saw a blank screen for about two seconds. Then an item popped up on the screen for 300 milliseconds and then there was a blank screen and they were to think about how pleasant the item might be. So, this was pleasantness rating. In contrast with pleasantness rating I asked people to try to remember the items. Crowder (1976) showed that if you ask people to remember items when you give them things to study then they tend organize the items in the mind. So, I am assuming that if I ask people to try to remember they'll be doing relational processing. I used the same relational processing task throughout all three of the experiments. I did use some variation in the item-specific processing task that I will cover later.

Now, to the experiment. I wanted the participants to do non-informed study and I wanted to get incidental learning. So, I asked them to rate each item for pleasantness in their mind after they viewed the item. Well, a lot of people knew that there was going to be a recognition test afterward. They tried to remember. This produced a confound, try to remember versus pleasantness rating. Well, I gave an exit interview and I asked them on the exit interview, “Did you really just try to do the pleasantness rating task or did you, maybe, think that there was a test coming and try to remember?” Fourteen people said they tried to remember. So, I eliminated fourteen people and the N was 16. Right off I said, “This is not good. I’ve got to find a better way to go.”

I did get some results for the pleasantness rating group after replacing fourteen people. What I found was a monotonic increase in correct recognition with the item-specific processing task. And there was a significant increase between test two and test three for the people in the pleasantness rating condition. In contrast, the relational processing group showed a monotonic decrease in correct recognition over time.

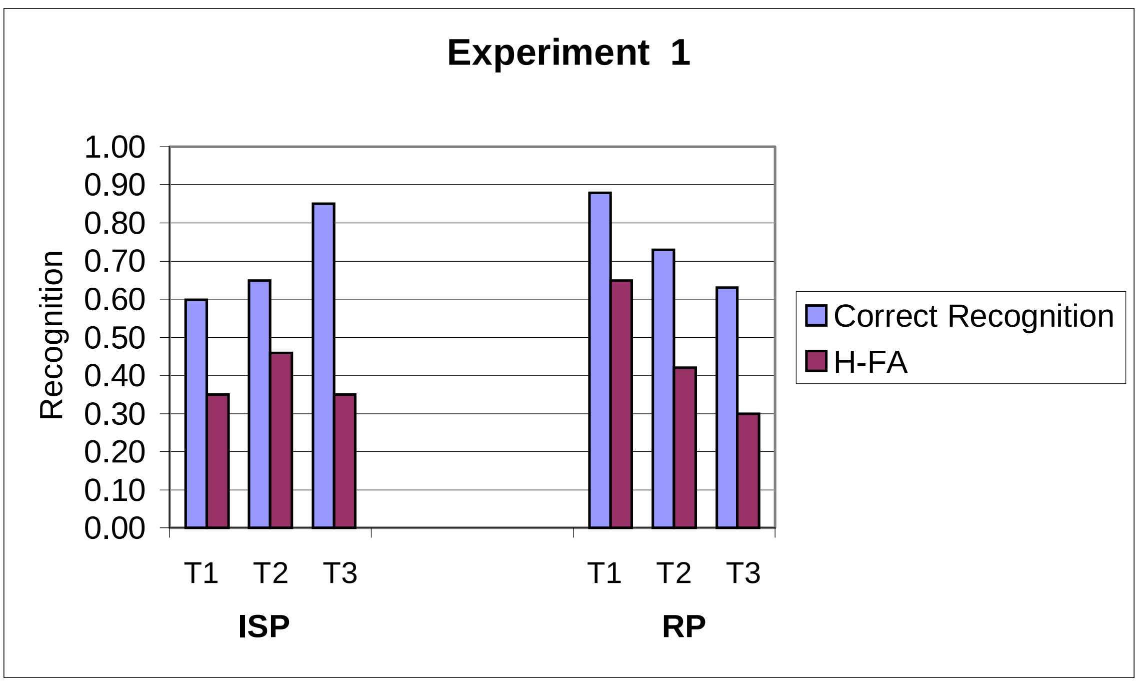


Figure 2. Experiment 1. Correct recognition and hit minus false-alarm (H-FA) scores from an item-specific (ISP) encoding task and a relational (RP) encoding task.

On to a better encoding task.

For experiment two, I was still using the laptop computer. I introduced a focus dot for 500 milliseconds, then presented the study item, and then a blank screen for a second and a half. I asked people during this blank-screen time to try to imagine the item that was just shown. So, I call this an image-formation encoding task. In doing this I had some good things happen. I got an immediate ceiling effect with 300 milliseconds exposure in the individual item group. So, I reduced the item exposure time to 80 milliseconds, and here are the results.

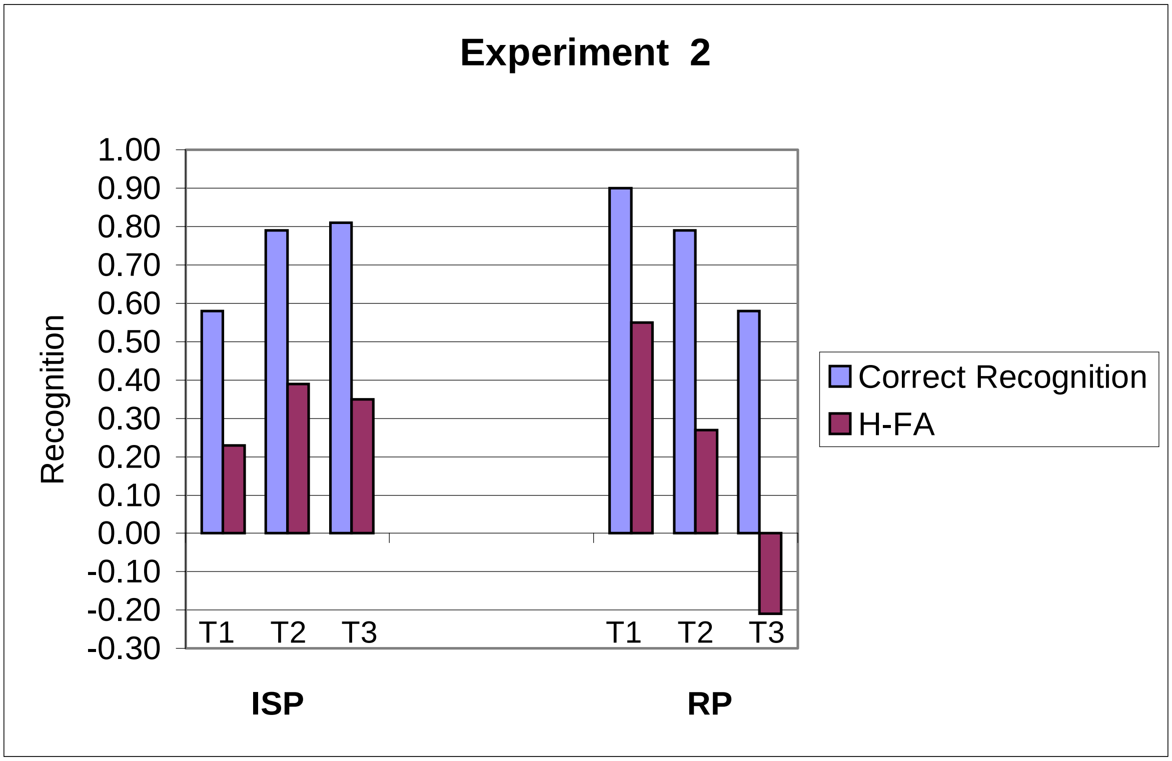


Figure 3. Experiment 2. Correct recognition and hit minus false-alarm (H-FA) scores from an item-specific (ISP) encoding task and a relational (RP) encoding task.

Again, there was a monotonic increase in correct recognition (Notice the item-specific encoding group in Figure 3.), and a monotonic decrease in correct recognition for the relational processing group. The significant difference in correction recognition shifted from between test two and test three to the period between test one and test two. And, I didn't have to eliminate any subjects! I included everybody. The N was again 16.

Now, at this point in time with the laptop experiments I knew that I was going to get hypermnesia. Things were looking good. I got the increase in correct recognition. Hits minus false-alarms were starting to fall in line and I wanted the next experiment to be easy for others to replicate in other environments. With the laptop computer I had used my own C programs and Assembly programs. I had hooked interrupt 8, changing the system timing. It just wasn't something that I felt comfortable putting on the web and letting everybody use. So, I looked around and found SuperLab Pro. SuperLab Pro saved me so much time programming that I used it for experiment three. I think that SuperLab Pro will satisfy your needs if you want to replicate the experiment or perform similar experiments.

So, in experiment three I went from an LCD display to a CRT monitor and I reduced the presentation time for individual study items to 60 milliseconds. People were doing very well with an 80 millisecond presentation rate and showed little variation. By reducing the presentation time to 60 milliseconds I was able to regain some variation in performance.

And here are the results of experiment three, with a two-minute delay. So, we had a significant increase in hit minus false alarm rates for the item-specific processing group between test one and test two. This is interesting. Some of the last papers that were written, in the early 90's, stated that recognition hypermnesia is probably not obtainable and probably doesn't occur. But, here we have a very good example of recognition hypermnesia occurring as measured by an increase in hit minus false alarm rates.

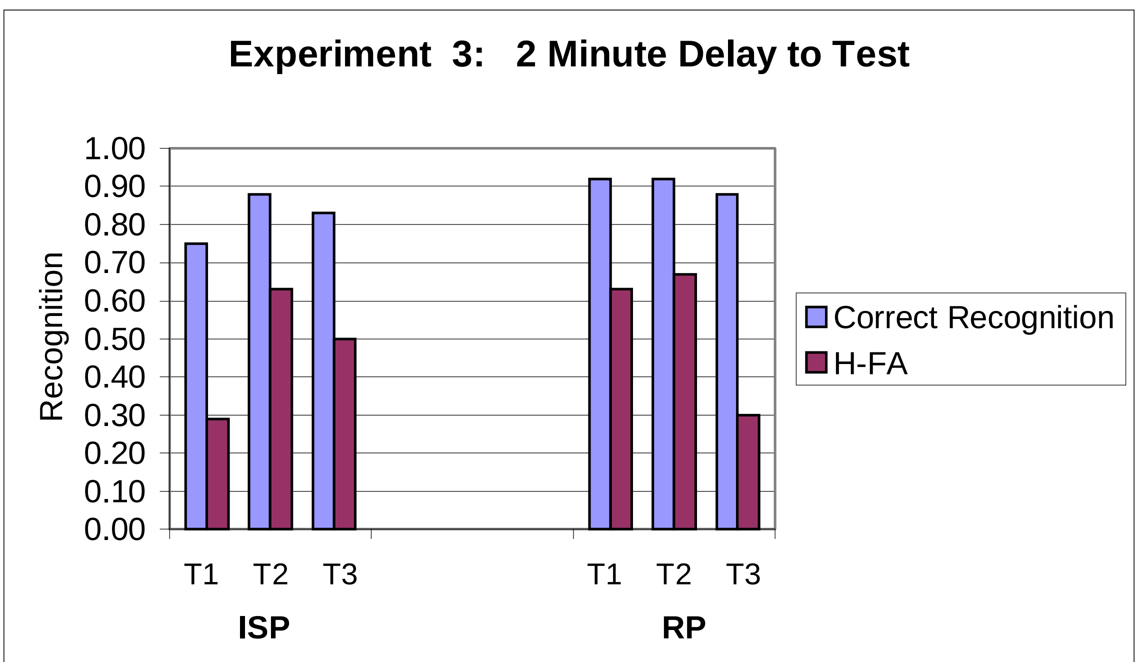


Figure 4. Experiment 3. Correct recognition and hit minus false-alarm (H-FA) scores from an item-specific (ISP) encoding task and a relational (RP) encoding task.

Here is what I think is happening. Earlier we had a three-minute delay between study and test and now we have a two-minute delay between study and test. So, I'm saying that this is a measure of the time complexity of the human memory system that forms this memory for line drawings.

So, I think it is interesting to consider the line drawings, how complex they are, or how simple, and how long it takes to incubate that memory so that you can start getting hypermnesia between the study phase and the test phase. That is the number that I am really interested in. We didn't get hypermnesia at three minutes. We didn't get it at four minutes. So, it looks like two minutes is about where you are going to get hypermnesia for these simple line drawings.

If you were to try to use faces in this recognition study then I would expect that it would take a bit longer because they are a more complex stimuli. The reason that I chose something less than five minutes is based upon some earlier studies with musical phrases. I found that with musical phrases hypermnesia is obtained after about 5 minutes with a five or six tone musical phrase. I know that the neural substrate for the auditory system is less massive than the neural substrate for the visual system. The visual system is a bigger system and the effect is just like what you would expect with a computer. With a computer, a bigger system does the processing faster and the smaller system does it slower.

There were two interesting results that were obtained and set aside, one in experiment one and one in experiment two. In the pleasantness rating task there was one subject that came in and got one right and zero wrong on test one, then one right and zero wrong, and then at the end this subject got one right and six wrong. So, on each test there are three correct images and six incorrect images and this fellow got one right and six wrong on the last test. I thought this was strange. So, I asked the subject if he had any idea why so many incorrect images were selected on test three. The subject did not have an explanation. However, during the study he had commented that the images were changing in his mind about the beginning of test two and again near the beginning of test three. So, I made a note of the session and then set the results aside and did not consider them in the analysis of experiment one. Preferring to consider the results separately.

In experiment two there was a subject that came in and got two right, zero wrong, then the subject got zero correct and six wrong, and again zero correct and six wrong on the last test. So, on the exit interview I asked the subject, "Do you have any idea why this happened?" The subject indicated that she had been diagnosed with dysgraphia and that perhaps this had a bearing on the test results. This adds an interesting dimension to the study as a potential method of screening for dysgraphia.

Since this inversion in the expected response was not obtained with the CRT monitor, used in experiment three, the difference between monitors should be considered and documented. The LCD display has a dimmer display and the contrast is not as great. There is not much difference between on and off with the LCD display.

(Figures 5 and 6 were shown here. Differences in the amount of light produced by the LCD display and the CRT display were pointed out. The difference between a focus dot and a blank screen was about two and one half millivolts with the LCD display. The difference between a focus dot and a blank screen for the CRT display was about 100 millivolts. Next, the time between updating the images on the monitors was discussed. The LCD display was refreshed every 14 milliseconds, or so. The CRT refresh rate was slightly faster.)

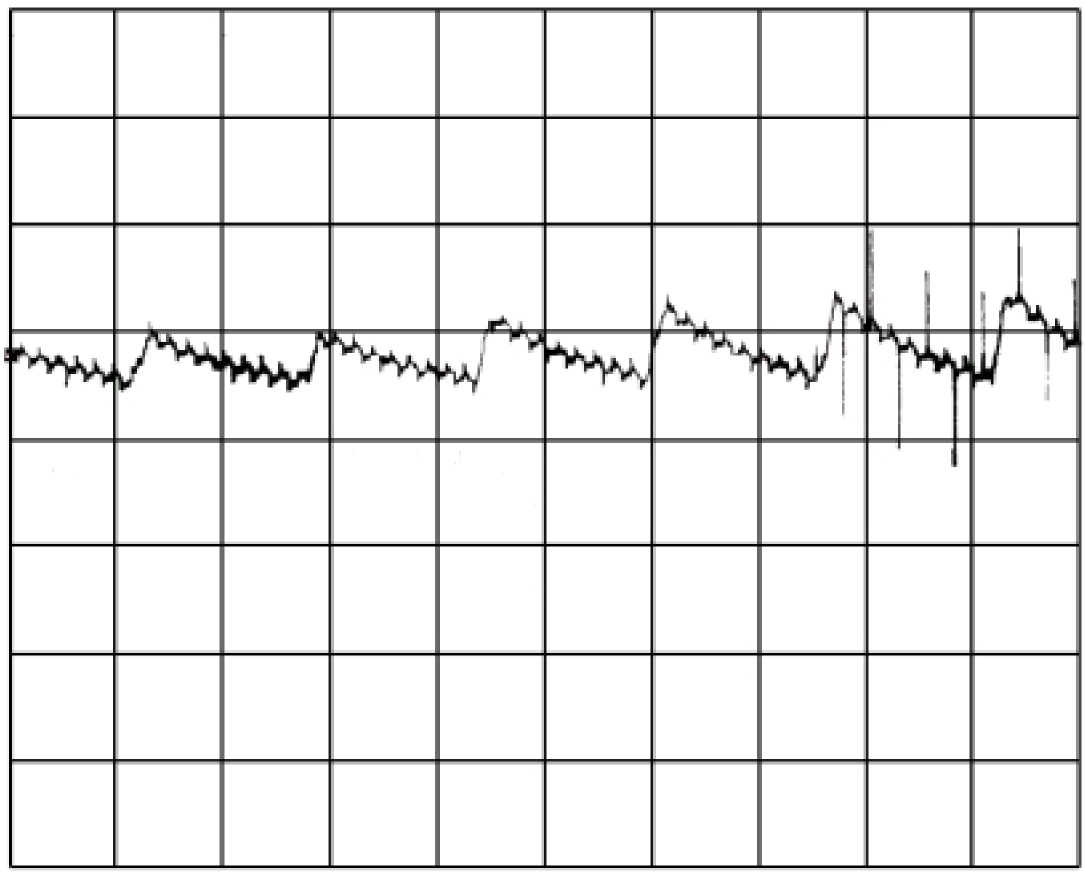


Figure 5. Visible light output of the LCD display used in Experiments 1 and 2. The vertical divisions are 5 mV apart and the horizontal divisions are 10 msec apart.

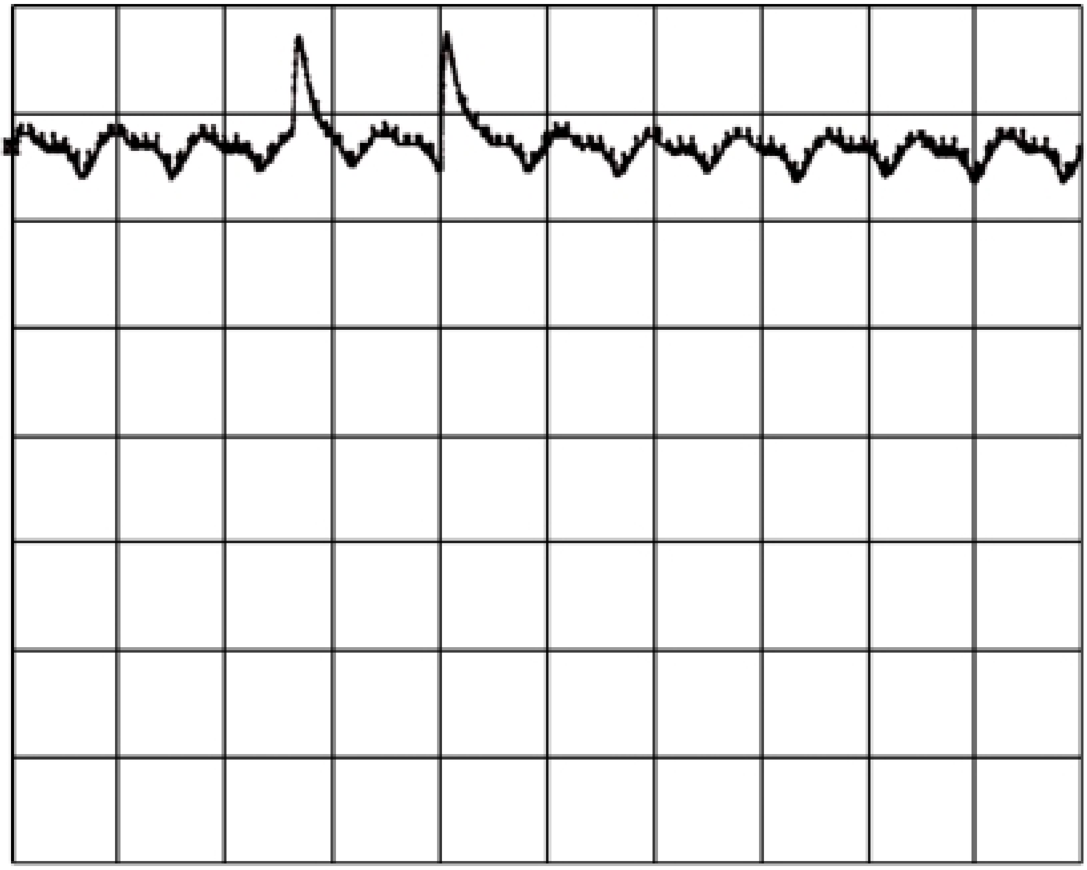


Figure 6. Visible light output of the CRT display used in Experiment 3. The vertical divisions are 100 mV apart and the horizontal divisions are 10 msec apart.

These traces bring to mind something about millisecond timing. If you have a 13 millisecond refresh rate on your CRT, what does it matter if you have millisecond or microsecond timing in your program? How will you really know the length of time that an image is presented? The answer is that you need to synchronize your presentation with the CRT scans.

Acknowledgements.

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displays. Subjects for the experiment were undergraduate students from the University of Texas at Dallas.

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