

Whose Choice is it Anyway? Montague's Experimental Results

Reference: McClure SM, Li J, Tomlin D, Cypert KS, Montague LM, Montague, RM (2004) Neural correlates of behavioral preference for culturally familiar drinks. [Neuron 44:379-387](#).

The main goal of the experiment was to see what, if any, areas of the brain were involved in determining preferences. Scientists gave subjects a series of three taste tests in which subjects choose which of two dark sugary drinks they liked best. Since these drinks are quite popular, scientists also asked the subjects which drink they preferred before doing the tests. Each test was repeated 3 times or 15 times. All drink tests were then repeated with the subjects in a functional magnetic resonance imaging (fMRI) scanner to see what parts of the brain were active.

fMRI can measure which part of the brain is being used during a task. Blood flows to the parts of the brain that are active and the fMRI detects where blood flow has changed. In the scanner, subjects only had to look at pictures of cups and taste the drink as it came down a tube. No active talking or choosing was involved. fMRI results provided researchers with the activated neural structures that reflected the participant's preferred drink.

No Label Taste Test – No Brand Influences on Taste

In the first test, subjects chose between two unlabeled cups, one cup contained Pepsi and the other contained Coke. The results showed that there was no greater preference for one drink over the other (Fig. 1D). Subjects whose stated preference was either Coke or Pepsi chose Coke about the same number of times (Fig. 1D).

During the No Label test in the fMRI scanner, the active part of the brain was a small area of the frontal cortex called the ventromedial prefrontal cortex (VMPFC, Fig. 2D). The VMPFC is involved in "signaling basic appetitive aspects of reward." This means the VMPFC is the part of the brain where pleasure associated with food is registered. This brain area was more active when a person tasted their preferred drink. More activity was seen as a bigger and brighter fMRI signal. When a person liked the drink, VMPFC was more active and the fMRI signal was bigger. Even though the person did not know the name of the drink, the scientists could tell by the fMRI signal which drink the person liked best.



Labeled Taste Tests – Brand Influence on Taste

Subjects were provided with two samples: one unlabeled and one clearly labeled Coke. Subjects were told the labeled cup contained Coke and the unlabeled sample could be either Pepsi or Coke (Figs. 3D and 4B). In reality, both cups always contained Coke. The tastes were identical but the subjects consistently chose the labeled Coke (Fig. 3D) rather than the unlabeled cup. During the One Label testing of Coke, in addition to the VMPFC, two additional brain areas were also activated: the hippocampus and the dorsolateral prefrontal cortex (DLPFC) (Fig. 4B.)



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In contrast, when the One Label test was repeated using labeled Pepsi and the unlabeled cup contained Pepsi, subjects showed no preference for either the labeled Pepsi cup or the unlabeled cup that contained Pepsi (Fig. 3D). Similarly, results from the fMRI images showed no detectable brain activity in any areas outside the VMPFC (Fig 4D). Results suggest that the Coke label had a bigger influence in biasing subjects' preference than the Pepsi label (compare bars in Fig. 3D).

Altogether, when subjects were not shown labels, preferences for Coke or Pepsi were equally distributed. The amount of brain activity in the VMPFC indicated whether a drink was liked in all No Label and One Label tests. However, when subjects were shown the Coke label, brain activity was also detected in the hippocampus and the DLPFC. These brain areas were not activated when the Pepsi Label was shown. Therefore, viewing the Coke label activated parts of the brain that were not observed when viewing the Pepsi label. The additional brain areas activated by seeing a Coke label may be involved in modifying behavior based on emotions, mood, and memory. DLPFC is active during cognitive control (active thinking) and working memory. In addition, these experiments suggest the hippocampus and the DLPFC may bias perceptions based upon previous emotions or biases. Specifically, the biased perception and emotional dispositions were associated with the brand Coke.

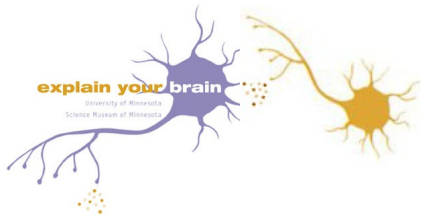
When processing feelings, the hippocampus plays a role in forming and recalling declarative memories. These memories and positive feelings were associated with the brand Coke. Even in people who would choose Pepsi on the basis of taste alone, seeing the Coke label and recalling the prestige of Coke changed what they thought they liked best. The scientists concluded: "Cultural information biases preferences through the DLPFC." When the choice in the taste test was influenced by a highly advertised brand, preferences were skewed towards the popular brand. So, subjects choose Coke when they remembered the culturally acquired value of Coke even when they otherwise might have chosen either Coke or Pepsi.

Main Point of the Experiment and This Lesson

- Different parts of the brain are activated in decision-making and recall. These include brain areas that may be involved in processing emotions and moods, as well as those involved in critical thinking.
- A subject's preference may be discovered by viewing brain scans without a subject saying a thing.
- The entire prefrontal cortex may be involved in executive decision-making, combining rational knowledge, facts, and anticipated outcomes with emotional influences. Development of the prefrontal cortex in teen years is important for the maturation of the rational thinking process to overcome undue emotional influences.
- Our decisions and preferences are influenced by what we experience.

What are the ethical questions raised by the ability to pinpoint brain responses?

The VMPFC is also associated with one's idea of oneself or self-image. Now "neuro"marketers want to image peoples' brains when they look at pictures of products to see which products people identify with and like best.



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Experimental Design



Three separate experiments were conducted.

- In the first, No Label, subjects chose between 2 unmarked cups: one containing Coke and one containing Pepsi.
- In the second experiment, one cup was labeled Coke and the other cup contained either Coke or Pepsi.
- In the third experiment, one cup was labeled Pepsi and the other cup contained either Coke or Pepsi.

Each experiment was repeated 3 times or 15 times. Then the entire series of experiments was repeated in the magnet.

Fig. 1D. The number of subjects who stated they preferred Coke (18) was similar to the number who stated they preferred Pepsi (18).

When presented with 2 unlabeled cups, each containing a different drink, 15 different times (trials), Coke was chosen about half the time, independent of whether the subjects said they preferred Coke or Pepsi.

These results are what would be expected if choices were made randomly and indicate that subjects did not have a consistent preference between the 2 drinks.

If all subjects chose Coke, the bar height would be 15. If all subjects chose Pepsi, the bar height would be 0. Thus, without any labels, subjects did not prefer one drink consistently over the other.

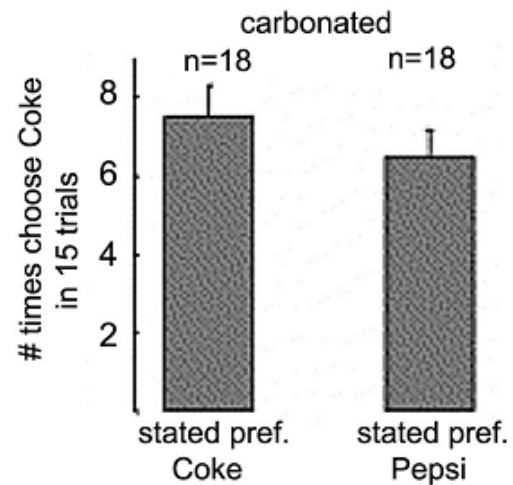
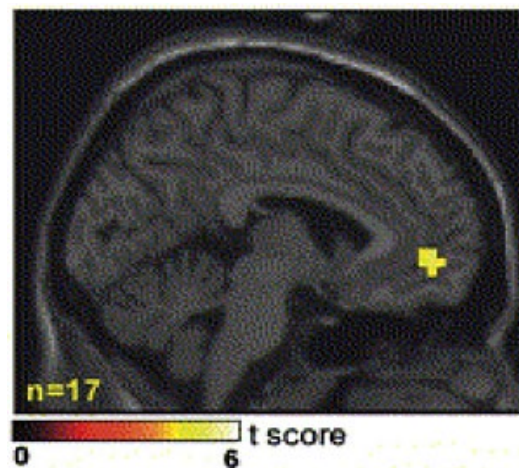


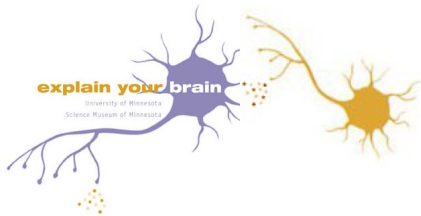
Figure 2D. fMRI during the No Label Test.

This is a slice of brain just off the midline.

The ventromedial prefrontal cortex (VMPFC, yellow pixels) was activated when subjects were presented with a drink to taste.

The more a subject liked a drink, the brighter the VMPFC appeared on the fMRI.





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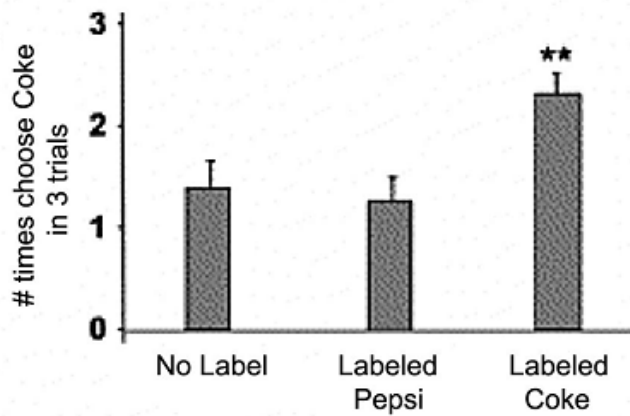


Fig. 3D. Average # of times (out of 3 repetitions) that Coke was chosen in the No Label and in each One Label test.

A score of 1.5 indicates choices did not reflect a preference for either drink.

A score of 3 indicates a strong preference for Coke.

A score of 0 indicates a strong preference for Pepsi.

The only condition in which a preference for either drink was observed was when the Coke label was present.

Coke® Delivery (Brand-cued - Light-cued)

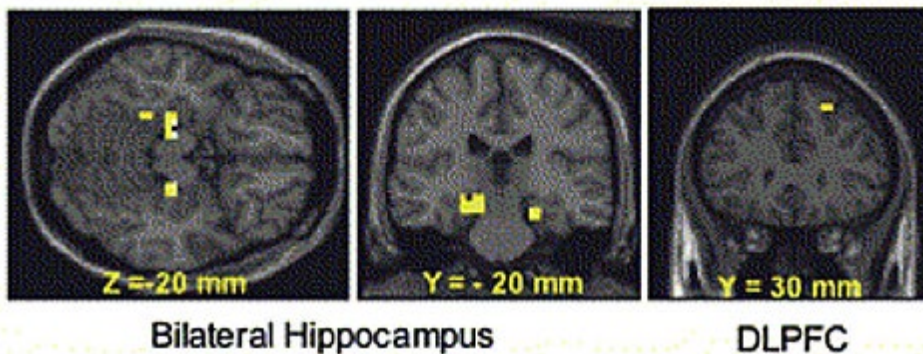


Fig. 4B. fMRI scans during the Coke Labeled test.

Brain activity was detected in both sides of the hippocampus (left and middle pictures, yellow dots) and dorsolateral prefrontal cortex (DLPFC) (right picture) when the Coke label (brand-cued) appeared compared to when no label (light-cued) was present. Left picture is horizontal slice of brain with nose on the right. Middle picture is vertical slice of brain about half way between the nose and the back of the head. Right picture is vertical slice of brain near the front of the head.

Pepsi® Delivery (Brand-cued - Light-cued)

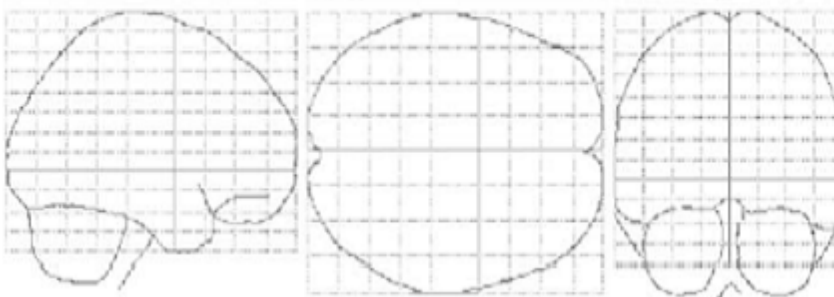


Fig. 4D. fMRI scans during the Pepsi Labeled test.

Brain activity was not detected in any extra brain structures when the Pepsi label appeared compared to when no label was present. Schematics show orientations of subtracted images with zero values (Brand-cued minus Light-cued).



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Neural Correlates of Behavioral Preference for Culturally Familiar Drinks
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Questions:

1. When Pepsi and Coke were administered anonymously (subjects didn't know which soda they were sampling), did they prefer one soda over the other?
2. How did knowing the type of soda affect preference?
3. What type of brain activity can a Coke label cause?
4. What part of the brain responds to sugar and water, and what does this part control?
5. What is *neuromarketing*?
6. Why do consumer rights activists criticize *neuromarketing*?
7. What is Montague's opinion on *neuromarketing*?
8. What is/are your opinion(s) on scanning the brain as a marketing tool?
9. Should marketing firms use brain scans to help sell products? Why or why not?