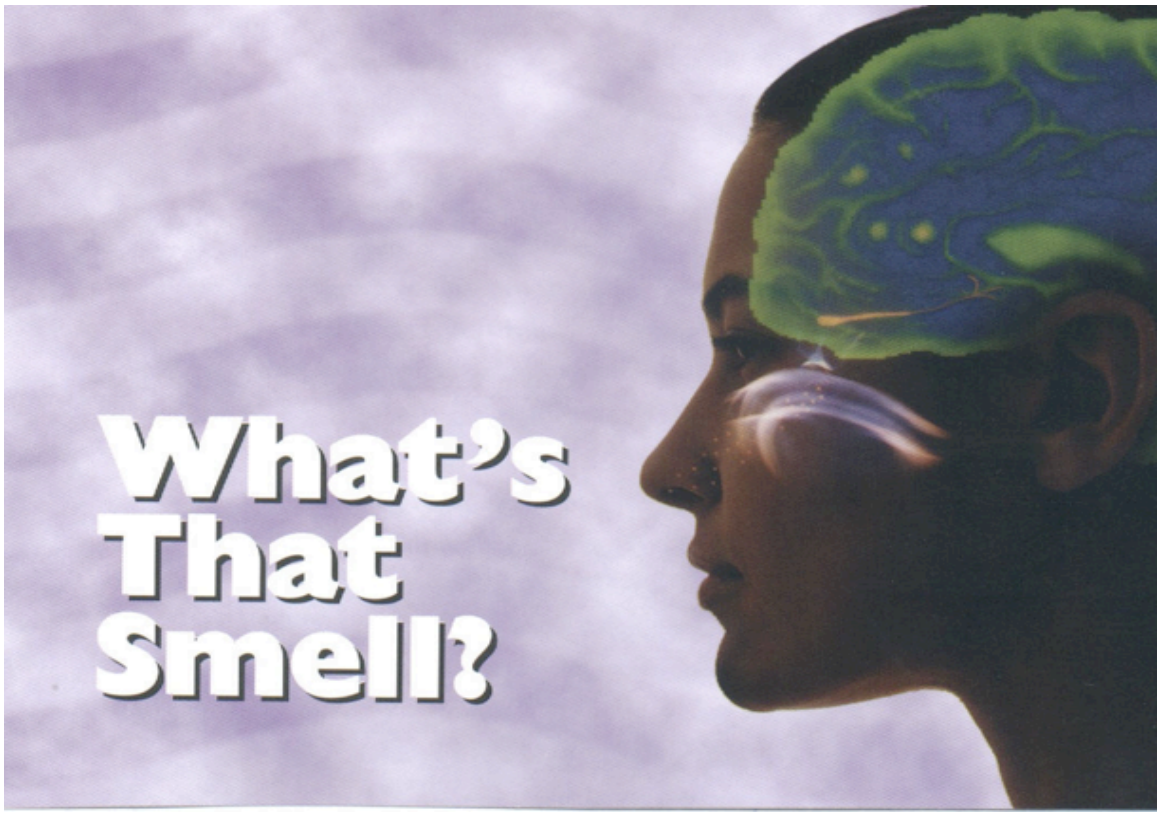
Is there a link between smell perception and brain activity?



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Introduction

Smells are around us everyday; we can enjoy them or be disgusted by them. The smell of flowers can make us feel happy, whereas the smell of dog pooh can make us miserable or sick. As a part of everyday live, we take them for granted without actually knowing what influence they can have on our brain, and which factors depend on their perception. Much research has proven the existence of a strong link between our brain and he way humanity perceives smell. The way an odor enters our brain is influenced by psychological circumstances and some scientists even state that there is a mechanism in the brain that focuses on what our nose is telling us when we want it to (Science Daily, 2005).

These assumptions trigged our curiosity and made us wonder: What would happen if we would let subjects sense a real perfume twice, but the first time we would tell them cheap and bad perfume and the second time we tell them the same perfume is extremely expensive? Can we, by use of EEG device, expose a link between the differences in brain activity caused by the perception that a perfume is “fake” or not?

Literature study

In order to improve the approach and development of our research and to find out what the research gap is that we are trying to fill, it is important to take other similar studies into consideration. Furthermore, the report of other studies provides background information for our research, and it emphasizes which notion this research elaborates on.

The first study that we will use as an important background to our own research is done by the Neuroscience Institute at UC Berkeley (Science Daily, 2005). As referred to in the previous, our experiment will consist of two tests:

1. The subject will sniff a perfume by Dolce & Gabbana while thinking that it is a very cheap and bad perfume.
2. The subject will sniff a perfume by Dolce & Gabbana and will know it is a very expensive and good perfume.

However, if the situation occurs that we do find a difference in brain reaction between the first and the second experiment – so between perception of a real and fake perfume related to its smell - this does still not guarantee that the cause is entirely psychological. At the University of California neuroscientists have scanned the brains of people sniffing odors and found a solution to this difficulty: it turns out that the brain is detecting and processing all the odors around us, but a particular area of the brain actively tunes this out unless the odor reaches a high level, such as when we walk into a cloud of strong perfume. The reason for this phenomenon is that the brain releases the block and begins to pay attention to the smells around us. It even tunes in very precisely to specific smells, allowing us, for instance, to search for a hint of a light smell somewhere around us. "We've identified a novel brain mechanism that functions as a gate for information, enabling our brain to focus on what our nose is telling us when we want it to, and more

importantly, ignore it when we choose to," said Noam Sobel, assistant professor in the Helen Wills Neuroscience Institute and in the Department of Psychology at UC Berkeley. This gives a clue that perception might be related to the perceived value of objects. From an evolutionary point of view this would make perfect sense: dividing more attention to what is valuable seems adaptive and therefore it is not unlikely that such a mechanism would be the result of evolution (Science Daily, 2005). This could explain why our brain could receive the smells differently, even it is exactly the same smell: our nose simply tells us about the perceived value of what is coming in.

The core of our research is concerned with value perception. This is closely related to goal-oriented behaviour: our actions are largely based on the predictions we have of how much value a certain action will yield. According to Liu et al., reward-seeking behaviour is a two-step process: the first step is to predict the outcome of an action (which happens in terms of perceived value) and the second is processing the feedback from the environment (Liu, 2003, p. 197). Biologically, reward-seeking behaviour is controlled by dopamine hormones released by the reward centre of our brain. Liu et al. state that "[j]udging the relative values of stimuli for making choices about which action to take to obtain a reward seems to depend critically on the prefrontal regions (areas rich in dopamine) of the brain's frontal lobes" (Liu, 2003, p. 1). With respect to our experiment, this means that the perfume when presented as having high value is expected to elicit a different response in the prefrontal regions (due to dopamine release) from when it is presented as having low value. Finally, it is important to note that Liu et al. made use of visual cues whereas we make use of verbal cues (we tell our participants the price and value of the perfume).

Finally, we present two other studies within our scope of research. Firstly, Humoo (2010) has presented a study that acts within our scope of research, as "the study focuses on expressions of visual, auditory and olfactory perception (Humoo, 2010)". Furthermore several concrete examples and theories related to perception and human senses are brought forth and presented in this article. Secondly, Keller (1993) recognizes that "brand knowledge is conceptualized according to an associative network memory models in terms of two components, brand awareness and brand image (i.e., a set of brand associations)(Keller, 1993, p. 1)".

To emphasize, the studies mentioned above provided inspiration for this research; they present notions that are existing within the scope of our research. For example, this research uses Keller's notion, as the quest investigates price perception by experimenting with brands. The experiment will be executed by letting the subjects sense a "real" perfume of a famous (and therefore maybe positively or expensively perceived) brand such as D&G, and then let them smell it. Additionally, we will inform them of the price of the (actual) perfume. However, even though we *tell* them it's the real perfume, we actually give them a fake one to smell. To quickly recap: ultimately, we want by means of the EEG compare the brain reactions of the first experiment in which the perceived value of perfume is high to the second experiment in which the perceived value of the perfume is low. Research was conducted on several aspects of the brain concerning smell. However, measuring the different perceptions of a real brand of perfume and the fake version has not been done yet. This research therefore tries to expose a link between the differences in brain activity caused by the perception that a perfume is "fake" or not.

Execution of the experiment (progress report 3, 08-04-2011)

Collecting data for our experiment has been a challenging process, as a group we came across several difficulties and obstacles both during the preparation and initiation of the experiment.

For our experiment, we tested a total number of twelve subjects. We had initially hoped to test at least fifteen individuals but the lack of time and other practical problems prevented us from doing so. Once the experiment was finally set up (EEG scan, Perfume, Data program), testing subjects went very smoothly and we faced no major technical issues or unusual events.

We used an EEG with 14 electrodes that recorded a total of 62 distinct signals. The raw signals were transformed in alpha waves, beta waves, gamma waves and delta waves. These signals were then saved in a database.

One factor that may have influenced our results is the fact that the whole room was filled with different types of perfume. This occurred due to the fact that some of the individuals being tested were already wearing perfume themselves. The fact that there were different types of perfumes, instead of one intended perfume (perfume being tested), could have interfered with the subject's sense of smell that were tested, and thus caused different brain reactions. Although both male and female individuals were asked to participate in our experiment, we did not pay attention to the gender we were testing. This may also influence our final result because male and female may perceive quality and price differently.

Finally, not all subjects believed in the validity of our statements about the value of the perfumes to the same extent. Obviously, the effect of perceived value should be stronger when a subject's is more convinced of the value differences of the perfumes. This should not be a main problem though as the experiment was a swift one: most doubts arose when the experiment was already performed and the data secured. Moreover, also in the real world not all people are equally susceptible to external influences (such as commercials and advertisements).

Data analysis

With our experiment we try to prove our hypothesis that there will be a difference between the perception of perfume 1 and the perception of perfume 2.

H0: There is no difference in perception between perfume 1 and 2; response 1 = response 2.

H1: There is a difference in perception between perfume 1 and 2; response 1 = not response 2.

In order to understand how we can measure a level of "perception", we first have to determine the definition of perception with regard to EEG test. According to this definition, perception is brain activity that is measured by the EEG sensor-locations F and

AF. F stands for Frontal cortex, and AF stands for Anterior frontal cortex.

The Frontal cortex, along with the other associational cortical areas such as the Anterior Frontal cortex facilitate attention to incoming stimuli from the primary sensory regions and recognition. It is important for behavioral responses to external and internal stimuli and therefore level of smell perception can be measured with the help of these cortexes.

Every participant smelt two exactly the same perfumes; however, perfume 1 was said to be cheaper and we explicitly pretended that perfume 2 was to be more expensive. We measured the brainwaves of each subject with both perfume 1 and 2 and our results of the EEG measurements were stored in a database. In the following we will reveal and analyze these results. In order to analyze the results, we calculated the average outcome of brain activity for each sensor-location. **We did this for both perfume 1 and perfume 2 after which we compared the results in a graph (see figure 1).**

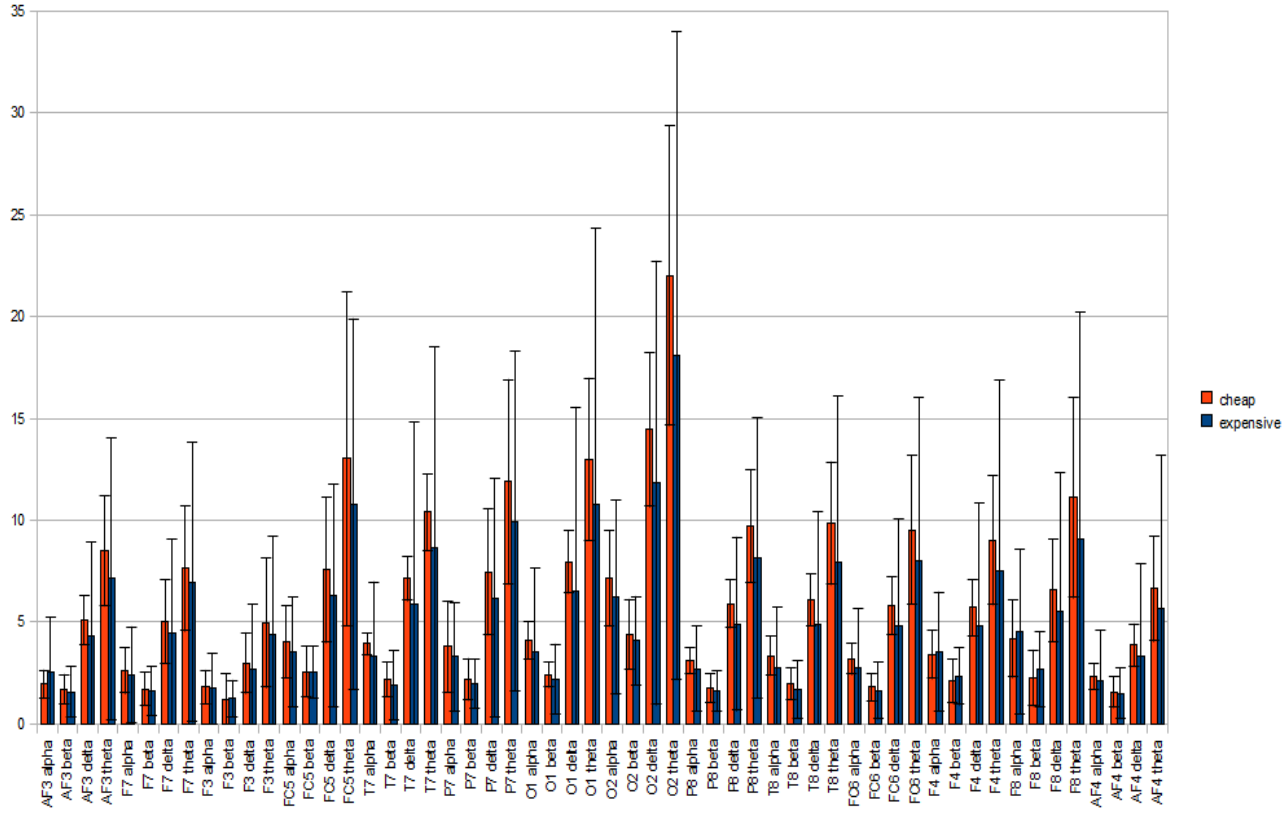

Figure 1

Explanation: The horizontal line represents the different brainwaves. The red color represents the brain activity of these brainwaves for the “cheap” perfume, whereas the bleu color represents brain activity for the “expensive” perfume.

On the basis of these results we concluded that the brain activity of perfume 1, the "pretendable cheaper one", was higher for the results of almost every sensor-location (see graph). Following, we performed several steps to prove whether there was a significant difference between the brain activity of perfume 1 and perfume 2.

1. Calculating standard deviations.

After calculating the standard deviations of each sensor-location, we assumed that several outliers were biasing our results. Therefore we detected the outliers as follows: using the excel command Conditional Formatting, with condition 1 is greater than: average + 3*st.dev. The outliers came up colored, after which we deleted the rows that contained them from our databank. By doing so, our standard deviations became smaller and more secure.

2. Prove the actual difference in perception between perfume 1 and perfume 2.

The next step was to prove whether there was an actual difference between the perception of perfume 1 and perfume 2. We did this by calculating the t-value of every sensor-location under F and AF (by doing a t-test). When taking an alpha of 0,05 it was outstandingly that 10 out of 12 results of T-values for the F and AF measurements (of the difference between the two perfumes) were to be significantly different for the right hemisphere measurements. In words, this means that for 10 out of the 12 relevant sensor-location in the right hemisphere, there is a significant difference between the levels brain activity of perfume 1 and perfume 2. Whereas for the left hemisphere only 4 out of 12 measurements were significantly different. It was very outstanding was that on the left hemisphere all AF sensor locations were significantly true, those were the 4 out of 12. And the other 8 out of 12, F, are not significantly true. For the right hemisphere the same phenomenon occurred: in the AF 3 out of 4 were significantly true, whereas 7 out of 8 of the F were significantly true.

Furthermore, some attention has to be appointed toward the fact that the significant trueness of the t-test outcomes is highly related to the place of the measurements (so specific hemisphere and specific sensor-location). The results have shown that brain activity of price perception is especially significantly varying between the hemispheres for the measurements with the F sensor-locations (in the left hemisphere none of the F sensor-locations measurements were significantly different for the two perfumes, whereas for the right hemisphere 7 out of 8 measurements of F-locations showed a significant difference of brain activity between the two perfumes). Yet, according to our own knowledge and literature research the academic community has not yet come up with an explanation for the outstanding difference of price perception between the hemispheres. Therefore, as this experiment showed that there is a significant difference, future directions should aim to find an explanation for the difference.

In Conclusion

The literature background information we used for our experiments was concerned with value perception. Research done by Liu (2003) suggested that an object presented as having a high value is expected to elicit a different response in the prefrontal regions of the brain and Keller states that " brand knowledge is conceptualized according to an associative network memory models". This made it interesting for us to actually measure the different perceptions of the brain towards a "real" brand of perfume and a "fake" one. On the base of former research we came up with the following hypothesis:

"There is a significant difference in brain activity when the subjects thinks it is smelling a cheap perfume and an expensive one, even though it is in actual fact the same."

The experiment has given evidence that the perception of price is determining for the perception of perfume. This evidence is given, because we have shown a significant difference between the perception of perfume 1(cheap) and perfume 2 (expensive).

However, as side effects could have biased our experiment, repetition of the experiment would be required for a more reliable conclusion in this sphere. Besides, future directions should examine more concrete explanations of why the perception of price influences the perception of the perfume, and how this comes about.

Sources

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