

'Smells' Producing Brain Activity: What Your Nose Really Knows

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Summary

Word labels influence our sense of smell. Oddly enough, these labels can even activate the brain in the absence of authentic odors.

What *is* in a name? Could it be that an item's title or label bears so much influence as to tweak our perception of that item's properties? Apparently so. It appears that our senses can be effortlessly misled by our brains into believing that we like or dislike a particular stimulus, based upon the description assigned to that stimulus. Take soft drinks for example. Much media hype was produced over the Pepsi Challenge, a series of blind taste tests administered by Pepsi Product officials in which subjects were found to prefer the taste of Pepsi over the taste of Coke. Last year, a team of neuroscientists decided to put an empirical twist on these findings, by testing to see if subjects' *brains* could tell the difference (McClure et al., 2004). Researchers found that even when subjects tasted unlabeled sips of Pepsi and Coke, their ventromedial prefrontal cortical (VMPFC) activations were correlated with their pre-established preferences for a particular brand. Thus, if a subject has asserted, prior to the taste-test of the two anonymous brands, that he or she preferred to drink Pepsi, then his or her VMPFC was more likely to display activity when he or she actually tasted the unlabeled Pepsi product. It was then established that a person's partiality for one or the other elicits more brain activity in the ventromedial prefrontal cortex than does the non-preference soft drink.

While labels can indeed manipulate our sense of taste, they also seem to have some bearing over our sense of smell. In 2004, Oxford researchers Ivan de Araujo and Edmund Rolls, along with Swiss researchers Christian Margot and Isabelle Cayeux, reported that positive verbal cues not only elicit consequent brain activities, but they also revise our olfactory experience as well (de Araujo et al., 2005).

Prior research had indicated that verbal labels could influence a person's hedonic olfactory perception (Herz and von Clef, 2001). Hedonic perception refers to our positive or negative evaluations of a stimulus, such that pleasant smelling odors have positive hedonic values and unpleasant odors have negative hedonic values. By simply coupling an odor with the word "vomit", subjects were more likely to rate the odor more negatively than when the same smell was labeled as "parmesan cheese". Other research concluded that when smells are paired with an analogous verbal label, activity occurs in the medial orbitofrontal cortex (Gottfried and Dolan, 2003).

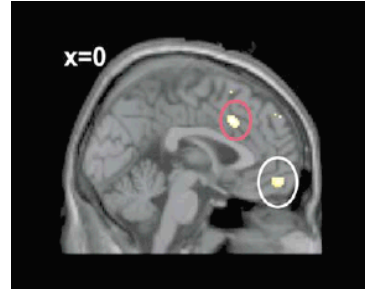


Figure 1. Sagittal view of the Medial Orbitofrontal Cortex (white) and Anterior Cingulate Cortex (red) in Brain (Rolls et al., 2003).

Not only is OFC activated by cognitive stimuli, but it is also involved with emotions as well (Purves et al., 2004). Similarly, the OFC can also be activated by olfactory stimuli (Rolls and Baylis, 1994). The OFC is one of three main regions of the prefrontal cortex and it houses olfactory cortical areas (Rolls, 1999). It responsible for inferring the rewarding attributes of olfactory stimuli. Because it's involved in rewarding and punishing effects of stimuli, it serves as a criterion for emotional behavior. Here, the medial OFC and the ACC are being activated in response to pleasant odors.

In light of these new findings, Araujo and his colleagues decided to expand on this idea and take that study to the next level (de Araujo et al., 2005). Using fMRI imaging, they examined human brain activity as both verbal and olfactory stimuli were presented to the subjects. They were particularly interested in determining whether or not verbal cues could neurologically impact hedonic values of odors.

Subjects were asked to rate the odor while brain recordings were taken, and the odor was labeled as either "cheddar cheese" or "body odor". Not only were the smells rated more positively when they were believed to be "cheddar cheese", but they also produced more brain activity. What is more, subjects were also presented with clean air, and it too was labeled as either "cheddar cheese" or "body odor". Oddly enough, when the smell was believed to be cheddar cheese it was given higher ratings and elicited more brain activity.

After carefully speculating their study's implications, Araujo and his colleagues concluded that when olfactory stimuli is perceived in a positive light, brain activity can be produced. Moreover, this brain activity can occur even in the absence of an actual odor. In this case, the rostral anterior cingulate cortex and the medial orbitofrontal cortex each underwent more activity when paired with positively hedonistic stimuli. Additionally, the chemical olfactory stimuli activated the amygdala bilaterally when labeled as "cheddar cheese". Hence, this study supported previous research suggesting that olfactory pleasantness is represented in the medial OFC, that pleasant odors activate medial regions of the rostral OFC (Rolls et al., 2003), and that the anterior cingulate cortex is activated during hedonic judgments. It also

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provided new evidence that the anterior cingulate medial OFC can be modulated even in the absence of an olfactory stimulus (de Araujo et al., 2005). Essentially, cognitive inputs seem to strongly influence our responses to olfactory stimuli. Furthermore, the brain is activated during smell, whether or not an odor is truly present.

So how does this occur? Why are we able to “smell” things that aren’t really there? To answer this query, let’s visualize the following scenario: we are instructed to close our eyes and stick out our tongue, and someone places a sour lemon drop on our tongue. Even imagining this scenario can evoke a response quite similar to that of the actual experience: our faces curl up and we jolt back upon the shock of the sour tang. It seems that our initial encounters with a stimulus are stored as memories in our brain, and often times the corresponding sensory experiences are as well (Gottfried et al., 2004). Therefore, when we are presented with a previously encountered stimulus, our brain also retrieves the corresponding sensory responses as a means for preparing us for the stimulus. So next time we stop to smell the roses we might wonder to ourselves, “Am I experiencing this rose’s true fragrance, or am I recalling the fragrances of roses that I remember from my grandmother’s rose bushes?” Who nose?

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