Neural Processing of Body Odor

Understanding the body odor/brain activity relationship and its potential implications on the creation of perfumes and personal hygiene products

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Consider the rank odor of the old man perspiring beside you on the bus, the fresh smell of cut grass, the foulness of the passing garbage truck, or the appetizing aroma wafting out of the local bakery. Odors constantly surround us in countless forms, both positive and negative, but few of us stop to think about them. Scientists and laymen alike have long considered humans to be "microsmatic animals," meaning that for us, the olfactory sense plays a minor role compared to the other senses. However, an increasing number of studies have begun to paint a different picture, one that suggests that olfactory information plays a very significant role in our everyday decisions. This article reviews recent insights into how the human brain processes body odors and the implications this may have for both lifestyle and use of perfumes and personal hygiene products.

Need for a Reality Check?

Body odors carry informational cues of great importance for the individual across a wide variety of animal species. For a long time, the thought that humans could be counted among these species was dismissed outright. However, it is now known that each of us has a unique odor that carries information related to our genetic makeup and also about personal environmental variables such as diet and hygiene. And, much like our fellow animals, humans are able to extract biological and social cues from conspecific body odors (i.e. odors from our own species) that provide information and direct our behavior. For example, studies have demonstrated that human body odor conveys information that allows us to identify individuals, directs us toward a partner with an advantageous genetic makeup, and informs us of the health status of others.[1,2,3]

Body Odors and the Brain

The percept, or mental impression, of a body odor commonly includes an emotional character that evokes a strong valence of liking or disliking. For example, the body odor from a lover may be a very pleasant percept, whereas the same percept from the person sitting next to you on the bus may be highly negative. When we hear the two words "body odor," most of us think about an unpleasant percept related to heavy perspiration. This odor is consciously perceived and reflects a response to a small subset of the numerous chemicals (about 120) that comprise an individual's body odor. In contrast, we typically are not consciously aware of perceiving the chemicals within our or others' body odor that serve as social signals.

A recent study demonstrated that body odors are processed mostly outside of brain areas that have long been considered the main processing centers for olfaction.[4] We found that body odors are primarily processed in areas responsible for emotional and attentional processing. What does this signify? First, in contrast to odors not of bodily origin (general odors), body odors are processed more like emotional stimuli. More importantly, this differential processing indicates a separation between the conscious perception of body odors and the social signals they contain. Our studies indicate that this separation is automatic; when we try to fool the system by presenting "fake" body odors comprised of chemicals that do not originate from the human body, these fake body odors are still processed by the brain as general odors. Remarkably, even when subjects mistakenly identify the fake body odor as real body odor, the brain processes the odor as though it is a general odor. Somehow, the brain is capable of identifying body odors, probably through recognition of specific chemicals. These results lead one to ask: Why has the brain developed these special processing networks in addition to the general olfactory pathway? What are the behavioral implications?

Sniffing Out a Stranger

When trying to understand a phenomenon in one sensory modality, it is often instructive to examine how similar phenomena have been handled by other modalities, such as vision or audition. Indeed, the differential brain processing demonstrated for body odors vs. general odors is mirrored in the visual system: visual stimuli having high survival value, such as images of snakes or spiders, receive heightened attention and prioritized access to brain processing areas compared to less threatening visual stimuli. Thus, critical information is transmitted through

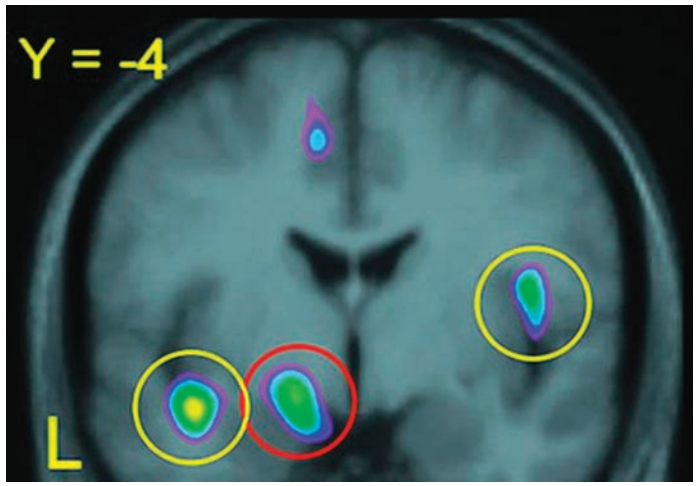
a specialized pathway, which is faster and capable of accessing action centers; in contrast, general information is sent through a separate sensory pathway that is slower but more accurate.

Imagine a scenario in which Adam and Eve walk down a garden path heading to their shed for some gardening tools. Suddenly, Adam catches a glimpse of a snake lying in the grass to his right. His visual system alerts him, and his body, now controlled by non-conscious processes triggered by the fast pathway, starts to turn away from the snake as his fear network is activated. Meanwhile, the slower but more accurate visual pathway has had time to process the "snake" and reports that what he's seeing is just the garden hose that Eve left out overnight. The arrival of this information, however, cannot prevent the evasive action set into motion by the high-priority pathway, and after taking a quick jump to the left and emitting a high-pitched scream, Adam is left with a rapid heartbeat and a slight feeling of embarrassment. This prioritized system and its effects are commonly referred to as pre-attentive processing. We have all experienced "misfires" courtesy of a processing system that operates under the principle that errors are better than omissions. Put in perspective, it's safer to react fearfully to the zebras 10 times in error than to miss the lion once.

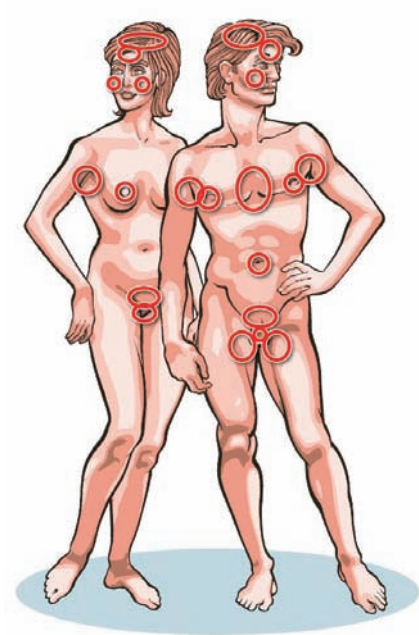
This knowledge about the visual system's special processing of biologically important stimuli leads us to speculate that body odors similarly possess a high level of inherent relevance for the perceiver. To test the hypothesis that body odors are processed differentially, we measured how fast the brain processes a body odor compound relative to a general odor of similar valence and intensity. We discovered that the brain processed the body odor compound up to 20% faster than the general odor, indicating that our olfactory system functions similarly to the visual system for biologically relevant stimuli.[5]

In the visual system, these biologically important stimuli have prioritized access to the brain's fear network. To investigate whether body odors also activate the fear network, we exposed subjects to body odors from strangers while measuring their brain activity. Body odor from a stranger elicited activation in the brain's fear network (amygdala and insular cortex; **See F-1**), demonstrating that the mere smell of a stranger elicits cerebral processing patterns similar to those responding to visual images of a snake. Together, these studies indicate that body odors are processed in a pre-attentive manner, similar to the prioritized processing of visual images that are important for survival. Our team's recent research suggests that exposure to the body odors of friends or lovers can produce a soothing effect. Exactly what this means for our everyday interactions is not known and is currently under investigation.

Smelling the body odor of a stranger activates the brain's fear network, as indicated in this PET scan; the red circle marks increased activity in the amygdala and yellow circles surround a bilateral increase of activity in the insular cortex **F-1**



The apocrine glands are thought to produce the chemicals that act as chemosignals within body odor; these glands become active around puberty and are typically found in areas of the body associated with body hair **F-2**



The Future of Hygiene: Should One Stop Showering?

Though it is true that body odors contain signals that aid individuals in selecting a partner whose genetic makeup compliments their own (thus benefiting their future children by passing on a more diverse and hence more responsive immune system), the effect of these signals is quite small for any given couple (but highly important over the evolutionary time scale). Nonetheless, body odors are consistently listed as one of the more important criteria used when selecting a partner, although they are typically cited as reasons to reject a potential mate rather than as an attractant. It is not clear whether deodorants and antiperspirants mask or eradicate body odor signals. Also unknown are the identities of the specific chemicals responsible for these signaling effects and the gland(s) that emit them. The apocrine glands are suspected to be involved because they become active around puberty and are concentrated in pubic and underarm areas **(See F-2).** Until the origin and nature of the volatile chemicals responsible for biologically important odors are known, we can only speculate about the impact of hygienic products and behavior on the biological message conveyed in our body odors. However, based on the scientific evidence to date, it is perhaps unwise and probably even useless to try to spread personal chemical signals by refraining from showering before social activities. Or to put it more frankly, smelling someone's sweat is seldom a purely pleasurable experience.

Since this column is read primarily by those involved in industry, here are some thoughts beyond the scope of basic research. Our knowledge has now reached the stage where it is reasonable to begin pondering ways to enhance the positive emotional and informational signals concealed within body odors, while simultaneously reducing the conscious negative odor percept. And because smelling the odor of someone we love or someone we are related to can be a soothing, pleasant experience, perhaps a therapeutic potential in these types of odors could be identified. Finally, wouldn't it be wonderful if we could one day eliminate those awkward first dates and instead, sniff out our future partner using samples of body odor?

References:

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