Factors affecting K9 Olfaction

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Odorant transport to the sensory part of the nose is the first critical step in olfaction. The process of odorant transport through the nasal cavity to the olfactory epithelium during *sniffing* is very fluid and dynamic. The basic concept involves collection of odorant via active *sniffing* followed by transport of that inspired odorant within the nasal cavity back to the *olfactory recess*. To date, the exact process of how odorant molecules reach the olfactory recess during sniffing without being filtered by respiratory airways is not completely understood.

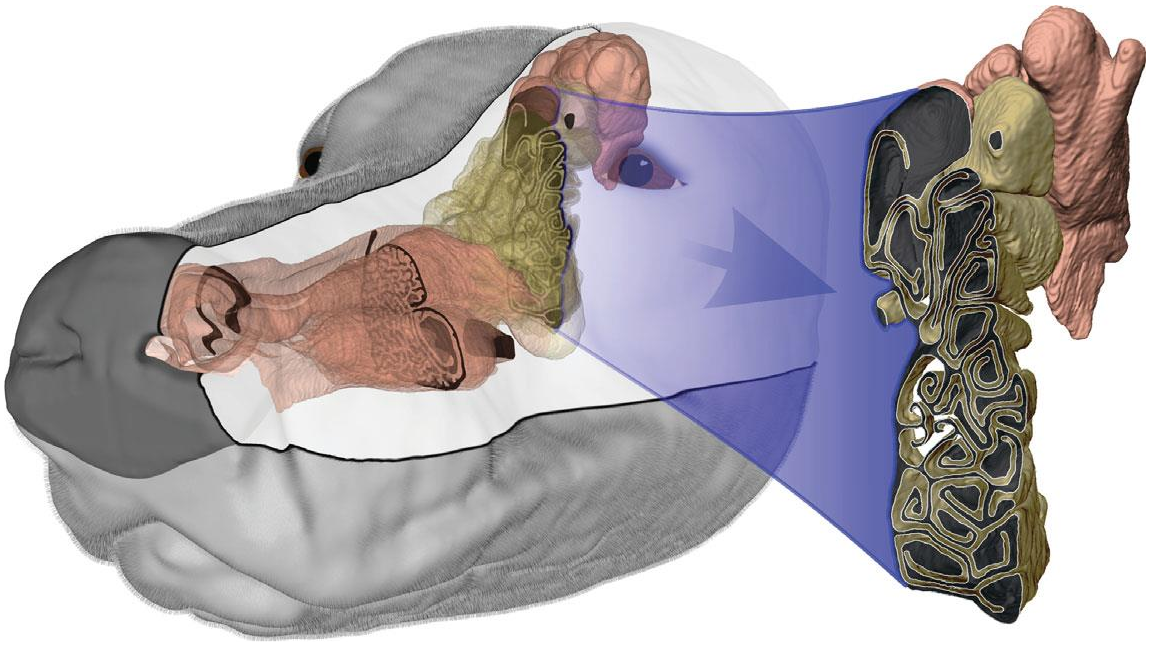

PHOTO 1: courtesy of Cravens et al. J. R. Soc. Interface (2010*)*

- The **olfactory (yellowish-brown**) region is the primary 'sensory' area located in the rear of the nose, this is where odorant detection occurs; The **respiratory (pink) region** is the non-sensory region primarily in the front of the nose (Craven et al. 2007)
- The **olfactory recess** is located in the **rear** of the nasal cavity contains scroll-like ethmoturbinates, that are lined with the olfactory epithelium. The ethmotubinates significantly increase the surface area for odorant molecules to bind to odorant receptors.
- The **olfactory epithelium** lines the convoluted ethmoturbinates recessed in the **rear of the nose** (yellow-brown) and contains hundreds of millions of sensory neurons

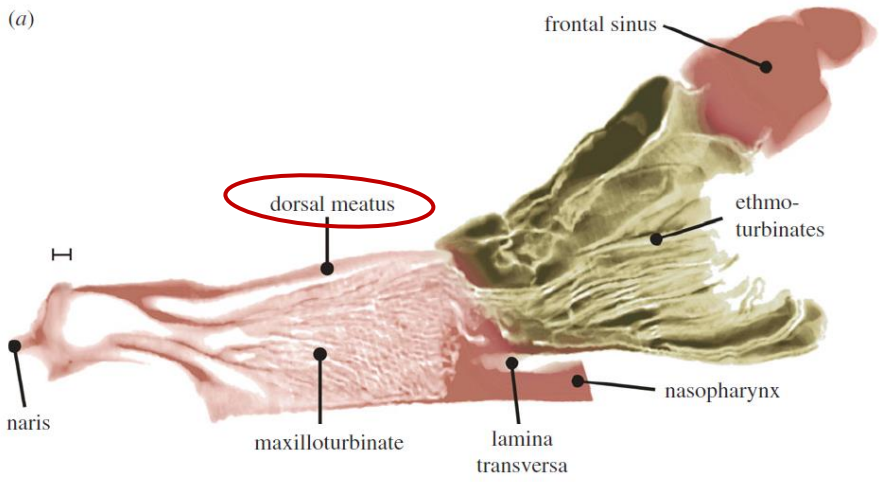

PHOTO 2 Courtesy of Cravens et al. J. R. Soc. Interface (2010)

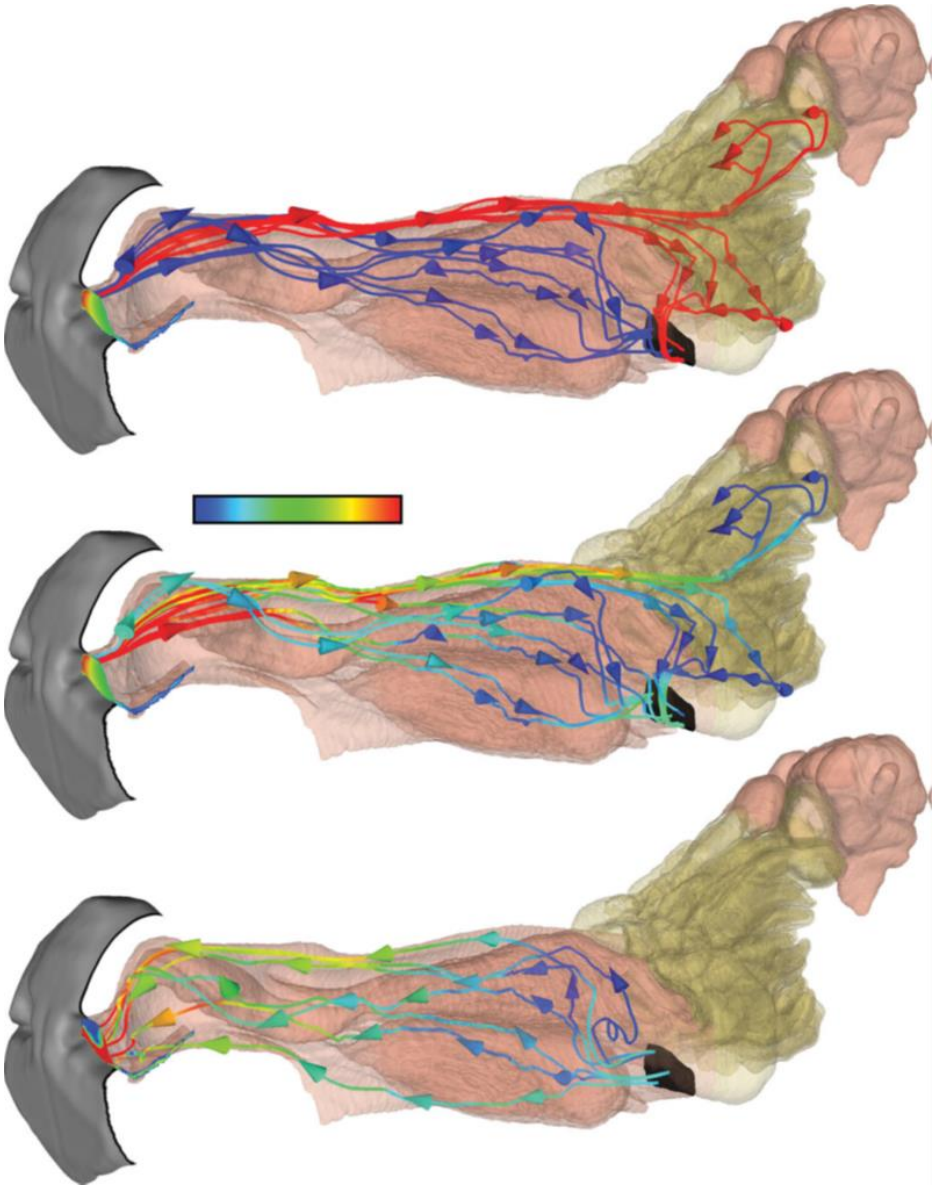

Photo 3: Courtesy of Cravens et al. J. R. Soc. Interface (2010*)*

Within the nasal cavity, inhaled odorant molecules are carried by airflow, travel to the olfactory epithelium where they dissolve in the mucus (viscous liquid) via olfactory binding proteins that transport these odorants to the olfactory receptor (OR).

Canines have **distinct respiratory and olfactory flow paths** within the nasal cavity. They have a unique nasal airflow pattern during active sniffing that optimizes odorant delivery to the sensory part (rear part) of the nose:

- Due to the anatomical structure of the dog's nasal cavity (scrolls of turbinates) that intranasal airflow patterns control whether or not odor-laden air reaches the olfactory region of the nose.
- The '**olfactory recess'**, located in the **rear** of the nasal cavity (yellow-brown), is excluded from the main respiratory airflow path of the nose (pink area above in Phot 1).
- The nasal cavity has three main 'passageways' termed the dorsal, middle, ventral meatus; The **dorsal meatus** (see photo 2) bypasses the respiratory airways leading primarily to the olfactory recess.
- During rest, only a small proportion of air travels through the dorsal meatus to the olfactory recess (< 15 – 20%)

ODORANT CELLS AND RECEPTORS

- There are various different types of receptors, those of which detect odor (odorant receptors or OR) and those that detect noxious aversive stimuli. **Odorant receptors (OR**) detect odor and are almost exclusively located in olfactory epithelium of the olfactory recess (back of the nasal cavity); very few reside within the respiratory epithelium (front part of nose).
- Olfactory receptor cells (OTC) or neurons contain the OR. The detection of odor occurs only through the olfactory epithelium and olfactory nerves cells (OTC) located in the olfactory recess. Odor intensity is proportional to the number of OTC activated.

"OVERWHELMING" SENSES OR BURNING OUT OLFACTION"

- Many inhaled odorants/chemicals can stimulate nerve endings in the respiratory epithelium nasal mucosa through various tactile sensations like warmth, coolness, sharpness. These non-odorant sensory receptors in the respiratory epithelium are stimulated by some aversive stimuli, not odor.
- The K9's sense of smell is considered about 1,000 to one million times more powerful than a human nose. Similar to how people react initially to an overwhelming odor, there are plenty of aromas/odors that could easily "overwhelm" and seem initially very aversive or portrayed as a strong ODOR to a K9, yet not actually cause any damage to their olfactory acuity.
- Unique to the K9's ORC and Olfactory Epithelium (OE), is that they have a great potential for spontaneous regeneration and extensive repair following injury, therefore, any local damage to

the OE, may only result in transient alterations in olfaction. Every 30-60 days ORCs are replaced by new ORCs. Of note, replacement ORCs do not necessarily contain the same OR of the neuron that died. In fact, evidence supports the fact that the type of receptor that is generated on the new OTC is, in part, **stimulated by the predominant odor(s) the K9 smells**.

BLUF:

- Repeated exposures to the target odor over a period of several months leads to an increase in the number of OR that bind to the target odor; therefore, increases the K9's acuity to this target odorant.

EFFECTS OF DIRECT INTRANSAL EXPOSURE FROM CHEMICALS OR DRUGS IN "BURNING OUT" OLFACTION

- Anything that **causes Inflammation, alters blood flow or affects the hydration of the K9's nasal cavity** may potentially effect olfaction to some degree; To what degree and for how long really remains a mystery.

- Local injury to the olfactory epithelium from **high exposure** or **chronic exposure** to an irritating chemical (eg contact irritant), may lead to some effect on olfaction; however, to date, there is really no definitive, validated evidence, to show sniffing/snorting any type of drug or chemical significantly or permanently alters olfaction:
    - There is some evidence that chronic, repeated exposure to rooms treated with insecticides have resulted in acute nasal irritation and diminished olfaction, in which resulted in permanent effects on olfactory acuity in one dog.
    - No reports of permanent loss of olfaction in bed-bug detection or pest-detection K9s is reported.

- People that CHRONICALLY snort cocaine, have shown some transient loss of olfaction; however, most evidence reveals that among most heavy cocaine abusers, even those with intranasal damage, they do NOT develop permanent olfactory dysfunction.

- Intranasal meds/toxin exposure to dogs – really no well-founded studies evaluating specific intranasal exposure to various toxins or drugs:
    - There are no studies evaluating the effects of **intranasal vaccinations** on scent detection; however, as intranasal vaccines may cause nasal discharge for up to 5 days after administration and it is reasonable to hypothesize that there may be a detrimental effect on performance.
    - A DHS funded study conducted by the University of Pennsylvania Working Dog Center has collected data regarding the effects intranasal naloxone for treatment of Opioid Toxicity. Part of the study evaluated the effects on intranasal naloxone administration on canine olfactory acuity. Preliminary data displays no adverse effects.
- Of note: It is generally considered that any local damage from a contact irritant (drug, chemical / toxin, etc.) is generally considered reversible, most likely since olfactory neurons regenerate

spontaneously, but the degree and duration of olfaction impairment and normalization of function cannot be predicted

ADDITIONAL FACTORS REGARDING INTRANASAL EXPOSURE TO DRUGS AND CHEMICALS:

- The olfactory recess and main olfactory sensory area of the K9 lies deep in the rear of the nasal cavity and OFF the main airflow passageway. Only a small percentage of inspired air travels to the olfactory recess.

- Intranasal application of drugs and or chemicals that may alter the size / diameter of blood vessels (vasculature) within nasal cavity and, thus, alter blood flow and airflow dynamics within the nose most likely have minimal effect on olfaction:
    - Only the respiratory portion/epithelium (pink portion in photo 1) of the nasal cavity contains a rich vascular network of blood vessels, the **olfactory epithelium does not** and as such the olfactory part of the nose does not undergo vascular changes;
    - Therefore, factors that influence the nasal vasculature are not expected to affect the unique nasal airflow patterns to the olfactory epithelium that occur during sniffing.

BLUF: Due to the location of the olfactory epithelium/recess and the unique canine nasal airflow patterns, chemical irritants that could physically destroy or injure olfactory receptors, most likely never reach the olfactory region in significant amounts to cause significant alterations in canine olfaction. Of course, each situation is unique and many physiological aspects of canine olfaction still need to be studied and elucidated

EFFECTS OF DRUGS GIVEN ORALLY OR PARENTALLY (VIA INJECTION) ON K9 OLFACTION:

- Consider that really any drug (administered via any route: oral or via injection) or any medical condition could potentially affect a K9's olfactory acuity.

- However, to date, we have little to no data regarding how most drugs as well as most medical conditions influence K9 olfaction. Most often we extrapolate from data in humans, although, even in humans, there have been hundreds of systemic (oral and parental) medications postulated to permanently alter sense of smell, but only very few drugs have been objectively tested and validated to do so.

- In K9s, the only drugs that have been shown to influence smell to any degree include **very high dose metronidazole** (beyond what is often used clinically) and **high dose steroids**. There is unpublished data revealing select anesthetic inhalants diminished olfaction, but there was an exponential return to full olfactory acuity over a short period of time (eg 24 h).

- The effect of **cannabinoids** or **opioids** on olfactory function in dogs has not really been studied either, and it is interesting to note that the olfactory system has both cannabinoid and opioid receptors, where in people, both exogenous cannabinoids and opioids have been shown to increase olfactory thresholds/impair olfaction (albeit transiently).

- Beyond this data, there is no definitive, validated evidence, that has shown that any one drug consistently or permanently alters K9 olfaction.

RECOMMENDATIONS FOR EXPERIENCING AN ACUTE EXPOSURE TO A CHEMICAL OR DRUG:

Aside from the recommended medical / veterinary related treatment required for any detection K9 that has experienced an acute exposure to a drug (prescription or unintentional exposure), chemical or toxin, regardless the route of exposure, the following is typically my recommendation to help ensure no impairment to the K9's olfactory acuity.

- Place K9 on MED HOLD (do not work them) for at least 24 – 48 h; this period is not scientifically based, but mainly due to my clinical experience based on the fact that any acute, short-term exposure is less likely to cause any long-term or permanent effects on olfaction.

- Prior to returning the K9 to full-active working status, run them through an odor recognition test and mock certification course (whichever you and your K9 certified through) to ensure the K9 is "hitting" on the target odors and functioning as usual.

References:

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