Dependence of intra-nasal odorant concentrations on sniff behaviour

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Abstract

It has been known for the past three decades that optimum odour perception is achieved with just a single sniff, as was demonstrated by the early experiments of Laing [1]. Thus, the act of sniffing is itself an intrinsic aspect of the olfactory percept. Nevertheless, despite its importance there is still much uncertainty as to what is actually happening to odorant molecules inside the nose during sniffing. To provide a first assessment of the relationship between sniffing and odorant delivery to the olfactory epithelium, we have performed direct intra-nasal odorant concentration measurements at the nostril and olfactory cleft using proton-transfer-reaction mass spectrometry (PTR-MS) [2] during different sniffing procedures. In particular, absolute intra-nasal odorant intensities were monitored in real-time according to inhalation performance.

Experimental methods

An olfactometer (Burghart model OM2s) [3] provided defined odorant pulses for sniffing. Due to performance problems [4], only one compound – diacetyl (with a buttery odour) – was used as the odorant stimulus.

Diacetyl-saturated headspace gas from an aqueous solution in the sparger was delivered to the olfactometer outlet (system at 40 °C) at 5 s pulses of identical intensity.

Direct coupling of the PTR-MS (Ionimed model hs-FDT) to the olfactometer (figure 1, far left) enabled reference pulse measurements prior to each *in vivo* test (figure 1, far right).

The second PTR-MS inlet provided real-time detection of diacetyl within the nasal cavity via connection to a medical catheter positioned in the nose of the test subject – either at the nostril or olfactory cleft (figure 1, centre left), which was held in place by glasses worn by the subject (figure 1, centre right).

After direct assessment (in triplicate) of the olfactometer delivery pulse before each intra-nasal measurement, the test subject was asked to perform either a normal, rapid or forced sniff (in random order; figure 1, far right).

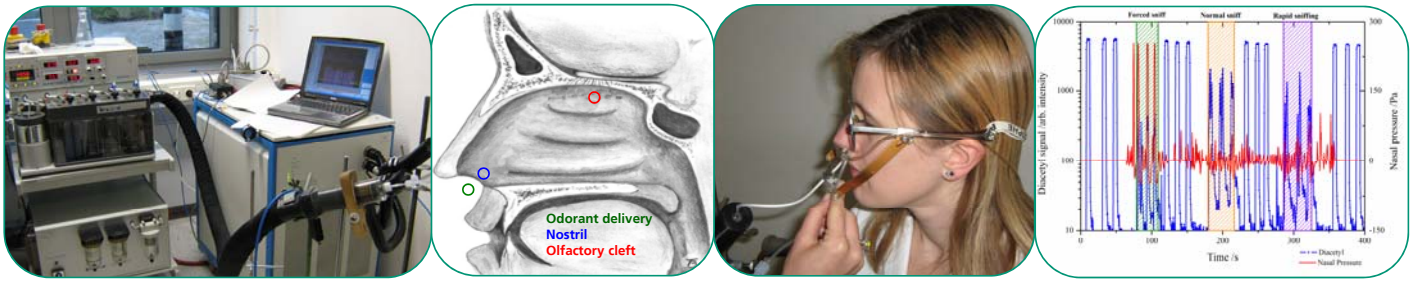

Figure 1 Experimental set-up

Far left: Olfactometer and PTR-MS instruments used respectively for generating and detecting odorants. *Centre left:* Nasal cavity, indicating odorant sampling positions. *Centre right:* Subject during a test procedure, with olfactometer outlet held just below nostril. *Far right:* Exemplary raw data of diacetyl levels at the olfactory cleft.

Results and discussion

Mean values for all subjects (n=12) reveal the range in nasal inspiratory pressures for the three different sniffing modes (figure 2, top left).

Diacetyl measurements at the nostril indicate that levels are equally high for normal and rapid sniffing, but are much reduced during a forced sniff (figure 2, bottom left), which may result from dilution effects whereby odorant concentrations entering the nose decrease with an increasing volume of air.

On the other hand, concentrations at the olfactory cleft decrease successively with increasing sniff magnitude (for rapid, then forced sniffs; figure 2, bottom right), which might arise from a change in airflow dynamics within the nose, such that less air reaches the olfactory cleft for more intense sniffs.

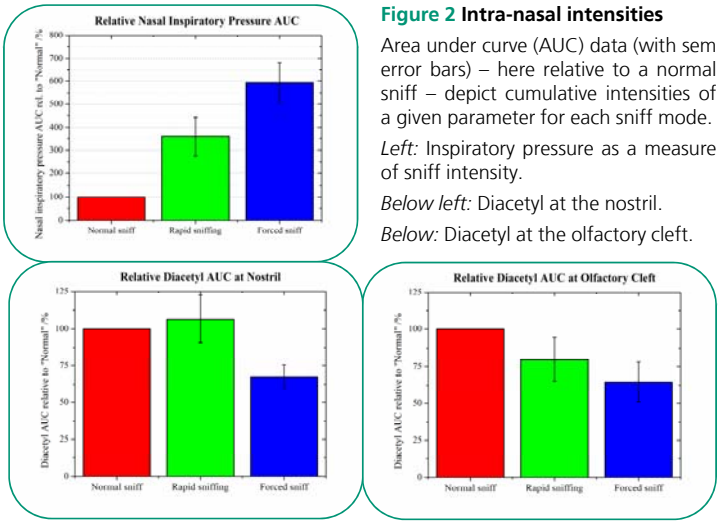

Figure 2 Intra-nasal intensities

Area under curve (AUC) data (with sem error bars) – here relative to a normal sniff – depict cumulative intensities of a given parameter for each sniff mode.

Left: Inspiratory pressure as a measure of sniff intensity.

Below left: Diacetyl at the nostril.

Below: Diacetyl at the olfactory cleft.

Measured diacetyl levels at the olfactory cleft also reflected ratings of perceived intensities. Further investigations are necessary to establish the direct cause of this effect, which may additionally have contributions from nasal mucosal uptake.

References

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