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Olfaction - Behavioral/perceptual

Mice can extract spatial information from temporal dynamics of the odour landscape

Tobias Ackels

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The spatiotemporal dynamics of natural odour plumes shaped by airflow turbulence provide valuable cues about the location of odour sources. Recent experiments demonstrate that correlated odour intensity fluctuations arise when odours originate from the same source, while even a source separation of 50 cm results in uncorrelated odour profiles.

We here investigated further whether mice can utilize the spatial information carried by natural odour plumes for distance discrimination. Using a wind tunnel and innovative odour delivery devices, we generated and recorded odour plumes, and replicated them within an "olfactory virtual reality" system.

By examining the temporal characteristics of odour plumes generated in the wind tunnel, we propose that features operating at a frequency higher than the respiratory cycle of mice hold greater significance for the distance discrimination task compared to slower timescales, such as average concentration over a trial. Training mice in high-throughput behavioural conditioning tasks, we observed their ability to differentiate distances based on odour cues. Furthermore, by presenting odour plumes recorded at various distances in the virtual reality environment, we discovered that a subset of olfactory bulb projections neurons, Mitral and Tufted cells, exhibited differential responses corresponding to different distances. Notably, these responses were linked to the temporal features of odour plumes and showed correlations with sub-sniff temporal patterns.

Our findings highlight the mice's capability to extract and utilize complex temporal information from odour plumes for distance discrimination. On the cellular level, we shed light on the intricate mechanisms of olfactory source localization in olfactory bulb neurons. This study expands our understanding of olfactory perception and provides a foundation for further exploration in sensory neuroscience.
Presentation type: Oral presentation

The effect of food and non-food odors on inhibitory control in obese and non-obese individuals

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Pleasant odor stimuli have been found to reduce response inhibition, which refers to the executive ability to withhold or cancel inappropriate actions, in healthy-weight individuals. However, the interaction between olfaction and inhibitory control in obesity remains understudied. Inhibitory control plays a crucial role in food-related behavior, and olfaction is one of the main sensory determinants for food intake. Here, we aim to determine if inhibitory control differs between individuals with obesity (BMI ≥ 30 kg/m^2) and non-obese individuals (BMI range = 18-25 kg/m^2) following the presentation of different odor stimuli related to edibility (food odors vs. non-food odors) and caloric density for food odors (high-calorie content vs. low-calorie content). The study is currently underway with 12 participants per group (expected *n* per group = 25), matched for age and sex. Participants performed a Go/No-Go task which included three isointense odor primes: orange (low-calorie food odor), cookie (high-calorie food odor) and lavender (non-food odor); clean air was used as a control. Mixed-effects models revealed that individuals with obesity exhibited reduced inhibitory control compared to non-obese individuals, as indicated by higher No-Go error rates (p<0.001). Odor presentation resulted in faster Go responses (p<0.001) and higher No-Go error rates (p=0.006), indicating reduced inhibitory control compared to the control condition. These effects were more pronounced for food (vs. non-food) odors in both groups (ps<0.001). Furthermore, the high-calorie (vs. low-calorie) food odor triggered faster Go responses and higher No-Go error rates only in individuals with obesity (p=0.013). This study adds to the current understanding of the effects of odor stimuli on goal-directed behavior, emphasizing the influence of odor edibility, weight status, and their interaction on response inhibition and readiness. This work was supported by the "COG19" project (grant number 40900003).
Presentation type: Poster presentation

Digital Transformation of Olfactory Training

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Olfactory training (OT) has shown promise in improving patients' olfactory performance (Pieniak et al.,2022). However, traditional OT methods, e.g., sniffing essential oils, present methodological challenges. Variability in smell delivery and difficulties in monitoring adherence hinder the rigour of OT research and potential clinical gains (Olofsson et al.,2021). Conventional strategies for tracking progress, e.g., diaries, are prone to data fabrication and add to users' workload. These limitations restrict long-term engagement with OT and impede users' progress monitoring (Pieniak et al.,2022). To address the challenges, we propose a digital adaptation of OT. Smell Care (developed by OWidgets Ltd) consists of a Smell Delivery Device and a Companion App. The Device has six scent channels. The Device's operation is characterised by spatial and temporal precision, directing the

scents to the user and reducing residual room odorization. The App displays the scent name during administration. After a 10-second delivery, users rate the scent intensity. Comprehensible graphs display performance over time. The App provides researchers with user engagement data. Dropout rates in OT are often attributed to the absence of desired effects, emphasizing the criticality of considering social, emotional, and individual circumstances for the success of this digital technology (Blandford et al.,2018). In a 6-month feasibility study in participants' homes, we investigated these factors and challenges associated with digital OT. Our study involved 24 UK participants with mild to moderate smell impairments, engaging in digital OT twice daily and documenting experiences through a Smell Training Journal monthly interviews and questionnaires. Drawing on expertise from Medical Sciences, Human-Computer Interaction, and Built Environments, findings from this study guide future clinical trials and design recommendations for smell-based technologies, transforming the landscape of smell care.
Presentation type: Poster presentation

“The problem with asking a consumer a question is that they'll give you an answer…”

Garmt Dijksterhuis

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Olfactory research may occupy a unique position where it is concerned in bridging the gap between theoretical and practical research. Due to the ephemeral quality of its stimuli, the inattentive processing, and its many unconscious behavioural effects, linking olfaction studies in the laboratory to real life applications has always been difficult. The discrepancy between laboratory and real life studies was critically addressed in Köster (2003), wherein the title of this abstract can be found as a quote (p. 364).
In his paper Köster presents several fallacies that may have misled many researchers, in particular when behavioural effects were the subject of investigation. This seems to be true irrespective of it being whole products being studied or isolated odourants/flavourants, and irrespective of the type of application, food, personal care or household products. The fallacies, drawn mainly from psychological theory, address several (misguided) assumptions about consumer behaviour. These resulted in Dijksterhuis, de Wijk and Onwezen (2022) to publish three criteria for the (in)validity of consumer research methods based on consumers 1) reflecting on their own behaviour, 2) being aware of a measurement taking place or 3) knowing the research question.
As the aim of most olfactory and flavour research is to predict when and why consumers will accept a particular product, I’d like to pose that our research is concerned with understanding human behaviour, and hence is part of psychological science. Four basic principles seem to underly the arguments in Köster (2003), viz. that our research questions and ensuing methodology should be: 1) holistic, in that they include as many aspects as possible, 2) embodied, in that they appreciate that the consumer is grounded in a biological system, 3) focusing on consumers’ individual experiences and 4) implicit, in realising that the reasons for behaviour are typically inaccessible to the subjects themselves (Dijksterhuis 2016).

Presentation type: Oral presentation

People with olfactory dysfunction due to COVID-19 have a fundamentally different olfactory perceptual fingerprint compared to healthy controls.

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Olfaction begins with sensory detection and continues with perceptual interpretation of the stimuli. A possible measure of olfactory perception is an odor independent olfactory perceptual fingerprint (OPF) defined by Snitz et al. It has been shown that there are differences in perception among normosmic and hyposmic people, however the OPFs of patients with olfactory dysfunction have not been studied thus far. We aimed to investigate, whether OPF can distinguish patients with olfactory dysfunction due to COVID-19 from controls and which perceptual descriptors are important for that separation. In our study, we included 99 healthy controls and 41 patients. They rated ten odors using eight descriptors' 'pleasant', 'intense', 'familiar', 'warm', 'cold', 'irritating', ‘edible' and ‘disgusting'. An unsupervised machine learning method, hierarchical cluster analysis, showed that OPF can distinguish patients from controls with accuracy of 83%, sensitivity of 51% and specificity of 96%. Interestingly, patients who were clustered together with the majority of the controls had a significantly higher TDI and identification score compared to patients who were clustered separately. We also observed a statistically non-significant (p = 0.07), yet trending difference in parosmia rate. For the comparison between patients and controls principal component analysis showed that familiarity and intensity were the key qualities to explain the variance of the data, however, all perceptual descriptors except disgust were important. All in all, we showed that people with olfactory dysfunction have a fundamentally different olfactory perception from healthy people This work is part of the project “Olfactorial Perceptronics” funded by Volkswagen Stiftung.
Presentation type: Poster presentation

The Nasal Cycle is Associated with the Perception of Pain

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The Nasal Cycle is a periodic shift in extent of nasal airflow between the left and right nostrils. The change in dominant nostril may be linked to transitions in autonomic arousal, potentially indicating a shift between sympathetic and parasympathetic tone. Given the strong link between autonomic tone and the sensation of pain, we hypothesized that pain may be reflected in the nasal cycle. We tested for this by simultaneously measuring nasal airflow in each nostril before, during, and after pain in 11 healthy participants (M/F=7/4, mean age=29±6). To cause pain we used cold-pressor test (CPT), where participants immerse their hand in freezing water (2°C) for as long as they can, for up to 3 minutes. Pain can be estimated by both the time the participant can endure, and their self-reported subjective ratings of pain. The nasal cycle was estimated by two standard parameters: Laterality Index (LI), namely the flow ratio between the nostrils (FlowR-FlowL/FlowR+FlowL), and inter-nostril correlation (NC), namely the correlation between the flows of the two nostrils. These were entered into an rmANOVA with a condition of experimental phase (before, during pain, after). We observed a significant main effect for LI ($F(2,20)=5.045$, $p=0.017$), reflecting a shift from right to left-nostril dominance during pain (mean LI Before:0.26±0.3, During Pain:0.205±0.294, After:0.199±0.301; before vs. after: $t(10)=2.82$, Cohen's $d=0.85$, $p=0.018$; before vs. pain: $t(10)=2.3$, Cohen's $d=0.7$ $p=0.044$). Moreover, across participants, increased subjective pain intensity was associated with increased correlation between nostrils during pain (Spearman's $r=0.639$, $p=0.034$). These remarkably strong effects that emerged in only 11 participants imply a genuine link between the nasal cycle and experience of pain, with clear clinical implications. Further work will determine whether this serves as merely a reflection of pain experience, or in turn, a causal determinant in sensation of pain.
Presentation type: Poster presentation

Chemical communication of positive emotions in humans

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Humans can communicate their emotions to others via volatile emissions from their bodies. There is now solid evidence for human chemical communication of fear, stress and anxiety. Positive emotions, however, have been more rarely studied. Here, a series of studies will be presented, examining the autonomic, verbal, and behavioral responses of receivers exposed to axillary odors of donors having undergone a positive mood induction procedure or being in a neutral state. Body odors were presented without and with perfume added. A first study using video inductions showed a decreased heart rate and increased performances in creativity tasks in response to 'positive' body odors compared to 'neutral' ones. A second study aimed at increasing the ecological relevance of our approach, by using virtual reality to induce emotions, and a third one was an at-home experiment involving dyads knowing each other. Overall, the results of these studies suggest that chemical communication of positive emotions exists in humans, and that this phenomenon is subject to variations that are not yet well understood.
Presentation type: Oral presentation

Cooking schools for patients with smell loss

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Introduction
A reduced or missing sense of smell has become a widely known problem in the wake of COVID-19. However, it has for a long time been a frequent handicap, with approximately 15% of the population suffering from a reduced sense of smell (hyposmia) while 2-3% completely lack the sense of smell (anosmia). The disorder affects the quality of life and around 90% of patients complain of impairment of the eating experience, making this the most common problem in these patients.
Methods
Patients with smell loss were offered a 5-week cooking school course with a focus on emphasizing the other senses to regain enjoyment of food. Before starting and three months after the course, testing of the sense of smell (TDI) was carried out. Before starting, after the last session, and three months after the course, the participants filled in questionnaires about their senses, quality of life and food and cooking habits. Through combined theory and practice on the cooking school, the ability to taste with basic flavors and highlight the sensory benefits of the food with texture, temperature, tactility and trigeminal stimulation was trained.
Results
Through five classes of the cooking school, 49 participants with loss of smell have completed a cooking school course (37 women, mean age 57 years, median duration of loss of smell 36 months). There was a significant improvement in the sense of smell three months after the cooking school, both by testing (n:29; Scale 1-48; 21.0 vs 23.1, p=0.03) and subjectively (n:31; scale 0-100; 24.3 vs 37.2, p =0.03). Food had a greater positive effect on quality of life after the cookery school (n:34; scale 0-100; 52.5 vs 66.25, p=0.04).
Positively evaluated recipes have been adjusted according to feedback and published as an online cookbook.
Conclusion
Focusing on food and cooking in patients with loss of smell can have a positive effect on both the sense of smell and quality of life.

The project is financially supported by the VELUX Foundation.
Presentation type: Oral presentation

Is olfactory working memory dissociated from visual and auditory working memory?

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Performance on working memory tasks is typically positively correlated, despite using different materials and task types. Individual differences in working memory performance are thus believed to relate to a common factor. However, the majority of work in the field has been conducted with visual or verbal stimuli. Much evidence suggests that olfactory memory is different from visual and verbal memory, but little research has been done on how olfaction relates to working memory. In this study, we aim to investigate if olfactory working memory is dissociated from visual and auditory working memory by looking at individual differences across sensory modalities on a common working memory task. In a cross-sectional design, 25 participants (ages 20–30) with a normal sense of smell are to perform a visual, auditory, and olfactory version of the n-back task. Performance across sensory modalities will be analyzed with correlation analysis. Preliminary results from 7 participants show a significant positive strong correlation between the visual and auditory n-back, but no significant correlation with the olfactory n-back. The preliminary results could indicate that there is indeed a dissociation for olfactory working memory. However, the data collection is ongoing, and the results will be presented in full at ECRO 2023. The study is funded by the Swedish Research Council (Vetenskapsrådet).
Presentation type: Poster presentation

Smell or music : what relaxes me more ?

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Objective – At a time when the search for well-being has become a societal priority, understanding how to induce positive emotions through non-pharmacological approaches is more than welcome. Odors and music are commonly used to achieve such a goal. However, while odors have a direct access to the limbic system through the olfactory system, auditory inputs are previously processed by a thalamic relay. Moreover, odors are intimately linked to respiratory activity through olfactomotor efforts. What is the impact of such a difference on the ability of odors or music to induce a relaxation state? We hypothesized that, through the privileged access of odors to the limbic system and its impact on respiration regime, positive odors have a peculiar ability to induce a relaxation state.

Methods – 30 healthy human participants were instructed to choose the most personally pleasant (positive) odor and music among a panel of 10 samples. Then, each participant was exposed to her/his most pleasant odor, music, or no stimulus (baseline), for a duration of 10 minutes. To get objective relaxation data, brain activity was recorded by EEG (32 active electrodes), breathing was captured through a nasal cannula and a ventral belt, and heart rate variability (HRV) was extracted from ECG recording. Subjective relaxation was assessed through questionnaires.

Results – Positive odor decreased respiratory rate and increased HRV, while positive

music increased respiratory rate and decreased HRV. Both odors and music were similarly able to raise brain activity related to relaxation (theta or alpha power). Data concerning subjective relaxation feelings are currently processed.

Conclusion – Preliminary results suggested a similar ability of positive odor and music to induce neuronal relaxation state while being associated with opposite physiological signatures.

Funding – Roudnitska Foundation, ANR. Odors provided by Sevessence©.
Presentation type: Poster presentation

Congenital anosmia is associated with altered ongoing nasal respiratory airflow

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Humans use their nose for two primary purposes: One is to constantly scan the environment for chemical information, and the second is to pass filtered and humidified air to the lungs for ongoing respiration. Humans with isolated congenital anosmia (ICA) use their nose for the second purpose alone. We therefore hypothesized that this difference will manifest in altered patterns of ongoing nasal airflow in ICA.
To address this hypothesis, we used a wearable spirometer to monitor left and right nasal airflow for 24 hours in 21 participants with ICA and 31 normosmic controls. Participants maintained an activity diary throughout the 24 hours. We split the data to wake and sleep, and further parsed the data to 5-minute blocks for which we extracted Respiratory Frequency, Respiratory Magnitude (the height of the respiratory peak), and an estimate of variability in these measures, namely the 5-minute standard deviation.
Using an analysis of variance on the airflow data with conditions of Sense of Smell (ICA/Normosmic) and Level of Arousal (Wake/Sleep) we observed a significant interaction between Sense of Smell and Arousal ($F(1,50)=4.72$, $p=0.035$), reflecting significantly less inhalation peaks per minute in ICA during wake (ICA: 19.5±5.8, Normosmics: 23.8±4.5, $t(50)=2.8$, $d'=0.8$, $p=0.004$), but not during sleep (ICA: 13.9±3.5, Normosmics: 15.1±3.5, $t(50)=1.22$, $p=0.23$). This decreased inhalation peaks per minute did not influence the number of breaths per minute in ICA compared to Controls ($F(1,50)=2.5$, $p=0.12$), but was significant for Arousal ($F(1,50)=54.8$, $p<0.001$). These differences, when entered into a SVM classifier, detected ICA at 73% accuracy, with 62% TPR (ICA classified as ICA) and 81% TNR (normosmics classified as normosmics).
In other words, we could identify anosmia by ongoing nasal airflow alone. We predict that using higher-order airflow parameters we will be able to significantly improve the performance of this classifier.

Presentation type: Poster presentation

HRV-TRACKER : proof of concept for a tool to detect respiratory stress and respond with an olfactory stimulation.

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Our brain orchestrates breathing through a balance of afferent sensory information and efferent volitional information. An anomaly in this balance triggers painful sensations regrouped under the term of dyspnea. Dyspnea represents a physical pain and also a psychological distress. Therapeutical opportunities to correct dyspnea respiratory abnormalities exist, however they are not always available and sometimes not sufficient. In these cases, the dyspnea is called persistent and need new therapeutical leads to be alleviated.
In this context, an olfactory stimulation (OS) could represent a good candidate. OS has been identified to yield beneficial clinical effects in non-respiratory pathologies such as depression or dementia but also in respiratory pathologies. Some studies showed that using menthol could reduce the sensation of respiratory discomfort.
In clinic, to adapt to the omnipresent aspect of dyspnea, an OS should be able to be delivered at any moments. Thus, we propose to develop a device that identifies respiratory stress (RS) and subsequently diffuses an OS. The first step is to develop an algorithm capable of identifying RS and decide whether or not deliver an odor. To do so, we used the autonomous nervous system sympathetic branch increase during a stress event that we can capture with the measure of Heart Rate Variability (HRV) metrics computed from the Electrocardiogram. We used a machine learning algorithm to decide to deliver the OS or not as a function of the HRV metrics. To test our algorithm, we induced experimental RS in 30 healthy subjects while diffusing a pleasant, unpleasant and without OS while recording their ECG.
Our results show that our algorithm manages to identify RS and deliver odor during stress. Besides, we measured that with an OS, specifically chosen by the subject as being pleasant, the algorithm no longer identify stress HRV profile present without OS, suggesting that OS alleviate respiratory discomfort.

Presentation type: Poster presentation

CD20 functions as a mammalian odorant receptor that mediates innate avoidance of predator-derived compounds.

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The mammalian olfactory system has evolved the capacity to detect and discriminate between millions of odorants and to trigger appropriate behavioral actions in response to these sensory stimuli. While much has been learned about how olfactory sensory neurons detect odorants and signal their presence, the mechanisms by which specific innate, unlearned behaviors are initiated in response to ethologically relevant odors remains incompletely understood. Here, we present evidence revealing that CD20 functions as a mammalian odorant receptor that recognizes compounds produced by the natural mouse predators, the wolf and the ferret. CD20 is expressed in a previously uncharacterized subpopulation of olfactory sensory neuron in the main olfactory epithelium of the murine nasal cavity, and genetic deletion of CD20 results in mice which are unable to appropriately avoid predator derived odorants. Together, this work reveals a novel mechanism by which odors that trigger innate behaviors critical for organismal survival are sensed by the mammalian olfactory system.
Presentation type: Oral presentation

Smell identification skills and food neophobia in preschool and elementary school children

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Child food neophobia - a rejection or avoidance of novel foods by children can affect the quality of children's diets and lead to serious eating disorders. Scientist began to search for effective ways to reduce such symptoms. These interventions were linked to the development of sensory perception, mainly by referring to the senses of sight, taste, and touch. However, little is known about the effect of olfactory training on reducing this echildhood problem.
The present study investigated whether and how child food neophobia can be reduced by olfactory training. The study involved 326 children aged 4-9 years (M=6.15, SD=1.31; 52% girls). Children first took part in an assessment of their level of child food neophobia , olfactory identification skills , and interest in and use of odors. Subsequently, 130 children from the experimental group participated in a standard 12-week olfactory training (Hummel et al., 2009).
After the training period, we observed some increase in odor identification scores in the experimental group ($F(1,289)=3.85$; $p=.051$), but food neophobia did not change as a result of olfactory training ($p>.05$). These results suggest that although food neophobia can be reduced through some sensory channels, olfactory training alone does not appear to be that effective.
Presentation type: Poster presentation

Different chemosensory EEG signals of human brain in elemental and configural odor mixtures

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Most of the odors we encounter in our daily lives are odor mixtures. Odor mixtures can be perceived either elementally, meaning each component is still discernible, or configurally, which means the single odorants blend together to form a new unity. This study explores whether the brain signals of single odorants within a mixture are more similar to those of elementally perceived mixtures or configurally perceived mixtures. Previous studies in humans showed that as the number of single odorants within the mixtures increases, the mixtures are perceived more configurally. However, how the brain processes these mixtures when the odor mixtures are perceived configurally has yet to be thoroughly explored in humans.
Therefore, this thesis aims to investigate the brain processes of configural odor mixtures in humans by analyzing the behavior responses and brain activities with EEG measurement. Consistent with previous studies, I found that as the number of single odorants within the mixtures increased, identifying the single odorants within the mixtures became more difficult, especially when the number exceeded three. As such, I classified mixtures with two single odorants as being perceived elementally and mixtures with three or more odorants as being perceived configurally.
When measuring brain signals for single odorants and odor mixtures, I found that the brain signals for single odorants were more similar to those of elemental mixtures than those of configural mixtures. This suggests that within the olfactory system, there are differences between elemental and configural odor mixtures at olfactory processing.
Presentation type: Poster presentation

Investigating the relation between Semantic Space and Olfactory Perceptions using Language Models

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The relationship between language and perception is a foundational subject in cognitive science Most languages lack dedicated olfactory vocabularies. Odor descriptions are often ambiguous and that presents a challenge for understanding

olfaction through language analyses.
Traditional approaches to investigating odor vocabularies have limitations in terms of dataset size, semantic relationships, and inclusion of comprehensive olfactory words. We address these limitations by leveraging recent advancements in Natural Language Processing (NLP) that range from early models like Word2Vec to contextual models like BERT, and finally to large language models (LLMs) such as ChatGPT and GPT-4. We focus on evaluating the capacity of different generations of language models to capture olfactory-semantic relationships. We meticulously assess four prominent language models—Word2Vec, FastText, BERT, and ChatGPT—using various configurations. We compare the resulting semantic spaces for olfactory vocabulary with three distinct ratings-based datasets, each representing different facets of olfactory-semantic representations. The evaluation includes the famous Dravnieks dataset as well as two novel datasets involving perceptual odor-pair ratings and imagined odor-pair ratings. We show that (1) screening text corpora for odor terms can enable learning word embeddings that resemble human ratings, but that (2) LLMs, such as Chat-GPT, resemble what humans imagine odors to smell like, rather than human odor perception.
The findings of this study shed light on the capabilities of an NLP approach to capture olfactory information and contribute to the understanding of perceptual and semantic representations of odors. Moreover, we show the potential use of AI models as substitutes for human participants in generating olfactory-related responses, providing resources for researchers and practitioners in the field of olfaction.
Presentation type: Oral presentation

Multisensory integration and attention towards odors enhance the efficacy of olfactory training, in relation to molecule complexity and physical activity

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Background: The systematically repeated exposure to odors, known as olfactory training (OT), has been shown to be of value in the treatment of olfactory dysfunction. The present study aimed to investigate whether the efficacy of OT could be modulated with multisensory integration, attention toward daily odors, molecule complexity, or physical activity.

Methods: One hundred healthy participants were recruited and divided into four groups. Except for controls (n = 26, mean age ± sd = 36 ± 15 years) all participants performed OT four times a day. In the “Video” group (n = 26, age 39 ± 19 years) OT was performed while watching specific and congruent video sequences. In the “Counter” group (n = 24, 38 ± 17 years) participants additionally counted the number of odors one day per week, and in the “Training only” group no additional measures were taken in addition to OT (n = 24, 38 ± 20 years). “Single-molecule” odorants or “complex mixture” as training stimulation were distributed randomly. Sniffin’ Sticks tests (odor identification, odor discrimination and odor threshold), cognitive tests, and

a series of scales were measured at both baseline and after 3 months of OT. The degree of physical activity was recorded.

Results: Olfactory function improved in the Video and Counter groups after OT, especially for odor threshold and discrimination. Single-molecule odorants boosted odor discrimination improvement. Overall, the increase in olfactory discrimination and identification positively correlated with the degree of physical activity.

Conclusion: Both multisensory interaction and attention towards odors appear to improve the efficacy of OT in healthy individuals. Importantly, this improvement also correlates with the degree of physical activity and single molecule training stimulation.
Presentation type: Poster presentation

Clustering skills related to human chemosensory communication

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People differ in a variety of traits which might affect chemosensory communication. The current study aimed at clustering individuals based on social characteristics and the perception of human happiness chemosignals, and to explore whether these clusters would differ in their evaluative neural processing of human happiness chemosignals.
N = 53 individuals (n = 27 women) were presented with pooled axillary sweat sampled from women while awaiting the arrival of a loved one after a period of separation (happiness sweat). The samples were presented via a constant-flow olfactometer (100 ml/s) while EEG was recorded (25 trials, 0.5 s, ISI: 18.5-22.5 s). In each trial, participants indicated if they had detected an odor (detection rate), and if they would find an individual emitting such odor attractive (likeability rate). Event-related potentials were calculated, and the P3 component was detected at electrode Cz. Participants answered the Social Interaction Anxiety Scale (SIAS; social anxiety) and completed the Reading the Mind in the Eyes Test (RMET; Theory of Mind). They were clustered based on detection rate, likability rate, SIAS, and RMET using hierarchical clustering with Ward's method and squared Euclidian distance.
The analysis revealed 4 clusters. Clusters 1 (n = 23) and 2 (n = 5) were both characterized by high SIAS and RMET scores, but cluster 1 featured high likeability and detection rates, while cluster 2 had low likeability and medium detection rates. Clusters 3 (n = 17) and 4 (n = 8) had low SIAS and RMET scores, with cluster 3 featuring high detection but low likeability rates, and cluster 4 featuring low detection and high likeability rates. Cluster 2 showed the smallest P3 amplitude, differing from both cluster 1 ($p = .033$) and cluster 3 ($p = .048$).
The current study suggests that there are specific sets of characteristics based on social functioning and chemosensory sensitivity which relate to evaluative processing of human happiness chemosignals.
Presentation type: Poster presentation

Exploring the Mechanism of Phantosmia: Induction of odor phantoms through brain stimulation during radiotherapy

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Aim. Our prospective study aimed to investigate the characteristics of phantosmias induced by RT, to identify factors that influence the occurrence, intensity and hedonic ratings of phantosmia.
Methods. A total of 106 patients (37 women) who underwent an RT in brain, ENT-related, and other body regions were included. Medical history and treatment parameters were collected in a structured medical interview. Olfactory function was measured using the Sniffin' Stick Odor Identification Test at baseline. Phantosmias and also phosphenes were recorded based on a self-report questionnaire.
Results. There were 37% of the patients experiencing phantosmias, 51% experiencing phosphenes, and 29% simultaneously experiencing both sensations. Phantosmias were typically perceived as a chemical-like, metallic or burnt smell. Younger age ($F = 7.81$, $p < 0.01$), radiation in the brain region ($\chi2 = 14.05$, $p = 0.02$), absence of taste problems ($\chi2 = 10.28$, $p = 0.01$), and proton RT ($\chi2 = 10.57$, $p = 0.01$) were related to these abnormal sensations. Phantosmias occurred in 10 out of 17 cases who underwent radiation in the temporal lobe, 22 out of 54 cases in the frontal lobe, 2 out of 7 cases in the occipital lobe, and 9 out of 41 cases in the parietal lobe. History of chemical/dust exposure predicted lower intensity ($B = 1.52$, $p = 0.02$) and lower unpleasantness ($B = 0.49$, $p = 0.03$) of phantosmia.
Conclusions. Phantosmias and phosphenes are common during RT. The treatment settings and individual arousal level influence the occurrence, intensity and hedonic of phantosmia and phosphene. Phantosmias and phosphenes may involve more central neural than peripheral mechanism, and they could be elicited with activation of areas that are not regarded to be part of the olfactory or visual network.
Keywords phantosmia, phosphene, radiation therapy, proton, photon
Presentation type: Poster presentation

Giving a voice to adults with COVID-19: An analysis of open-ended comments from smell longhaulers and non-longhaulers

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Smell disorders are commonly reported with COVID-19 infection. Some patients show prolonged smell-related issues, even after the respiratory symptoms are resolved. To explore the concerns of patients, and to provide an overview for each specific smell disorder, we explored existing data from a longitudinal survey, and contained self-reports on the changes of smell that participants experienced at two time points. People who still suffered from smell disorders at the second time point, hence named 'longhaulers', were compared to those who were not, hence named 'non-longhaulers'. Specifically, three aims were pursued in this study. First, to classify smell disorders based on the participants' self-reports. Second, to classify the sentiment of each self-report using a machine learning approach, and third, to find specific keywords that best describe the smell dysfunction in those self-reports. We found that the prevalence of parosmia and hyposmia was higher in longhaulers than in non-longhaulers. Furthermore, the results suggest that longhaulers stated self-reports with more negative sentiment than non-longhaulers. Finally, we found specific keywords that were more typical for either longhaulers compared to non-longhaulers. Taken together, our work shows consistent findings with previous studies, while at the same time, provides new insights for future studies investigating smell disorders.
Presentation type: Poster presentation

Diagnosing Parosmia

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Parosmia, a condition characterized by distorted olfactory perceptions, has gained increasing attention due to its impact on quality of life, in particular following COVID-19. Despite the millions of people affected by it, its diagnosis and management still present significant challenges. This talk aims to provide an in-depth exploration of recent advancements in diagnosing parosmia, encompassing a comprehensive overview of assessment techniques and their accuracy, underlying mechanisms, and their implications for clinical decision-making.
Presentation type: Oral presentation

Impact of olfactory training on odor dilutions sorting ability in adult and elderly population.

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Olfactory training (OT) is employed in the rhinological practice to rehabilitate the sense of smell. OT's potential to restore olfactory sensitivity and increase odor discrimination and identification abilities has been demonstrated in patients with smell loss and aging population prone to olfactory decline. A recent study employing machine-learning algorithms showed that sorting different dilutions of the same odor is an olfactory ability independent from the three most studied olfactory functions (olfactory sensitivity, odor discrimination, odor identification). The presented project aims to verify the effects of OT on the sorting ability in adult and elderly individuals.
Participants performed OT with either 4 odors (lemon - citronellal, cloves - eugenol, eucalyptus - eucalyptol, rose - phenyl ethyl alcohol) or odorless propylene glycol (PG) bi-daily for 12 weeks. Before and after the OT their dilution sorting ability was assessed for 3 smells – 2 from the OT set (cloves, rose) and 1 not employed in OT (strawberry). The dilution sorting task involved sorting 6 dilutions of the odor, starting from 1% dilution in PG which was further diluted in 1:2 ratio. Participants used a web-based app to log all OT sessions to control for OT adherence. In adults (n=86; 46 women, M_{age}=27.7±2.6 years), OT did not affect the dilution sorting ability for any of the odors (all F<.57, all p>.452). Preliminary results obtained for the elderly population (n=60; 50 women, M_{age}=71.9±5.1 years) also did not reveal any effect of OT on the dilutions sorting ability (all F<.1; all p>.763). Our results suggest no effect of OT on the newly described olfactory ability of sorting odor dilutions and corroborate the notion that dilutions sorting ability is independent from threshold, discrimination and identification abilities. Further research is planned to verify if OT improves dilution sorting ability in patients with anosmia.
Funding: National Science Centre grant (OPUS 2020/37/B/HS6/00288)
Presentation type: Poster presentation

Differences in verbal descriptions of anxiety, aggression, and happiness sweat

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Humans usually fail to identify the emotional state of individuals based on sweat released volatiles in forced-choice tasks. The current study explores whether differences in verbal descriptions of anxiety-, aggression-, and happiness-related sweat exist, assessing odour descriptions without participants being forced to choose between emotional odour labels.
Axillary sweat was collected from women via cotton pads in three conditions: anxiety (final university exam, n = 21), aggression (retaliating against a frustrating opponent in a competitive social encounter, n = 17), and happiness (awaiting the arrival of a loved

person after a period of separation, n = 25). The sweat samples were presented via a constant air-flow olfactometer (100 ml/s): anxiety sweat for 0.5 s to n = 28 individuals (n = 12 women), aggression sweat for 0.4 s to n = 84 individuals (n = 44 women), and happiness sweat for 0.5 s to n = 53 individuals (n = 27 women). Participants described the sweat samples using a standard list of 147 hedonically pleasant and unpleasant verbal descriptors, and were free to select as many descriptors as they wanted. Chosen by at least 10% of the participants, happiness-related sweat received the highest number of 5 positive descriptions (warm; woody, resinous; leather; cool, cooling; floral), while anxiety-related sweat received only 2 (warm; sweet), and aggression-related sweat only 1 (warm). Conversely, anxiety-related sweat received the highest number of 4 negative descriptions (stale; chemical; medicinal; heavy), happiness- and aggression-related sweat, however, each received only 1 (stale). Although chemosensory communication does not rely on conscious perception, the current study suggests that intuitive verbal descriptions might reflect the emotional valence of a given chemosensory signal.
Presentation type: Poster presentation

The Brain Mechanisms Behind the Chemistry in Social Chemistry

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Nonhuman terrestrial mammals sniff themselves and each other to decide who is friend or foe. Humans also sniff themselves and each other, but the function of this is unknown. Because humans seek friends who are similar to themselves, we hypothesized that humans may smell themselves and others to subconsciously estimate body odor similarity, which, in turn, may promote friendship. To test this, we recruited nonromantic same-sex friend dyads and harvested their body odor. We found that objective ratings obtained with an electronic nose, and subjective ratings obtained from independent human smellers converged to suggest that friends smell more similar to each other than random dyads. We then recruited complete strangers, smelled them with an electronic nose, and engaged them in nonverbal same-sex dyadic interactions. We observed that dyads who smelled more similar had more positive dyadic interactions. In other words, we could predict social bonding with an electronic nose. In a current ongoing continuation, we are manipulating participant body-odor (using Deo candy), and exposing them to images of potential friends with either congruent or incongruent body-odor, all within an MRI scanner. The contrast of incongruent versus congruent body-odor generated increased activity in the anterior cingulate cortex, precuneus, cuneus and the cerebellum, a brain network previously associated with “self-other” comparisons. We conclude that self-body-odor may provide a template for the social brain, underlying the chemistry in social chemistry.
Presentation type: Oral presentation

The effect of olfactory training on verbal fluency: insights from a study on healthy adults and elders

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Olfaction is linked to cognitive functioning due to neural connections between the olfactory and limbic systems. One of the cognitive functions that olfaction is associated with is verbal fluency, the ability to generate words or produce fluent speech. Previous studies show that olfactory training (OT) improves the general verbal fluency. This study examined the effects of OT on verbal fluency with respect to a general and olfaction-related wording in healthy adults (without olfactory or cognitive impairments). A total of 86 adults (54% women; M_{age}=27.7±2.61 years) and 60 elderly (83% women; M_{age}=71.9±5.07 years) were invited to the study. Participants underwent a 12-week OT wherein they sniffed four odors: (1) citronellal (lemon); (2) phenyl ethyl alcohol (rose), (3) eucalyptol (eucalyptus); (4) eugenol (cloves) twice a day. The control group performed the same activity with odorless propylene glycol. Compliance was monitored using a dedicated web-based application. Verbal fluency was measured by listing as many words as possible within 60 seconds: either (a) grocery or (b) fragrance products. Participants listed items from the same category in both the pre- and post-OT measurement. OT did not significantly impact verbal fluency, regardless of the type of items listed and age (both F<2.29 and p>0.136). Post-hoc analysis showed a trend-level increase in verbal fluency in the elderly OT group (p=0.58), regardless of semantic category (grocery vs fragrance products) These findings suggest that OT does not enhance verbal fluency in adult individuals who are likely to be at the peak of their cognitive and olfactory performance, but might slightly benefit verbal fluency in elderly.
This work was supported by National Science Centre in Poland (#2020/37/B/HS6/00288 awarded to AO).
Presentation type: Poster presentation

Olfactory and trigeminal event-related potentials in pregnant and non-pregnant women – an exploratory study

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Objective: Chemosensory function in pregnant women requires a more profound understanding in the context of the inconsistent results of self-reports and objective studies. Methods: Here, on a sample of 14 pregnant and 13 non-pregnant women, we measured EEG-derived electrophysiological response measures supported by a series of psychophysical tests. Results: The present data support the view that the olfactory event-related potential (ERP) amplitudes or latencies of the P1, N1, and P2 components remain unchanged in pregnant women. In line with these findings,

pregnant and non-pregnant women performed equally well in psychophysical olfactory tests. Furthermore, we found that pregnant women displayed a lower degree of sensitivity to trigeminal stimuli compared to non-pregnant controls. Conclusion: While to some degree counterintuitive, our results indicate a “flattening” of chemosensory processes, which might be interpreted in the context of changes in psychological processes that occur during pregnancy. Taken together, the current results suggest that while pregnant women do not differ from non-pregnant ones in terms of olfactory function, their chemo-somatosensory function is decreased. Identification of sources of funding: none.
Presentation type: Poster presentation

Invigorating effects of food odors and pictures: a novel incentive delay paradigm

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Consummatory and anticipatory properties (“liking” and “wanting”) of odors are powerful reward cues that guide dietary choices and food consumption. Yet, modality-specific paradigms that explicitly probe differential effects of liking and wanting on reward processing remain scarce. This study addresses this gap by establishing a novel incentive delay paradigm that separates invigorating effects of consummatory and anticipatory reward value of sensory food stimuli across modalities. To establish a behavioral baseline, healthy, sated, female participants (N=38) were presented with non-predictive sensory cues before a reaction task that was either rewarded or unrewarded. These cues were selected from a sensory stimulus battery that dissociated liking and wanting through inclusion of food (liked and wanted) and nonfood (liked, not wanted) stimuli that were presented through either the olfactory or visual modality. A significant reaction time advantage indicated differential reward system activation for rewarded versus nonrewarded trials ($p<.001$). As expected, this advantage was not further modulated by the anticipatory and consummatory hedonic properties of the non-predictive sensory cue in our sated healthy population. Likewise, no systematic differences between sensory modalities were observed. We predict that hungry study populations with a metabolic need for food intake might differentially show a processing benefit for anticipatory food cues, which would be reflected in more efficient reward network activation for wanted as opposed to merely liked stimuli, and that this effect would be specific to the olfactory modality. Studies that test these hypotheses are currently ongoing. Future work will expand these findings to clinical populations characterized by apetite dysregulation to establish a potential perceptual-motivational basis for differences in reward-seeking behavior.

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Presentation type: Poster presentation

The science behind marketing: emotional effects of fragranced (cosmetic) products

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Odors and fragrances are known for their emotional effects and strong link to memory. The strong connections between odors with emotions and memories are based on neurological characteristics in humans. As such, the cosmetic industry (amongst others) widely uses fragranced products. The cosmetic industry is a fast-moving industry, with products on the market changing rapidly. The perceived informational value through advertising is thus one of the most powerful factors in stimulating the interest and desire to try new products. Marketing claims are an effective strategy to promote the products' characteristics, in particular the emotional effects of used fragrances. According to the EU Regulation (EC) No 1223/2009, cosmetic claims "shall not be used to imply that these products have characteristics or functions which they do not have". Therefore, they should be based on independent research that explicitly proves promised effects. However, there is a lack of transparency of the supporting studies and an increasing scepticism in the population that the claims are trustworthy.
To counteract these problems, scientific knowledge about odors and their impact as well as about valid and reliable study designs is needed. Additionally, the needs and available resources, including time and money, of the industrial partners should be considered. Therefore, we developed an adaptable, resource-saving, placebo-controlled study design to investigate emotional effects, e.g. activation or stress reduction. After a standardized emotional induction, the product or a placebo is applied. Measuring stress hormone levels, HRV (heart rate variability), and EEG as well as using psychological questionnaires, we were able to show not only the effects of our emotional inductions, but also the effect of the product. With the help of this research we are able to provide support for interested industry partners during the evaluation of the function of their fragrances.
Presentation type: Oral presentation

Scent of sickness and decay: emotion regulation during exposure to unpleasant smells

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Our psychological well-being depends on the ability to downregulate emotions (Morawetz et al., 2020). A disturbance in emotion regulation has been linked to reduced ability to activate the conscious control networks in the brain. Investigation of emotion regulation with negative images is the standard approach in the field. Smells have unique affective qualities, are neuronally distinctly processed, and are potentially more difficult to regulate cognitively. The aim of this project is to test whether emotion regulation of how we respond to negative smells in brain and behaviour relies on a network more associated to implicit emotion regulation.
We tested 30 normosmic participants using 3T imaging at Donders Institute, with the Lundstrom olfactometer for odor delivery (Lundström et al., 2010). Our paradigm involved presentation of 3 different negative odours (Pyridine, nButanol and isovaleric acid) for 8 seconds and subsequent instruction to either perceive and maintain the emotion elicited by the odour or downregulate the emotion elicited by the odour. Regulation instructions based on reappraisal techniques are given to the participants. After each trial participants rate their valence and arousal in response to the smell-condition combination. Differences in behaviour and brain activity during the trial between decrease and maintain as well as valence arousal interactions are calculated.
The main effect of regulation for valence was not significant ($F_{1,29}=3.453$, $p=0.073$; $\eta_p^2=.106$), but for arousal it was significant ($F_{1,29}$; $p=0.005$; $\eta_p^2=.244$). Initial brain analyses indicated that the tasks activates subcortical areas, insula and brain areas found in classical emotion regulation tasks. Further analysis will be conducted to elucidate the unique neuronal pattern.
In summary, conscious control of smell induced emotional states seems to be possible and similarly strong compared to classical visually induced emotional states.
Presentation type: Poster presentation

The scent of cuteness: Neural signatures of infant body odors

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The smell of the own baby is a salient biological cue for kin recognition and bonding. We hypothesized that infant body odors function like other sensory cues of the Kindchenschema by recruiting neural circuits of pleasure and reward. In two fMRI studies, we presented infantile and postpubertal body odors via a computer-controlled olfactometer to nulliparae and mothers (N=78). All body odors increased BOLD response and functional connectivity in circuits related to olfactory perception, pleasure and reward. Neural activation strength in pleasure and reward areas positively correlated to perceptual ratings across all participants. Compared to postpubertals, infant body odors specifically enhanced BOLD signal and functional connectivity in reward and pleasure circuits, suggesting that infantile body odors prime the brain for prosocial communication. This result supports the idea that infant body odors are part of the Kindchenschema. The additional observation of functional

connectivity being related to maternal and kin state speaks for experience-dependent priming.
Presentation type: Oral presentation

Influences of hunger and attentional focus on perceptual deviance processing in odour mixtures

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Olfactory cues are key elements of food identification, influencing acceptance or rejection prior to taste evaluation. The extent to which differences between novel and learned “safe” odours influence acceptance critically depends on a person’s attentional focus and metabolic state. Interactions between these factors thus likely play an important role in acquiring novel taste preferences, but to date remain poorly understood. We addressed this by investigating the impact of attention and hunger on perceived food odour identity. Participants smelled odours ranging from pure food to pure non-food, while instructions asked them to attend to either the food or non-food component and rate its perceptual dominance. We hypothesized that the attentional manipulation would enhance sensitivity to contamination of one odour with another. A selectively higher contamination sensitivity to the food odour during hunger than satiety (within subjects) was expected. Logistic mixed regression revealed that concentration of the attended odour in the evaluated stimulus significantly influenced the dominance perception of the attended stimulus ($p < 0.001$, OR= 1.09). The interaction between target odour concentration and hunger was marginally significant ($p = 0.0864$, OR = 2.717), hungry people were more likely to identify the non-food odour as food than sated people. Fitted sigmoid functions revealed that the points of subjective equality (PSE; where food and non-food are perceived equally strong) shifted depending on hunger level and identity of the attended odour. These findings highlight that participants’ attentional focus and hunger state can interact to shape their perception of food odour identity. These interactions may thus hinder or promote the acquisition of novel flavour preferences during attempted changes in eating behaviour, with important implications for interventions that promote public health and well-being. (Funded by: ERC STG 947886)
Presentation type: Poster presentation

Olfactory impairment in an animal model of multiple sclerosis

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Olfactory impairment occasionally occur in autoimmune central nervous system (CNS) inflammation, including multiple sclerosis. The aim of this study was to evaluate whether olfactory impairment occurs in experimental autoimmune encephalomyelitis

(EAE) as an animal model of multiple sclerosis. EAE was induced by immunization of myelin oligodendrocyte glycoprotein (MOG) peptides in C57BL/6J mice. Bioinformatic and immunohistochemical analyses were done in the olfactory bulbs and olfactory mucosa with EAE. Behavioral tests revealed that the searching time for a bait was significantly delayed in EAE mice. Neuroinflammatory lesions, characterized by microgliosis and astrogliosis, were identified in the olfactory bulbs with EAE. Inflammatory cells were also found along the olfactory nerves and in the submucosa of olfactory mucosa. Western blot analysis of olfactory marker protein (OMP) showed that OMP was significantly downregulated in the olfactory mucosa with EAE. Differentially expressed genes (cut-offs, fold change > 2 and adjusted $p < 0.05$) and their related pathways in olfactory bulbs were subjected to gene ontology (GO) pathway analysis and gene set enrichment analysis (GSEA). Twelve hub genes were found, three of which (Ctss, Itgb2, and Tlr2) were validated by qPCR to be related to GO pathways such as immune response and regulation of immune response. GSEA showed that neuron-related genes including Atp6v1g2, Egr1, and Gap43 and their pathways were significantly downregulated. Collectively, the present data imply that neuroinflammation in the olfactory pathway induces olfactory impairment in EAE, which was further evidenced by bioinformatic analysis. * This research was supported by the National Research Foundation of Korea (Grant number: NRF-2019R1A2C1087753).
Presentation type: Poster presentation

To be or not be situated, that’s the question: the role of context in sensory testing

Monique Smeets

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"Fundamental research is difficult, but applied research is even more difficult" was one of the famous quotes from Ep Köster. This may well be true for fundamental researchers demonstrating scientific principles, with applied scientists facing the challenge of having to demonstrate the feasibility and business relevance by translating the scientific principle into a consumer product that is both efficacious and enjoyed. This challenge often deals with contextual factors such as
1) the situation in which a product or technology needs to perform,
2) the product matrix in which the technology needs to work,
3) the industry context in which the product needs to be delivered (e.g., cost, competitor products).
The first factor has also been referred to as “the situational fallacy” by Ep (Köster, 2003) and it has received increasing attention in sensory research as well as in a wider literature on situated cognition, focusing on the importance and often ignored role of social, cultural and situational features as a significant cognitive resource. For example, it is now well appreciated that food products should be evaluated in the (social) settings they tend to be consumed in combination with foods they are normally accompanied with. In contrast, the second and third factors have been quite neglected, yet they can severely limit or complicate translating the scientific principle into an efficacious product.
In this presentation I intend to share examples of various product and industry

contexts from the Fast Moving Consumer Goods industry to illustrate how they can complicate the process of translation from scientific principle to business application. A Phase Gate approach with crucial phases of the R&D process and gates for evaluation of progress can be helpful to prevent product failure at early rather than later phases of innovation.

Köster, E. P. (2003). The psychology of food choice: some often encountered fallacies. Food quality and preference, 14(5-6), 359-373.
Presentation type: Oral presentation

Lost in translation: the journey from fundamental science to product application

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The field of human taste and olfaction is witnessing significant breakthroughs with numerous opportunities for application in consumer products. While this may seem easy, in reality the road of successfully translating a scientific insight into a product can be paved with obstacles. In this symposium, which is dedicated to Ep Köster (1931 - 2022) who pioneered an applied chemosensory science, we will offer you a peek at the wondrous world of the Fast-moving Consumer Goods industry and Ingredients Industry R&D. How can we as academics and R&D scientists work together to make the science truly translational?
Presentation type: Oral presentation

Olfactory perception and odor awareness in young children with food neophobia

Agnieszka Sorokowska , Dominika Chabin , Aleksandra Kamienska , Sabina Barszcz , Katarzyna Byczynska , Edyta Sperling , Andzelika Frankowska , Anna Oleszkiewicz

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Child food neophobia, i.e., rejection or avoidance of novel foods in young age, is a prevalent problem that affects quality of children's diet and impedes the development of healthy food preferences. Olfaction is an obvious candidate for a food neophobia correlate as it largely affects food perception and enjoyment. However, existing studies rarely examine the association between olfaction and food neophobia in children and they are often limited to questionnaires and or very simple measures. Here, we tested whether food neophobia in children is predicted by various aspects of olfactory sensitivity and we additionally examined the contribution of odor awareness and a range of demographic factors to this problem. A group of 238 children aged between 3 and 9 (M=7.08, SD=1.85; 52,9% girls) and their primary caregivers took part in an assessment of food neophobia, odor awareness, odor pleasantness

perception, olfactory thresholds for detection of two odors (unfamiliar food- and non-food odors), as well as odor identification skills. A multiple regression model including food neophobia, all olfactory sensitivity measures and other variables of interest indicated a significant predictive power of threshold for unfamiliar non-food odor detection and odor identification. Olfactory sensitivity seems to significantly contribute to food neophobia, regardless of a range of demographic and psychological factors.

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Presentation type: Oral presentation

Odor pleasantness and edibility underlie odor crossmodal associations

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Humans live in a multisensory world and as a consequence, the brain dedicates considerable resources to multisensory processing. Olfaction is a modality in which multisensory processing is particularly important. For example, odor, taste, color, and texture are strongly associated in food and drink. Despite many studies demonstrating associations between odors and other sensory modalities, the strength of these associations across sensory modalities is unknown. Furthermore, it is unclear what odor dimensions are relevant in odor crossmodal associations. To investigate this we presented 50 British participants with 16 odors spanning two odor dimensions: pleasantness (pleasant vs. unpleasant) and edibility (edible vs. inedible). Participants were asked to rate to what extent associations with vision, sound, taste, or texture came to mind when they smelled an odor on a 0 (not at all) to 5 (very much) scale. Vision was the modality most strongly associated with odors, followed by taste and texture, with sound the least associated. Using linear mixed effects models with participants and odors modeled as random effects, we found associations in all modalities except taste were stronger for pleasant compared to unpleasant odors. Surprisingly, associations in all modalities except vision were stronger for inedible compared to edible odors. Our results suggest the strength of odor associations varies across sensory modalities. Importantly, odor pleasantness and edibility are two key factors driving crossmodal associations, supporting suggestions made elsewhere that they are primary dimensions in the perceptual space of odors.

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Presentation type: Oral presentation

A mechanism for olfactory constancy

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Olfactory receptor neurons (ORNs) in the nasal cavity sense VOCs. These ORNs undergo constant turnover and shift in their response as a function of fatigue and exposure. Despite this variability, olfactory perception appears constant over time, suggesting robust mechanisms compensating for fluctuations. Here we put forth a novel hypothesis where the two-nostril system allows maintaining constancy despite drift in the olfactory image. We propose a winner-takes-all competition between nostrils in pattern identification. If one nostril registers strong identification, the other recalibrates its image accordingly. To test this hypothesis, we constructed an apparatus allowing delivery of different stimuli to each nostril. The apparatus contains a barrier between nostrils, 3D-printed to fit each participant's nose. In an ongoing experiment, participants were trained to identify four complex odorants (O1-4). After participants reach criteria, in an altered-identification task, we incrementally replace O1 with a new, unidentified odorant (OX), one nostril at a time, while keeping O2-4 the same. Separate participants completed the same tasks without nostril separation to control for learning. After completely replacing O1 with OX, participants named the odors. Results from 26 participants (N=13 in each group) revealed a significant effect of the manipulation: In 52% of trials, participants named OX as if it were O1. Participants named OX correctly in only 19% of trials ($z = -14.4$, $p < .01$). Despite a soft trend in the direction of our hypothesis whereby this perceptual shift was greater in the group with nostril separation (Separated: 54% shifted, only 15% correctly named, Without: 50% shifted, 23% correctly named), this interaction was not significant (OX: $\chi^2 = .41, p = .52$, O1: $\chi^2 = .01, p = .93$). The current data imply a remarkably fast shift in olfactory perception, but only minimally support our hypothesis. Final determination on this front awaits completion of the intended cohort.
Presentation type: Poster presentation

Examination of chemosensory perceptions using DTI

Divesh Thaploo

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Olfactory function can be evaluated using standardised psychophysical tests, like UPSIT or Sniffin' Sticks, allowing a categorization into normosmia, hyposmia, or anosmia. Regarding results from functional MRI, it is important to note that people with anosmia exhibit normal patterns of activation in key olfactory brain regions even though they have no smell function. In addition to FMRI, diffusion imaging, or diffusion weighted imaging, is used to understand structural changes in the brain, in particular white matter integrity. However, it still remains to be seen how this develops into a clinical routine.
Presentation type: Oral presentation

How glass becomes odour.

Lena Trost

Bauhaus-University Weimar

Within my PhD project I claim that the association of smell to a thing, object, is enough to create a smell and the actual reception exists even if the smell is imaginary. The objective is to create an aesthetic experience which combines typical stimuli of perceiving art with touch and smell.
The body of my artistic practice is the material glass. I use glass as a tool to trigger smell memories. Glass is known for being odourless and is, like odour, both tangible and intangible at the same time.

The key question is, which stimuli most directly taps into the individual olfactory memory?

I developed my Digital Glass Tasting Website as an artistic method to answer this question in a both playful and explorative way. The users of the Digital Glass Tasting Website are invited to smell glass under different multisensorial conditions using glasses of their daily life.

Essential results and preliminary conclusion:
The experiences of the Digital Glass Tastings have shown that short sentences create the concentration for sensing imaginative smell. The combination of colour and smell descriptions create deeper and longer responses.

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Alexander Tutsek-Stiftung, Munich, Artist residency Schloss Balmoral, Graduiertenzentrum Hochschule Koblenz
Presentation type: Poster presentation

Sensing and avoiding sick conspecifics requires Gαi2+ vomeronasal neurons

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Rodents utilize chemical cues to recognize and avoid other conspecifics infected with pathogens. These cues are recognized by healthy conspecifics via the vomeronasal or accessory olfactory system, triggering an innate form of avoidance behavior. However, the molecular identity of the sensory neurons and the higher neural circuits involved in the detection of sick conspecifics remain poorly understood. We employed mice that are in an acute state of inflammation induced by systemic administration of lipopolysaccharide (LPS). Through conditional knockout of the G-protein Gαi2 and deletion of other key sensory transduction molecules (Trpc2 and a cluster of 16 vomeronasal type 1 receptors), in combination with behavioral testing, subcellular

Ca2+ imaging, and pS6 and c-Fos neuronal activity mapping in freely behaving mice, we show that the Gαi2+ vomeronasal subsystem is required for the detection and avoidance of LPS-treated mice. The active components underlying this avoidance are contained in urine whereas feces extract and two selected bile acids, although detected in a Gαi2-dependent manner, failed to evoke avoidance behavior. Our analyses of dendritic Ca2+responses in vomeronasal sensory neurons provide insight into the Gαi2-dependent discrimination capabilities of these neurons for urine fractions from LPS-treated mice. We observed Gαi2-dependent stimulation of medial amygdala, ventromedial hypothalamus, periaqueductal grey, as well as the lateral habenula, a previously unknown target involved in these tasks. Thus, these results indicate that the sensing and avoidance of LPS-treated sick conspecifics depends on the Gαi2 vomeronasal subsystem, and on brain circuits downstream of the olfactory periphery and in the lateral habenula. These results provide new insights into the neural substrates and circuit logic of the sensing of inflammation in mice.
Presentation type: Poster presentation

Is there a male body-odor associated with unexplained recurrent pregnancy loss (uRPL)?

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In the Bruce effect, pregnant mice miscarry following exposure to bodily odors emitted from a male stranger. Lesions to the female accessory olfactory system negate this effect. Bruce-like effects have been implicated in other mammals, and in our previous study (Rozenkrantz et al, eLife, 2020), we found that women who experienced uRPL displayed altered perceptual and brain responses to men's body-odor (BO), suggesting a possible link between uRPL and the olfactory system. In our current study, we sought to examine the contribution from men by asking whether uRPL-men and control-men emit different BO. We collected BOs from the spouses of the women who participated in our previous study, using T-shirts worn for two consecutive nights. Twenty-one women with uRPL and 24 control women sniffed and rated 34 BO jars (17 uRPL-men, not their spouse) on a visual analogue scale. We found that uRPL-men's BO was rated as more pleasant, sexually attractive and fertile than control men's (rmANOVAs for each parameter but intensity revealed a significant effect of men BO type (all $F(1,43)>14.24$, all $p<0.001$), no women-group effect or interaction). Fifty-one nulliparous women who are not related to the study performed the same task, and the results were replicated (pleasantness, sexual attraction and fertility: all $t(50)>2.88$, $p<0.006$, intensity: $t(50)=0.87$, $p=0.38$). We then used a PEN3 electronic nose (eNose, Airsense) to sample 37 male BOs (18 uRPL). Using the data from the 10 sensor 80-second time series, a Linear SVM classifier successfully classified the odors to uRPL or control-men at 69.9% accuracy in a five-fold cross-validation test ($p<0.001$

estimated by repeating the process 1000 times and shuffling the labels). These initial results suggest that uRPL and control-men's BO have different chemical composition. This implies a possible contribution of men to the effect we found in Rozenkrantz et al, and combined, further strengthen a link between uRPL and the olfactory system.
Presentation type: Poster presentation

Do sweet odors activate food-related concepts and prime subsequent food choice

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Previous studies suggest that food odors can act as a prime and have the potential to influence food choice unawareness. However, little is known about how and under what circumstances odors can prime healthy food choices. Taking an olfactory priming perspective, we hypothesized that ambient odors may act as a prime that affects subsequent food choice by activating mental representations of food concepts. We tested which concepts (healthy, sensory, or product-specific) are actually activated by odors, and how this affects subsequent food choices. A between-subjects design was used in the current study, 112 Dutch participants were divided into three odor exposure conditions: healthy odors (apple/banana), unhealthy odors (chocolate/caramel), and non-odor (control). They were exposed to the (non-)odor for 5 minutes, and then completed a lexical decision task to assess reaction times to different word categories (health-related, sensory-related, neutral, and non-words). Next, they performed a screen-based food choice task in which they were required to choose what they wanted to eat from four (in-)congruent food-word options, repeated four times (one choice for each odor). Results showed that participants responded slowest to non-words, and slower to healthy-related words and sensory-related words than neutral words. However, there was no main effect of odor exposure on reaction times, nor an interaction between odor condition and word category. In addition, participants tended to choose unhealthy food products regardless of odor exposure, we did find that participants were more likely to choose flavor-congruent foods after banana and cameral odors exposure but not apple and chocolate odors. In conclusion, individuals are able to classify stimuli as words or nonwords, but ambient sweet odors did not seem to prime food-related concepts or affect food choices. We therefore recommend further studies to identify the boundaries of the priming effect of odors on food choice.
Presentation type: Poster presentation

Olfaction - Central processing

Emotional chemosignals processing in affective disorders

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Human chemosignals, or body odors, have been shown to be an effective modality of social communication. Importantly, individuals exposed to emotional body odors report a partial reproduction of the affective state of the sender. This phenomenon is particularly relevant in conditions in which social interactions are impaired, such as in depression and social anxiety, and especially in individuals with subclinical symptoms. Here I will present a high-density EEG study in which we investigated how body odors collected in a happiness and a fearful condition can modulate the subjective perceptual experience and the neural processing of neutral faces in individuals with depressive symptoms, social anxiety symptoms, and healthy controls (for each group N = 22). Time-frequency analysis was performed to simultaneously investigate the affective disposition and cognitive processing of neutral faces presented in the context of emotional body odors. Emotional body odors confirmed their role as powerful emotional cues, especially in healthy individuals, being able to modulate the processing of neutral faces. Moreover, this study demonstrated that the group with depressive symptoms presented an altered affective disposition and cognitive processing of the neutral faces only in the clean air condition, but not when they were presented with the emotional body odors. With respect to the group with social anxiety symptoms, a higher motivational disposition toward the neutral faces presented in the context of the fear odor emerged, confirming a preferential processing for negative and threatening stimuli in social anxiety. With the results of this study, I will provide a psychophysiological framework for the role of both happiness and fear body odors in affective disorders. The potential role of body odors in the treatment of these disorders will also be discussed.

FUNDING: European Commission Horizon 2020 research and innovation program [grant number 824153] to the POTION project
Presentation type: Oral presentation

Development of action potential initiation in the early olfactory pathway

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Olfaction is a critical sense for identifying, discriminating, and remembering chemical stimuli in the environment. It is vital in early mammalian life, and in rodents is essential for survival from birth. Projection neurons in the main olfactory bulb (OB) – mitral/tufted cells (M/TCs) – are the only route by which olfactory information from the nose is transmitted to higher processing centres in the brain, transmission which depends on action potential (AP) propagation. Organismal survival therefore depends

on the initiation of APs in M/TCs being functional from birth.
However, mouse M/TCs are not fully mature at birth. They are known, for example, to undergo extensive, activity-dependent dendritic pruning in the first postnatal week. Is M/TC AP firing similarly immature and plastic in early life? In fact, how M/TCs acquire the ability to fire mature APs remained entirely unknown. The axon initial segment (AIS) initiates and modulates APF firing, however, aside from one classic study suggesting that the AIS of M/TCs is surprisingly immature at birth, nothing is currently known about the maturation of M/TC excitability.
Here, we combined structural and functional approaches to characterise the development of the axon initial segment (AIS) and excitability in early M/TCs. We observed a progressive lengthening of the AIS revealed by immunostaining of the AIS master organiser molecule Ankyrin-G. Whole-cell patch-clamp electrophysiology recordings showed an overall electrically immature profile of M/TCs, both in passive membrane properties and action potential firing parameters.
Together, these results link structure to function in a hitherto unstudied developmental process that is crucial to the operation of an entire sensory system.

Presentation type: Oral presentation

Serotype-dependent tropisms of recombinant adeno-associated viruses in the mouse main olfactory bulb

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The main olfactory bulb (MOB) integrates information from sensory neurons in the main olfactory epithelium and targets downstream (sub)cortical nuclei via two projection neuron populations, i.e., mitral and tufted cells. However, reliable tools to selectively target either of the two neuron types are currently lacking.
Recombinant adeno-associated viruses (rAAVs) have become a powerful tool for unraveling brain connectivity because of their efficiency, low cytotoxicity, and robust transduction. With rAAVs, cell type-specific transduction efficiency depends on various factors, such as viral volume, titer, and serotype. Here, we set out to identify rAAVs best suited for studying mitral and / or tufted cell projections in the main olfactory system. To this end, we compared transduction patterns of different anterograde rAAV serotypes after stereotactic MOB injections in transgenic Tbx21-Cre mice, a driver line that provides genetic access to olfactory bulb projection neurons. We established an intact brain preparation that enables comprehensive histological analysis of entire circuits via confocal imaging at cellular resolution.
Our main findings reveal that, although rAAV serotype impacts transduction, other factors such as genomic design, play a crucial role in determining the cell-type specificity of rAAV transduction. Future investigations aim to develop reliable experimental tools that selectively target long-range projecting MOB mitral cells.
Presentation type: Poster presentation

Activity–dependent plasticity in the olfactory bulb

Elisa Galliano

University of Cambridge

Dopaminergic (DA) inhibitory interneurons in the olfactory bulb (OB) act at a crucial point in the early olfactory pathway, modulating the gain of the first synapse from the nose to the brain. DA neurons are extremely plastic cells, capable of regulating their shape and function in an activity-dependent manner, and even of regenerating throughout life. Long-believed to be a homogeneous population, recent evidence has instead uncovered a striking heterogeneity in their shape, function, and developmental profile – including their axonal phenotype and ability to undergo adult neurogenesis. Moreover, we have recently shown that DA neurons subtypes differ in their plastic responses to changes in olfactory inputs. Indeed, only a subclass of axon-bearing/non-regenerating DA cells respond to brief olfactory deprivation by implementing structural plasticity at their axon initial segments, and intrinsic plastic changes that result in decreased excitability. Conversely, ongoing work in our lab indicates that while anaxonic/regenerating DA cells fail to modify their structure or intrinsic excitability, they employ multiple synaptic plasticity mechanisms to respond to the same brief sensory deprivation. Interestingly, excitatory neurons in the OB circuit – both projection cells and local interneurons - display substantially fewer deprivation-induced plastic changes. These findings support the hypothesis that modulation of inhibition may be a fast-acting mechanism employed by circuits to rapidly adapt and fine-tune sensory processing in the face of continually fluctuating inputs. Future work in our lab aims to uncover how such different and cell-type targeted activity-dependent plastic changes are employed to generate appropriate neuronal outputs at the network and behavioural level.

Presentation type: Oral presentation

Neural differences in odor encoding and odor recognition memory in Parkinson's disease with and without cognitive impairment.

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Objectives: To investigate the variations in brain activity among healthy individuals, Parkinson's Disease patients without(PD) and with mild cognitive impairment (PD-MCI) during an odor encoding (OE) and odor recognition memory (ORM) fMRI experiment, building upon our previous finding that correct odor recognition is associated with neural suppression in the insula and limbic system.

Methods: Thirty-one healthy controls and 31 PD patients (20 PD and 11 PD-MCI) were examined with fMRI across OE and ORM. Independent Component Analysis was employed to analyze the data, and group differences were tested using ANOVA.
Results: One OE component (3.4% of explained variance) consisted of the anterior piriform cortex, basal ganglia, and anterior insula. PD-MCI patients exhibited significantly lower recruitment of this network compared to both healthy controls ($p<0.001$) and PD patients ($p=0.003$), with no significant difference between healthy controls and PD patients. One ORM component (3.8% of explained variance) included the amygdala, posterior piriform cortex, entorhinal cortex, hippocampus, thalamus, and anterior insula bilaterally. Healthy controls exhibited significantly higher recruitment of this network compared to PD ($p=0.018$) and PD-MCI ($p<0.001$) patients, while no significant difference was observed between PD and PD-MCI patients. Hit responses during ORM differentiated PD patients with and without MCI from healthy controls ($p=0.042$ and $p<0.001$, respectively). False alarms did not differ significantly between the groups. There was no significant difference in age between PD and controls or PD and PD-MCI.
Conclusions: These preliminary results illustrate that PD-MCI patients demonstrate reduced engagement of areas related to olfaction during OE. ORM successfully differentiated between healthy controls and patients, but not between the two PD subgroups.
Funding: The study was financed by Swedish governmental funding of clinical research (ALF).
Presentation type: Poster presentation

Mitral, tufted, and everything in between: electrophysiological classification of bulbar projection neurons in the mouse.

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Mitral and tufted cells in the olfactory bulb act as an input convergence hub and transmit information to higher olfactory areas. Since first characterized, they have been classed as distinct projection neurons based on size and location i.e. laminarly arranged mitral cells and diffusely spread tufted cells across both the mitral layer (ML) and external plexiform layer (EPL). New *in vivo* work has shown that these neurons encode complementary olfactory information, akin to parallel channels in other sensory systems. Yet, many *ex vivo* studies collapse them into a single class, mitral/tufted (M/T), when describing their physiological properties and impact on circuit. Using immunohistochemistry and whole-cell patch clamp electrophysiology in acute slices from mice, we attempted to align *in vivo* and *ex vivo* data, to find a simple classifier of projection neurons in the ML and EPL based on intrinsic firing properties.

We aimed to produce an unbiased classifier of putative mitral (pMC) and putative tufted cells (pTC). Light microscopy and immunohistochemistry in acute and fixed slices confirmed that projection neurons in the ML have disparate soma sizes. As M/T

cells have been divided based on soma size we used a diameter-based k-means analysis which returned a divisor that mirrors literature. Applied to electrophysiological data we found that pMCs and pTCs are distinct in several intrinsic parameters like action potential threshold (pMC(n=24) 2.8±0.34 pA/pF; pTC(n=12) 5.5±0.98 pA/pF; unpaired t-test p=0.0025) and relative afterhyperpolarization (pMC(n=20) 17.6±0.94 pA; pTC(n=9) 12.6±1.1 pA; unpaired t-test p=0.007) and homogenous in others. Together these results illustrate the heterogeneity of M/T cells and suggest that they cannot be simply classified based on their intrinsic firing properties alone.

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Presentation type: Poster presentation

Binge eating-induced olfactory cortex suppression promotes feeding

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Appropriate feeding behavior is the foundation of maintaining homeostasis. Elevated feeding rate (binge eating) is a common trait of eating disorders, and it is associated with obesity. It is also known that flavor perception regulates feeding. However, the effects of feeding rate on sensory feedback from flavor perception remain unknown. We developed a liquid food delivery system that enables Ensure (artificial energy-dense flavored milk with high incentive salience) consumption at different feeding rates. Using miniscopes for *in vivo* calcium imaging in freely foraging mice, we identified distinct neuronal responses in the anterior olfactory (piriform) cortex (aPC) upon slow and binge eating; we observed clear excitatory flavor responses during slow eating but unspecific activity suppression upon binge eating. This binge-induced suppression is only observed in aPC, while neuronal responses in gustatory or somatosensory cortices remain similar in both slow and binge eating. Mechanistically, odor inputs from olfactory bulb mitral cells remain stable upon binge eating, suggesting the suppression is not inherited from upstream elements of the olfactory pathway. Local inhibitory circuits in aPC do not play an active role in suppression, since aPC GABAergic neurons are also suppressed during binge eating.

We further excluded inhibitory effects of dopaminergic and serotonergic modulation in aPC since dopamine and serotonin release are decreased upon slow and binge feeding.
We found that the strength of binge-induced suppression in the aPC predicts mice's total Ensure consumptions on different recording sessions and optogenetically suppressing aPC neurons upon binge eating in closed-loop experiments can promote feeding behaviors. Taken together, our results provide clear circuit mechanisms of binge-induced flavor modulation, which may contribute to binge-induced overeating due to reduced sensory feedback of food items.
Presentation type: Oral presentation

Aquaporin-4 water channel regulates the neuronal activity in the olfactory bulb by affecting the astrocyte morphology

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Astrocytes constantly adapt their dynamics to support neuronal functions. Such plasticity is mediated by ion and water flux, which rely on the water-selective channel aquaporin-4 (AQP4). AQP4 has different isoforms (M23, M1 and extended) expressed in the glial cells of the olfactory bulb (OB). Although they are implicated in several mechanisms ranging from the regulation of astrocyte morphology to neuronal activity modulation, their role in the OB is still unclear. Hence, we sought to understand the contribution of AQP4 isoforms to the astrocyte's functionality in the OB. First, we analyzed the astrocyte morphological properties through the 2D and Sholl analysis. We found that the astrocyte branch length and dimensions are reduced in AQP4M23-KO mice, suggesting that the M23 isoform affects the astrocytic structure in the OB. Then, we evaluated the neuronal activity in the glomerular layer (GL) in response to a novel environmental odorant stimulus such as amyl acetate by analyzing the immediate early gene c-Fos expression. We found a decrease in the number of c-Fos positive cells in AQP4M23-KO compared to wild type during the basal neuronal activity and an increase of the activated cells under stimulated conditions, suggesting that M23 contributes to setting the basal levels of neuronal activation in the glomerular layer. Furthermore, compensation mechanisms are implemented to re-establish the odorant-evoked response in the mouse model lacking the M23 isoform.
Altogether, our results establish that AQP4 isoforms have a critical role in modulating neuronal homeostasis, shedding light on the involvement of astrocytes in mediating this process and providing a foundation to dissect the contribution of these cells in controlling neuronal activity in the olfactory bulb.
Presentation type: Poster presentation

Development of information processing in the olfactory circuit of neonatal rats

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Rodents are born deaf and blind, and rely completely on their sense of smell for survival during the first two weeks of life. Despite being highly functional, the circuits that process odor inputs are structurally immature, and it remains unknown neonatal olfactory circuits reliably process information. We aimed to characterize olfactory circuit function by performing extracellular recordings and pharmacological manipulations in the olfactory bulb (OB) and piriform cortex (PCX) of unanesthetized rat pups ranging in age from several hours to three weeks after birth. We found that neonatal olfactory system exhibits highly structured and coherent odor-evoked oscillations (respiration-driven slow oscillations with nested 10-20 Hz spindle oscillations) that are reminiscent of adult beta oscillations. Oscillatory activity patterns remain stable during the first two weeks of life, after which they undergo rapid, quantitative changes to a mature state. Like adult beta oscillations, neonatal olfactory oscillations originate in the OB but are shaped by the PCX via net-inhibitory feedback projections that target granule cells. Finally, projection-specific optogenetic manipulations reveal that cortical feedback is sufficient to alter OB oscillatory activity. Thus, despite known structural changes at the cellular, molecular and synaptic levels, neonatal olfactory processing is characterized by highly stable network-level activity patterns that share characteristics with the adult olfactory system in terms of phenomenology and underlying circuitry.
Presentation type: Oral presentation

Axonal projections of main and accessory olfactory bulb principal neurons in mice

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Olfactory sensory cues are processed in the rodent central nervous system via at least two complementary pathways, the main and accessory olfactory pathway. This dichotomy is reflected structurally, by both the peripheral sensory organs and the first central processing stages. While sensory neurons in the main olfactory epithelium detect various chemosensory stimuli and project to the main olfactory bulb, sensory neurons in the vomeronasal organ are specialized to transduce semiochemicals as well as other socially relevant chemostimuli and project to the accessory olfactory bulb. Despite their proximity, main and accessory olfactory bulbs are structurally and functionally independent and are thought to target largely segregated downstream nuclei.
We set out to delineate mitral/tufted cell axonal projections from either bulb using state-of-the-art tracing techniques in largely intact brain samples. Our implementation of stereotactic microinjection of recombinant adeno-associated viruses and Cre-dependent viral genome expression enabled selective investigation of either main or

accessory olfactory bulb principal neuron projections. Moreover, viral genome expression was selectively restricted to mitral/tufted cells using the transgenic t-box protein 21 (tbx21) Cre driver mouse line. Axonal projections were subsequently assessed utilizing whole-brain slice preparations as well as cleared tissue samples, enabling the identification of three-dimensional projection pathways and secondary olfactory integration areas.
Altogether, we describe axonal projections of main and accessory olfactory bulb principal neurons, which innervate both unique and common central nuclei. Our findings provide the structural basis for future physiological investigations aimed at unraveling neuronal integration of information that is relayed along both olfactory pathways.
Presentation type: Poster presentation

Olfactory bulb and olfactory cortex communicate odor valence in the gamma and beta band.

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An organism's approach and avoidance behavior is facilitated by correct discrimination of odor valence; a task considered to be one of the main objectives of the olfactory system. Odor valence processing has in previous work been shown to take place as early as in the olfactory bulb. However, how this information in humans is transmitted further into the olfactory cortex is not known. Here, we introduce two studies where participants were presented with odors and rated their perceived valence after each trial. Neural responses in the olfactory bulb and olfactory cortex were reconstructed using the collected EEG. Functional connectivity between these two areas was determined by the coherence spectrum and was related to perceived valence through decoding accuracy of support vector machine learning. Moreover, effective connectivity was determined by frequency resolved granger causality. In both studies we demonstrate direction-dependent communication where the olfactory bulb communicates odor valence to the olfactory cortex in the gamma band while the olfactory cortex later communicates back in the beta band. The early gamma activity is predicted by high unpleasantness ratings and the later beta activity is predicted by low unpleasantness ratings in both studies. These results demonstrate that the olfactory bulb and the olfactory cortex primarily communicate degrees of odor unpleasantness across multiple frequencies in a direction-dependent manner.
Presentation type: Poster presentation

Typology of Adult-Child Olfactory Engagement During Shared Book Reading

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The impact of olfaction on children's learning is a nascent area of research, with little knowledge on how smell impacts children's everyday learning activities such as book reading. Our project, funded by the Norwegian Research Council, is the first to investigate olfaction in relation to children's experiences of fictional stories. In this presentation, we will present the results of a study in which we investigated the learning opportunities afforded by adult-child shared book reading of scratch-and-sniff books. Observation data from ten adult-child dyads reading olfactory books at home was analysed for quality markers of adults' and children's olfactory engagement. Our analysis was guided by socio-cultural learning theories and resulted in the proposition of a "Typology of Olfactory Engagement" (TOE), which we offer as a methodological tool for systematically analysing family reading practices that involve olfaction-enhanced books. We will illustrate the individual indicators of TOE with examples from the data with attention to the unique behavioural engagement, such as book's manipulation, rigour of scratching and smelling and others. TOE needs to be expanded with data from other groups and with other types of reading stimuli and we conclude with some recommendations for future research in this area.
Presentation type: Poster presentation

Decoding Parosmia: Central contributions

Divesh Thaploo

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Imagine smelling a pleasant odor like peach as completely disgusting and unpleasant, as faeces. Little is known about this condition called "parosmia" which has a direct impact on diet, mental health and quality of life. Among other hypotheses, aberrant recovery of olfactory sensory neurons has been suggested as possible explanation for this phenomenon. In order to examine the central-nervous contributions, we looked at 148 patients with different degrees of parosmia using resting state functional magnetic resonance imaging (rs-fMRI) at a 3T scanner (Siemens, Germany). To examine the overall picture, we employed whole-brain functional connectivity (FC) and region of interest-based FC measures. Region of interest-based FC rested on key olfactory structures as seeds, the bilateral piriform cortex and bilateral orbitofrontal cortex. Whole brain ICA based connectivity suggested reduced FC in Salience and Executive control Network. ROI-based connectivity also suggested reduced FC between olfactory regions. At the level of the whole brain, changes in FC were compatible with enhanced perception of disgust, which is also one of the key olfactory-induced emotions. These changes are even seen at the level of individual brain regions suggesting reduced information flow between olfactory regions. Overall, the present results suggest that the enhanced perception of "disgust" and distortion of stimulus

guided decision-making in parosmia is related to changes in information transfer between key relays of the olfactory system.
Presentation type: Oral presentation

Electrophysiological characterization of periglomerular cells in the mouse accessory olfactory bulb

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The mouse accessory olfactory system (AOS) is crucial for detecting chemosensory signals during social interactions among conspecifics. The vomeronasal organ serves as the peripheral sensory structure of this system, and sensory information is transmitted through the vomeronasal nerve to the accessory olfactory bulb (AOB). The AOB consists of mitral cells (projection neurons) and local interneurons, including granule cells and periglomerular cells (PGCs). Vomeronasal sensory neurons send excitatory synaptic input to AOB mitral cells through multiple glomeruli, which are surrounded by PGCs. However, the specific physiological function(s) of PGCs as well as whether they form a homo- or heterogeneous neural population remains unknown. Here, we investigate the biophysical properties of PGCs using whole-cell patch-clamp recordings from visually identified PGCs in acute mouse AOB slices. To detail cell type-specific features, we analyze passive and active membrane properties, voltage-activated currents, and action potential firing. Our findings reveal unique characteristics of PGCs, providing initial insights into their physiological properties within the mouse AOB. We demonstrate that, given their large input resistance, PGCs are highly sensitive to electrical stimulation. With fast action potential kinetics, PGCs discharge at high frequencies. In addition, voltage-dependent potassium, sodium, and calcium currents display distinct activation and inactivation properties. Our results provide first insight into physiological characteristics of an elusive AOB neuron population. Ongoing research in this field will further enhance our understanding of the sensory processing principles in the AOB network.
Presentation type: Poster presentation

Representations of odorant concentrations and mixtures in cortical projections to the olfactory bulb.

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Sensory systems are organized hierarchically. Early stages format transduced signals and successive processing steps perform complex computations to extract relevant

sensory representations. This feedforward hierarchy is broken by cortical projections that terminate in early processing areas. In the olfactory system the descending inputs from the cortex vastly outnumber the afferent received from the sensory periphery. Therefore, revealing how these projections contribute to the coding of complex stimuli including odorant concentrations and their mixtures is necessary to understand sensory processing throughout the olfactory system. We expressed the calcium indicator GCaMP6f in the anterior piriform cortex and used multiphoton imaging to measure the stimulus-response properties of cortical projections to the olfactory bulb (OB) in awake mice. We used two sets of odorant stimuli that revealed surprising aspects of how odorants, and their mixtures, are represented in cortical projections to the OB. First, monomolecular odorants spanning a concentration range of four orders of magnitude evoked responses in feedback projections that, as a population, reflected concentration invariance. However, at the level of individual boutons, we observed responses that had complex and non-monotonic concentration dependence that favored a select concentration range. We next imaged bouton responses to odorant mixtures that contained between 2 and 12 components. When presented with complex mixtures of odorants, the activity of cortical projections rarely exceeded the activity evoked by individual mixture components and was representationally distinct from component odorants. As a reference, we imaged the same panel of odorant mixtures in the olfactory epithelium, where we found a strong relationship between representational similarity and mixture complexity. Our current studies reveal how behaviorally relevant mixture information is inherited by the OB from the cortex.
Presentation type: Oral presentation

Olfaction - Peripheral processing

Decoding parosmia in the periphery

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What could be the cause of olfactory disorders? And is the peripheral olfactory system involved? Odor perception is decoded first at the odorant receptors (ORs) level, which belongs to the large family of G protein-coupled receptors and more particularly to the rhodopsin-like family, also called class A. Understanding how ORs could be involved in olfactory disorder requires knowing how they bind odorants and how these molecular machines convert an agonist binding into a neuronal signal. Here, we study this sub-family of G protein-coupled receptors at the molecular level thanks to recent advances in their structural elucidation. We used the diversity of the odorant receptor repertoire to create new optimized synthetic receptors based on their consensus sequences. Using these consensus ORs cases, we study the role of amino acids in their expression through molecular modeling, site-directed mutagenesis, and flow

cytometry. Their functionality is also assessed by in vitro assays. We then developed a protocol to produce and purify the most promising ORs which allowed us to obtain the very first structural elucidation of diverse members of the mammalian OR family. This research is crucial, not only to understand the strategy of our brain to perceive its olfactory environment but also to identify general mechanisms governing the function of ORs.
This work was funded by the National Institutes of Health (NIH) (K99DC018333 - CAdM; R01DC020353 - HM, NV, AM)
Presentation type: Oral presentation

Functional morphs of fibroblast cell within olfactory neuroepithelium of fish

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Olfaction plays some major functional roles in fish. *Lepidocephalichthys guntea* [Hamilton, 1822] is a small indigenous fish of South-East Asia [IUCN Red List category: Least Concern, ver. 3.1]. Lamina propria is composed of different types of cells *viz.,* endothelial cell, macrophage, fibroblast cell, schwan cell, mast cell and secretory granulocytes. The evidence of axon bundles is frequently characterized within the lamina propria region of fish using 2.5% glutaraldehyde as primary fixative and 1% solution of osmium tetroxide as secondary fixative in 0.1M phosphate buffer, pH 7.2-7.4 at 40C and viewed under transmission electron microscope [AIIMS, New Delhi]. Fibroblasts are the pluripotent connective tissue cells of olfactory neuroepithelium in fish. From our observation at the time of neurogenesis, the fibroblast cell shows functional morphs. These cells are morphologically spindle in shape, with an elongated nucleus and a thin rim of cytoplasm. In fish, they may be regarded as the residential fibroblast cells. At the time of neurogenesis, the fibroblast cell shows a distinctive character, having prominent golgi apparatus, rough endoplasmic reticulum, active mitochondria, numerous secretory vesicles and evidence of pro collagen substances. Probably the formation of procollagen within the lamina propria region is the indication for the synthesis of extracellular substances that may trigger the functional integrity of the respective tissue concerned.

Presentation type: Poster presentation

Development and characterization of a patient-derived organoid model of an olfactory ensheathing cell tumor

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Olfactory ensheathing cells (OECs) are specialized, non-myelinating glia that play an integral role in maintaining axonal connections between olfactory sensory neurons in the periphery and glomeruli in the olfactory bulb. Olfactory sensory neurons are replaced continually throughout adulthood, suggesting that OECs retain an ability to interact with or promote axons growth from the periphery to the bulb. In vitro cultures of OECs have been difficult to establish, due in part to their generally low turnover, limiting the ability to easily perform mechanistic studies on OEC function. Objectives and Experimental Methods: Here, we derived an organoid culture model from a patient with a well-differentiated, low grade OEC tumor that was invading along the olfactory nerve. Results: Immunohistochemistry revealed that the tumor was S100B (+) and CD57 (-), confirming the diagnosis. Cells from the low-grade OEC tumor grew well in culture for >10 passages and maintained an OEC-like state with expression of key OEC marker proteins, including S100B and SOX10. The architecture of organoid cultures recapitulates the histologic organization of the original tumor specimen, suggesting that 3D cellular interactions are retained in vitro. Mass spectrometry proteomic assay of organoid-conditioned medium provided a measure of the OEC secretome, revealing the presence of important juxtacrine signaling factors, including semaphorins, while paracrine mediators were largely absent. Conclusions: the OEC culture model will be useful for co-culture assays with olfactory neurons and progenitors and provides a means for identifying mechanisms of OEC function.
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Presentation type: Poster presentation

Sniffing Out the Early Signs: Olfactory Impairments in NPC1 Disease Progression

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Niemann-Pick type C1 (Npc1) is a rare neurodegenerative disorder linked to faulty cholesterol biosynthesis and irregular lipid regulation. It's suggested that Npc1 gene suppression leads to olfactory system defects. The unsolved question lies in whether these impairments present themselves in the disease's early stages. To address this question, we examined a mouse model with the I1061T missense mutation in the Npc1 gene, reflective of human Npc1 disease. Western blotting demonstrated reduced expression of olfactory marker protein, a molecular marker of mature olfactory sensory neurons in the olfactory epithelium and bulb in Npc1 (I1061T) mice. Analysis of Tubulin beta 3 class III (Tubb3), a marker for immature and transient olfactory sensory neurons, revealed no difference between I1061T and wild-type mice, suggesting that in this animal model we could observe a decline in mature neurons in the olfactory epithelium.
Our preliminary data suggest that Npc1 mouse models are suitable for studying the olfactory system's structure. Future experiments will leverage electrophysiology to

investigate whether structural deficits in the olfactory system lead to a decrease in olfactory function. This work will undoubtedly enhance our understanding of Npc1 disease progression and could possibly facilitate the use of the sense of smell as a marker to assess pharmacological treatments for the disease.
Presentation type: Poster presentation

Chemesthesis: the second dimension of odors and its impact on olfaction

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Unlike vision and audition, in olfaction we do not understand how physical properties of a stimulus are translated into perceptual characteristics. While most studies focus on the olfactory system as the primary mechanism for detecting airborne chemicals and facilitating odor perception, most volatile stimuli at high concentrations activate both olfactory sensory neurons (OSNs) and chemosensory trigeminal fibers. The trigeminal system elicits sensations such as cooling, warming, pricking, or irritation when stimulated by odorants, but it also interacts with the olfactory system at peripheral and central levels of the nervous system.
To gain insights into the interplay between the olfactory and trigeminal systems, we compared physiological and perceptual responses in mice and humans. In both systems, the olfactory stimulus was 2-phenethylalcohol (PEA, rose), which does not activate the trigeminal system while the trigeminal stimulus was CO2, which does not elicit an olfactory response. By varying the concentrations of CO2, we aimed to determine the impact of trigeminal activation on the olfactory signal. In a mouse model, co-stimulation of these systems influenced the generation of olfactory signals in the olfactory epithelium (OE) measured with the electro-olfactogram (EOG) technique.

Similarly, the effects of trigeminal activation on odor perception were evident among trained human participants who rated the perceived intensity of binary mixtures of PEA and CO2. Combining animal electrophysiology and human psychophysics allowed us to explore the integration of both olfactory and trigeminal components in odor intensity encoding. Ultimately, the findings from this research will lay the groundwork for developing a model that encompasses multiple molecular and sensory factors, benefiting both the scientific community and industries involved in scent-related applications.

This work was supported by the Monell Chemical Senses Center Seed Fundings Program.
Presentation type: Oral presentation

Neural correlates of olfactory perceptual shifts

Mark Conway , Merve Oncul , Jamie Johnston

University of Leeds

Sensory systems can maintain perceptual constancy over stimulus intensities spanning many orders of magnitude. In the olfactory system, where odour identity is thought to be represented by a combinatorial code, a cascade of mechanisms is proposed to maintain object constancy in the face of concentration dependent changes in the activated receptor channels. In this study we explore the neurobiology at the boundary condition of where an odour percept breaks down with concentration. We use a combination of behavioural paradigms and in vivo imaging of neural activity within the olfactory bulb and find that a change in odour percept corresponds to rapid and complete adaptation in just a few glomeruli that are most sensitive to the odour. This concentration dependent shift to fast adaptation is already present in the signal delivered by the olfactory receptor neurons and is not a property of circuit interactions within the olfactory bulb. It therefore seems that mechanisms to promote concentration invariance are unable to operate when rapid peripheral adaption has occurred. Furthermore, our data imply that odour identity relies on a sparse combinatorial code, as perceptual constancy depends on the activity of only a few olfactory receptor channels.
Presentation type: Poster presentation

Evolution of vertebrate olfactory receptor repertoires

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The vertebrate sense of smell employs four major and several minor olfactory receptor families, with staggered evolutionary origins in cephalochordates (ORs), the common ancestor of vertebrates (TAARs and V1Rs, adorb/A2C) or the common ancestor of jawed fish (TAARs and V2Rs). We have taken advantage of the recent availability of high quality genomic databases of early-derived chordates to re-assess the origin of these olfactory receptor families. We clarify the TAAR receptors of lamprey (jawless vertebrate) as a TAAR-like sister clade to the TAAR family of jawed vertebrates (TARL). This sister clade is also present in jawed vertebrates but there it has not undergone gene expansion and is not expressed in olfactory sensory neurons. We show the lamprey V1R family to consist of six genes, one of them a direct ortholog of a gene conserved in bony fish. We report the presence of one to two V2R receptors in lampreys, thus backdating the origin of the V2R family to the common ancestor of vertebrates. Moreover we show that adorb is present already in cephalochordates (lancelets), hemichordates (acorn worms) and echinoderms (sea stars and sea urchins), suggesting its presence in the common ancestor of deuterostomes. Neither lamprey V2Rs nor lamprey adorb are expressed in olfactory sensory neurons. We conclude that the evolutionary origin of V2Rs, TARL, and adorb/A2C olfactory receptors is dissociated from the origin of their function as olfactory receptor.
Presentation type: Poster presentation

Sensory detection of volatile pup-derived molecules by the mouse vomeronasal organ

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Newborns release volatile molecules that are detected by the olfactory system of adult mice triggering pup-directed behaviors, such as parental care or infanticide of unfamiliar pups. However, specific pup-derived pheromones and the sensory neurons in the olfactory system that detect them remain poorly characterized. Here we used a combination of calcium imaging and immunodetection of immediate early genes in vomeronasal sensory neurons to investigate the response to volatile mouse pup-pheromone candidates identified by mass spectrometry. Both ex-vivo calcium imaging and in vivo exposure revealed activation of vomeronasal neurons by combinations of volatile pup-derived molecules. We further characterized the sensory responses using a knockout mouse line deficient for sensory detection in apical vomeronasal neurons. Next, we used a behavioral approach to study the response of adult virgin males and females, as well as fathers and mothers to combinations of pup pheromone candidates painted on dummy newborns. We observed that he presence of these molecules on dummy newborns was capable of promoting typical pup-directed behaviors in the adult mice. Together, these results provide evidence of the involvement of vomeronasal neurons in the detection of volatile pup pheromone candidates identified by mass-spectrometry.
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Presentation type: Poster presentation

Modulation of olfactory bulb circuits by satiety

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A feedback loop exists between the digestive and olfactory systems; metabolic state regulates olfactory sensitivity, while depressed olfactory sensitivity decreases food intake and improves metabolic health. How metabolic state alters odour processing and how this is linked to altered perception and feeding behaviour is poorly

understood. Insulin is a key metabolic signal with the highest density of receptors found in the olfactory bulb and insulin applied exogenously to the olfactory bulb suppresses olfactory sensitivity. We have been exploring how insulin regulates the olfactory bulb circuitry using a combination of patch-clamp electrophysiology, 2-photon calcium imaging, immunohistochemistry, and behavioural tests. We began by focusing on how the first synapse in the olfactory system is modulated by insulin. Periglomerular neurons provide the first layer of inhibition in the olfactory bulb, surrounding the glomeruli where the olfactory nerve terminates. We find that a subset of these periglomerular neurons express insulin receptors, which inhibit a voltage-gated potassium current normally active at resting membrane potentials. Using 2-photon imaging we show that insulin reduces evoked Ca^{2+} transients in olfactory nerve terminals which was dependent on feedback inhibition from periglomerular neurons. In vivo, imaging shows that the sensitivity of periglomerular neurons to odours is increased by satiety whereas the olfactory nerve input is reduced. Periglomerular neurons seem to play a key role in the state-dependent modulation of olfactory transmission from the nose to the brain.
Presentation type: Poster presentation

Processing of sickness-related cues in the mouse accessory olfactory system

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During chemosensory evaluation, mice assess the health status of conspecifics. We hypothesize that health state detection is mediated via the accessory olfactory system. We address this hypothesis using an integrated approach. Combining chemical analysis of urine, physiological recordings of vomeronasal sensory neurons, and behavioral responses to chemosignals from healthy versus sick individuals, we investigate the neural basis of sickness detection in mice. Using animals, which develop a chronic colitis upon T-cell injection, we monitor disease progression and collect urine / bedding from individuals at defined time points. Our experiments reveal i) health state-dependent activation patterns of vomeronasal sensory neurons, ii) the molecular identity of candidate sickness-related cues, and iii) their effects on ecologically relevant social behaviors in group-housed animals. Together, we provide chemical, physiological, and behavioral evidence that supports a concept of sickness-related cue processing via the mouse accessory olfactory system.
Presentation type: Oral presentation

Physiological investigation of stimulus dose-dependent signal modulation in mouse olfactory transduction

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Adaptation to prolonged or repetitive stimuli is a critical feature of sensory systems, allowing dynamic adjustment of sensitivity. In olfactory sensory neurons (OSNs), activation of odorant receptors (ORs) and subsequent G-protein-dependent cAMP signaling are balanced by Ca^{2+}/calmodulin-dependent negative feedback, resulting in sensory adaptation. Many ORs exhibit high sensitivity with activation thresholds in the low (sub)micromolar concentration range (Firestein et al., 1993; Grosmaitre et al., 2006). Thus, OSN sensitivity spans a range of several orders of magnitude. Whether, beyond adaptation, complementary dose-dependent modulatory mechanisms exist is yet to be identified.
Our pilot Ca^{2+} imaging experiments in dissociated mouse OSNs, using IBMX + forskolin as a "broadband" stimulus, revealed response summation and even potentiation in a dose-dependent manner at short inter-stimulus intervals. With increasing stimulus concentrations, the ratio of OSNs with elevated responses decreased, while the ratio of neurons showing adaptation increased. Here, using patch-clamp recordings from OSNs in acute slices, we investigate (i) which signaling cascade steps/components are modulated during adaptation versus summation processes, (ii) whether dose-dependence is receptor (in)dependent, and (iii) whether the ability to modulate responses is a stable or transient feature of OSNs. Together, we aim to gain insight into how mammalian OSNs shape their odor sensitivity and response strength to cover an extensive range of stimulus concentrations. Moreover, by assessing OSN output, we will learn how signal modulation translates into changes in action potential discharge and, thus, the information conveyed to the brain.

Presentation type: Poster presentation

Spatial transcriptomic reconstruction of the mouse olfactory glomerular map suggests principles of odor processing

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The olfactory system's ability to detect and discriminate between the vast array of chemicals present in the environment is critical for an animal's survival. In mammals, the first step of this odor processing is executed by olfactory sensory neurons, which project their axons to a stereotyped location in the olfactory bulb (OB) to form glomeruli. The stereotyped positioning of glomeruli in the OB suggests an importance for this organization in odor perception. However, because the location of only a limited subset of glomeruli has been determined, it has been challenging to determine the relationship between glomerular location and odor discrimination. Using a combination of single-cell RNA sequencing, spatial transcriptomics and machine learning, we have generated a map of most glomerular positions in the mouse OB. These observations significantly extend earlier studies and suggest an overall organizational principle in the OB that may be used by the brain to assist in odor decoding.
Presentation type: Poster presentation

Olfaction - Other

Management of Parosmia and Qualitative Olfactory Disorders

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Parosmia, the distortion of smells, is a symptom in qualitative olfac- tory disorders that severely affects patients' mental well-being and enjoyment of their everyday lives. The condition was first documented in 1895 and can affect up to 5% of the general population. Etiologies of parosmia include sinonasal dis- eases, viruses, surgeries, traumatic brain injury, neurological and psychiatric con- ditions, toxic chemicals, and medications. Parosmia has seen a surge in cases since the onset of the COVID-19 pandemic and is linked to changes in brain structure following an infection. The evaluation of the symptom is done using surveys, smell identification tests, fMRI, MRI, PET/CT, and gas chromatog- raphy. Treatment for parosmia can vary in duration, which makes it essential to focus not only on helping the patients regain normosmia, but also on supporting the patient through the recovery journey. Parosmia should not be confused with phantosmia, in which the distortion of smells occurs in the absence of olfactory stimuli. The etiology of phantosmia can vary from infections and traumatic brain injury to psychiatric disorders like schizophrenia. Unlike parosmia, the treatment of phantosmia is less straightforward, with an emphasis on determining the eti- ology and providing symptomatic relief.
Presentation type: Oral presentation

Olfactory sniffing is altered in patients with Parkinson's disease

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Background: Olfactory decline may precede motor symptoms by several years or decades in Parkinson's disease (PD). The olfactory decline in PD can be measured using various standard olfactory tests, such as UPSIT and Sniffin' Sticks. However, such tests require full cooperation of the patient, and are sensitive to the patient's ability to report their subjective experience.
Objective: To develop an objective non-verbal non-task-dependent olfactory test for PD detection.
Methods: We relied on the "sniff response", namely the automatic modulation of nasal airflow to account for odorant properties. We measured nasal airflow in response to presentation of pleasant (Citral molecule, CAS 5392-40-5, by Sigma-Aldrich), unpleasant ('Asafoetida' scent by DreamAir or Skatole molecule, CAS 83-34-1, by Sigma-Aldrich) and blank (empty jar) odor stimuli. Healthy participants typically reduce sniff vigor in response to unpleasant odors.
Results: We measured the sniff response of 30 PD patients (3W, mean age = 66.5 ± 7.13 years, MDS UPDRS total score = 54.4 ± 22.3, disease duration = 6.3 ± 5.7 years, 4 right-handed) and 32 matched healthy controls (4W, mean age = 64.5 ± 7.53 years, 5 right-handed). We found that whereas healthy participants modulated sniff vigor in accordance with odorant valence, PD patients did not (Repeated measures ANOVA, $F_{1,59} = 8.27$, $P = .006$). Post-hoc analysis using Bonferroni correction revealed that only the healthy participants reduced sniff duration in response to unpleasant odorants (Healthy: mean difference: 0.155, $t = 4.6$, $P_{bonf} < .001$; PD: mean difference: .013, $t = 0.37$, P = NS). This difference allowed for 74% PD classification based on the sniff response alone (SVM linear classifier, leave-one-out cross validation). Finally, independent of the sniff-response, sniff inhale volume was correlated with the motor disease severity (MDS UPDRS part III, $r = -0.38$, $P = .039$).
Conclusions: These results imply a potential novel biomarker for PD detection.
Presentation type: Poster presentation

Utilizing an array of engineered insect ORs as a detection mechanism for disease associated volatiles

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Odorant receptors (ORs) are highly sensitive receptors that respond to a diverse range of volatile compounds. While organisms relying on olfaction for survival possess remarkable abilities to detect trace chemicals, our current measurement techniques

are inadequate in comparison. Traditionally, dogs have been trained to identify disaster survivors or diagnose illnesses by detecting trace chemicals. However, dog training is costly and time-consuming. Recent studies have shown significant differences in the chemical profiles of human breath between healthy individuals and those infected with pathogens such as malaria, tuberculosis, or COVID-19. Leveraging the unique chemical profiles associated with diseases could provide a robust method for disease detection. In this study, our objective is to engineer insect ORs to selectively activate in the presence of volatiles associated with diseases. Specifically, we focused on MhOR5, an odorant receptor from the Jumping Bristletail (*Machilis hrabei*), a basal insect that lacks the OR co-receptor (ORco) found in modern insects. MhOR5 is a well-characterized receptor with broad selectivity and an experimentally determined structure, making it an ideal candidate for targeted engineering. We expressed MhOR5 in a heterologous cell system using HEK293T cells and tested its response to disease-associated volatiles (DAVs). Through Rosetta ligand docking analysis, we identified key residues that potentially contribute to ligand selectivity. Subsequently, we generated mutants of MhOR5 by introducing specific residue mutations and evaluated their impact on receptor activation. Our findings revealed distinct ligand selectivity among most mutants in response to individual DAVs. This methodology establishes a solid foundation for engineering ORs with specificity towards particular chemicals and for developing engineered OR arrays for disease diagnosis. This work was funded by the Bill and Melinda Gates Foundation (BMGF INV-037981).
Presentation type: Poster presentation

Olfactory bulb activity shapes the development of entorhinal-hippocampal coupling and associated cognitive abilities

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The interplay between olfaction and higher cognitive processing has been documented in the adult brain, yet its development is poorly understood. In mice, shortly after birth, endogenous and stimulus-evoked activity in the olfactory bulb (OB) boosts the oscillatory entrainment of downstream lateral entorhinal cortex (LEC) and hippocampus (HP). However, it is unclear whether early OB activity has a long-lasting impact on entorhinal-hippocampal function and cognitive processing. Here, we chemogenetically inhibited the synaptic outputs of mitral/tufted cells, the main projection neurons in the OB, during postnatal days 8-10. The transient manipulation leads to a long-lasting reduction of oscillatory coupling and weaker responsiveness to stimuli within developing entorhinal-hippocampal circuits accompanied by dendritic sparsification of LEC pyramidal neurons. Moreover, the transient inhibition reduces the performance in behavioral tests involving entorhinal-hippocampal circuits later in life. Thus, the early OB activity is critical for the functional LEC-HP development and maturation of cognitive abilities.

Presentation type: Poster presentation

Perfumery - bridging the gap between ancient art and modern science

Gafsou Danyel

Via Scent ltd

Olfaction research focuses on using the scientific method to elucidate the mechanisms behind smell perception. Perfumers on the other hand are trained to create smell perception (odors) that evoke memories and emotions.
Historically, perfumers have always followed a deeply intuitive approach to olfaction, with knowledge and skills traded between experts and passed on between generations. Now a new generation of perfumers is emerging that embraces technology and science in addition to traditional skills.
In this symposium we want to inspire the audience and shed light on the question how new developments in science and technology influence perfumery, and the other way around.
Presentation type: Oral presentation

The importance of thinking beyond chemical identity when presenting volatile odorants

Adam Dewan

Florida State University

The physical properties of most sensory stimuli are well understood and can be precisely controlled. In contrast, olfactory stimuli are frequently composed of a myriad of different volatile chemicals that differ in their chemical structure, volatility, how they adhere to surfaces, and interact with other chemicals in both the liquid and gaseous phases. To simplify these issues, most olfactory studies rely on the presentation of monomolecular odorants under standard environmental conditions. While this approach allows odor identity to be precisely manipulated, controlling the concentration and kinetics of the odor pulse is still a major challenge. An easy and affordable method to estimate vapor concentration would increase the transference of experimental data across laboratories and allow odorants to be presented at equivalent standardized concentrations. Our approach uses a photoionization detector and simplified olfactometer setup to assess the relationship between the liquid and vapor-phase concentrations of odorant/solvent pairs. The resulting equilibrium equations successfully correct for behavioral sensitivity differences observed in mice tested with the same odorant in different solvents and were overall similar to published measurements using a gas chromatography-based approach. Although these results take an important step towards the creation of a practical archive for vapor-phase odorant quantification, they do not help constrain the relevant range of odorant

concentrations that should be used in functional studies. To help address this issue, we have defined the minimum relevant concentration for a variety of structurally diverse odorants using our behavioral thresholding approach in mice. It is our hope that these liquid-/vapor-phase equilibrium equations and behavioral thresholds will allow researchers to appropriately choose stimulus intensities for functional studies in a manner that will allow more accurate comparisons across laboratories.
Presentation type: Oral presentation

Ackr3 expression of sustentacular cells shapes the local immune response of the olfactory mucosa

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Because of the exposed localization of the olfactory mucosa (OM) to environmental factors, it has to provide the ability to neutralize pathogens and prevent their invasion. Misregulation of the immune response in the OM, like chronic inflammation, was shown to result in an overreacting, horizontal basal cell (HBC) driven, inflammation with subsequent loss of neurons (Chen et al. 2019). Furthermore, it was recently shown that the long-lasting smell loss after SARS-CoV-2 infection might be caused by a persistent inflammation of the OM (Finlay et al. 2022). By using a conditional knockout (cKO) mouse model for the atypical chemokine receptor 3 (ACKR3) in the sustentacular cells (SCs), we demonstrate that SC expressed ACKR3 regulates the local immune response of the OM. ACKR3 is known to trigger β-arrestin signaling and controls migration of leucocytes by scavenging chemokines, but nothing is known about its immune regulating function in the OM. Differential expression analysis of total OM transcriptomic data shows a significant increase of immune related genes in ACKR3 cKO mice. Matching these genes to a public single-cell RNA sequencing data set of the OM (Wang et al. 2022) reveals a major localization of the upregulated transcripts in leucocytes located in the lamina propria. Interestingly, some of the immune related genes are also referring to cell types of the olfactory epithelium like HBCs, SCs and bowman glands. Additional immunofluorescence experiments show a significant increase of leucocyte invasion into the OM, confirming the results of the differential expression analysis. The transcriptomic data, along with immunofluorescence experiments, demonstrate the relevance of SC expressed ACKR3 on the regulation of the immune response of the OM.
Presentation type: Poster presentation

Treatment of postviral olfactory loss

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Background/objective: Sudden onset olfactory dysfunction is one of the specific symptoms of a viral infection of the upper respiratory tract, and especially for SARS-CoV2 (Haehner et al., 2020). Although most infected persons (75%) only experienced transient symptoms (Niklassen et al., 2021), around 5% are affected by persistent symptoms for up to more than one year (Tan et al., 2022). The focus of this study was to investigate whether olfactory training with concomitant medication using vitamin A nose drops or mometasone furoate nasal spray provides an additional benefit in the restoration of olfactory function and improvement of parosmia in patients with persistent olfactory dysfunction due to postinfectious aetiology.
Study Design: prospective intervention study
Materials and methods: Participants were 146 patients, age 20-83 years, with olfactory dysfunction (duration 1-48 months), all of whom performed “olfactory training (OT)” for 12 weeks. Fifty-two patients formed the OT control group, 52 additionally used vitamin A nasal drops in the “Kaiteki”-position and 42 were prescribed mometasone furoate nasal spray with a long applicator alongside with OT. Orthonasal olfactory function was determined by using “Sniffin’ Sticks”, retronasal function with “taste powders”. In addition, participants rated olfactory performance and nasal patency and filled in questionnaires pertaining the respective interventions.
Results: The analysis showed statistically significant improvements of all intervention groups in almost all investigated olfactory functions. However, the groups only showed differences for odor thresholds with patients in the vitamin A group exhibiting higher scores compared to the two other groups.
Conclusion: Over a 12-week intervention period vitamin A appeared to exhibit a benefit over mometasone furoate nasal spray or OT only.
Funding: This research received no external funding.
Presentation type: Poster presentation

The Development of Normative Data for the NHANES 8-ITEM Pocket Smell Test®

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Normative data are currently lacking for interpreting scores from the 8-item Pocket Smell Test® (PST®), a brief “scratch & sniff” olfactory screening test derived from the 40-item University of Pennsylvania Smell Identification Test (UPSIT®). Although the basis for the olfactory testing in the 2013-2014 U.S. National Health and Nutrition Survey (NHANES), the 8-item PST® has not been widely employed outside of this context, despite its commercial availability. This is due, in part, to two factors. First, the NHANES sample included only persons 40 years of age or older, thereby limiting its use in younger subjects. Second, the test lacks applicable normative percentile data to allow for determining normal or abnormal function for an individual relative to his or her gender or age, unlike the published norms for the UPSIT® and other widely used olfactory tests. To establish PST® normative data, we combined 3,485 PST® scores from the NHANES database with equivalent PST® items extracted from an UPSIT® database of 3,900 persons ranging in age from 5 to 99 years. Receiver operating characteristic (ROC) curves were used to determine cut-points for defining clinically

useful categories of anosmia, probable microsmia, and normosmia. Additionally, decade-related age- and gender-adjusted percentile data were established across the entire age spectrum, making it possible to use the 8-item PST® to determine not only absolute dysfunction (probable microsmia and anosmia), but dysfunction relative to a person's age and gender. Overall, women outperformed men and an age-related decline in test scores was evident for both sexes after the age of 40 years. Based on the ROC analyses, PST® scores of 3 or less (AUC=0.81) defined anosmia, whereas a score of 7 or 8 (AUC of 0.71) defined normosmia. Probable microsmia was defined as a score ranging from 3 to 6. This study provides an accurate means for interpreting 8-item PST® scores within nunerous clinical and applied settings.
Presentation type: Poster presentation

A World of New Opportunities in Olfactory Tech

Danyel Gafsou

F&F Tech

The realm of olfaction is undergoing a surge in attention, as a myriad of applications now require precise measurement of odor perception.
This workshop offers a distinctive opportunity to delve into various facets and implementations of Olfactory technology and the importance of standardization.
Danyel Gafsou, an independent perfumer and olfactory tech consultant, will kikoff the event and present the 5 main areas of olfactory tech.
Ehsan Danesh, a representative from the esteemed Institute of Electrical and Electronics Engineers (IEEE), will introduce attendees to IEEE's role in shaping technological benchmarks. Ehsan's presentation will briefly discuss the IEEE P2520 to set different standards of measure scent perception using e-nose devices across diverse applications.
Throughout the event, we will engage in live discussions using a roundtable format. These discussions will center on different aspects of setting standards to measure perception and using e-nose.
We envision these discussions as a springboard for active participation, with attendees invited to contribute to subsequent quarterly P2520 meetings.

To ensure tailored groupings, we would appreciate if you can fille the questionnaire on :
https://docs.google.com/forms/d/1EcsaK3KyWLk21p61mspsTCukbvmWjjJedQnjU08D-tk/edit
Presentation type: Oral presentation

Smell and beyond: olfaction and its relation to the other senses

Elbrich Postma [1], Bradley Goldstein [2]

[1] Wageningen University, [2] Duke University School of Medicine

Olfaction is one of the five senses, and is important for several aspects in our daily life, such as detecting hazardous situations and our eating behavior. However, olfaction should not only be seen in itself, but also in relation to the other senses. For example, for flavor perception, olfaction and taste are closely intertwined. Therefore, this symposium highlights the relation between olfaction and the other senses from different perspectives, including diverse research techniques and speakers with various backgrounds. These insights lead to a better understanding of the importance of olfaction in our daily life.
Presentation type: Oral presentation

Causes and management of hyposmia: what can we learn from other sensory systems?

Bradley Goldstein

Department of Head and Neck Surgery & Communication Sciences, Duke University School of Medicine, Durham, NC, USA

Olfaction is a critical sensory system that is vulnerable to damage. Humans may experience olfactory dysfunction due to infection, trauma, aging, neurodegenerative disease, or other causes. At present, both a detailed understanding of pathobiology of certain types of olfactory disorders and specific, effective treatment options remain limited. The theme of this Symposium is “olfaction and its relation to the other senses”. Here, we consider how disorders of other sensory systems have been studied, current management approaches that have been employed, and compare these to the current state for olfaction. In other systems such as vision or hearing, etiologies may be categorized as central or peripheral, or as conductive versus sensorineural, or mixed. Specific treatments are aimed accordingly; for instance conductive hearing problems may be amenable to middle ear surgery, while sensorineural problems due to cochlear hair cell degeneration may be treated with a cochlear implant to directly stimulate the auditory nerve. However, recent efforts at regenerative strategies for the peripheral auditory system, combining drugs targeting specific signaling pathways, have had limited success. In the visual system, viral gene therapies have been applied for genetic retinal diseases due to loss-of-function alleles. Future treatment strategies for olfactory disorders may be considered in the context of the lessons learned from the visual and auditory systems. Finally, an active area of research involves defining the roles of specific sensory impairments on the development of cognitive decline, and potential strategies to protect or prevent this decline.
Presentation type: Oral presentation

Evolution of sex pheromone signals and responses

Astrid Groot

University of Amsterdam, IBED

Mate choice directly affects the level of gene flow between individuals within and between populations. Therefore, the evolution of sexual communication systems is likely an important determinant in the speciation process. Night-active Lepidoptera (moths) are ideal organisms to address these questions, because they are one of the most diverse group of animals (~140.000 species), with well-defined sexual communication: females produce a species-specific sex pheromone that attracts males from a distance, after which close-range courtship occurs which includes female choice (1,2), there is communication interference between sympatrically occurring species (3), and moths contain parasites that may affect their sexual attraction. Through a combination of genetic analyses and behavioral lab and field experiments, we investigate the genetic changes underlying sexual interactions that lead to population divergence, including QTL and transcriptomic analyses and CRISPR/cas9 experiments (4-7) and field studies on the biological relevance of this variation (8,9). We also measure the natural selection forces affecting sexual attraction, including parasites and pathogens (10,11), and try to extrapolate micro-evolutionary processes to macro-evolutionary biodiversity patterns (12,13).
1) Zweerus et al. 2021, Anim Behav 179; 2) Zweerus et al. 2022, Ecol Evol 12; 3) Groot et al 2006, PNAS 103; 4) Lassance et al. 2010, Nature 4661; 5) Groot et al. 2014, Proc B 281; 6) Koutroumpa et al. 2016, PNAS 1133; 7) Unbehend et al. 2021, Nat Comm 12; 8) Unbehend et al. 2014, Plos One 9; 9) Van Wijk et al. 2017, Sci Rep 7; 10) Barthel et al. 2015, BMC Evol Biol 15; 11) Gao et al. 2019, J Invert Pathol 170; 12) Groot et al. 2016, Annu Rev Entomol 61; 13) De Pasqual et al. 2021, TREE 36.
Presentation type: Oral presentation

Mechanistic basis of vomeronasal pump operation

Christoph Hamacher [1], Rudolf Degen [1], Melissa Franke [1], Victoria K. Switacz [1], David Fleck [1], Raghu R. Katreddi [2], Martin Strauch [3], Nao Horio [4], Enno Hachgenei [5], Stephen D. Liberles [4], Jeroen Kalkman [6], Dorit Merhof [3], Paolo E. Forni [2], Geraldine Zimmer-Bensch [7], Yoram Ben-Shaul [8], Marc Spehr [1]

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In most mammals, the vomeronasal organ (VNO) is crucial for the detection of semiochemicals, which trigger a wide range of innate behaviors. The VNO is a blind-ending cylindrical structure with a mucus-filled lumen, from where sensory neurons can detect solved stimuli. Few physiological studies have addressed vomeronasal stimulus uptake. Accordingly, fundamental mechanisms underlying vomeronasal operation remain elusive. Here, we investigate the molecular and cellular mechanisms

that control stimulus uptake into the mouse VNO. Using both antibody staining and genetic cell labeling, we demonstrate that the lateral non-sensory VNO tissue is largely built by smooth muscle cells (SMCs), which are innervated by cholinergic and / or adrenergic fibers. Superresolution and fluorescence lifetime imaging microscopy reveal two SMC populations with longitudinal and circular orientation. Stimulation of acute coronal VNO slices from mice expressing GCaMP6f in SMCs, led to either elevated calcium levels and strong contractions in the lateral non-sensory tissue upon noradrenaline (NA) stimulation or elevated calcium levels in select SMCs located close to the lumen upon acetylcholine (ACh) exposure. NA-mediated contractions are also observed in tissue slices from juvenile mice that retain the cartilaginous VNO capsule. With this support structure intact, NA stimulation results in expansion of the VNO lumen. This effect is also detected in intact skull *post mortem* preparations using optical coherence tomography. Together, these morphological and functional data suggest that vomeronasal pumping is mediated by antagonistic SMC types, selectively activated by NA or ACh, respectively.
Presentation type: Poster presentation

Novel perspectives of mouse olfaction

Andres Hernandez-Clavijo , Moritz Nesseler , Victoria Switacz

RWTH Aachen University

Mice rely on the sense of smell for all basic life activities, including foraging, social recognition, mate choice, defining territory, and more. This central role that olfaction plays in physiology served as the evolutionary driving force for the extraordinary development of the murine olfactory system, making mice a perfect model organism to unravel the mechanisms underlying olfactory system physiology. The study of the mouse sensory system enabled researchers to uncover fundamental as well as complex aspects of chemoreception that were later translated to other organisms like humans. We aim to highlight recent developments in mouse olfactory research and will present diverse research topics spanning from peripheral to central olfactory pathways.
Presentation type: Oral presentation

Smelling in the Past, the Wild, and the City

Kara Hoover

University of Alaska Fairbanks

The unifying theme of my research is adaptation to ecological challenges—e.g., migration to a new environment, climate change. Adaptation to an environment is driven by biology, ecology, behavior, and culture. My work in human olfaction is centered on the evolutionary trajectory shaping human populations across space and time. I'll cover three pillars of my work in this lecture. First, I'll present my recent work smelling through Neandertal and Denisovan noses for the first time in 50,000 years.

Second, I'll present my work smelling in the wild or how our sense of smell operates in the built environment. This work will include some new research on human genetic variation in olfactory sensitivity. Third, I'll present my work on sensory inequities, a term I use to describe how sensory environments vary, often due to differences in socio-economic status (as intersected by other demographic markers such as race/caste/ethnicity/tribe, gender, sexual orientation, and ability). This work is both theoretical and practical, with the latter aspect focused on olfactory impairment and COVID-19.
Presentation type: Oral presentation

How well do we smell? Comparing our sense of smell to our other senses.

Digna Kamalski

UMC Utrecht, department of otorhinolaryngology and head/neck surgery

The sense of smell is often considered the least important of the senses. Patients often only understand the importance of smell, when it is lost. The question is why we undervalue our sense of smell. Are our other senses simply functioning better? Can we compare our senses?
In this talk, you will hear the view of an otorhinolaryngologist, with examples from her patient clinics.
Presentation type: Oral presentation

Study of chicken olfactory receptors (CORs) using in silico approach

Aurore Lamy [1], Rajesh Durairaj [1], Cécile Bienboire-Frosini [2], Patrick Pageat [3]

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Chemical communication is based on the release and perception of semiochemicals, mostly detected by the vomeronasal organ (VNO), which can induce physiological and behavioural responses in animals. Many studies have shown the significance of pheromones and the absence of VNO in birds. Thus, in birds, these molecules can be detected by the olfactory receptors (ORs) of the chemosensory neurons in the olfactory epithelium (OE), triggering signal transmission to the olfactory bulb and the brain. Several computational studies have been reported about the structural modeling of mouse and human ORs and the receptor deorphanization from the ligands. However, there is only one experimental structure of OR currently available.

Therefore, the sequence and structural annotation of ORs are necessarily studied using in silico approach. This study focuses on chicken ORs (CORs). Using computational tools, the CORs were analyzed for sequence conservation, phylogeny, topology, and to construct the structural models. We have initially selected 15 CORs which are expressed in chick OE. The results showed that COR sequences share an average of 56% identity with different mammals and 84% with helmeted guinea fowl. Phylogenetic studies showed the evolutionary relationship between mammalian orthologs and the 15 selected CORs. Furthermore, the CORs were screened based on the 7-transmembrane OUT topology analysis. Then, the 15 selected sequences were used to construct models using the fast homology search of MMseq2 with AlphaFold. According to structure quality and sequence identity, we have selected 5 COR models (COR4, COR7, COR8, COR9, and OR5J2) and validated them by GROMACS molecular dynamic simulation (MDS) in a membrane complex. Indeed, during simulations each model reaches a RMSD stability below 0.3 nm for at least 25 ns. The results allow us to envisage a study of deorphanization on the receptor models, which will improve the understanding of chemical communication in poultry.
Presentation type: Poster presentation

Biological Functions of Extra-nasal Olfactory Receptors in Energy Metabolism, Cancer, and Aging

Sung-Joon Lee

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Some olfactory receptors (ORs) are expressed in non-nasal tissues and activation of these receptors stimulates tissue-specific functions activating intracellular signaling pathways. It has been reported that the ORs in extra-nasal tissues could regulate energy metabolism and cancers and more recent findings showed that ORs can also be involved in the regulation of cellular aging process. In energy metabolism, the function of Olfr544 has been intensively studied. Olfr544 increases adipose lipolysis and hepatic fatty acid oxidation thus reduces adiposity. In skeletal muscle, Olfr544 increased mitochondrial biogenesis and, in enteroendocrine cells, Olfr544 increases GLP-1 and cholecystokinin secretion modulating eating behavior. The expression of ORs are altered in several cancers compared with levels in non-cancerous tissues and play critical antitumor functions. For example, OR51E2 is upregulated in several cancers including prostate cancer cells but is downregulated in colorectal cancer cells compared to those of non-cancerous cells. The ligand of OR51E2, β-ionone, inhibits anticancer activity in these cancer cells. In colorectal cancer cells, activation or OF51E2 increases intracellular calcium concentrations and suppress MEK-ERK signaling axis thus suppresses tumorigenesis. Alternatively, recent findings suggest that ORs are involved in the regulation of cellular senescence in keratinocytes, myotubes, and colorectal cancer cells. Collectively, these findings suggest that ORs have diverse functions and could regulate energy metabolism, cancer, aging processes in multiple tissues.
Presentation type: Oral presentation

The social nose: Recent insights on chemical communication in humans

Arnaud Leleu [1], Valentina Parma [2]

[1] University of Burgundy, [2] Monell Chemical Senses Center

Humans are a social species. From the very beginning of life, we grow within a social environment, cooperate and bind with conspecifics, and care for each other. Lack of social connection has serious consequences, culminating in an increased chance of early death by 20%. The sensory determinants of human sociality have been largely investigated, and a growing body of evidence indicates that body odors convey a wealth of information about an individual's traits (e.g., identity, age) and states (e.g., emotion, health status). This symposium will offer recent insights on how human chemosignals foster sociality across a variety of relational contexts and developmental stages.

Presentation type: Oral presentation

The neurophysiology of olfactory reversal learning

Nick Menger , Yuri Pavlov , Boris Kotchoubey

Institute of Medical Psychology and Behavioural Neurobiology, Tübingen

Reversal learning plays a crucial role in conditioning experiments as it can serve as an important indicator of cognitive flexibility. By studying reversal learning, we can gain valuable insights into the process of association formation and re-learning. When it comes to olfaction, it stands out from other sensory modalities due to its unique thalamic and extra-thalamic pathways. In light of this, our research focused on investigating olfactory conditioning using a reversal paradigm. In our experiment, one odor (CS+) was paired with an aversive loud sound (US), while the other odor served as the unconditioned stimulus (CS-). Following a predetermined number of trials, we reversed the contingency, making the CS+ odor the CS- odor, and vice versa. To gather comprehensive data, we employed multiple measures, including behavioral observations, skin conductance, heart rate, pulse wave, nostril muscle activity, and EEG. A total of 41 subjects participated in the study. The results revealed that only perceived intensity of the odors could be conditioned, but this learned response seemed to persist the reversal, and was not re-learned for the new CS+ odor. In contrast, perceived pleasantness and all neurophysiological measures showed minimal effects, indicating that there were no significant differences between the two conditions overall. These findings suggest that establishing an association between an olfactory stimulus and an aversive auditory event may pose challenges. This difficulty could potentially arise from the unique nature of the extra-thalamic olfactory pathways, which might be crucial for the formation of such associations.

Presentation type: Poster presentation

EvOlf: a multimodal deorphanization approach for therapeutically relevant odorant receptors.

Aayushi Mittal [1], Sanjay Kumar Mohanty [1], Mudit Gupta [2], Gaurav Ahuja [1, 2]

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In the human genome, proteins encoded from ~25,000 genes are designated as the prime drivers of complex biological processes. Considering a cell's molecular, functional, and physiological complexity, the required number of functional proteins outnumber the ones encoded by the genome. Moreover, this complexity is further exaggerated in disease states such as cancer, where the overall functional networks are much more sophisticated and, therefore, to ensure survival, cancer cells selectively activate a set of ectopic genes whose functional importance, at least in the context of cancer biology is very limited. One such example of a gene family is that of Odorant Receptors (ORs). In addition to their expression in the sensory epithelium of the nose, almost 92.5% (370/400) of the ORs are reported to be expressed in non-olfactory tissues, both in homeostatic and pathological states. We recently traced the expression of ORs at the single-cell resolution across multiple cancer types and observed their potential relevance with cancer cell differentiation status and prognosis. To identify their potential (non)agonists, we created one of the largest datasets encompassing GPCRs-ligand information across vertebrates. We utilized this gigantic database to develop state-of-the-art Machine Learning architecture to deorphanize orphan GPCRs (including ORs). Our Model (EvOlf) identified putative ligands for orphan GPCRs, of which a subset of them are being experimentally validated using a heterologous expression system. Taken together, the present work utilizes the power of Artificial Intelligence to deorphanize therapeutic-relevant GPCRs.

Presentation type: Oral presentation

Modulation of associative memory by odour context

Elena Nicolaou , Céline Schutte , Melanie Wiehe , Guillen Fernandez , Nils Kohn

Cognitive Neuroscience Department, Radboud University Medical Centre, Donders Institute for Brain, Cognition and Behavior

The olfactory sense, unique in its direct connection to the amygdala and hippocampus, can play a significant role in emotional memory (Lundström et al., 2011; Schlichting & Frankland, 2017). We aimed to explore how olfactory cues affect memory integration in two studies, based on our associative spatial memory paradigm (Liu et al., 2020). In study 1, we hypothesized that olfactory cues enhance memory encoding and retrieval compared to auditory cues due to specific neuronal input from the piriform cortex. In study 2, we proposed olfactory cues enhance memory

compared to no context, with piriform cortex's augmenting role.
We tested 30 normosmic participants using 3T imaging at Donders Institute, with the Lundstrom olfactometer for odor delivery (Lundström et al., 2010). Our paradigm involved associating pictures to locations on a cartoon map, paired with a context stimulus (olfactory/auditory for study1; olfactory/none for study2). In an fMRI recall phase, participants indicated where on the map a previously shown picture was located and its associated smell or sound. More detailed recall questions were asked outside the MRI.
Preliminary results from study 1 show that both sound and smell stimulation led to reliable neuronal activity patterns. However, there was no observed interactive effect of memory retrieval in brain activity, nor significant behavioral differences between smell and sound contexts. Study 2 data acquisition is ongoing, and we intend to further analyze and pool results from both studies.
In preliminary summary olfactory context cues do not seem to have a neuronal or behavioural facilitative influence on memory integration when compared to auditory context.
Presentation type: Poster presentation

Parosmia: mechanisms, diagnosis and intervention

Valentina Parma [1], Jane Parker [2]

[1] Monell Chemical Senses Center, [2] University of Reading

In this symposium, we propose to address a novel way to conceptualize mechanistic models of parosmia, we present a new test to diagnose parosmia on a large scale, explore behavioral strategies to treat parosmia, as well as provide coping mechanisms to those for whom therapies are not currently available.
Presentation type: Oral presentation

Modeling the Structure-Odor-Relationship (SOR) through sensory testing

Robert Pellegrino

Monell Chemical Senses Center

If you have a modern phone, you can capture a visual scene as a photograph, alter it, send it to a relative in another country in an instant, and store it so you can look at it for years to come. None of this is currently possible in olfaction. In vision and audition, we know how to map physical properties to perception: wavelength translates into color and frequency translates into pitch. By contrast, the mapping from chemical structure to olfactory percept is poorly understood, limiting our ability to describe and control odors. This, in turn, limits our ability to understand how the olfactory system encodes perception. Olfaction has a higher dimensionality than the other senses, but recent models have shown that with enough data, machine learning techniques can

predict human perception from molecular structure. We hypothesized that the rate-limiting step for building a model that predicts human perception from molecular structure is the collection of high-quality psychophysical data. Here I will discuss how these datasets have enabled us to create an odor map, analogous to a color wheel where nearby stimuli are perceptually similar, that individuals can explore using an olfactometer that generates an odor corresponding to each position on the map. We demonstrate that individuals can navigate this organized odor map better than a shuffled map. Additionally, navigation was quicker with subsequent trials, demonstrating a learning effect. Our ability to organize odor space and nonverbally assess odor quality paves the way toward digitizing olfaction.
Presentation type: Oral presentation

An evolutionarily conserved olfactory receptor is required for sex differences in blood pressure

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Olfactory receptor 558 (OLFR558) is an evolutionarily conserved olfactory receptor whose role oustide the olfactory epithelium is unknown. We used RNAScope to show that Olfr558 is expressed in vascular smooth muscle, including the renal afferent arteriole; the human ortholog (OR51E1) exhibits a similar pattern of expression in published RNASeq data. We then measured blood pressure (BP) in Olfr558 wild-type (WT) and knockout (KO) mice via telemetry. It is well-established that males (M) have a higher BP than females (F). We measured systolic (SBP), diastolic (DBP), and mean arterial pressure (MAP) using n=7-9 per sex and per genotype. We find that, as expected, Olfr558WT M have higher BP than F, including MAP (M:101.0±1.6 vs. F:89.0±0.9 mmHg, $p<0.0001$), SBP (M:113±2 vs. F:102±1mmHg, $p=0.0025$), and DBP (M: 89±2 vs. F:75±01mmHg, $p<0.0001$). However, sex differences in BP are absent when comparing M vs F Olfr558 KO (MAP M: 96±2 vs. F: 95±1mmHg; SBP M: 110±2 vs. F: 108±2mmHg; DBP M: 81±2 vs. F: 82±2mmHg). To explore this finding, we analyzed kidney renin expression by qPCR and plasma renin activity (PRA) by ELISA, and measured pulse wave velocity in females. In male KOs (n=10-12), kidney renin mRNA decreased (0.4±0.1 vs WT: 1±0.1 $p=0.001$), as did PRA (201±21 vs WT: 402±15, $p=0.001$); both kidney renin mRNA and PRA were unchanged in female KOs. However, females exhibited increased pulse wave velocity (PWV; KO: 4.6±0.4 vs WT: 3.2±0.2 m/s, $p=0.0069$, n=8-11). The human ortholog of OLFR558, OR51E1, was previously identified as a locus associated with DBP, and we also have identified an OR51E1 variant with a sex-specific effect. In sum, an evolutionarily conserved olfactory receptor is required for sex differences in BP.

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Presentation type: Oral presentation

An electronic olfaction system rivalling the speed of smell in mice.

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Olfaction helps animals navigate their environment to find food, escape predators, locate mating partners. In natural environments, odorants are usually dispersed by turbulent processes, and encounters with odour cues are usually brief and occur in a highly intermittent fashion. Odour-guided navigation therefore requires animals to be capable of detecting and recognising odours during these brief encounters with low latency and high temporal precision [1]. Indeed, it has been shown that Drosophila is capable of decoding odours within milliseconds [2], and mice can access and behaviourally report temporal features of odour plumes at timescales up to 40Hz, much faster than their sniffing rate [3].
Technical solutions to odour-guided navigation have high potential in e.g., disaster management, environmental monitoring, and security, but still lag dramatically behind the capabilities of animals. Inspired by fast olfaction in animals, we have developed a miniature accelerated electronic olfaction system based on metal-oxide sensors. We evaluated the system in a high-temporal-precision setup that was recently used in mice [3] and found that it can recognise odour pulses within milliseconds. It can match, and even exceed, the capability of mice to decode temporal features of rapidly fluctuating stimuli. The highly integrated system can be mounted on small robots for olfactory navigation experiments, e.g., in a "robotic twin" setup, where the effectivity of biological and non-biological navigation strategies are assessed in turbulent but controlled environments, while accessing information about source location encoded in turbulent-induced fluctuations of odour concentration [4].

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Presentation type: Oral presentation

Machine learning assisted odor assessment based on molecular structures

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The sense of smell plays an important role in associating products such as fragrances and detergents with their brands for consumers. Consumers want new products with characteristic odors that are harmless to health and are environmentally sustainable. Therefore, it is crucial to identify substances that can be used for such products early in the development process to reduce costs. Machine learning (ML) can be utilized to leverage structure information of molecules and mixtures to predict their properties such as odors. This is a challenging problem that often requires specialized knowledge. Here, we present ML approaches we developed to classify and assist in odors assessment based on molecular structures that can be used in early discovery to identify molecule candidates. For this, we use the DREAMS Olfaction Challenge dataset and an in-house dataset consisting of molecule mixtures found in 16 whiskey samples. In previous work by Haug et al. 2023, the whiskey samples were analyzed by a semi-automated in-house software (Grasskamp et al. 2023) and their perceived aromas were acquired through a sensory panel. We created a data processing pipeline that uses a corpus of reference molecules to identify, extract and vectorize molecular features to train a convolutional neural network and predict the top 5 applicable whiskey aromas with an average accuracy of 85.3%. Moreover, building upon our previous work using 2D Olfactory Weighted classification algorithm – OWSum (Schicker et al. 2023), we also present a novel ML approach that uses 3D-electronic density distribution of molecules to learn their structures and infer properties such as their odor classes. We show that this approach can be further extended to other properties of interest for cosmetic industry such as classification of a molecule as a health hazard.
Funding: The research was funded by the Bavarian State Ministry for Economic Affairs, Regional Development and Energy via the project “Campus of the Senses”
Presentation type: Oral presentation

Plasticity of flavor learning in utero: An assessment through the changing pattern of olfactory responses in human fetuses and neonates

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Mammalian fetuses are able to sense flavor cues transferred through the maternal diet in the amniotic fluid. Such prenatal chemosensory experience engages fetal learning and memory that extends into the postnatal environment. Despite its importance, we know very little about what human fetal chemosensory abilities mean for postnatal food-related behaviors. The effects of prenatal flavor exposure in humans have been investigated on infant behaviors, however, longitudinal investigation of reactions from fetal to neonatal life has to date been lacking. To address this, we assessed fetal and neonatal olfactory responses to flavors transferred from the maternal diet in the last trimester of pregnancy. 32 fetuses/neonates (kale flavor exposure, n = 14, carrot flavor exposure: n = 18) were involved in this study from 36 weeks until the first postnatal

month. At 36 weeks, fetal facial reactions were measured via a 4D ultrasound scan and a reliable coding system (FACS; Ekman & Friesen, 1978) after maternal ingestion of one flavor capsule. After 36 weeks scan, mothers consumed the same flavor capsule repeatedly for 3 consecutive weeks. In the first postnatal month (mean age: 3.06 weeks), neonatal facial reactions to kale, carrot and control odor were analyzed using FACS. Repeated flavor exposure during the last 3 weeks of pregnancy resulted in an increased frequency of laughter-face-like reactions from fetal to neonatal stage when exposed to non-bitter-tasting flavor. More interestingly, a changing pattern from cry-face-like to laughter-face-like reactions from fetal to neonatal stage occurred when exposed to bitter-tasting flavor in utero. This study has important and novel implications in sensory science by providing a window into the chemosensory world of the human fetus, which could reduce the likelihood of fussy eating when introducing solid foods conveying bitter taste.
Presentation type: Oral presentation

Does size matter? Olfactory bulb volume of patients experiencing long-term COVID-19 related olfactory dysfunction: The COVORTS study.

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Long-term olfactory dysfunction after COVID-19 is becoming an increasingly worrying symptom of post-COVID syndrome. Three years after the onset of the pandemic, still little is known about the mechanism behind the long-term olfactory impairment experienced by many patients. The olfactory bulb (OB) is the first region where olfactory information enters the brain. Studies have shown abnormalities in OBs of early COVID-19 patients, however, follow-up is lacking. We aimed to quantify OB volume in patients with COVID-19 related olfactory dysfunction over time, and compare to healthy controls. This preliminary analysis was performed with 11 COVID-19 patients with olfactory dysfunction, and 11 healthy subjects (Sniffin' Sticks score > 30.5) matched on gender and age. All subjects were scanned with MRI, using a specialized T2 weighted sequence to image OB (28 slices, slice thickness: 1 mm). Patients in the COVID-19 group were scanned twice, once within 6 months of their original infection (T1), and 6 months later (T2). At T1, mean Sniffin' Sticks score for the COVID-19 group was 22.8, and 24.6 at T2. Manual segmentation of the left and right OB was performed on each slice of the MRI-scan where the bulb was visible. Consequently, volume in mm3 was calculated. There was no significant difference in total OB volume between T1 (94.0 mm3) and T2 (106.0 mm3) for the COVID-19 group ($p=0.12$). Similarly, a two-sample t-test between the COVID-19 group and healthy patients (114.5 mm3) showed no significant differences in total OB volume ($p=0.12$ at T1, $p=0.50$ at T2). A moderate positive correlation was found between Sniffin' Sticks score and total OB volume when all measurements were grouped together ($r(20)=0.49$, $p=0.02$). Overall, OB volume and olfactory function are in line, albeit not significant, indicating a trend towards recovery over time. Updated results including

more participants in both groups will be presented at the conference. Funded by ZonMW: 10430102110001.
Presentation type: Poster presentation

Inhaling colour - olfactory synaesthesia in art history

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There appears to be a dramatic mismatch between smell and language, at least in most western vocabularies. Many people have a hard time describing scents or related phenomena. But exactly this lack of vocabulary inspired the Symbolists, Futurists and other avant-garde authors and artists to invent their own words to describe their innovative olfactory practices and modernist relation to smell. Synaesthesia - which was widely accepted by both scientists and artists between ca 1890-1940 - was one of the main tools to achieve this. The Futurists followed contemporary scientific insights such as those presented by Charles Henry who ran a sensory lab at the Sorbonne in Paris. Smell, like sound and vision, was thought to be an electromagnetic phenomenon and artists were considered to be able to translate vibrations of any kind into any other sensory realm. This was reflected in their vocabulary. Sound played am pivotal role in these cross-modal approaches of smell related descriptions, which was expressed through concepts such as 'accordi di fetori' (stench chords, Valentinelli, 1915), 'modulazioni olfattive' (olfactory modulations, Valentinelli, 1915), 'smound' (Septimus Piesse, 1865) and 'octave of smells' (Septimus Piesse, 1965). Visual labels such as colour and shape were also utilized (ranging from yellow to green to purple), as were haptic terms and even kinaesthetic references such as 'archi mobili di odori' (moving arches of smells).

During this presentation the audience will smell examples based on historical texts and those present are challenged to use synaesthetic terms to describe scents and decide wether this is a helpful tool and whether there is any consensus.

Sources:

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Presentation type: Oral presentation

Odor Evoked Autobiographical Memory: A Pilot Study for Finding Appropriate Odors in Turkish Population

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Evidence shows that olfactory evoked personal memories are different from information evoked by the primary senses. Most such studies were carried out in countries such as Germany, the Netherlands, Sweden. Cross-cultural studies show that the role and attributed importance of odors differ in different cultures. This means that there may also be cross-cultural differences in the features of olfactory evoked autobiographical memories. There is a need for studies in different cultures, which then may contribute to our understanding of the mechanisms underlying the Proust phenomenon. In this pilot study, we aim to identify a subset of odors that are effective in evoking autobiographical memories. The enrollment target is 30 participants, of which 6 participant have been completed so far. A total of 30 cues were used to elicit autobiographical memories. Items were generated by replication of some stimuli used by other studies and also by inclusion of items that would be meaningful to a Turkish population. The study conducted in a single session. Participants were exposed to olfactory cues for 30 sec and asked to relate any autobiographical memory for the given cue. 3 minutes was allowed for retrieval. When a memory was evoked, the participant provided a short description of the event, rated emotional valence of the memory and then the familiarity, pleasantness and disgustingness of the odors. A preliminary analysis of the results of 6 participants showed that on average the odors are rated as familiar, as pleasant and emotions of both positive and negative valence are experienced. Importantly, most odors evoke autobiographical memories.We draw a tentative conclusion that effective odors that are culturally appropriate for Türkiye are in the selected set of odors. Once the ongoing data collection is completed, a subset of odors that can be identified less effective in evoking autobiographical memories will be excluded for use in future studies.
Presentation type: Poster presentation

Taste - Behavioral/perceptual

Hedonic or metabolic sensing: contrasting responses to sucralose and sucrose between the sweet-liking phenotypes

Rhiannon Mae Armitage [1], Vasiliki Iatridi [2], Phebe Green [1], Giorgia Marzola [1], Martin R Yeomans [1]

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Phenotypic differences in liking for sucrose are well established, with three distinct responses found in the UK, USA and Asia: extreme sweet-likers (ESL), moderate sweet-likers (MSL) and sweet dislikers (SD). However, given increasing evidence that humans may be able to sense the metabolic value of oral carbohydrates, responses to sucrose could reflect either sensing of sweetness, its metabolic significance or both. One way to address this is to test if phenotypic differences in sucrose liking extend to non-nutritive sweeteners. Specifically, we explore for the first-time individual differences in liking responses to the low-energy sweetener sucralose. In the UK, 83 adults (18-38 yrs; 22 Male, 61 Female; 34 ESL, 34 MSL and 15 SD) attended a lab

experiment with two taste tests: one using 1.0M sucrose (342.3 g/l) and the second five concentrations of sucralose (0.548, 0.274, 0,137, 0.069 and 0.034 g/l). Mixed 3-way ANOVA, with sucralose concentration and replicate within-participant and phenotype defined by sucrose between, found a significant phenotype x concentration interaction ($F(8,320) = 11.45$, $p < .001$), with very similar phenotypic liking patterns for sucralose as sucrose. Contrasting the liking ratings of 0.548g/l sucralose and 1.0M sucrose stimuli revealed a significant interaction between tastant and phenotype ($F(2,80) = 13.33$, $p < .001$), with distinct responses between the three phenotypes. Although, phenotypic differences were more pronounced for sucrose. No significant differences were found between sweet intensity ratings, but the 0.548g/l sucralose was significantly less sweet than 1.0M sucrose ($F(1,80) = 37.47$, $p < .001$). Overall, we observed comparable individual differences in sweet taste liking for sucrose and sucralose, with liking dependent on sweetness intensity. This strongly suggests these phenotypic differences are driven purely by sweet taste, not sweet-signalling. A Leverhulme Trust studentship and grant RPG-2018-068 funded this work.
Presentation type: Poster presentation

Can non-invasive vagus nerve stimulation condition preference for new flavors paired with low-fat foods ?

ilkim BÜYÜKGÜDÜK [1, 2], Anıl Can ÇETİN [2], Berna ZENGİN [1], Dilan Deniz KOYUNCU [3], Uğur DAL [3], Maria VELDHUIZEN [1]

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Conditioned flavor preference can be formed when a novel flavor is associated with for example palatable taste and/or with positive post-digestive effects. Recent research on the vagus nerve (VN) using chemogenetic and optogenetic stimulation has shown that vagal gut-brain communication underlies this learning. If VN activity triggers food reward, we predict that non-invasive VN stimulation (nVNS, compared to pseudo-stimulation) will condition liking for new flavors paired with low-fat foods.

In order to select flavors for conditioning, 17 participants tasted and rated 10 flavors using the sip-and-spit method. The participants rated liking and wanting. Two flavors that are similarly near to neutral in liking were chosen for the conditioning sessions. To induce associative conditioning, we coupled one low-fat stimulus with nVNS and another low-fat stimulus with sham stimulation in a counterbalanced within-participant design. The paired stimuli were then presented to the subjects for 20 days. At the end of conditioning sessions participants were asked to taste and rate 10 flavors again, as they did before the conditioning sessions.

No significant interaction between time (before vs after conditioning) and condition (nVNS vs sham) was identified in either the liking or wanting ratings. However, participants' flavor wanting scores increased over time, but this main effect of time was statistically significant only in the nVNS condition (p=.024).

Our initial result shows that VN stimulation does not readily condition flavor liking in

humans as it does in animals. Despite this, it shows that nVNS has a potential positive effect on increasing the participants' desire to consume more new flavors paired with low-fat foods. Further research is necessary to understand the specific impact of nVNS on the progression of flavor wanting scores.

Funded by TÜBİTAK(118C299)

Presentation type: Oral presentation

Benign taste experience during development impacts rodent taste learning and processing in adulthood.

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Sensory experience modulates perception and learning of new and familiar stimuli. For example, in taste learning, benign experience with a taste decreases the associativity of that same taste (conditioned stimulus; CS) with a future conditioned taste aversion (CTA); a phenomenon known as latent inhibition. Recently, we have shown that even familiarity with tastes other than the CS can influence later learning toward novel tastes (Flores et al., 2016). These data suggest that benign taste experiences, are in fact only seemingly benign and can modulate future taste learning. Given that benign taste experiences are ubiquitous in everyday life, it is important to consider how experiences during developmental learning might impact future taste processing. Here, we test the hypothesis that early life experience with sucrose will cause latent inhibition of future aversion learning of sucrose paired with lithium chloride. We expect that latent inhibition of learning will generalize to equally palatable concentrations of fructose and saccharin. Lastly, we test the hypothesis that latent inhibition will be correlated with higher perceptual thresholds of sucrose in adulthood. We test the above using a CTA paradigm in Long Evans Rats who experienced sucrose during different developmental periods (gestation, lactation, or weaning). A one-way ANOVA shows that early exposure to sucrose does not induce latent inhibition of CTA learning later in life, and instead leads to stronger CTA learning in adulthood. Additionally, aversions generalized to fructose and saccharin and generalization strength correlated with lower thresholds for sucrose during adulthood. These findings begin to characterize the impact of incidental taste experiences early in life on future taste learning in adulthood within rodents. This work was supported by the South Carolina, IDEA Networks of Biomedical Research Excellence, Faculty Fellow Award through the National Institute of General Medical Sciences.
Presentation type: Oral presentation

T1R2-mediated sweet sensing in a lizard

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Sugars are an important class of nutrients found in the flowers and fruits of flowering plants. Although T1R2-T1R3 has been identified as the mammalian sweet receptor, some birds rely on a repurposed T1R1-T1R3 savory receptor to sense sugars. Moreover, as the radiation of flowering plants occurred later than the last common ancestor of amniotes, sugar may not have been an important diet item for amniotes early in evolution, raising the question of whether T1R2-T1R3 is a universal sugar sensor or only a mammalian innovation. We examined the molecular basis of sugar detection in a lizard, a representative of an understudied but phylogenetically relevant group of amniotes. Using brief-access behavioral tests and functional characterization of taste receptors, we demonstrated that the nectar-taking Madagascar giant day geckos (*Phelsuma grandis*) significantly preferred sugar solutions (sucrose, fructose and glucose) over water and can detect sugars using the canonical mammalian sweet receptor T1R2-T1R3. These results revealed the existence of T1R2-mediated sweet taste in a non-avian reptile, which has important implications for our understanding of the evolutionary history of sugar detection in amniotes.
Presentation type: Oral presentation

Mediterranean Aromatic Plants Enhance Salty Taste Perception in Hyposmic Patients

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Objectives of the study: Mediterranean aromatic herbs and spices may represent a possibility for the improvement of anosmia and ageusia. The aim of the study was to evaluate the role of Mediterranean aromatic plants in the enhancement of salty perception in patients with hyposmia. To this goal, the saltiness perception of saline solutions obtained from pure salt (NaCl, S) and different types of sea salt (FS) flavored with different aromatic plants (myrtle, fennel, rosemary, helichrysum, liquorice, saffron, and orange) were assessed in total patients with hyposmia compared to healthy controls.

Experimental methods: One hundred forty-eight subjects were enrolled, 57 (35 women and 22 men) were hyposmic patients (age: 35.7 ± 14.1 years) and 91 (62 women and 29 men) were healthy controls (age: 31.4 ± 13.6 years). The olfactory function was measured with Sniffin' Sticks Extended Test, while the gustatory function was evaluated using Taste strips test with four concentrations for taste each modality (sweet, bitter, sour, and salty). Salty taste dimensions (pleasantness, intensity, and familiarity) of saline solutions (0.04 and 0.1 g/mL) obtained from S and FS were assessed in total patients with hyposmia compared to healthy controls.
Results: At the dose of 0.04 g/mL, saline solutions of FS, containing 6-30% of flavoring extract, were perceived in patients with hyposmia as equally intense, but less familiar, than pure salt solution, with similar scores in pleasantness dimension. In patients with hyposmia, the salt flavored with orange/saffron, characterized by 30% less of NaCl, emerged as the most interesting in potentiating saltiness perception.
Conclusions: Our data confirmed that the addition of Mediterranean herbs and spices to sea salt enhanced salty taste perception in patients with hyposmia, as in healthy controls, suggesting a potential role of FS in the reduction of salt intake in daily diet and to obtain a better gustatory perception of the food.
Presentation type: Poster presentation

Effects of specific sensory satiety combined with sweet taste inhibitors on managing sweetness attraction: a preliminary study.

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Objective: More effective procedures for controlling excessive attraction towards highly palatable foods are needed to prevent the development of disordered eating behaviour. By assessing the effect of specific sensory satiety combined with the application of sweet taste inhibitors, this study represents a first step to addressing this issue.
Methods: Nine healthy, non-smoking participants with normal-weight, aged between 18-23 years and without taste alterations were recruited. Using a within-design approach, each participant completed three randomly assigned experimental sessions. Following the protocol of specific sensory satiety, each session included the repeated presentation of the target sweet stimulus under three conditions: 1)in-vivo presentation of the sweet item with a placebo (water), 2)in-vivo presentation of the sweet item with the sweetness inhibitor (Gymnema sylvestre spray), and 3)in-imagination presentation of the sweet item with the sweetness inhibitor (Gymnema sylvestre spray). During each session, sweetness intensity, pleasure and desire were dynamically assessed using SensoMaker software for 30 seconds.
Results: The application of the inhibitor successfully enhanced the decrease of the intensity of all three dimensions, resulting in a slight reduction in self-reported sweetness and desire as well as a significant decrease in pleasantness, compared to the placebo plus specific sensory satiety condition.
Conclusions: This research sheds light on the potential of sweet taste inhibitors when used with other behavioural interventions to temporarily devaluate the rewarding

properties of sweetened products. These findings contribute to the emerging literature on the psychological use of plant-derived bioactive compounds and provide a basis for further investigations in this area.
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Presentation type: Poster presentation

Taste of modern diets

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Fresh and processed foods are available in modern food-environment where taste can signal presence of nutrients. Whether these taste–nutrient relationships are maintained across different processing level is not well-understood, and less is known about contribution of different taste quality to population energy intake (EI). We aim to investigate association between perceived taste intensity and a food's nutrient content in context of food-processing, and to further examine relative contribution of different taste-clusters to total EI, stratified by weight-status. Diet data from Singapore MEC2 (N=7011; 21–75y) were collected through questionnaires. Taste and nutrient profiles for each 269 foods were derived using a taste-database and food-composition table. Each food was categorized into NOVA-system (unprocessed, processed, ultraprocessed foods- UPFs) to compare the strength of taste–nutrient relationships. Multivariable-adjusted models were used to examine associations between relative consumption of foods from different taste-clusters and processing level, EI, and BMI within population. Sweetness and mono- and disaccharide content of foods were associated across all processing level, although this association was weaker for UPFs (r=0.42) than unprocessed foods (r=0.72). In contrast, associations between fat-sensation and fat content (r=0.74), and saltiness and sodium content (r=0.84), were stronger for UPFs. Individuals had higher EI or were overweight derived greater %E from processed-foods rather than UPFs, and this energy was higher from savory–fatty and lower from neutral foods than those with lower EI and normal weight (all,P<0.001). 80% of individuals’ dietary energy was from both savory–fatty and neutral foods, independent of differences in total EI and weight-status. Taste–nutrient relationships are maintained across different processing level. Greater consumption of foods that have a high savory–fatty taste was associated with increased EI and overweight.
Presentation type: Oral presentation

Salty Solutions: Investigating the Contribution of the Salivary Proteome to Human Salt Taste Sensitivity in Health and Disease

Laura van Vuuren , Gert Jansen

Erasmus MC

Despite the strong links between high dietary salt intake and disease, surprisingly little is known about the regulation of human salt taste in health and disease. Several diseases, including chronic kidney disease (CKD), are characterized by impaired salt taste and therefore result in an undesirable high dietary salt intake. Human salt taste is mediated by the epithelial sodium channel (ENaC), but its regulation in taste buds is poorly understood. From its regulation in the kidney, it is known that ENaC can be activated by proteolytic cleavage. Recently it was shown that the salivary proteome of salt-sensitive subjects is enriched with proteases, whereas salt-resistant subjects had more protease inhibitors.

We assessed the salt detection threshold (SDT), the lowest detectable concentration, in CKD patients and controls, collected saliva and analysed the salivary content. Our results confirmed that on average CKD patients have a higher SDT than controls. Similarly, higher age correlates with higher SDT. Next, we aim to explore the relationship between salt taste sensitivity and salivary content, e.g. electrolytes and proteome, and to identify any differences related to kidney disease. The saliva of the patients showed increased mean pH, osmolality, and [Cl-], and reduced [Ca2+]. Analysis of the proteomes is currently ongoing.

In a subsequent phase, we will analyse whether proteins whose abundance in salivary proteomes correlates with salt sensitivity contribute to ENaC activity. Based on knowledge of regulation of ENaC activity, we will first focus on proteases and protease inhibitors. For these analyses we have created two human ENaC expressing models, Xenopus oocytes and Caenorhabditis elegans. We will incubate these models with proteins enriched in saliva and measure regulation of ENaC by measuring currents or behaviour, respectively. We expect that our analyses will provide a new paradigm for human salt taste with possibilities for intervention.
Presentation type: Oral presentation

Taste - Central processing

State dependent modification for taste and macronutrient sensing in the brain

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Taste and nutrition sensings are essential for guiding feeding behaviors. Although the sensory perception for taste or macronutrient in the CNS is suggested to change depending on internal states, the mechanism remains unclear. Here we show that hypothalamus is involved in the modulation for taste or nutrient sensing during hunger.

(1) Hypothalamic taste modification by AgRP neurons in hunger
In brief access test, overnight fasted mice exhibit increased preference for sweet and tolerance for bitter. Similar phenomenon was observed when orexigenic AgRP neurons were activated. Activation of the LH projected AgRP neurons also recapitulated the hunger-induced change. Neural circuit tracing indicates that AgRP neurons project to parts of the Vglut2 neurons in the LH and these neurons send projections to LS and LHb. Pathway-selective chemogenetic inhibition for $Vglut2^{LH}$ projection in the LS only increased preference for sweet taste. By contrast, $Vglut2^{LH}$ projection in the LHb decreased tolerance for aversive taste.

(2) Macronutrient sensing by CRH neurons in hunger
It is reported that fasted mice prefer high carbohydrate diet over high fat diet, which is caused by the activation of CRH neurons in the PVH. Using fiber photometry, we recorded the CRH neural activities during intragastric infusion of glucose or intralipid in fasted mice.Interestingly, glucose infusion acutely supressed CRH neuron. In contrast, intralipid infusion showed a slow inhibition pattern. Furthermore, injection of gut hormone CCK, secreted by introduction of fatty acids, significantly activated CRH neurons. We hypothesize that dintinct macronutrient sensing pattern in CRH neuron may lead to the preference change in hunger.

In summary, we found two distinct hypothalamic neurons contribute to the modifications of taste or nutrition sensing, which could be important for optimizing feeding behavior under energy deficit.

These studies were supported by Japan KAKEN Grants(15H05624, 18H02160, 20K19735).
Presentation type: Oral presentation

Experience-dependent plasticity of gustatory insular cortex circuits and taste preferences

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Early taste experience in human infants, for example, has lasting effects on taste preferences, likely resulting in an appreciation of foods from someone's youth and cultural heritage. Taste preferences also influence consumption of nourishing food and avoidance of dangerous substances. Although evidence suggests that early experience may influence preference, it is not known whether this effect is limited to critical periods or extends throughout life. Furthermore, the involvement of cortical circuits for taste in the establishment of taste preferences has not been investigated.

Using a brief access test, we determined that exposure to a variety of tastes in weanling mice (early exposure “EE”) persistently enhanced the preference for sweet tastants compared to naïve mice exposed only to water and chow. The same exposure in adult mice did not affect sucrose preference, pointing to the presence of a sensitive window for the development of taste preference. The modulation of preference depended on the presence of nutrients and calories as well as an intact olfactory epithelium. EE modulated neural function, resulting in a relative increase in inhibition in gustatory cortex (GC) and sharpened representation of sucrose concentrations. In line with increased inhibition, we observed increased inhibitory synaptic transmission in GC following EE and accelerated accumulation of perineuronal nets (PNNs) on parvalbumin (PV+) expressing GABAergic neurons. Degrading PNNs with intra-GC infusions of chondroitinase ABC restored sensitivity to taste exposure in adults, indicating that accumulation of PNNs within GC are a limiting factor to the plasticity of taste preference. These results establish a link between early nutrition and brain development, point to the presence of a critical period for the postnatal modulation of taste preferences, and identify inhibitory circuits in GC as essential contributors to the formation and maintenance of the preference for sweet.
Presentation type: Oral presentation

Time-Frequency Analysis for gustatory Event Related Potentials can be used as a diagnostic tool in taste disorders

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Introduction: The key to a correct diagnosis and an adequate treatment of taste disorders (dysgeusia) is a detailed assessment, which is a challenge in everyday clinical practice. In adddition to psychophysical tests, EEG-derived gustatory Event Related Potentials (gERP) are used as an electrophysiological approach to taste function. However, the responses identified using conventional time-domain averaging showed low signal-to-noise ratio.
Methods: In this study, 44 patients with dysgeusia and 59 healthy participants were examined using the neuronal processing of taste stimuli analyzed with Time-Frequency Analysis (TFA). Participants underwent a comprehensive clinical examination of taste and olfactory function. In addition, gERPs were recorded from 128 active electrodes in response to stimulation with two different concentrations of salty solutions, which were applied with a high precision gustometer.
Results: Patients showed significantly lower scores for gustatory chemical and electrical stimuli ($p \leq 0.008$), but their performance in suprathreshold taste testing did not differ from controls. For gERPs, higher amplitudes of peak N1, and lower amplitude of peak P2, were observed in patients recorded in the electrode Pz compared to controls ($p \leq 0.024$). High concentrated stimulus evoked larger P2 amplitudes at Pz compared to low concentrated stimulus, but only in controls ($p = 0.009$). Moreover, TFA showed that stimulations led to a stronger power in controls than in patients in the low frequencies (0.1-2 Hz), which was correlated to psychophysical taste scores ($p \leq 0.043$), and a significant long-lasting desynchronization of alpha-band (8–12 Hz), which was delayed in time.

Conclusions: These changes might indicate a compensatory neuronal activation in patients due to the taste impairment. Overall, the results of this study suggest that TFA coupled with gERP can be a useful tool for the diagnosis of dysgeusia.
Presentation type: Poster presentation

Neuronal connectivity and activity changes in the gustatory cortex that underlie associative taste memory acquisition and consolidation.

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Memory formation is not an instantaneous event, but rather a dynamic process that progressively evolves across time in different brain regions. In conditioned taste aversion (CTA) learning (wherein an associative memory is formed between a palatable taste and malaise), molecular studies suggest the existence of 2 distinct memory phases in the gustatory cortex (GC): an early acquisition phase (2-3 hours following training), followed by a memory consolidation phase about 3 hours later. Recently we showed that distinct neuronal activity changes in the GC occur during these phases: the population response to the conditioned taste changes continuously, its overall magnitude only increases during the acquisition and consolidation phases, and the known quickening of the ensemble-state dynamics appears only after consolidation. These results suggest the existence of epoch-specific rules that govern neuronal network reconfiguration and taste coding changes during CTA memory acquisition and consolidation. To reveal these rules we implanted rats with Neuropixels probes in the GC and neighboring brain regions and recorded the continuous activity of hundreds of neurons simultaneously for 72 hours, before, during, and after CTA. We employed pairwise neuronal cross-correlation-based techniques to characterize the connectivity map between the recorded neurons, and single-neuron response analyses to portray the coding information of each neuron. Comparing changes in the response patterns of neurons across the learning, as well as the changes in connectivity maps highlight the rules by which memories evolve.
This research was funded by the Israel Science Foundation and the Colton Familiy foundation
Presentation type: Oral presentation

Taste - Peripheral processing

Taste perception of chemical compounds found in nutritional supplements.

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Nutritional supplements are used to strengthen deficiencies and rebuild the proper functions of the body. They contain two main classes of chemical compounds: excipients including bulking agents, sweeteners, acidity regulators, antifoam agents, and active molecules such as vitamins and minerals. Vitamins and minerals are known to generate bitterness, which may contribute to off-taste of nutritional supplements, which may lead to the reduction of their intake and decrease of the treatment's efficiency. To better understand the mechanisms involved in off-taste perception, we combined human sensory analysis and taste receptor functional assays. In order to identify and quantify the nature of these negative perceptual sensations, 16 trained panelists carried out a sensory characterization of some effervescent nutritional supplements using the quantitative descriptive analysis method. We thus demonstrated that the bitterness is the main taste quality responsible for the off-taste. To identify the compounds responsible for bitterness, we tested all the chemical compounds present in the nutritional supplement for their ability to activate the human TAS2R bitter taste receptors. We found that some compounds are able to activate a small number of TAS2Rs, while others activate several receptors. Our results revealed that it is possible to create new nutritional supplement formulations with reduced bitterness, and therefore lead to a better acceptability.
Presentation type: Poster presentation

Role of bitter taste receptors in the human intestine in the regulation of metabolism and innate immunity during obesity.

Inge Depoortere

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The gut, which is the key interface between food and the human body, "tastes" what we eat in much the same way as the lingual system. Indeed, taste receptors are expressed on epithelial cells and monitor the presence of nutrients but also of non-nutrients such as bitter compounds to elicit appropriate physiological processes. During this talk, I will focus on the role of bitter taste receptors (TAS2R) in the gut as metabolic regulators in patients with obesity that affect the release of appetite regulating gut hormones and a stress regulated cytokine that acts as a defense signal. Further, the role of TAS2Rs in the regulation of innate immune factors (mucins, defensins) that affect E. coli growth and thus shape the gut microbiota, will be elucidated as well. The role of TAS2R deletion polymorphisms as a tool to predict therapeutic responses will be illustrated. These studies should elucidate whether targeting of extra-oral bitter receptors with specific agonists may represent a relevant strategy to control energy homeostasis and innate immune responses.
Presentation type: Oral presentation

Evidence for a role of LPAR5 (GPR92) in the palatability of protein hydrolysates for the domestic cat (*Felis catus*)

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As obligate carnivores, domestic cats rely on animal protein for their nutritional needs. The umami taste receptor (TAS1R1-TAS1R3) helps cats to detect nucleotides and amino acids that indicate sources of protein. However, some protein sources are characterised by an abundance of peptides, rather than free amino acids and nucleotides. Protein hydrolysates (peptones) are protein degradation products consisting largely of peptides. They are widely used within the pet food industry as both convenient sources of nutrition and for their role in palatability for cats. In this study we confirmed the positive taste response of cats to a peptone from animal tissue when dissolved in water and offered in a two-bottle choice test. Cats showed a significant preference for increasing concentrations of peptone solution ($p < 0.0001$) when 0.1% and 1% concentrations were compared to water and to each other. We also studied the response of the cat lysophosphatidic acid receptor 5 (cLPAR5, cGPR92) which has previously been shown to be expressed in the circumvallate papillae of mice and activated by peptones (but not by amino acids or nucleotides). We screened a library of 144 compounds against cLPAR5 when expressed in a heterologous assay system using CHO cells. The library included amino acids, nucleotides, fatty acids, biogenic amines, phospholipids, pyrophosphates, peptides, protein hydrolysates and pharmacological compounds. cLPAR5 was activated by 23 different compounds but only from the classes of phospholipids, pyrophosphates and peptones. The most potent stimulators of cLPAR5 by far were phospholipids, with EC50 values in the low micromolar to high nanomolar range. Peptones and pyrophosphates activated cLPAR5 at concentrations in the millimolar range.
Presentation type: Poster presentation

The human taste code

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Objectives: To reveal the human taste code
Introduction: Since antiquity human taste has been divided into 4-5 taste qualities. However, responses in taste fibers of other animal species have only partly clustered according to human qualities. We realized taste qualities vary according to phylogeny, where species closer to humans show higher fidelity to human taste qualities.
Methods/results: We compared psychophysical data and taste nerve recording from

humans to behavioral tests and single taste fiber recordings in chimpanzee, rhesus and marmoset. Our data show how, with phylogenetic closeness to humans, taste fibers responded more exclusively to tastants within each human taste quality. We then used the sweet taste modifiers, miraculin (Mir) and gymnemic acid (GA). In human, Mir adds sweet to sour taste and doubles nerve responses to acids. After Mir, nonhuman primates also doubled acid intake while both acid-specific and sweet-specific single taste fibers responded to acids. In human GA eliminates sweet quality. In chimpanzee GA abolished taste fiber responses to sweet without affecting responses to other tastes. Conclusions: Information from each type of taste receptor cell reaches a specific cortical taste area where it gives rise to taste qualities; taste is created in the cortical region where taste fibers deliver action potentials, thus satisfying the criteria of labelled-line coding which follows Mueller's law of specific nerve energy for pain, touch, and temperature where sensation is created in the cortex after conveyance by sensory fibers. In humans these cortical areas give rise to the taste qualities, sweet, sour, bitter, salt and umami.This principle has not been detected in other species due to species differences in taste receptor structure and cortical taste areas.
Presentation type: Poster presentation

Volatile short-chain aliphatic aldehydes act as taste modulators through the orally expressed calcium-sensing receptor CaSR

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Aldehydes are natural volatile aroma compounds generated by the Maillard reaction of sugars and amino acids in food and affect the flavor of food. They have been reported to exert taste-modifying effects, such as increases in taste intensity at concentrations below the odor detection threshold. The present study examined the taste-enhancing effects of short-chain aliphatic aldehydes, such as isovaleraldehyde (IVAH) and 2-methylbutyraldehyde, attempted to identify the taste receptors involved. The results obtained revealed that IVAH enhanced the taste intensity of taste solutions even under the condition of olfactory deprivation by a nose clip. Furthermore, IVAH activated the calcium-sensing receptor CaSR in vitro. Receptor assays on aldehyde analogues showed that C3-C6 aliphatic aldehydes and methional, a C4 sulfur aldehyde, activated CaSR. In contrast, no activation was observed for alcohol or fatty acid analogs with similar structures of these aldehydes. These CaSR-activated aldehydes functioned as a positive allosteric modulator for CaSR. The relationship between the activation of CaSR and taste-modifying effects was investigated by a sensory evaluation. Taste-modifying effects were found to be dependent on the activation state of CaSR. Collectively, these results suggest that short-chain aliphatic aldehydes function as taste modulators that modify sensations by activating orally expressed CaSR. We propose that volatile aroma aldehydes may also partially contribute to the taste-modifying effect via the same molecular mechanism as kokumi substances.

Presentation type: Poster presentation

Emerging role of bitter taste receptors in inflammation

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Bitter taste-sensing type 2 receptors (TAS2Rs), belonging to the subgroup of family A G-protein coupled receptors (GPCRs), play a key role in the perception of bitterness. Although initially, TAS2Rs were considered to be exclusively distributed in the apical microvilli of taste bud cells, recent studies have demonstrated the presence of these sensory receptor genes and proteins in several extra-oral tissues, such as, e.g., gastric, intestinal, lung, pancreatic, adipose or ovarian tissues. Following their ubiquitous presence, critical points of extra-oral TAS2Rs biology, such as their structure, cellular and metabolic functional roles, signaling transduction pathways, mutational polymorphism, and molecular evolution, have been and still are widely studied. The TAS2R signaling cascade, for instance, has been demonstrated to be a pivotal modulator of inflammatory processes and innate immunity in a number of organs and tissues of the gastro-intestinal tract, the lung and immune-competent cells of the blood. The latest advances in this field raise the possibility of utilizing TAS2Rs as therapeutic targets for inflammation-associated diseases. The focus of this review is (1) to provide an update on the latest findings from in vitro and in vivo studies regarding the expression and the molecular basis of TAS2Rs' functional role in inflammatory processes in extra-oral tissues, and (2) to — considering clinical findings — discuss the therapeutic potential of TAS2Rs targets, which are appealing due to their ligand selectivity, expression pattern, and/or pharmacological profiles.

Presentation type: Oral presentation

Activation of bitter taste receptors regulates expression of growth differentiation factor 15 in the small intestine of patients with obesity

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Objectives
Bitter taste receptors (TAS2Rs, 25 subtypes) expressed on enteroendocrine cells regulate the release of gut hormones involved in appetite signaling. GDF15, a stress related cytokine, was recently identified as a novel satiety signal acting via the GFRAL receptor located in the area postrema. This study aimed to investigate whether activation of TAS2Rs induces a stress response in gut epithelial cells to affect GDF15 expression in patients with obesity.
Methods
Jejunal mucosa was obtained from patients with obesity undergoing bariatric surgery. Primary crypts were isolated, cultured for 24h and stimulated with vehicle or bitter agonists for 4h followed by RT-qPCR for GDF15. Immunofluorescence colocalization studies were performed between GDF15 and TAS2R4/10/43. The role of TAS2Rs was tested by 1) pretreatment with a TAS2R antagonist, GIV-3727; 2) determining TAS2R43 polymorphisms.
Results
TAS2R4/10/43 expressing cells colocalized with GDF15 immunoreactive cells in primary crypts from patients with obesity. The TAS2R4 agonists, gallic acid (1mM) and azithromycin (0.075-1mM), and the TAS2R10 agonist erythromycin (1mM) markedly increased ($p<0.001$) GDF15 mRNA expression in primary jejunal crypts from patients with obesity. GIV-3727 blocked the effect of gallic acid ($p<0.001$) but not of azithromycin on GDF15 mRNA expression. The TAS2R43 agonist aloin (0.03-0.1mM) decreased ($p<0.001$) GDF15 mRNA expression in patients who are more sensitive to aloin [TAS2R43(+)W35] but was ineffective in patients that were less sensitive [TAS2R43(+)S35] or that had a TAS2R43 deletion polymorphism. Bitter-induced GDF15 mRNA expression only resulted in a release of GDF15 after a secondary bitter stimulus.
Conclusions
TAS2Rs are involved in the effect of the bitter agonist gallic acid and aloin on GDF15 mRNA expression in patients with obesity. TAS2Rs in the gut may represent interesting therapeutic targets to affect satiety signaling via GDF15.
Funded by FWO G081523N; CSC202008370227
Presentation type: Oral presentation

Taste - Other

Detection of bitterness in faba beans (*Vicia faba* L. *minor*) is mediated by the activation of bitter taste receptors (TAS2Rs)

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Faba beans exhibit environmental, agronomic, food functional, and nutritional benefits, and are a promising alternative to animal proteins. The presence of off-flavours, and in particular bitterness, is a barrier to their consumption. However, little is known about the compounds of pulses that activate the 25 human bitter taste receptors (TAS2Rs). To better understand the role of the saponins and alkaloids in faba bean bitterness, three cultivars and three fractions (flour, starch and protein) obtained by air-classification were studied for their bitter properties. First, the identification and quantification of these molecules was carried out using UHPLC–HRMS (ultra-high-performance liquid chromatography–high-resolution mass spectrometry). The low-alkaloid cultivar fractions and the protein fractions exhibited higher saponin content. Second, these data were correlated with the bitter intensity of the fractions evaluated by a trained panel. Only the two alkaloids, vicine and convicine, were highly correlated with the bitter perception. Third, the bitterness of the two alkaloids and soyasaponin βb was studied using a cellular-based functional taste receptor assay. Vicine only activated TAS2R16 whereas 11 TAS2Rs were activated by soyasaponin βb. However, due to the low concentration of soyasaponin βb and the high concentration of vicine, the origin of the faba bean bitterness is highly suspected to be related to vicine. This research leads to a better knowledge of the compounds involved in the bitterness of faba beans and the effect of cultivar and air-classification on their bitter content. Choosing ingredients with low-alkaloid content or using alkaloid removal treatments could improve the flavour of faba beans and increase the consumer acceptability.
Presentation type: Poster presentation

Are sweetness preferences modifiable? The development of the primary outcome variable to assess the effects of sweetness exposure on preferences

Eva Marija Cad [1], Claudia Tang [2], Hanne de Jong [1], Monica Mars [1], Katherine Appleton [2], Kees de Graaf [1]

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Sweetness is a highly liked and extensively researched sensory attribute, significantly contributing to calorie intake worldwide. A recent scoping review identified over 35,000 papers on sweetness and health. Several health organizations recommend lowering the consumption of sweet-tasting foods, arguing that lowering dietary sweetness lowers preferences, which would in turn lower sugar, energy intake and body weight. However, empirical sensory data supporting this narrative are lacking. In fact, whether sweetness preferences (and perceptions) are modifiable remains unclear. To investigate this, a randomized trial has been ongoing since 2020, aiming to evaluate the long-term effects of low, regular, and high sweetness exposure on preferences. A total of 180 adults will be randomly allocated to either low (10-15% energy from sweet foods), regular (25-30% energy from sweet foods), or high dietary sweetness exposure (40-45% energy from sweet foods) for six months. The Ethics Board of Wageningen University approved the study (NL72134.081.19), and it is registered on ClinicalTrials.gov (NCT04497974). The detailed protocol has been published in BMC Public Health (https://doi.org/10.1186/s12889-022-14946-4). The primary outcome is

the change in sweetness preference from baseline to six months. To assess preferences and liking, six series of sweet stimuli (familiar, unfamiliar, liquid, semi-solid, and solid) were constructed, in four consecutive experiments, each with five levels of sweetness intensity ranging from low to high, with an optimal liking level in the middle. As a control, two series of stimuli varying in saltiness (familiar, liquid, solid) were developed. Ranking on a Scale was used to assess preferences and liking, while perceptual ratings of intensity were collected using VAS. Results showed an effect of familiarity on liking across experiments, while psychohedonic and psychophysical functions had similar shapes across familiar and unfamiliar foods.

Presentation type: Poster presentation

The Impact of COVID-19 on Taste Loss

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Objectives: Obtain fungiform papillae with taste buds for histological examination and molecular analysis.
Introduction: Many patients with COVID-19 report taste loss, but it is unknown if taste buds (TB) are affected. To study the impact of COVID-19 on taste loss a taste test was performed and biopsies of fungiform papillae (FP) were taken to identify morphological and molecular changes in TB of patients reporting taste loss after COVID-19 infection. The taste test includes paper strips with no taste and the five basic tastes. All 29 subjects complained about taste loss, but only 9 (31%) had an actual taste loss when tested. The patients with a pathological result were offered biopsy of their FP for analysis of the TB, while those with a normal result were asked if they wanted to participate in the control group. The results of the biopsies are awaiting; thus this poster will focus on the method of the study.

Material and method:
Taste test: Taste was tested with Waterless Empirical Taste Test by Sensonics. It contains 53 paper strips with no taste and varying concentrations of: sweet (sucrose), salt (NaCl), sour (citric acid), bitter (caffeine) and umami (monosodium glutamate). Some patients had a quality specific taste loss, e.g. for sweet only, while others had a group specific loss; e.g. type II cell taste loss: sweet, bitter and umami. None had a selective loss of salt or sour.
Biopsy: Biopsies were taken shortly after the taste test.
The tongue was anesthetized with Xylocaine spray and visualized in details by using a headlamp, and small biopsies were taken with a 3-mm scissor with a curved tip. The tongue was held steady with a gauze. The FP were cut by holding down the scissor tip below the base of the FP and were removed with a single cut. Biopsies were fixed in 4% buffered formaldehyde for subsequent histological analysis. Samples for molecular analysis were fixed in RNA later.
Results/conclusion: awaiting.

Presentation type: Poster presentation

Sweet compounds evoke biased signalling at the G protein level in T1Rs

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Sweet taste receptors are a topic of interest for culinary enthusiasts. In mammals, sweet taste is predominantly transduced through family 1 taste receptors: T1R2 and T1R3. These are G protein coupled-receptors which dimerise to form the sweet receptor complex (SRC), increasing their sensitivity to sweet tastants. Compounds have been developed that are sweeter and less calorific than their natural counterparts. While previous studies have suggested differences in their sweetness relative to sucrose, comprehensive examination of their activity at the canonical sweet receptors have not yet been completed.
The objective of this study was to characterise T1R receptors' activity and interactions at the receptor/G protein level (expressed in HEK293 cells). Using BRET2 based biosensors for protein dissociation (Olsen et al., 2020), it was determined that T1Rs employ a variety of G proteins to transduce their signal. T1R stimulation by sweet compounds primarily induced inhibitory Gi/0 proteins over the stimulatory Gs proteins, which was corroborated by cAMP accumulation assays. Furthermore Gq/11 Ca2+ mobilising G proteins were also activated which was verified using the Fluo-4 photo activity assays. Additionally, G13 dissociation was observed, and this was consistent with transcriptional activity at the serum response factor response element (SRF-RE), which is downstream of RhoA activation. Greater dissociation of G proteins was observed when the T1Rs were combined as the SRC, and this promoted bias toward Ca2+ mobilising G proteins.
These results represent the first systematic analysis of G protein activation and signalling bias at the T1Rs. One example is the tendency for man-made sweeteners to bias toward Ca2+ mobilising G proteins (suggested to be responsible for taste transduction) compared to naturally derived ones. The study displays the basis for further research into these receptors at tissue level, where expressed G proteins may vary.
Research funded by AstraZeneca.
Presentation type: Poster presentation

Multisensory - Behavioral/perceptual

Facilitation of facial identity processing following exposure to self or romantic partner body odors: A psychophysical adaptive approach

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Olfaction is now recognized as having a pervasive influence on human social cognition (e.g. de Groot, Semin, & Smeets, 2017). Human body odors have been found to modulate the perception of both invariant (e.g., attractiveness, trustworthiness, etc.) and transient (e.g., emotional expressions) face characteristics (for review, see Damon et al., 2021). Here, we examined whether body odor of self or romantic partner influenced a face discrimination mechanism: the sensitivity to facial identity information. We assessed whether exposure to (axillary) odor cues could sharpen the facial perception of related identity compared to a control odor condition, and lead participants to rely on smaller amount of visual information to recognize identity in faces. We assessed identity discrimination thresholds (i.e. Just-Noticeable Difference, JND) for self and romantic partner faces by measuring the JND between a prototypical face and self or romantic partner faces mixed with the prototype with various identity ratios, using a 2-interval forced-choice task with an adaptive psychophysical method (i.e. the psi method). Results showed that both self and partner body odors facilitated the perception of related identity, $F(1, 23) = 7.84$, $p = .010$, $\eta^2p = .25$, as participants showed smaller JND during exposure to body odor compared to neutral odor. Overall, exposure to the body odor of a familiar individual led to more fine-grained visual processing of related facial identity. Significant positive correlations between the baseline JND (i.e. with a neutral odor) and the magnitude of the odor effect (i.e. the difference in JND between the odor and neutral conditions) further suggest that the higher the JND, the stronger the influence of the odor, $r(22)= .57$, $p = .003$, and $r(22) = .46$, $p = .025$, for self and partner odor, respectively. These results accord well with the inverse effectiveness rule, stating that multisensory integration increases as a reverse function of unisensory responses.
Presentation type: Poster presentation

Can we modulate coffee flavour perception with brain stimulation? Probing the effect of tDCS over the IPS on flavour perception.

Zuzanna Dedyk , Nils Kohn , Melanie Wiehe

Radboud University Donders Institute

In this study, we aimed to investigate whether flavour perception can be modulated by non-invasive brain stimulation (NIBS) using transcranial direct current stimulation (tDCS) targeting the intraparietal sulcus (IPS), a multisensory integration area implicated in flavour perception. We chose specialty coffee as our stimulus due to its complexity and diverse flavour profiles, as well as, established industry standard rating procedures. Our hypothesis stated that stimulation of the IPS with cathodal tDCS would modulate coffee flavour perception on at least one of its characteristics, such as acidity, sweetness, or aftertaste.

We conducted a sensory evaluation training followed by a sensory evaluation task on a separate day in which participants tasted coffee samples and rated their flavour characteristics under two conditions: with and without tDCS brain stimulation over bilateral IPS. We found that stimulation with cathodal tDCS modulated hedonic judgments of flavour characteristics, specifically body level and overall rating. Moreover, we observed less consistency in ratings under the stimulation condition compared to the non-stimulation condition, as well as compared to consistency among expert coffee raters.

Our findings provide proof of principle that non-invasive brain stimulation with tDCS can modulate flavour perception in humans, supporting the notion that the IPS plays a role in integrating information from different sensory modalities to create a cohesive perceptual experience of flavour. This study contributes to the growing body of research on the influence of brain stimulation techniques on cognitive processing and sheds light on the potential of tDCS as a tool for investigating the neural mechanisms underlying flavour perception. Further research with larger sample sizes and more complex designs is warranted to better understand the underlying mechanisms and potential applications of brain stimulation in modulating flavour perception.

Presentation type: Poster presentation

The smell of sustainability. The role of olfactory perception on the acceptability of recycled plastic packaging.

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Using packaging made from recycled plastics is a sustainable way of reducing plastic waste. However, post-consumer plastic might present an off-odor which has been reported by people when purchasing these products for the first time. Because this perception is not shared by all consumers, we investigated what could drive it since information, attitudes, as well as visual factors, can all play a role.
Methods: Sixty females were tested in a mixed design with packaging with different levels of recycled plastic and colours (cream vs grey) as within-subjects factors, and knowing vs. not knowing that the plastic was recycled as a between-subjects factor, on the characteristics (pleasantness, intensity and familiarity) of the odour perception of the plastic packaging and its acceptability and willingness to buy.
Results: Preliminary results show that increasing the percentage of recycled plastic significantly decreased the pleasantness and familiarity of the odour but not the intensity. For the packaging made of 100% recycled plastic, acceptability and willingness to buy decreased significantly. Only for the 100% recycled plastic, the grey colour had a negative effect on willingness to buy and acceptability. Knowledge about the plastic being recycled did not show any significant effect.
Because the off-odour of recycled plastic packaging affects pro-environmental

consumer behaviour, future research could focus on sensory design and leverage cross-modal interaction to compensate for the reduced odour pleasantness, for example by changing the hue or brightness of the packaging colour.

Funding: This work was supported by Unilever.
Presentation type: Poster presentation

Better living through Sensory: exploring how the sensory properties of food can support healthier eating behaviors

Ciarán Forde

Wageningen University and Research

Food choice and energy intake are influenced more by the sensory and cognitive aspects of eating than the nutritive properties of the food being consumed, yet chronic disease and ill-health result from prolonged exposure to diets low in nutrients and high in energy-density. The role of low quality dietary patterns in the development of diet-related chronic conditions is undisputed, yet this knowledge is of little value if we do not understand and change unhealthy food patterns. Sensory properties are important in shaping ‘what’, ‘how much’ and ‘why’ we eat, and influence the learning that drive our dietary patterns to influence health and well-being across the lifespan. Not all calories are created equal, and food texture, taste and aroma direct food choices, inform our eating behaviours and through this influence meal size. Research has demonstrated the joint impact of eating at a faster rate and consuming higher energy dense foods in promoting greater energy intakes. By including ‘sensory’ ratings as variables in population wide dietary intake studies, we have pioneered the development of ‘Sensory Epidemiology’ to make connections between the sensory properties of diets, and their link to intake patterns that influence health and body composition. Eating behaviours are malleable and can be moderated using textures to change energy intake. Sensory Scientists are uniquely positioned at the cross-roads of food science, nutrition and consumer behaviour to understand how food perception can influence the transition to healthier and more sustainable diets. Addressing the serious public health challenges posed by the modern food environment will require changes in food composition and intake behaviours that are easily adopted by consumers. A foods sensory properties makes it possible to promote healthier diets and can inform the development of successful strategies that keep food enjoyment and satisfaction at the heart of healthy eating.
Presentation type: Oral presentation

Odour-taste associative learning in flavour preference formation

Putu Agus Khorisantono

Karolinska Institutet

The multisensory nature of the flavour percept, which unites olfaction, gustation and somatosensation in one experience, creates an object representation of a specific food item. These object representations are crucial in guiding our eating behaviour, ensuring adequate intake of nutrients and avoidance of potential poisoning. Recent work has further highlighted that flavour percepts are modulated by both postprandial metabolic processing and associative learning, but to date, the cognitive and cortical processes underlying this integration of signals from different sources remain to be fully understood. This talk will summarize research findings emerging from the study of olfactory-gustatory concordance processing in different experimental contexts. By presenting participants with stimulus mixtures that gradually add a contaminant to a familiar mixture, we show that the impact of flavour familiarity follows a probabilistic gradient, and that this gradient can be influenced by internal states and prior knowledge. We will also provide an overview of the cortical networks that are involved in taste-associated odour processing and discuss possible functional mechanisms for odour-taste associative learning. Our findings will be discussed with respect to the evolutionary advantages of the behavioural flexibility: a weighted processing of sensory input helps to balance tolerance for natural variation in previously unknown flavour combinations (exploration) against optimising nutrient intake and contamination avoidance by maximising intake of previously known flavours (exploitation). The talk will end with an outlook on future research paths that might incorporate effects of cognitive states on the concordance gradient, and the incorporation of sensory inputs beyond the chemical senses, such as texture and temperature, as dimensions along which concordance can be modulated.

Funding: ERC StG 947886 – OLFLINK
Presentation type: Oral presentation

Odor influence on rapid visual categorization in the infant brain depends on the demand of the visual task

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To make sense of their environment, human infants rely on odor cues along with cues from the other senses. Earlier studies have indeed found that infant visual perception can be facilitated by the reception of odor cues, the mother's body scent boosting neural face categorization at 4 months of age. Interestingly, however, previous infant studies in the audiovisual domain found that such intersensory facilitation is noted only when unisensory perception is not fully effective, a principle known as 'inverse effectiveness'. Therefore, we aim to evaluate here whether this principle also applies to olfactory-visual interactions by manipulating the demand of the visual task. We recorded scalp EEG in 2 groups of 4-month-old infants while they watched rapid streams of pictures (6 pictures/sec = 6 Hz) with human faces inserted every 6th picture to tag a face-selective response at 1 Hz in the EEG spectrum. Group 1 was exposed to variable natural images (high visual demand), while images in group 2

were simplified to make face categorization less demanding. During visual stimulation, infants were alternatively exposed to their mother's body odor or to a baseline odor. We expected to replicate a maternal odor effect on face-selective neural activity in group 1 while no odor effect should be found in group 2. For both groups, we found an occipito-temporal face-selective neural response, but with a significantly larger amplitude for the simplified images, reflecting less demanding categorization. Importantly, maternal odor enhances the response to the natural, but not to the simplified, face images, supporting our hypothesis that maternal odor improves face categorization only when the visual task is demanding for the 4-month-old brain. Overall, this study reveals that the principle of inverse effectiveness can apply to olfactory-visual interactions in the developing brain.
This work was financially supported by the French National Research Agency (contract ANR-19-CE28-0009)
Presentation type: Poster presentation

Learning to see faces with the nose

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Human infants must rapidly develop the ability to perceive conspecifics across the senses to engage in social interaction. In this concert of the senses, olfaction is an early-maturing sense and primary medium of social communication from birth onwards. In contrast, human vision is poor at birth and follows a protracted development over the first year of life. Yet, infants already categorize a variety of visual stimuli as faces at a few months of age. Does olfaction foster face categorization in the developing visual system? In this talk, I will address this issue through a series of experiments using scalp electroencephalography (EEG), and demonstrate that one of the most relevant social odors for young infants, the mother's body odor, shapes face categorization in their brain. I will show that maternal odor enhances face-selective neural activity over the right occipital cortex at 4 months, this effect being absent for nonface objects, except for objects that can be perceived as faces (eliciting face pareidolia in adults). I will also illustrate how the facilitating effect of maternal odor gradually declines between 4 and 12 months as face categorization becomes more efficient by itself. Finally, I will reveal that the odor effect fades in the 4-month-old brain when face categorization is made less demanding for the young visual system. Altogether, these findings will disclose how the developing brain builds upon the first odor learned during mother-infant interactions to apprehend the social environment in the less mature sense of vision, in direct relationship with the ability to reach efficient categorization from the sole visual input.

This work was financially supported by the "Conseil Régional Bourgogne Franche-Comté" (PARI grant), the FEDER (European Funding for Regional Economic Development), the French "Investissements d'Avenir" program, project ISITE-BFC (contract ANR-15-IDEX-0003), and the French National Research Agency (contract ANR-19-CE28-0009).
Presentation type: Oral presentation

Direct measures of liking and intensity of taste/smell/chemesthetic stimuli are similar between people who had or did not have COVID-19

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We aimed to assess the impact of COVID-related smell and taste disturbances on post-COVID chemosensory sensitivity.
Seventy-four young adults reported their COVID-19 history and completed an in-person chemosensory test in which they rated *intensity* and *liking* for 6 odorants (galaxolide, guaiacol, beta-ionone, trimethylamine, phenylethyl alcohol, 2-ethyl fenchol) and 6 solutions that are exemplars of taste qualities or are chemesthetic stimuli (sucralose, sodium chloride, citric acid, phenylthiocarbamide, menthol, capsaicin) on a scale from 1 to 9. Participants (aged 21+/-1 year, 14 males, 60 females) were grouped by whether they reported having COVID-19 (n=34) or not (n=40) in the time preceding the testing (27-2 months), and the two groups were compared on all measures using a Mann-Whitney U test. Additionally, participants who had smell/taste disorders during COVID-19 (n=26) were compared with those who did not have COVID (a Mann-Whitney U test). For participants who reported having COVID-19, the effects of smell disorder status (no-impairment, total anosmia, other impairment, n=8, n=19, n=7, respectively), and taste disorder status (no-impairment, total ageusia, other impairment, n=10, n=18, n=6, respectively) were analysed (a Kruskal-Wallis test).
Overall, there were no differences in *intensity* ratings or *liking* except the *liking* for sucralose, which was lower in people who reported a history of COVID-19 than those with no history (medians 6 (IQR 4.0-8.0), 7 (IQR 6.7-8.0), respectively; p=0.044). Moreover, no difference in the rating of *liking* and *intensity* was found between participants who had smell/taste disorders during COVID-19 and those who did not have COVID-19 (p>0.05). *Intensity* ratings and *liking* were not affected by the status of smell (p>0.05) or taste (p>0.05) impairments during COVID. While taste and/or smell loss is a common feature of long COVID, these results suggest that most young adults recover their sense of taste, smell, and chemesthesis.

Presentation type: Poster presentation

Multisensory interactions underlying the expression of flavor preferences: insights from rodents

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Wake Forest School of Medicine

Flavor is a major determinant of consumption. Although commonly referred to as “taste”, flavor is a multisensory experience: drawing from gustatory, olfactory and somatosensory inputs, each sourced from separate peripheral senses. Previous work in humans demonstrates that multisensory flavor cues are integrated to inform perceptual decisions. However, the computations underlying multisensory flavor interactions and their role in food choice remain poorly understood. Drawing from previous work on other multisensory systems, we evaluated the validity of the maximum likelihood estimation (MLE) framework in explaining multisensory flavor preference decisions. We used rats as a model system to obtain preferences in a series of daily two-alternative free choice tests, in which animals drank from two bottles containing taste, odor or taste+odor mixture solutions. Mean preference and variance over repeated presentations of the same condition (“reliability”) were analyzed. The MLE framework predicts that judgments of multisensory stimuli are a weighted average of the unisensory component judgement; that the weight components carry is proportional to their relative reliability; and that multisensory judgements are more reliable than their component judgements. Results from naïve rats (raised on standard chow) confirm these predictions. Results from rats raised with a limited set of specific taste-smell mixtures further show that the ability to weight taste and smell components is unaffected by flavor congruency. Finally, results from rats raised on a diet consisting of a wide variety of real foods show that sensory enrichment increases the overall weight animals place on odor components. This work provides a quantitative framework for understanding the multisensory interactions underlying hedonic evaluation of flavor and the factors that shape them, and suggest specific hypotheses regarding their neural underpinnings.
Presentation type: Oral presentation

Flavour symposium: perception and integration

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Flavour, often synonymous with pleasure, is perhaps the most enticing component of food and beverage consumption. Yet, despite a general understanding of what flavour entails, the intricacy of how the different sensory components integrate to form this harmonious percept is relatively poorly understood. Moreover, there is a considerable lack of knowledge on external and internal factors governing flavour perception, and potential consequences on feeding behaviour. Traditionally, flavour research has focussed on individual contributions of the involved sensory modalities. However, from an ecological standpoint, flavour arises from a synergy of many, rather than a single sensory input. Understanding flavour perception requires research on the neglected aspect of multisensory integration to take centre stage.
We have invited four speakers covering various aspects of multisensory integration in different model systems (rodent, human, patients), using different methods and techniques (neurophysiology, chemogenetics, optogenetics, sensory epidemiology, perceptual, behavioural and clinical studies), and addressing the different chemosensory modalities (smell, taste, thermosensation). The final speaker will place flavour into a broader perspective, by discussing its influence on dietary energy intake.

Presentation type: Oral presentation

Odor-induced taste enhancement in two clinical populations with reported chemosensory dysfunction.

M. Yanina Pepino

Department of Food Science and Human Nutrition, University of Illinois at Urbana Champaign, Division of Nutritional Sciences, University of Illinois at Urbana Champaign, Carle Illinois College of Medicine

Adding odors to foods or beverages can enhance taste perception, known as odor-induced taste enhancement. This presentation will focus on the discussion of data from our research group investigating whether individuals with reported chemosensory dysfunction exhibited any alterations in odor-induced taste enhancement. Our studies included 40 head and neck cancer survivors who completed radiation therapy 3±2 yrs ago and 27 patients with Wolfram syndrome, a rare genetic disease associated with various symptoms, including impaired vision, audition, and olfaction. We compared their responses to age- and gender-matched healthy control groups. We used the general Labeled Magnitude Scale to evaluate taste and smell intensity for various stimuli, including sucrose with strawberry extract, citric acid with lemon extract, sodium chloride in a vegetable broth, and caffeine in coffee. Participants tasted these solutions and rated their perceived intensities with and without nose clips. Our findings revealed that while the ratings of smell intensity were reduced for at least one stimulus in both clinical populations, the magnitude of odor-induced taste enhancement remained similar to that observed in healthy control groups. Interestingly, within the healthy control groups, older participants showed a higher magnitude of retronasal odor-induced taste enhancement compared to younger participants. These findings suggest that odor-induced taste enhancement is not only preserved in populations with decreased smell sensitivity, but it may be that the enhancement effect is particularly effective when chemosensory input is diminished due to aging or disease. These observations highlight the resilience and adaptability of the human sensory system and suggest that incorporating odors into foods could potentially enhance the enjoyment and satisfaction for individuals with diminished olfactory function. Funding: USDA National Institute of Food and Agriculture Hatch projects [698-921]
Presentation type: Oral presentation

Olfactory dominance in spatial memory: Investigating sensory interference effects using virtual reality technology and a hand-held olfactometer.

Malina Szychowska , Jonas Olofsson

SCI-LAB, Gösta Ekmans Laboratory, Department of Psychology, Stockholm University

Understanding how our spatial memory and navigation systems depend on sensory impressions is a key issue in psychology. These cognitive abilities are strongly associated with olfaction. It has been proposed that olfaction co-evolved with navigation, and spatial memory for animals to find food sources. In contrast, the higher senses (sight and hearing) exhibit greater neuroanatomical separation between perceptual and cognitive processes. Such differences in structural organization between the senses could cause the spatial memory to prioritize olfaction, leading to “overwriting” of sound-based representations with smell-based ones. In this study, we used Virtual Reality (VR) technology with a custom-made hand-held olfactometer, to explore sensory interference effects in our spatial memory and navigation systems. Participants memorized locations of smell (olfactory condition) and sound objects (auditory condition) within two visually identical virtual environments. Participants first completed memory encoding and recall tasks in both conditions separately, with the initial condition randomized across participants. This was followed by a global recall of locations of smell and sound objects in a random order, and a one-week delayed global recall. Performance was measured as a distance error between original and recalled locations. Results showed stronger presence of retroactive interference of smells on sounds, rather than vice-versa. Specifically, for participants who first encoded locations in the auditory condition, performance during global recall declined for sounds, but not for smells, suggesting that the memory representation of smells interfered with that of sounds. These results support the idea of olfactory dominance in our spatial memory, aligning with recent research in non-spatial working memory tasks. Funded by the Consolidator grant from the Swedish Research Council for Jonas Olofsson "What can the sense of smell teach us about higher brain functions?"
Presentation type: Poster presentation

Motivating long-term engagement: insights from a 30-day chemosensory tracking study on COVID-19 awareness

Maria Geraldine Veldhuizen [1], Parvaneh Parvin [2], Robert Pellegrino [3], Nicola Pirastu [4], Paule Joseph [5], Richard Höchenberger [6], Kathrin Ohla [6], Global Consortium of Chemosensory Research group author [1]

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The longitudinal tracking of odor intensity ratings for household items can predict COVID-19 infection (Iravani et al 2022). The Global Consortium of Chemosensory Research developed a web-based interface application to collect chemosensory ratings of a single stimulus, namely a daily consumed beverage, which can be repeatedly assessed over time. The primary objective of the study was to encourage the general public to complete a 30-day tracking period in order to raise awareness of chemosensory perception. This study consisted of a large convenience sample of 7551 participants (5268 women, 2190 men, 26 non-binary, 62 prefer not to say), on average 42 years old (+/- standard deviation 15), mostly from Europe (n=6736). Across all participants (pp), the median number of sessions completed was 1, with an average of 1.84 sessions (± sd 4.35). The distribution of completed sessions was strongly skewed with 6,481 pp completing only one session and 44 pp completing 30+

sessions. During a session, a pp sampled a beverage and then rated smell, sweetness, bitterness and sourness intensity as well as nasal patency. 4826 pp had a covid diagnosis during 1+ sessions. 4917 pp sampled coffee, 1560 tea, 618 juice and 456 another item. Many pp experienced chemosensory symptoms during the first session. Our analysis will focus on the subset of pp who completed 3+ sessions (n = 616), examining the patterns of app usage (including regularity, consecutive days) and other variables (item choice, chemosensory symptoms, and demographics) that predict 30-day completion. Furthermore, we will explore the variability in ratings based on chemosensory symptoms. We conclude that participants are rarely motivated to continue app usage beyond one session, a critical factor that future longitudinal studies need to address. However, participants may still continue to be aware of chemosensory symptoms in a more structured manner than before app usage, which can be directly assessed in future studies.
Presentation type: Poster presentation

How can we measure chemosensory creativity?

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Creativity is one of the most important 21st-century human skills in the age of increasing automation. However, research on creativity has predominantly focused on visual or language-based expressions, overlooking the significance of the chemical senses. Chemosensory creativity, which relates to olfactory and gustatory experiences, has a rich cultural history that goes back at least several millennia and is currently thriving worldwide. From flavour innovation in plant-based meat replacements to Michelin star chefs and social media food influencers, chemosensory creativity is making a substantial impact in a wide range of professional and everyday contexts.

In this workshop, we will offer a range of interactive activities designed to explore different aspects of smell and taste-related creativity. The first part of the workshop will engage participants in four hands-on exercises targeting two types of creativity judgements. These are 1) product-based creativity, where participants will judge several food combinations including wine, cheese and chocolate, and 2) person-based creativity tests, where participants will complete existing semantic exercises related to flavour pairings and recipe creation. After a group discussion session, participants will hear about the creative process of artists like Mondrian. The audience will smell several scents as part of the presentation. By encouraging participants to reflect on their own learnings from the workshop activities, we aim to stimulate new directions in creativity research.

We believe that a deeper understanding and promotion of chemosensory creativity will not only have a theoretical contribution to human cognition but also be a crucial step in facilitating the much-needed shift in consumer dietary habits towards more sustainable

and healthy foods that are simultaneously delicious and desirable.
Note: max. 40 participants, registration is required:
https://forms.gle/xmiJAFVkDBAqgVqH9
Presentation type: Oral presentation

Multisensory - Central processing

Effects of tVNS Location on ERPs in Response to Food

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Effects of non-invasive, transcutaneous Vagus Nerve Stimulation (tVNS) on food reward systems were shown before in animals and humans. However, the optimal stimulation location on the ear for the Auricular Branch of VN is still under discussion. Two main candidate locations are Cymba Concha and Tragus. In our experiment we tested stimulation of these two locations as well as the combination of both. Earlobe-helix combination stimulation was used as the sham condition. Using electroencephalogram (EEG) is advantageous in terms of observing the near-instantaneous effects on neural activity (in miliseconds). Other advantages of using EEG are reduced cost and the ability to include participants with a higher BMI (compared to fMRI). In addition, since the participant is seated, EEG allows for a more naturalistic eating context. Since the swallow breath contains flavor, the absence of event-related EEG studies using sip-and-swallow protocols is a crucial gap. Here we present data from a sip-and-swallow protocol with event-related EEG responses time-locked to swallowing of a food stimulus (cacao milk). The participants sipped the stimulus for 50 trials per block upon hearing an auditory cue. A pair of EMG (electromyogram) electrodes, for detecting muscle activity, were connected on the submental muscle under the participants' chin and utilized for detection of swallowing to obtain the exact time point for consumption. We have completed data collection with 15 participants (4 EEG sessions per participant for each stimulation location). Ongoing data analyses are done with EEGLAB and ERPLAB on MATLAB and with MNE on Python. In addition to comparing the responses to stimulation from different locations, we demonstrate that a sip-and-swallow EEG protocol is possible in terms of data quality.

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Presentation type: Oral presentation

Neural correlates of food liking and wanting in healthy-weight participants and participants with obesity

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Food reward is not a unitary concept. While “liking” refers to the hedonic pleasure during food consumption, “wanting” refers to the motivation to obtain a reward. Studies comparing liking and wanting in healthy-weight individuals (HW) and participants with obesity (OB) have brought mixed evidence. Here we compared the neural correlates of these two sub-components of food reward in HW and OB participants. Participants came in the lab after overnight fasting. They reported their trial-by-trial hedonic experience (liking) while consuming a high-calorie food (milkshake) and a tasteless solution. Participants also completed an analog of a Pavlovian-Instrumental Transfer test (PIT) to measure cue triggered wanting. They first learned to associate a neutral geometric figure to a food reward and an instrumental action to the reception of the food reward. After this learning phase, we measured the influence of the Pavlovian stimuli associated to food reward on the effort mobilized. The solutions were administered inside the scanner with a Magnetic Resonance Imaging-compatible gustometer to assess neural responses during consumption. 25 age and gender matched HW participants (age: 35.93±12.37, BMI = 22.37±1.77) and 57 OB participants without diabetes (age: 38.96±12.26 years old, BMI = 35.54±3.15) were tested. Our results show a dissociation in the neural activation patterns during both liking and wanting with increased prefrontal activation in OB participants versus increased cerebellar activation (in particular of lobe VIII and Crus II regions) in the HW participants. This could suggest differential brain activation patterns in taste-related reward processing. We could speculate that OB participants exert more control in these high-calorie food related tasks explaining increased prefrontal activation, whereas HW individuals rely more on the posterior cerebellum as part of a self-related emotional processing network. Fundings: Novo Nordisk; SNSF grant to GC (PCEGP1_181094)

Presentation type: Poster presentation

Nutrients and food textures: influences on preferences, learning, and neural reward processing in primates

Fabian Grabenhorst

University of Oxford

Oral processing of food involves a chain of sensory and neural events in which a food’s physical structure elicits oral sensations and subjective valuations that guide eating behavior. For example, foods high in sugar and fat typically produce a

characteristic flavour in the form of a sweet taste and thick, smooth texture ('mouthfeel'). These sensory signals are thought to contribute to the reward value of food, to the near-universal preferences for foods high in sugar and fat, and to unhealthy eating behavior and the development of obesity. This talk will review our recent findings from behavioural and neurophysiological experiments in monkeys and humans showing that (i) nutrients and sensory food qualities constitute biologically critical rewards that influence human-typical sophisticated economic food preferences (Huang, Sutcliffe, and Grabenhorst, 2021, PNAS); (ii) nutrient components of food rewards guide reinforcement learning and decision-making (Huang and Grabenhorst, 2023, Journal of Neuroscience); (iii) two key oral-texture parameters—the coefficient of sliding friction and viscosity—are processed in reward structures of the human brain in a manner that predicts individual differences in fat preference during naturalistic eating (Khorisantono et al., 2023, under review). Of particular interest was the finding that the coefficient of sliding friction, measured in our experiments from the interactions between fatty liquid foods and real oral surfaces (pig tongues), partly mediated the effect of a food's fat content on subjects' economic food preferences and brain reward responses. Our findings have implications for the design of foods that have both healthy nutrient composition and attractive oral-texture properties that mimic the reward value of dietary fat.

This work was funded by the Wellcome Trust and the Royal Society.

Presentation type: Oral presentation

The neural representation of oral cooling by central trigeminal neurons

Christian Lemon

University of Oklahoma

Temperature sensation is a component of flavor perception. In mammals, the high resting temperature of the tongue surface promotes intraoral cooling sensations during mouth openings for heat exchange, communication, and feeding behavior, as notable to humans during consumption of chilled foods and beverages. While cool temperatures applied to the oral mucosa can excite taste fibers, oral cooling more strongly engages primary afferent and central neurons of the trigeminal system, which supplies somatosensation and nociception to craniofacial tissues. Several prior studies have characterized peripheral trigeminal ganglion neurons and the mechanisms that imbue them with sensitivity to cool temperatures, and there is a building understanding of how downstream central trigeminal neurons and pathways in the brain represent neural information about intraoral cooling. This talk will discuss efforts to elucidate the functional organization of central trigeminal neurons and circuits that convey signals for oral cooling in the brain. Using neurophysiology and statistical clustering methods in mouse models, we have identified different subpopulations of medullary trigeminal neurons that project to the thalamus and respond to innocuous moderate or extreme oral cooling and cold stimulation of oral epithelia. Recordings from genetically targeted mice have found these subpopulations of orosensory cooling neurons to variably depend on oral thermal input from the cold

and menthol receptor transient receptor potential melastatin 8 (TRPM8) and suggest they may serve different functions. These data pertain to understanding trigeminal components of flavor coding and how somatosensory features of flavor stimuli may interact with and influence other orosensory modalities, such as taste, to shape ingestive preferences. Funded by NIH grant DC011579 to C.H.L.
Presentation type: Oral presentation

Integrative neural processing of somatosensation and taste in the parabrachial nucleus

Jinrong Li , Christian Lemon

University of Oklahoma

Taste and oral somatosensation are main components of flavor sensation during food consumption and contribute to protective behaviors. Brain pathways for taste and somatosensation are often studied independently. Yet it is intriguing to know whether they intersect in the brain, potentially reflecting their common role in detecting and avoiding potentially harmful substances. In this talk, I will present the results of a series of studies exploring the integrative neural processing of oral somatosensation and taste in the parabrachial nucleus (PbN). We first recorded neural spikes extracellularly of gustatory neurons in the PbN while orally applying thermal and chemesthetic stimuli in anesthetized mice of both sexes. The circuit connection profile from an oral somatosensory region of the trigeminal nucleus caudalis (Vc) to PbN taste neurons were also tested by applying stimulation to the Vc. We found most taste neurons spiked to Vc pulse stimulation. A subpopulation responsive selectively to the bitter taste stimuli cofired to capsaicin, mustard oil, and noxious heat. Combined with optogenetic techniques, we found the nociceptive activity in PbN bitter taste neurons was suppressed during inhibition of the Vc, implying convergent trigeminal input contributed to such activity. Given that trigeminal TRPV1-lineage fibers transmit somatosensory noxious thermal and pain information, we hypothesized that these fibers participated in the integration of taste and somatosensation in the PbN. In this experiment, we employed TRPV1-ChR2 mice and found optical excitation of TRPV1-lineage fibers more likely elicited responses in bitter taste neurons in lateral PB nuclei that responded to noxious heat and chemesthetic stimuli. Overall, these results show multisensory convergence between gustatory and somatosensory representations in the brain, indicating existing predictable overlap of different sensations related to hedonic coding. Funded by NIH DC011579 to CHL.
Presentation type: Oral presentation

How odor transcends taste differently between individual with normal weight and individual living with obesity: time frequency analysis of EEG

Shirley Xue Li Lim , Christopher Aveline , Charlotte Sinding

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Worldwide prevalence for obesity has tripled between 1975 and 2016 with a staggering number of 2.8 million individuals succumbing to this disease as of 2021. To address this issue, one of recommendations by WHO was to reduce salt/sugar consumption. It has been shown that aroma can increase taste's intensity perception, a phenomenon known as odor-induced taste enhancement (OITE). However, the underlying neural mechanisms of this phenomenon remain unknown. Hence, we aimed to better understand the neural mechanisms of odor-induced taste enhancement between normal weight (NW) individuals and individuals with obesity (OB). Here, we proposed to probe the brains' responses of OITE with electroencephalography (EEG) by employing time-frequency analysis approach to measure the event-related (de)synchronization (ERDS). In this EEG experiment, 33 NW and 28 OB evaluated the intensity of three solutions, i.e., odour (vanillin), taste (sucrose) and flavor (vanillin + sucrose). We anticipated that if OITE occurs, there would be a higher synchronized activity in the flavor condition when compared to the taste condition. Across both groups, EEG results revealed synchronization activity in the delta band (1Hz-4Hz), and these synchronized activity differs between condition and time points. Importantly, we found a significant increase of synchronized activity (600ms-800ms) at the temporal region for flavor; (230m-1000ms) for taste but not for odor. Within groups, only OB group showed a significant increase between the early and late period, suggesting an OITE effect. These results suggest that OITE induced by the integration between taste and odour is a late brain processing phenomenon. Taken together, we propose that OITE may involve a 'feedback loop' mechanisms that reactivates the taste cortex following integration, and that OITE demostrated promising potential in addressing the issue of reducing sugar intake for OB.
Presentation type: Poster presentation

The impact of diet on hippocampal dependent learning and memory processes.

Supreet Saluja

Karolinska Institutet

This talk forms a part of a larger symposium led by Dr. Janina Seubert and Dr Maria G. Veldhuizen, titled Acquisition and modification of flavor preferences.

A growing body of animal and human research suggests MTL function (of which the hippocampus is a part of) plays an important role in shaping food intake, preferences and learning of hunger signals. This talk will discuss recent findings from human research led by Professor Richard Stevenson, which suggest that impairments to MTL function, from western style diet consumption - i.e., diets high in saturated fats, added sugars and salts - may impair one's ability to learn their hunger signals, and consequently, promote intake of obesogenic foods. The main findings that will be discussed are as follow: (1) poorer hippocampal performance (memory) as measured by neuropsychological tests, are related to increased intake of western style diets ; (2) The change in how much one wants a food (relative to liking), following meal

consumption, is predicted best by individuals ability to anticipate how filling a food may be (a process reliant on memory); and (3) interoceptive cues of hunger are more common between offspring's and their parents, relative to non-related parents, further supporting the role of memory based processes (and MTL function) in hunger.
Presentation type: Oral presentation

Music and Food in the Brain: Modeling auditory influences on multisensory flavor perception

Alberte B. Seeberg [1], Ana Teresa Queiroga [1], Patrícia Alves da Mota [2], Henrique M. Fernandes [1], Peter Vuust [1], Qian Janice Wang [3]

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Eating is the most life-critical multisensory experience we encounter on a daily basis, but how exactly does the brain integrate and make sense of the different sensory inputs? In this study, we investigated how music influences the brain's encoding of taste and reward. Functional magnetic resonance imaging (fMRI) and behavioural data were collected from 28 healthy participants. The fMRI session was divided into three blocks: taste only, music only, and taste+music combinations. In the scanner, participants received sweet (TSw, 138.1 g/L sucrose) and sour (TSo, 2.4 g/L citric acid) tastant solutions and listened to soundtracks composed to associate with sweetness (MSw) and sourness (MSo). In the subsequent behavioral session, participants repeated the taste/sound combinations while evaluating tastant pleasantness, intensity of sweetness/sourness, and sound-taste congruency on 9-point visual analog scales. In the baseline validation fMRI analysis of TSw and TSo, we found overlapping activation in areas related to taste (rolandic operculum - ROL, insula - INS), sensory processing (postcentral gyrus - PoCG) and pleasure (putamen). Comparing taste-only with music-only trials, we found overlapping activation in areas related to taste (ROL) and multisensory integration (precuneus) between MSw and Tsw. Similarly, for TSo and MSo, we found overlapping activation in both taste (ROL, insula) and auditory (Heschl's gyrus) areas. Behavioural results supported the perception of congruence between matching tastes and sounds and incongruence between mismatched pairs.
This study provides novel insights into the neural mechanisms underlying the interaction between taste and music. These findings contribute to our understanding of multisensory integration and shed light on the potential impact of this interaction on real-life perceptual experiences.
Presentation type: Poster presentation

Multisensory - Peripheral processing

Chemosensing beyond the oral-nasal cavity, how diverse tissues can smell and taste

Jocelijn Meijerink

Wageningen University

The symposium will highlight novel findings in the field of chemosensing in extra nasal tissues with relevance for health and disease. In particular, the symposium will focus on the specific roles of olfactory receptors and bitter receptors and their underlying mechanisms in the gastro intestinal tract, the immune system and the vascular system, in relation to metabolic health, inflammation and blood pressure. The field of chemosensing in extra nasal-oral tissues is a new and exciting area of science of high importance to (patho)physiology.
Presentation type: Oral presentation

Synchronized expansion and contraction of olfactory, vomeronasal, and taste receptor gene families in hystricomorph rodents

Yoshihito Niimura [1], Bhim Biswa [2, 3], Takushi Kishida [4], Atsushi Toyoda [2], Masato Ito [5], Kazushige Touhara [5], Miho Inoue-Murayama [6], Scott Jenkins [6], Christopher Adenyo [7], Boniface Kayang [7], Tsuyoshi Koide [2, 3]

[1] University of Miyazaki, [2] National Institute of Genetics, [3] SOKENDAI (The Graduate University for Advanced Studies), [4] Nihon University, [5] The University of Tokyo, [6] Kyoto University, [7] University of Ghana

Chemical senses, olfaction, pheromone, and taste, are essential for the survival of most animals. It is well known that different modalities of senses compensate for each other, *e.g.*, primates with a well-developed vision have retrogressed olfaction. However, it is unclear whether such compensation occurs in evolution between different modalities of chemical senses. To address this question, we examined three receptor gene families for olfaction, pheromone, and taste, with a similar structure: olfactory receptor (OR), vomeronasal receptor type 1 (V1R), and bitter taste receptor (T2R) genes in Hystricomorpha, which is morphologically and ecologically the most diverse group of rodents. We also newly sequenced a high-quality genome assembly for the grasscutter, *Thryonomys swinderianus*. We identified orthologous gene groups among hystricomorph rodents for these gene families to separate the gene gain and loss events that occurred in each phylogenetic branch during Hystricomorpha evolution. The analyses revealed that the three gene families have expanded or contracted synchronously rather than compensatorily, suggesting that the development of one chemical sense cannot compensate for another. The results also showed that V1R genes evolved the most rapidly, followed by OR genes, and T2R genes were the most evolutionarily stable, reflecting the biological significance of each receptor family's ligands.
This work was supported by a Grant-in-Aid for Scientific Research (JSPS KAKENHI Grant Number 18K06359 to Y. N. and 19KK0177 to T. Koide) and by JST aXis Grant Number JPMJAS2017 to Y. N., A. T., M. I-M., and T. Koide and by National Institute of Genetics, NIG-Joint (1B2020) to M. I-M.

Presentation type: Poster presentation

Compromised chemosensory, trigeminal and salivary function in Long-COVID patients

Åsmund Rogn , Janicke Liaaen Jensen , Preet Bano Singh

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COVID-19 is known to affect the chemosensory functions. Although smell function has been studied broadly, little attention is given to understand the occurrence of combination of chemosensory and oral dysfunctions in Long-COVID patients.
The aims of this study were (i) to investigate the prevalence and combination of chemosensory and oral dysfunctions and (ii) to explore the types of odorants and tastants that were compromised in Long-COVID patients.
One hundred patients (68 women, mean age 41.6±12.9 yr) and 76 non-COVID controls (56 women, 41.8 ± 17.0 yr) were included in this cross-sectional case-controlled study. Participants' smell, taste, trigeminal, and salivary status were determined, and their experience of distorted smell and taste was recorded. Chemosensory function was measured using Sniffin' Sticks and Taste Strips. Questionnaires were used to assess parosmia, dysgeusia, dysesthesia and dry mouth.
Mean time since COVID-19 infection in patients was 12.4±7.1 months. Significantly higher prevalence was found in patients for parosmia (78.0%), hyposmia (48.0%), anosmia (40.0%), dysgeusia (32.0%), complete ageusia (3.0%), specific ageusia (27.0%), dysesthesia (11.0%) and dry mouth (17.0%) compared to controls (0% in all above except 11.8% in hyposmia). Bitter taste was the most common specific ageusia (18.0%) and coffee was the most common distorted smell (44.0%). Isolated olfactory dysfunction was found in 30.0% of the patients. Combination of dysfunctions included (a) olfactory and gustatory dysfunction (45.0%), (b) olfactory, gustatory and salivary dysfunction (9.0%), and (c) olfactory, gustatory, trigeminal and salivary dysfunction (4.0%).
These results suggest that Long-COVID patients suffer from a spectre of chemosensory and oral disturbances, and that these disturbances occur in different combinations. Treatment should be initiated to prevent possible permanent functional damages.
This study was fully funded by the University of Oslo.
Presentation type: Poster presentation

Multisensory - Other

Linking flavor sensations to food properties: The importance of modelling in science application

Veronica Galindo-Cuspinera

dsm-firmenich

Flavor psychophysics can provide a vast understanding of the mechanisms of human perception, how a specific taste can be modulated, and the role genetics have on individual perception. The challenge arrives when we need to translate this knowledge into real life applications in more complex environments such as food. Flavor perception combines taste, aroma, and texture, each influencing the other to deliver complex sensations. Identifying which physicochemical properties are most important and linked to the different flavor attributes is a task that requires combination of different disciplines to translate the information into measurable parameters that can guide product innovation. Data modelling through a sensomics approach is a starting point to deliver such insights although it is important to realize that not all models will be relevant, there are different aspects that need to be considered in order to have reliable results and a pragmatic approach to deliver an actionable insight that can be applied in the food industry. As Ep Köster† well said, "Fundamental research is difficult, but applied research is much more difficult"
Presentation type: Oral presentation

Differences in trigeminal function, olfaction, and nasal airflow measurements in patients with and without chronic rhinosinusitis

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Aims: This study aimed to determine how trigeminal, olfactory, and nasal airflow measures vary among patients with chronic rhinosinusitis (CRS) compared to healthy controls; whether these measures are proportionately affected by disease severity (nasal polyp grading); and whether intranasal trigeminal tests may be used to estimate nasal airflow.
Methods: Participants included CRS patients for surgery or repeat surgery and healthy controls. After a structured medical history, the following measures were obtained: trigeminal lateralization test and CO2 sensitivity (trigeminal function), “Sniffin’ Sticks” odor identification test (orthonasal olfaction), peak nasal inspiratory flow (PNIF) and rhinomanometry (RMM) (before and difference after decongestion; nasal airflow), and visual analogue scale (VAS) ratings for nasal airpuff sensation, smell ability, and nasal breathing. Lildholdt and Lund Kennedy nasal polyp gradings were also determined and participants also completed the Sinunasal Outcome Test-20.
Results: Seventy-one participants were included, 37 men, 34 women; aged 28 to 76 years (mean: 52). CRS patients had worse trigeminal function (trigeminal lateralization scores, $p=0.03$; and CO2 sensitivity, $p<0.001$) and decreased olfaction (smell ability VAS ratings, $p<0.001$; and odor identification scores, $p<0.001$) compared to healthy controls. There were no significant differences for nasal airflow between patients and

controls. Trigeminal function was not correlated with nasal airflow.
Conclusion: Trigeminal function and olfaction are decreased in patients with CRS, likely related to inflammatory processes. Nasal airflow, however, is a complex measure that may vary greatly between individuals and could potentially be influenced by several factors (i.e., nasal anatomy, lung function, nasal cycle), including previous nasal surgery. Although PNIF and RMM are common clinical tests for intranasal airflow, these results must always be correlated with clinical findings.
Presentation type: Poster presentation

Prevalence and Risk Factors of Smell and Taste Alterations in the United States during the COVID-19 Pandemic

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Background: Smell and taste are frequently impaired in patients infected with COVID-19. We examined the prevalence and risk factors of smell and taste alterations during the COVID-19 pandemic, and the proportion of affected individuals who sought healthcare.
Methods: Adults (18+ years old; n=29,482) were asked about smell and taste alterations and history of COVID-19 diagnosis in the U.S. National Health Interview Survey conducted from January through December 2021. Prevalence estimates were adjusted for the complex random sampling design and survey-weighted logistic regression was used to estimate risk factors after adjusting for age, sex, race/ethnicity, education, income, and geographic area.
Results: Prevalence of COVID-19 history was 14.2%. The prevalence of smell alterations was 19.7% (50.7% with COVID-19) and taste alterations was 13.3% (41.3% with COVID-19). Prevalence of either smell or taste impairment was 23.3% (55.9% with COVID-19). COVID-19 was the strongest risk factor for smell or taste alterations. Other significant factors were poorer overall health, coronary heart disease, angina, anxiety or depression, asthma, dry mouth, cold/flu past year, use of prescription medications, allergy, hearing loss, poor memory or concentration, and current cigarette smoking. Vaccination reduced the risk among those who had COVID-19, whereas a long period of cold/flu in the past year and xerostomia (dry mouth) further increased the risk for those with COVID-19. Among adults aged 40+ years, 15.5% (27.1% with COVID-19) reported having discussed their smell/taste problems with a healthcare professional.
Conclusions: Prevalence of smell/taste alterations increased almost 3-fold with history of COVID-19. Several other pre-existing health factors are also associated with smell/taste impairment and COVID-19. The COVID-19 pandemic has amplified the need for evidence-based guidance for assessment, treatment, and management of smell/taste impairments.
Presentation type: Poster presentation

Early development of the chemosensory brain

Joost Maier [1], Veronica Flores [2]

[1] Wake Forest School of Medicine, [2] Furman University

The chemical senses are typically studied in their adult state. However, adult chemosensation is profoundly shaped by complex developmental processes that start in utero and last until adolescence. The mechanisms underlying chemosensory processing in early life and their consequences for adult function are poorly understood, but have important implications for our understanding of perception and behavior across the lifespan. This symposium highlights recent work focused on how molecular, cellular and circuit-level neural processes during early development interact with environmental factors to shape chemosensory function, with a specific focus on eating behavior.
Presentation type: Oral presentation

A *Flavour* of the Future of Multisensory Interfaces

Marianna Obrist

University College London

Multisensory experiences, that is, experiences that involve more than one of our senses, are part of our everyday life. We often tend to take them for granted, at least when our different senses function normally (normal sight functioning) or are corrected-to-normal (using glasses). However, closer inspection to any, even the most mundane experiences, reveals the remarkable sensory world in which we live in. While we have built tools, experiences and computing systems that have played to the human advantages of hearing and sight (e.g., signage, modes of communication, visual and musical arts, theatre, cinema and media), we have long neglected the opportunities around touch, taste, or smell as interface/interaction modalities. Within this talk I will share my vision for the future of multisensory human-computer interfaces, exemplified through emerging technologies and devices and discuss what role touch, taste, and smell experiences can play in the future.
Presentation type: Oral presentation

Acquisition and modification of flavor preferences.

Janina Seubert [1], Maria Veldhuizen [2]

[1] Karolinska Institute, [2] Mersin University

Preference for specific food flavors-canonically smell and taste, but also texture and appearance- is a key factor that guides appetite towards specific food items and away from others. Those preferences are highly experience-dependent and change over the life course-yet, voluntary changes towards healthier or more sustainable diets are often experienced as difficult, and knowledge on how they can be facilitated remains limited. In recent years, flavor preference acquisition has been approached from various angles; this has resulted in an emerging mechanistic understanding that involves associative learning on the sensory and metabolic level, and brain systems involved in cognition, memory and reward. This symposium will bring together researchers representing these different perspectives to facilitate an integrated view on flavor preference acquisition.
Presentation type: Oral presentation

Other - behavioral/perceptual

Trigeminal impairment in chronic nasal obstruction

Chloé Migneault-Bouchard [1], Franciscus Johannes Maria Boselie [2], Johannes Frasnelli [1, 3]

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Chronic nasal obstruction (CNO) is a main complaint in ENT practice. It is often explained by structural deformities or edematous and inflamed nasal mucosa. In some cases, only little anatomical deformity or discrete obstructive mucosal inflammation is present even though patients complain of severe nasal obstruction. Our recent studies suggested that alteration of afferent neural pathways responsible for airflow perception, namely the intranasal trigeminal system may cause reduced subjective nasal patency that is perceived via trigeminal receptors located on the nasal cavity's epithelium. These receptors respond to temperature changes, and to chemical substances such as eucalyptol which causes the same sensation of cooling as does increased airflow. The trigeminal system plays a crucial role in the pathogenesis of treatment-refractory and anatomically inexplicable CNO. In order to prove his involvement in the perception of nasal patency, we aimed to create a model for this pathogenesis of CNO.

We are carrying out a double-blind crossover study with 34 healthy participants. They are randomised for either treatment (local mucosal anesthetic) or placebo (saline solution) for the first study visit, and the opposite treatment for the second visit. We examine the intranasal trigeminal sensitivity using the Trigeminal Lateralization Task with eucalyptol. We further use questionnaires and Peak Nasal Inspiratory Flow to evaluate subjectively and objectively the nasal patency, respectively.

After 7 participants (preliminary results), trigeminal sensitivity ($p=0.009$) and subjective nasal patency ($p=0.03$) are significantly lower after nasal anesthetic than placebo. No

difference was observed for objective nasal patency.

Our recent and current results shed light on trigeminal involvement in CNO, as we have shown that we can create a model of trigeminal dysfunction by local anesthetics. The created model opens the doors for future research concerning CNO.

Funding: FRQS; NSERC
Presentation type: Oral presentation

The Curvilinear Relationship between Perceived Stress and Spicy Food Craving: A Non-curve-mediation Model

Huizhen Qiu , Xiao Gao , Yidan Rui

Southwest University

Objectives: Stress can leads to food craving. This problem has received a lot of attention. It has been found that people tend to eat sweet foods when they feel stressed, while others tend to eat spicy foods. In view of the various benefits of spicy foods, this study sought to figure out whether stress and spicy food craving are related.
Methods: A cross-sectional investigation was used to get data from 196 valid female individuals, including the Perceived Stress Scale, the Spicy Food Craving Questionnaire and the Spicy Food Emotion Questionnaire. In order to test the relationship between spicy food craving and perceived stress, as well as the underlying mechanism, The Lind and Mehlum's three-step procedure testing U-shaped relationship and Hayes and Preacher's procedure testing instantaneous indirect effect was utilized in the current statistical analysis.
Results: Three-step procedure analysis confirmed U-shaped relationship between perceived stress and spicy food craving(β=0.188, $p<0.05$, $\Delta R^2=0.035$; β=0.182, $p<0.05$, $\Delta R^2=0.033$). Mediational analysis showed that the positive emotion when consuming spicy food has a non-curving mediating effect in the relationship between perceived stress and spicy food craving. On the whole, The results of the instantaneous effect showed that the indirect effect of stress on spicy food craving through emotion was significantly negative at low stress level(θ=-0.270, 95%CI(-0.773,0.213)), while the indirect effect was significantly positive at medium and high stress levels(θ=0.127, 95%CI(-0.158,0.454); θ=0.523, 95%CI(0.136,1.223)).
Conclusions: The current study found that the positive emotions generated by spicy food intake had a non-curving mediating role in the U-shaped relationship between stress and spicy food craving. This study firstly investigated the relationship between stress and spicy food craving. So it provided a fresh direction for future research on spicy food craving.
Presentation type: Poster presentation

Focusing on reducing cravings or violating expectations about loss of control: how does cue exposure therapy work?

Ghislaine Schyns , Anne Roefs , Anita Jansen

Maastricht University

Exposure therapy seems to work well for anxiety disorders, as well as for eating disorders and obesity. However, according to recent insights, the mode of delivery of exposure would be of great importance for treatment success: instead of focusing on fear/craving habituation, sessions should be aimed at maximizing inhibitory learning. One way to strengthen inhibitory learning is to violate expectations during exposure. In several studies, we examined the relationship between craving habituation/expectancy violation and treatment outcome during cue exposure therapy. 176 subjects were included (cue exposure n = 96, control n = 80); 16 men and 160 women. 148 subjects (84.1%) met the criterion for obesity (BMI > 30), the remaining 28 subjects (15.9%) were overweight (BMI > 25). Of the 96 subjects in the cue exposure condition, 21 subjects received one session, 56 subjects received two sessions, and 19 subjects received eight sessions of exposure therapy. Food cravings were monitored throughout the sessions, and expectations about loss of control were measured via self-report before and after therapy. For both measures, the association with overeating was investigated, measured in a behavioral task in the laboratory.
The results showed that habituating cravings during and between exposure sessions were not associated with overeating after cue exposure. However, the greater the violation of expectations about loss of control during cue exposure, the fewer subjects overate at the end of therapy. Cue exposure appears to be effective in reducing overeating, and the degree of this success appears to be related in part to the violations of expectations about loss of control during cue exposure. Although cravings often decrease during cue exposure sessions, this does not seem to correlate with better therapy outcome, at least with regard to overeating.
Presentation type: Oral presentation

Other - Peripheral processing

Vomeronasal organ inflammation in sheep: first description and histological characterization

Pietro Asproni , Violaine Mechin , Estelle Descout , Elisa Codecasa , Patrick Pageat

IRSEA – Research Institute in Semiochemistry and Applied Ethology

The vomeronasal organ (VNO) plays a crucial role in mammals since its sensory epithelium (VNSE) allows the detection of semiochemicals, contributing to their communication capabilities. Recently, we described the existence of inflammatory changes in the VNO of cats and pigs, associated with the presence of aggressive behaviours. This study aimed to investigate if also the sheep is concerned by this pathology, considering the key-role of chemical communication in this species. Twenty-four VNOs were sampled from 12 ewes that were humanely euthanized for another project (approved by IRSEA's Ethical Committee). VNO samples were

submitted to haematoxylin-eosin and immunohistochemical anti-Gαi2 protein staining, in order to measure VNSE condition, its thickness and the number of Gαi2+ neurons. The statistical analysis was performed to compare the presence of inflammation to the VNSE thickness and to the number of Gαi2+ neurons. Six of the 12 ewes (50%) presented both the VNSE healthy, 3/12 (25%) presented an unilateral VNSE inflammation and the remaining 3/12 (25%) a bilateral VNSE inflammation. Of the 24 analysed VNSE, 15 (63%) were healthy, 4 (17%) were affected by weak inflammation and 5 (20%) by moderate inflammation. The statistical analysis revealed that the inflammation did not statistically influence VNSE thickness and the number of Gαi2+ neurons ($P>0.05$), even if a strong decrease of these cells was observed in inflamed VNSE (50.2 cells/mm2) compared to the healthy one (98.3 cells/mm2). To our knowledge, these preliminary data represent the first description of vomeronasalitis in sheep. Contrary to what reported in pigs, this condition seems to affect a smaller part of animals, probably because the farming system allows the access to an exterior space, reducing the exposure to farm gases and dust. Contrary to porcine vomeronasalitis, this inflammation does not seem to induce neuronal loss, even if a strong decrease of Gαi2+ cells was observed in inflamed VNSE.
Presentation type: Poster presentation

Mapping of intranasal mucosal thermal sensitivity

Pauline Hanslik [1], Susanne Menzel [1], Coralie Mignot [1], Evgenii Gluskov [2], Roman Dubreuil [3], Moustafa Bensafi [4], Susanne Füssel [5], Thomas Hummel [1]

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Introduction: The olfactory and trigeminal intranasal systems are closely interlinked. Although olfactory sensitivity receives much attention - especially after the SARS-CoV2 pandemic with many people experiencing olfactory loss - little is known about intranasal trigeminal functions. Hence, this study aimed to characterize the intranasal trigeminal sensitivity to heat in relation to the expression of transient receptor potential channels (TRP).
Methods: A total of 20 healthy participants (aged 21-27 years, 11 women) were screened for olfactory function and trigeminal sensitivity. Under endoscopic control, thresholds to thermal stimuli were determined in 7 locations: anterior septum, lateral vestibulum, interior nose tip, lower turbinate, middle septum, middle turbinate, and olfactory cleft. For analyses of the expression of trigeminal receptors (TRPV1, TRPV3, TRPA1, TRPM8) nasal swabs were obtained at the anterior septum, middle turbinate, and olfactory cleft.
Results: Thermal thresholds differed between locations ($p=0.018$), with a trend of higher thresholds at the anterior septum ($p=0.092$). At all sites the highest receptor mRNA expression was detected for TRPV1 ($p<0.001$). The expression of TRPV3 RNA was highest at the anterior septum compared to the middle turbinate or olfactory cleft.

Thermal sensitivity correlated between TDI-score and trigeminal intensity ratings, a questionnaire regarding trigeminal function, nasal patency, and CO2 threshold, but there was no correlation with receptor RNA expression.
Discussion: These results suggested that there are topographical differences between the intranasal thermal threshold with the anterior septum being least sensitive to thermal stimuli.
Funding and acknowledgement: This project has received funding from the European Union's Horizon 2020 under grant agreement No. 964529 (ROSE). We also would like to thank Nicole Power Guerra for help with the statistical analyses.
Presentation type: Poster presentation

Gene expression of olfactory receptors in the murine small-intestine is affected by a high-fat diet and associated with enteroendocrine signalling

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Background: Enteroendocrine secretion is regulated by nutrient- and metabolite-sensing receptors in the intestinal lumen. Emerging evidence indicates the involvement of the GPCR family of olfactory receptors (ORs).
Objective: Identify nutrient sensing receptors involved in enteroendocrine signaling in metabolic health.
Methods: A 2-weeks controlled dietary intervention with a high-fat diet (HFD) and a low-fat diet (LDF) was performed in male C57BL/6J mice. Additionally, a chow-fed group was included. Differential gene expression, given in fold change (FC), was determined in mucosal scrapings of ten sections of the small intestine (SI) using Mouse genome 430 2.0 arrays.
Results: Comparing the HFD with the LFD group, 26 OR genes showed increased expression in the jejunum, whereas expression of five OR genes decreased in the jejunum and ileum. Notably, *Olfr920* was downregulated in consecutive sections of the SI (FC range -1,65 to -1,43), with similar trends observed for *Olfr111*. The gene expression of the gut hormone somatostatin (*SST*) was downregulated in the jejunum (FC range -1.29 to -1.45). The differential expression patterns of *Olfr920* and *SST* in response to the diet correlated strongly. Moreover, *Olfr920* showed a high inverse correlation with fatty-acid binding protein 2 (*fabp2*). When comparing HFD with chow, *Olfr558* was found to be upregulated in the duodenum, whereas a comparison between the LFD and chow showed that *Olfr165* (the most highly expressed out of all ORs) was downregulated in the distal jejunum.
Conclusions: The HFD affected the gene expression of multiple OR family members, particularly *Olfr920*, *Olfr111* and *Olfr558*. Through detailed sectioning of the SI we revealed that location-specific alterations in *Olfr920* gene expression were associated with *SST*, a master regulatory gut hormone. The identification of nutrient sensing genes involved in HFD-induced pathogenesis may yield new GPCR-targets relevant to metabolic disorders, obesity and diabetes.

Presentation type: Oral presentation

Other

Unraveling the universality of chemical fear communication: Evidence from behavioral, genetic, and chemical analyses

Jasper Groot

Behavioural Science Institute, Radboud University

Unraveling the universality of chemical fear communication: Evidence from behavioral, genetic, and chemical analyses
Presentation type: Oral presentation

Modification of G proteins according to the vomeronasal organ condition

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IRSEA - Research Institute in Semiochemistry and Applied Ethology

Chemical communication in mammals is insured by the vomeronasal organ (VNO), which oversees chemical cues detection. When altered, this organ cannot properly detect these cues strongly impacting the animal life.
Some spontaneous alterations have been recently described in domestic animals and laboratory models, such as inflammation and degeneration due to the aging process. These studies also investigated G proteins expression in VNO affected by these changes, revealing that Gαi2 and G αo proteins are significantly modified in altered VNOs. The aim of this communication is to review the literature that investigated these changes.
Concerning the Gαi2 protein, its expression was shown downregulated during aging in mice, from the age of 10 months ($p=0.0003$, Kruskal-Wallis test). In pigs, the number of Gαi2+ cells were also significantly decreased according to the intensity of the vomeronasalitis ($p<0.0001$, Fisher exact test). This protein was also slightly decreased in sheep when the VNO was inflamed ($p=0.07$, GLMM test). However, Gαi2 expression was not modified in the VNOs of mice reared in a confined environment with increased ammonia and dust levels ($p=0.3892$, GLMM).
Gαo protein expression, in contrary, was upregulated in the pathologically altered VNOs. Aging induced a strong increase of this protein expression in the VNO sensorial epithelium of mice ($p<0.0001$, GLMM). Gαo protein expression was also upregulated in the VNO of mice reared in confined conditions and exposed to ammonia and dust ($p<0.0001$, GLMM).
In conclusion, VNO alterations, whatever the cause, can induce several modifications of G proteins expression in the epithelium. These changes seem to induce a

downregulation of Gαi2 expression and an upregulation of Gαo protein expression. Since these proteins plays a key role in chemical communication, these findings bring new information and perspectives to better understand their regulation in healthy and altered VNO.
Presentation type: Poster presentation

The effect of a sweet-tasting pentose [L-arabinose] on glycaemic and insulinaemic responses after sugar consumption in a prediabetic population

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Background: L-arabinose is a sweet-tasting pentose reported to inhibit sucrase activity in the brush border of the small intestine. L-arabinose could serve as a functional ingredient to lower glycaemic responses after the consumption of sugar in people with prediabetic symptoms.
Objective: To assess the effects of L-arabinose supplementation on glycaemic and insulinaemic responses in a prediabetic population.
Methods: Eighteen adults (4 female/14 male; aged 73±4 years; BMI: 27.5±2.4 kg/m2) with prediabetic symptoms participated in a double-blind randomised cross-over trial with two treatments. In the intervention treatment, participants received L-arabinose (5g) added to a 50g sucrose drink. In the control treatment, participants received a sucrose-only drink. Circulating glucose and insulin concentrations were determined at fixed time points: before, 15, 30, 45, 60, 90, 120, and 180 min after consumption.
Results: The addition of L-arabinose to the control drink significantly lowered and delayed the peak glucose concentration ($p<0.001$): 8.3±1.1 mmol/l after 53±21 min compared to the control drink (9.5±1.5 mmol/l after 43±12 min). Insulinaemic responses were also significantly lower and delayed ($p<0.01$): 57.2±41 mmol/l and 40±23.8 mmol/l after 46±17 min and 78±30 min for the control drink compared to the addition of L-arabinose, respectively. The incremental area under the curve (iAUC) of the total glucose response tended to be lower after the addition of L-arabinose ($p=0.09$), whereas the iAUC for the insulin response was significantly lowered by 25%.
Conclusion: The consumption of L-arabinose together with sucrose results in a lower and delayed postprandial glycaemic and insulinaemic response in a prediabetic population.
Funding: This study was completed as part of the Pulp2Value project under the European Union (grant agreement No. 669105). This analysis was undertaken as part of a PhD studentship funded by Bournemouth University and Wageningen University and Research.

Presentation type: Poster presentation

Generation of a novel apical-out mouse enteroid model to investigate effects of food-derived bioactive compounds on the intestinal epithelium

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The use of 3D-small intestinal organoid models (enteroids) enables investigation of chemosensing mechanisms for nutrients, bioactive substances and metabolites, with the intestinal epithelium. Enteroids are non-cancerous mini-guts grown from stem cells that contain all different types of epithelial cells, including enterocytes, goblet cells, enteroendocrine cells, and Paneth cells. Therefore, enteroids represent a genotypically and phenotypically superior model compared to cell lines. Nevertheless, one challenge in using enteroids is the difficulty in accessing the luminal (or apical) surface of the epithelium, which is enclosed in the enteroids' interior. Therefore, we generated an enteroid mouse model (C57BL/6) in which the luminal surface of the enteroid faces outward (apical-out). Apical-out enteroids were created by removing extracellular protein matrix (ECM), thereby disrupting ECM-integrin receptor interactions. Flipping enteroid polarity (from apical-in to apical-out) was visualized by fluorescence confocal microscopy, in which the nuclei, actin cytoskeleton in the microvilli brush border, and fucose units in the mucus layer were stained. Additionally, we showed that apical-out enteroids were less sensitive to exposure of phenolic compounds, likely due to the mucus layer surrounding the apical brush-border. Based on gene expression of epithelial cell markers, we demonstrated that apical-out jejunal enteroids show better resemblance to jejunal tissue of C57BL/6 mice compared to apical-in jejunal enteroids. Altogether, apical-out enteroids provide a better mimic of the gastrointestinal lining compared to conventional apical-in enteroids. This model seems suitable to study the interactions between nutrients and their bioactive metabolites with nutrient sensing receptors expressed on specialized intestinal cell types. Consequently, their physiological effects such as secretion of gut hormones, antimicrobial lysozymes or protective mucus can be unveiled.

Presentation type: Poster presentation

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Nishihara	Hidenori	Thu-S9-003
Nordén	Frans	Wed-P2-055
Nys	Linda	Mon-S1-003
Obrist	Marianna	Wed-P2-073, Thu-K5-001
Ohla	Kathrin	Tue-P1-034
Oleszkiewicz	Anna	Wed-S6-006, Wed-P2-075, Tue-P1-030, Tue-P1-040
Olofsson	Jonas	Tue-P1-026
Olofsson	Jonas K.	Thu-S9-005, Tue-P1-042
On	Aretha	Tue-P1-039
Oncul	Merve	Wed-P2-083, Wed-P2-082
Öz	Zilan	Tue-P1-011
Pabst	Oliver	Tue-S4-002
Pageat	Patrick	Wed-P2-071, Tue-P1-037, Tue-P1-019
Parker	Jane	Tue-S3-005, Tue-S3-001
Parker	Jane K	Wed-S8-001
Park	Sung jin	Tue-P1-032, Thu-S9-006
Parma	Valentina	Mon-S2-001, Tue-S3-005, Tue-S3-001
Parvin	Parvaneh	Tue-P1-034
Pataky	Zoltan	Tue-P1-007
Pause	Bettina M.	Wed-P2-050, Wed-P2-047
Pavlov	Yuri	Wed-P2-081
Pearce	Abigail	Tue-P1-023
Pellegrino	Robert	Thu-S10-004, Thu-S10-002, Tue-P1-034
Pepino	M. Yanina	Wed-S8-003
Pereda-Loth	Veronica	Tue-P1-005
Perenboom	Corine	Wed-P2-065
Petersen	Petúr Henry	Tue-P1-025
Philpott	Carl	Wed-P2-061, Wed-P2-073
Pieniak	Michał	Tue-P1-040, Wed-P2-075, Tue-P1-030, Wed-P2-086
Pierron	Denis	Tue-P1-005
Pierzchajlo	Stephen	Thu-S9-005
Pinchover	Liron	Wed-P2-063, Tue-P1-015
Pinna	Andra	Tue-P1-036
Pinna	Ilenia	Tue-P1-003
Pirastu	Nicola	Tue-P1-034
Pirc	Matjaz	Wed-S8-001
Plailly	Jane	Wed-P2-046
Pluznick	Jennifer	Mon-S1-006
Pol	Korrie	Wed-P2-065
Pool	Eva R.	Tue-P1-007
Postma	Elbrich	Wed-S7-001, Tue-P1-024

Pretorius	Leoné	Wed-P2-065
Puścian	Alicja	Tue-S4-002
Qiu	Huizhen	Wed-P2-085
Queiroga	Ana Teresa	Wed-P2-070
Race	Benedicte	Mon-S2-005
Rashidi	Olga	Wed-P2-047, Wed-P2-050
Rastogi	Shavika	Thu-S10-005
Ravia	Aharon	Tue-P1-016, Wed-P2-063
Ravreby	Inbal	Wed-P2-063, Mon-S2-004
Rawal	Shristi	Tue-P1-002
Rayo-Morales	Raquel	Tue-P1-017
Reddy	Gautam	Tue-S4-006
Reed	Danielle	Tue-P1-001
Reh	Borja	Thu-S9-003
Reisert	Johannes	Tue-P1-033
Reissland	Nadja	Wed-S8-002
Rekow	Diane	Wed-P2-076
Richard	Stephane	Mon-S2-005
Rivalan	Marion	Thu-S9-001
Robaczewska	Edyta	Wed-P2-084
Robert-Hazotte	Aline	Mon-S2-005
Roefs	Anne	Thu-S11-006
Rogn	Åsmund	Tue-P1-014
Rohlfs Dominguez	Paloma	Tue-P1-005
Rokosz	Marta	Tue-P1-030, Wed-P2-075, Tue-P1-040
Rommel	Maria	Tue-P1-006
Rosa	Antonella	Tue-P1-003
Rosa	Matthew	Tue-P1-023
Rost	Benjamin	Thu-S9-001
Rozenkrantz	Liron	Wed-P2-063
Rui	Yidan	Wed-P2-085
Sabiniewicz	Agnieszka	Wed-P2-086
Saive	Anne-Lise	Wed-W2-001
Salles	Christian	Tue-P1-029, Wed-P2-051
Saluja	Supreet	Thu-S11-003
Sánchez-Catalán	María J	Wed-P2-054
Sander	David	Tue-P1-007
Santhanam	Lakshmi	Mon-S1-006
Savva	Androula	Wed-P2-068
Scacchi	Massimo	Tue-P1-041
Scarpina	Federica	Tue-P1-041
Schaal	Benoist	Wed-P2-080, Wed-P2-076, Wed-S8-002
Schaefer	Martin	Wed-P2-055
Schäfer	Andreas T.	Thu-S10-005
Schafer	Dorothy	Tue-P1-032
Schäfer	Laura	
Schicker	Doris	Thu-S10-003, Tue-S5-004
Schiff	Hillary	Wed-S6-005
Schmitz	Dietmar	Thu-S9-001

Schmuker	Michael	Thu-S10-005
Schoenherr	Anke	Thu-S9-001
Schutte	Céline	Wed-P2-088, Wed-P2-087
Schyns	Ghislaine	Thu-S11-006
Scilingo	Enzo Pasquale	Mon-S2-006
Seeberg	Alberte B.	Wed-P2-070
Segura-Carretero	Antonio	Tue-P1-017
Seidel	Leonie	Tue-P1-021
Seifert	Friederike D	Tue-S4-002
Senf	Katja	Tue-P1-027
Serini	Matilde	Tue-P1-041
Seubert	Janina	Wed-P2-068, Tue-P1-021, Thu-S11-001
Shields	Vonnie	Tue-P1-005
Shin	Taekyun	Tue-P1-009
Shushan	Sagit	Wed-P2-063, Wed-P2-064
Sieverding	Nora M.	Wed-P2-050
Similowski	Thomas	Tue-P1-036
Sinding	Charlotte	Tue-P1-038
Singh	Preet Bano	Tue-P1-014
Singh	Satnam	Thu-S10-003
Skiles	Jerry	Wed-P2-069
Smeets	Monique	Tue-S5-001, Tue-S5-005
Smeets	Monique A. M.	Wed-P2-079
Smith	Emma	Wed-P2-082
Snitz1	Kobi	Mon-S2-004
Sobel	Noam	Wed-P2-064, Mon-S2-004, Tue-P1-015, Wed-P2-063, Tue-P1-016, Wed-P2-049
Somoza	Veronika	Mon-S1-002
Soroka	Timna	Wed-P2-064
Sorokowska	Agnieszka	Wed-S6-006, Tue-P1-040
Speed	Laura	Wed-P2-045
Speed	Laura J.	Tue-S5-006
Spehr	Marc	Tue-P1-031, Wed-P2-060, Tue-P1-018, Tue-P1-022, Tue-S4-002, Wed-P2-072
Sperling	Edyta	Wed-S6-006
Stefens	Cédric	Wed-P2-082
Stopka	Pavel	Tue-S4-002
Strauch	Martin	Tue-P1-022
Streleckis	Aiden	Thu-S10-004
Stumpenhorst	Katharina	Thu-S9-001
Switacz	Victoria	Tue-S4-001
Switacz	Victoria K.	Wed-P2-072, Tue-P1-022
Szychowska	Malina	Tue-P1-026
Tagini	Sofia	Tue-P1-041
Tamir	Michal	Tue-P1-016
Tang	Claudia	Tue-P1-004
Tanner	Bailey	Wed-S6-004
Tantirigama	Malinda L. S.	Thu-S9-001
Teo	Pey Sze	Wed-S8-006

Tewari	Jeevan	Tue-S3-002
Thaploo	Divesh	Tue-S3-003, Wed-S7-002
Thiele	Julia	Wed-P2-062
Thijs	Theo	Mon-S1-003
Toda	Yasuka	Thu-S9-003
Tognetti	Arnaud	Tue-P1-005
Touhara	Kazushige	Tue-P1-012
Toyoda	Atsushi	Tue-P1-012
Trives	Elliott	Wed-P2-054
Tröger	Hannah-Lena	Tue-P1-031
Trost	Lena	Tue-P1-044
Trouillet	Anne-Charlotte	Tue-P1-028
Turrel	Matthias	Wed-P2-046
Uhl	Caroline	Wed-P2-067
Ürgen	Burcu Ayşen	Thu-S9-002
Ustun	Beyza	Wed-S8-002
Vacher	Helene	Tue-P1-028
Vaidehi	Nagarajan	Tue-S3-002
van Dam	Rob	Wed-S8-006
Van der Schueren	Bart	Mon-S1-003
Van Der Velden	Wijnand	Tue-S3-002
van Dijk	Birgit	Tue-P1-024
van Dinteren	Sarah	Wed-P2-084
Vanello	Nicola	Mon-S2-006
van Schaik	André	Thu-S10-005
van Vuuren	Laura	Thu-S12-004
Veldhuizen	Maria Geraldine	Thu-S9-002, Tue-P1-011, Thu-S11-001, Thu-S11-005, Tue-P1-034
Verbeek	Caro	Wed-W2-001
Vincken	Jean-Paul	Wed-P2-084
Vogel	Celina	Wed-P2-062
Vos	Isa	Wed-P2-079
Vuust	Peter	Wed-P2-070
Wang	I-hao	Tue-P1-032, Thu-S9-006
Wang	Qian	Mon-S1-003
Wang	Qian Janice	Wed-W2-001, Wed-P2-070
Wang	Yingqi	Tue-S4-002
Warner	Tom P. A.	Thu-S10-005
Warren	Helen	Mon-S1-006
Weissbrod	Aharon	Tue-P1-016, Wed-P2-064, Tue-P1-015
Weissgross	Reut	Wed-P2-063
Weiss	Jan	Tue-P1-028
Weiss	Tali	Tue-P1-015, Wed-P2-063, Mon-S2-004
Weng	Zhiping	Tue-P1-032
White	Samuel JB	Tue-P1-025
Wiehe	Melanie	Wed-P2-087, Wed-P2-066, Wed-P2-088
Wills	Edward	Tue-P1-023
Winiarski	Macej	Tue-S4-002
Winnig	Marcel	Wed-P2-069

Winter	York	Thu-S9-001
Witkamp	Renger	Mon-S1-004, Wed-P2-084
Wuensch	Lavinia	Tue-P1-007
Xu	Jiaojiao	Mon-S1-006
Yamashita	Atsuko	Thu-S9-003
Yang	Xinmeng	Wed-P2-053
Yanık	Hüseyin	Thu-S9-002
Yar	Berçem	Tue-P1-011
Yeomans	Martin R	Wed-P2-056
Yeshurun	Yaara	Mon-S2-004
Zak	Joseph	Tue-S4-006
Zampini	Massimiliano	Tue-P1-041
Zandstra	Liesbeth	Wed-P2-053
Zengin	Berna	Thu-S11-005
Zhang	Zihao	Wed-S6-003
Zimmer-Bensch	Geraldine	Tue-P1-022
Zufall	Frank	Tue-P1-028