ABSTRACTS

XLIII Annual Meeting of the Association for Chemoreception Sciences
Program Chair: Max Fletcher, PhD Virtual Meeting | April 19–23, 2021

O6-CELL TYPES IN TASTE BUDS AND TENTACLES

MONDAY, 1:00 PM - 3:00 PM

Cell Types in Taste Buds and Tentacles

Thomas Finger, Sue Kinnamon

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This symposium will discuss the current thinking about the diversity of cells within taste buds and chemotactile sensory organs of octopus suckers. While octopus suckers may seem an odd juxtaposition, both taste buds and sucker chemosensory receptor cells share the property of being contact chemosensory organs responsive to sapid chemical cues crucial for eliciting feeding. Both sucker chemotactile sensory organs and taste buds possess different morphological types of receptor cells that correlate with different functional properties. Vertebrate taste buds are classically described as possessing 3 types of elongate taste cells yet recent studies suggest additional cell types exist and raise the question of how to define cell types in any chemoreceptor system.
Funding Acknowledments: NIDCD DC014728 to T Finger and DC012555 and DC017679 to S. Kinnamon
FCOI Declarations: None

O7-CELL TYPES IN TASTE BUDS AND TENTACLES

MONDAY, 1:00 PM - 3:00 PM

Cannonical Cell Types in Mouse Taste Buds

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Early ultrastructural studies of mammalian taste buds identified three main taste cell types: Type I, II, and III taste cells. These categories have since been associated with distinct physiological and molecular features. Type I cells wrap around neighboring cells, and express molecular components that may degrade or take up neurotransmitters released from other cell types. In those ways, Type I cells may function as astrocyte-like support cells for Type II and III taste cells. Type II cells express receptors for bitter, sweet, or umami taste qualities, and release ATP as a neurotransmitter via unique channel synapses to activate P2X receptors on the gustatory nerve fibers. Many Type III cells express the proton channel OTOP1 and are thus responsive to acids. Unlike Type II cells, Type III cells transmit this information to nerve fibers via conventional vesicular synapses. As our body of knowledge regarding these cells grows, however, the lines between these cell categories have been somewhat complicated. Multiple cell types may be involved in the transduction of salty stimuli, and some taste cells may respond to multiple taste modalities. Anatomically, we find ultrastructural features that blur the lines between canonical cell types. Type III cells occasionally contain characteristics of channel synapses, which are canonically confined to Type II cells. Rarely, Type II cells contain atypical mitochondria that abut Type I cells, rather than nerve fibers. Type I cells share relationships with innervating nerve fibers that, while not fitting into a known synaptic structure, may nonetheless be important points of communication between the taste bud and afferent nerves. As we uncover more details of taste bud function, we may find that taste cells fit better on a spectrum than into distinct types.
Funding Acknowledments: NIDCD R01 DC014728 TF NIDCD R01 DC017679 SK
FCOI Declarations: None

O8-CELL TYPES IN TASTE BUDS AND TENTACLES

MONDAY, 1:00 PM - 3:00 PM

Salt-responsive Cells - A Unique Cell Type?

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Of the five basic tastes - sweet, umami, bitter, sour, and salty -, the least understood is salty taste comprising two pathways:

sodium taste and high salt taste. Sodium taste mediates behavioral attraction to sodium salts, whereas high salt taste mediates aversion to high concentrations of various salts. The epithelial sodium channel (ENaC) has been established as the Na^+ sensor in taste cells dedicated to sodium taste, which we can refer to as sodium cells. High salt taste reportedly recruits bitter- and sour-sensing taste cells; however, the identity of sodium cells and their intracellular signal transduction cascade were unclear until recently. We identified taste cells expressing ENaC and CALHM1/3 as sodium cells, whereby the entry of oral Na^+ elicits suprathreshold depolarization for action potentials driving voltage-dependent neurotransmission via a channel synapse involving the CALHM1/3 channel. Each taste bud is considered to consist of three distinct cell types: I, II, and III. To which taste cell type do sodium cells belong? Expression analyses of cell-type marker proteins suggested that sodium cells do not belong to any of the known taste cell types. Remarkably, however, sodium cells and type II cells share the CALHM1/3 channel synapse whose structure has been considered the most characteristic morphological feature of type II cells. Thus, the identification of sodium cells defines a previously unidentified taste cell population, and questions the current criteria of taste cell classification. I will discuss recent data on molecular and functional properties of sodium cells to provide a framework for refining taste cell classification.

Funding Acknowledgments: JST PRESTO JPMJPR1886 JSPS 19H03819, 20K21505, and 20H04908 Salt Science Research Foundation 18C2, 19C2, and 20C2

FCOI Declarations: None

O9-CELL TYPES IN TASTE BUDS AND TENTACLES

MONDAY, 1:00 PM - 3:00 PM

Non-canonical cell types in Taste buds

Kathryn Medler

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The peripheral taste system uses distinct signaling pathways to detect chemicals in potential food items. These signaling pathways are currently thought to be expressed in specific subsets of taste cells with no overlap between them. Bitter, sweet and umami stimuli have complex chemical structures and activate G protein coupled receptor (GPCR) pathways in Type II cells while salt and sour are detected by ionotropic receptors in Type III cells. The canonical taste model states that bitter, sweet, and umami stimuli are transduced by Type II taste cells using GPCRs and a common PLCβ2/IP_3R3/TRPM5 signaling pathway. We demonstrated that TRPM4 also has an important role in this pathway and is required for the normal transduction of these stimuli. More recently we identified a new population of taste cells that respond to multiple taste qualities including bitter, sweet, sour, and umami, which we termed Broadly Responsive (BR) cells. Using live cell Ca^{2+} imaging in isolated taste cells and transgenic mice, we determined that BR cells are a subset of Type III cells that respond to sour stimuli but also use a PLCβ3 signaling pathway to respond to bitter, sweet, and umami stimuli. Unlike Type II cells, individual BR cells are broadly tuned and respond to multiple stimuli across different taste modalities. Behavioral assays and analysis of the nucleus of the solitary tract (NTS) confirm that functional Type II and BR cells are both required for normal taste responses to bitter, sweet and umami stimuli. These data, along with other recent studies, reveal that the taste bud contains non-canonical taste cells that have critical roles in the transduction of multiple taste stimuli.

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FCOI Declarations: None

O10-CELL TYPES IN TASTE BUDS AND TENTACLES

MONDAY, 1:00 PM - 3:00 PM

Molecular basis of chemotactile sensation in Octopus

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Octopuses are voracious hunters that search the seafloor for hidden prey using their eight flexible arms. These arm behaviors are supported by a peripherally-distributed nervous system to sense and capture prey inaccessible to traditional sense organs. The sensory receptors employed to mediate these behaviors in cephalopods were unknown. Our investigation in this virtually unexplored 'touch-taste' sense led to the discovery of a novel family of chemotactile receptors (CRs) that mediate the octopus' contact-dependent, aquatic chemosensation CRs are found specifically in cephalopods, expressed in suction cups (suckers) along the arms, and mediate the detection of poorly-soluble terpenoid molecules from natural products which act as 'touch-taste' stimuli in aquatic environments. CRs are co-expressed in diverse patterns and form heteromeric ion channel complexes to specify signal detection and transduction, a filtering system suited to the octopus' uniquely-distributed nervous system. Furthermore, separate chemo- and mechanosensory cells express specific receptors and exhibit discrete electrical activities to encode chemical and touch information, respectively.

Funding Acknowledgments: NIH, SNF (swiss national science foundation) Searle Foundation, New York stem cell foundation

FCOI Declarations: None

O11-SATIETY-BASED MODULATION OF CHEMOSENSORY PROCESSING ACROSS ORGANISMS

MONDAY, 1:00 PM - 3:00 PM

SATIETY-BASED MODULATION OF CHEMOSENSORY PROCESSING ACROSS ORGANISMS

Thorsten Kahnt, Laura Shanahan

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It is well-appreciated that chemosensory perception and feeding behaviors are modulated by satiety, metabolic state, and body weight via central and peripheral brain mechanisms. The goal of this symposium is to bring together researchers who are seeking to understand these complex interactions at complementary levels through their work in organisms ranging from invertebrates to primates. Dennis Mathew will present data on how anorectic peptides modulate the function of olfactory neurons across satiety states in *Drosophila* larvae, and how dysregulation of peripheral mechanisms influences feeding behavior and animal physiology. Matthew Gardner will present data on how satiety-related changes in choice behavior for food depend on the orbitofrontal cortex. Maia Pujara will discuss findings on how interactions between orbitofrontal cortex and amygdala bias behavior when food palatability changes in nonhuman primates. Finally, Laura Shanahan will present work on how satiety influences perceptual decision-making and neural responses to food odors in humans. Together, these speakers will provide an overview of recent research on how satiety impacts chemosensory behavior in different species and the neural mechanisms driving satiety-dependent changes. By exploring this topic from a cross-species perspective, the symposium will highlight parallels in chemosensory processing across organisms, from simple to complex.

Funding Acknowledments: NIDDK R21DK118503 TK NIDCD R01DC015426 TK

FCOI Declarations: None

O12-SATIETY-BASED MODULATION OF CHEMOSENSORY PROCESSING ACROSS ORGANISMS

MONDAY, 1:00 PM - 3:00 PM

Analysis of starvation-dependent modulation of olfaction using the *Drosophila* larva.

Eryn Slankster[1], Roshni Jain[2], Dominique Baria[1], Brianna Dailey-Krempel[1], Seth Odell[3], Dennis Mathew[1,2,3]

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Starvation modulates an animal's sensitivity to food odors. A widely-accepted model is that during the animal's starved-state, lower insulin signaling leads to enhanced odor sensitivity and attraction to food odors. The model implicates NPF (fly ortholog of Neuropeptide Y) as a downstream target of insulin signaling. However, it does not account for the mechanisms by which insulin signaling changes odor sensitivity and behavior. We examine how insulin signaling mediates the starvation-dependent modulation of olfactory sensory neurons (OSNs). We hypothesize that insulin signaling impacts gene expression of downstream targets to influence neuron function. We take advantage of the fruit fly *Drosophila melanogaster* larva as a model system, which allows incisive molecular genetic analyses of olfactory neurons and their functions. Using an innovative molecular technique established in our lab, we show that insulin signaling in OSNs affects the transcription of *Rutabaga (Rut)* and *Synaptotagmin1 (Syt1)*, two downstream target genes. Next, we show that *domeless*, a receptor for leptin, also expresses in OSNs. Our evidence suggests that leptin and insulin signaling pathways interact within OSNs. However, it remains unclear why OSN-modulation requires multiple anorectic signaling mechanisms. Finally, we show that manipulating the insulin signaling pathway in OSNs impacts larval feeding behavior and body weight. Our results build upon the prevailing OSN modulation model and highlight opportunities to understand better OSN modulation mechanisms and their relationship to animal physiology. This project will generate new hypotheses and tools for the neuroscience community to understand how the internal contexts in which foraging decisions are made shape decision-making strategies.

Funding Acknowledments: Startup Funds, University of Nevada, Reno, NIGMS of the National Institute of Health under grant number P20 GM103650

FCOI Declarations: None

O13-SATIETY-BASED MODULATION OF CHEMOSENSORY PROCESSING ACROSS ORGANISMS

MONDAY, 1:00 PM - 3:00 PM

Shifts in Food Preference Following Selective Pre-Feeding Depend on an Intact Orbitofrontal Cortex

Matthew PH Gardner[1,2], Jessica C Conroy[1], Davied Sanchez[1], Jingfeng Zhou[1], Geoffrey Schoenbaum[1,3,4]

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Food preferences rely on a multitude of factors and are highly dependent on the current state of an organism. Many studies have indicated that preferences not only rely on general homeostatic regulatory states such as thirst and hunger, but can also vary depending on the chemosensory-specific features of recently consumed foods or fluids. This finding implies that decisions about what to consume rely on latent complex chemosensory representations of recently experienced stimuli. Although several recent studies have indicated that primary cortical chemosensory regions such as the gustatory cortex can exert direct control over decisions, other research has suggested that frontal regions, such as the orbitofrontal cortex (OFC) are required for decision-making more broadly. Recent work in humans has indicated that OFC is required for shifts in choices based on changed food preferences following sensory-specific satiety; i.e., extensive pre-feeding of a specific food such as roast beef. Using a choice task in which rats are required to make decisions by integrating the amount and type of food available for different options, we found that OFC is necessary for choice behavior when food preferences shift due to this type of sensory-specific pre-feeding. Surprisingly, OFC was not required for behavior on this multi-feature choice task when preferences remained static. This finding implies that OFC is uniquely necessary for food choices when latent specific chemosensory representations must be incorporated into the decision.

Funding Acknowledgments: NIDA ZIA-DA000587 GS
FCOI Declarations: None

O14-SATIETY-BASED MODULATION OF CHEMOSENSORY PROCESSING ACROSS ORGANISMS

MONDAY, 1:00 PM - 3:00 PM

A preliminary investigation of flavor-nutrient conditioning on decision-making and autonomic arousal in rhesus macaques

Maia Pujara[1,2], Jaewon Hwang[1], Nicole Ciesinski[1,3], Charday Long[1], Dawn Lundgren[1], Elisabeth Murray[1]

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Flavor-nutrient conditioning (FNC) elicits increased pleasantness ratings in humans and consumption in rodents for noncaloric fluids. Either amygdala (AMY) or orbitofrontal cortex (OFC) damage in monkeys disrupts flexible shifts in stimulus choice, but not consumption, following decreases in reward value. We adapted a paradigm developed in humans to test the causal role of OFC-AMY interactions in a decision-making task following selective FNC. All monkeys learned that two stimuli predicted two unique and equally preferred fluids. Monkeys then consumed the fluids, only one of which contained maltodextrin, used to increase the caloric content of one of the fluids and thus the reward value of the fluid selectively. Following conditioning, monkeys were evaluated for choices and pupil responses, as a measure of anticipatory arousal of reward. We also measured consumption of the two fluids before and after conditioning as a 'proof of concept' of the FNC manipulation. First, we predicted that all monkeys would show increased consumption of the fluid that was selectively paired with maltodextrin during conditioning. Second, we anticipated that monkeys with OFC x AMY lesions (n=4) would be impaired in making adaptive stimulus choices after increases in fluid value due to FNC. Third, we predicted that pupil size during stimulus presentation would track with the shift in expected reward value and that this would be positively correlated with choice for controls (n=5), but not for the lesioned group. All monkeys showed increased consumption of the conditioned fluid. However, this did not translate to a significant increase in choice or pupil size for the stimulus that predicted the conditioned fluid. Follow-up studies will address the factors affecting choice behavior and autonomic arousal following FNC.

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FCOI Declarations: None

O15-SATIETY-BASED MODULATION OF CHEMOSENSORY PROCESSING ACROSS ORGANISMS

MONDAY, 1:00 PM - 3:00 PM

How satiety modulates perceptual decision-making in olfactory circuits

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Prior work in both animals and humans suggests that food intake and odor perception are closely linked. For instance, multiple studies have shown that food odors are perceived as less pleasant in the sated state. However, whether and how satiety shapes olfactory perceptual decision-making remains unclear. To address this gap, we developed a novel olfactory decision-making task using binary odor mixtures. The mixtures consisted of food and non-food components (e.g., pizza and pine). On each trial of the task, human participants (n = 30) had to decide which component was dominant in the mixture. Participants completed the task before and after an odor-matched meal (e.g., pizza) so we could compare olfactory choices across hungry and sated states. We found

that participants were less likely to select the meal-matched food odor as dominant in the sated state. This behavioral change could serve to facilitate olfactory decision-making by dampening food-based cues when they are least relevant (i.e., when sated). We also acquired functional magnetic resonance imaging (fMRI) data while participants engaged in olfactory decision-making to investigate the underlying neural mechanisms. We found that food intake influences odor-evoked fMRI ensemble patterns in olfactory cortex. Specifically, in the sated state, (1) activity patterns evoked by food and non-food odors were less discriminable for meal-matched odors, and (2) activity patterns evoked by odor mixtures were less food-like for the meal-matched odor pair. Moreover, we observed state-dependent differences in functional connectivity between olfactory cortex and insula. Our work reveals how satiety state modulates olfactory decision-making in the human brain, and may have important implications for health and nutrition.

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FCOI Declarations: None

O16-PRESIDENTIAL SYMPOSIUM

MONDAY, 4:00 PM - 6:00 PM

Chemosensory behaviors of skin-penetrating nematodes

Elissa Hallem

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Gastrointestinal parasitic nematodes infect over a billion people worldwide and are a major cause of neglected tropical disease. These parasites have an infective larval stage that actively searches for hosts to infect using chemosensory cues. We are interested in understanding the chemosensory responses of infective larvae, as well as the neural mechanisms that underlie them. We found that infective larvae are robustly attracted to a diverse array of host-emitted odorants. They also respond to carbon dioxide (CO_2). Responses to CO_2 vary dramatically across species: some infective larvae are repelled by CO_2, while others show flexible responses to CO_2 that can be either attractive or repulsive depending on prior experience. To investigate the neural mechanisms underlying the flexible responses of parasitic nematodes to CO_2, we turned to the free-living nematode *C. elegans*. Like parasitic nematodes, *C. elegans* exhibits highly flexible responses to CO_2: well-fed adults are repelled by CO_2, while starved adults and dauer larvae are attracted to CO_2. We found that both CO_2 attraction and CO_2 repulsion in adults are mediated by the same microcircuit, and CO_2 response valence is determined by experience-dependent modulation of interneuron activity. Surprisingly, however, we found that CO_2 attraction in dauers is mediated by a different microcircuit consisting of the same CO_2-detecting sensory neurons but a distinct set of downstream interneurons. Thus, opposite CO_2-evoked behaviors can arise from experience-dependent modulation of the same microcircuit, and the same CO_2-evoked behavior can arise via different microcircuits. We are now investigating whether similar circuit mechanisms operate in parasitic nematodes to regulate their ability to find and infect hosts using CO_2.

Funding Acknowledgments: NIDCD
FCOI Declarations: None

O18-PRESIDENTIAL SYMPOSIUM

MONDAY, 4:00 PM - 6:00 PM

Sugar: A gut choice

Diego V Bohórquez

Duke University, Durham, NC, USA

Our motivation to consume sugars is thought to arise at the surface of the gut. However, the neural circuits are unknown. The Bohórquez Laboratory discovered a neural circuit linking gut to brain in one synapse. The circuit begins with a type of sensory epithelial cell that synapses with the vagus nerve. These epithelial cells are called neuropod cells. In the mouse small intestine, monosynaptic rabies virus infects neuropod cells and spreads onto vagal neurons that project to the nucleus tractus solitarius in the brainstem. This neural circuit is necessary and sufficient to transduce sensory signals from sugars. Silencing neuropod cells silences the ability of the animal to distinguish the caloric content in sugars. This gut sensor for caloric sugars is a portal for nutrients to drive our motivation to eat.

Funding Acknowledgments: 1DP2MH122402-01, 1R21AT010818-01
FCOI Declarations: None

O19-MAX MOZELL: THE WORK LIVES ON

MONDAY, 6:00 PM - 8:00 PM

Max Mozell: The Work Lives On

Theresa White[1,2]

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Max Mozell, one of AChemS' founders, passed away in March of 2020. Max's life in research was dominated by the study of olfactory perception and the effects of its loss on the patients with olfactory loss that he saw at the Smell and Taste Disorders Clinic at SUNY Upstate Medical University in Syracuse. This symposium is meant to honor his contributions to chemosensory research by looking at the latest developments in our understanding of the events in the nasal cavity. One of the things that Max would often say is that although

many mysteries remain in understanding olfactory perception, at least one aspect is clear: if molecules from odorous substances can't reach the olfactory receptors, there can be no perception. The airflow to deliver the molecules and the way that the molecules interact with the nasal mucosa are therefore central to the olfactory perceptual process. Changes in either the number of molecules or their distribution (and sorption) on the mucosa then alters incoming olfactory information, possibly resulting in dysosmia. This symposium will focus on recent findings in the peripheral olfactory system involving sniffing behavior, odor sorption, and molecular biology, as well as their application to clinical chemosensory disorders.
Funding Acknowledments: None
FCOI Declarations: None

O20-MAX MOZELL: THE WORK LIVES ON

MONDAY, 6:00 PM - 8:00 PM

The Sniffing Brain: From a Unit of Olfaction to a Unit of Cognition

Noam Sobel

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Inspired (to choose a term:-) by Max Mozell, our lab has focused on the role of sniffing in the olfactory process, and in this symposium honoring Max, I will first briefly review these efforts. I will detail how nasal airflow dominates patterns of neural activity throughout the human olfactory brain, how nasal airflow impacts olfactory perception, and how our two different airflows across nostrils result in two offset olfactory images sent from our nose to our brain with each sniff. Given this role of sniffing in olfaction, we have proceeded to use measures of sniffing as non-verbal non-task dependent measures of olfactory perception, and these have been informative in a host of disease conditions including Parkinson's disease, autism spectrum disorder, and disorders of consciousness. Finally, I will argue that given the shaping force of olfaction in the evolution of the mammalian brain and resulting cognition, the sniff makes for an essential unit of processing not only in olfaction, but in cognitive processes beyond.
Funding Acknowledments: EU ERC
FCOI Declarations: None

O21-MAX MOZELL: THE WORK LIVES ON

MONDAY, 6:00 PM - 8:00 PM

Mozell's Chromatographic Theory: A molecular basis of cognitive behavior?

Ann-Sophie Barwich

Indiana University Bloomington, Bloomington, IN, USA

Max Mozell's chromatographic theory, he told me for an interview in 2018, never was completed. His hypothesis states that the mucosa in the nasal epithelium yields a spatially differentiated pattern of odorants with different sorptive rates. Mozell formulated this idea before the olfactory receptor discovery in 1991 and the availability of genetic techniques that allow for target-specific probing of olfactory sensory neurons. His theory does not find many adherents in contemporary olfactory research, now focusing on decoding the stimulus with machine learning and neural principles with optogenetics. Notwithstanding, there are good reasons to reengage with Mozell's theory and translate some of its critical tenets into the 21st century. This talk highlights Mozell's interest in linking sniffing behavior to a molecular physiological mechanism at the periphery. It asks: What questions about the olfactory process did Mozell's theory address that may still be of value today?
Funding Acknowledments: NA
FCOI Declarations: None

O22-MAX MOZELL: THE WORK LIVES ON

MONDAY, 6:00 PM - 8:00 PM

Addressing smell loss: from a Clinical Olfactory Research Center to ongoing translational research efforts

Bradley J. Goldstein

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Max Mozell, PhD was instrumental in founding AChemS, in developing the Smell and Taste Disorders Clinic at SUNY Upstate Medical University in Syracuse, and was concerned about the care of patients with dysosmia and dysgeusia. The Center grant led to a robust basic and clinical chemosensory research environment, which fostered graduate student training and research career development, with lasting influences on current research programs. Here, we review some of the areas of focus related Dr. Mozell's efforts, as well as current work that has emerged from these early studies.
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FCOI Declarations: None

O23-MAX MOZELL: THE WORK LIVES ON

MONDAY, 6:00 PM - 8:00 PM

Lord Adrian's and Max Mozell's Analogy: Olfaction as a Spatial Sense.

David M Coppola

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Sensory epithelia contain arrays of receptors that capture relevant environmental information. Where there is a spatial dimension to the target stimulus, the distribution of receptors in these epithelia (e.g. retina and skin) is non-uniform to optimize information capture and neural processing. By contrast, odors, unlike visual and tactile stimuli, have no obvious spatial dimension. What need could there be for nearest-neighbor relationships, anisotropic distributions

of receptor cells, or other non-uniformities in the distribution of sensory neurons in the olfactory epithelium (OE)? More than a half century ago, the Nobel laureate Edgar Adrian provided the only widely debated answer to this question when he posited that the physical properties of odors, such as volatility and water solubility, determine a spatial pattern of stimulation across the OE that could aid in odor discrimination. A generation later his intellectual "grandson," Maxwell Mozell crystalized thinking about this problem by drawing a powerful analogy, based on his experimental observations, that likened the workings of the vertebrate nasal mucosa to a gas chromatograph machine. In a spate of now classic studies Mozell went on to establish what has come to be known as the 'sorption hypothesis' as a mainstream concept. However, despite the hypothesis' longevity it has undergone surprisingly few critical tests. In an ongoing effort to directly test the predictions of this hypothesis, we will report our latest results comparing electroolfactogram response maps to computational fluid dynamics simulations of airflow and sorption patterns in the nasal cavity. We find global but not local agreement with predictions of the hypothesis. These unexpected findings point to a need for further explication of the sorption hypothesis.

Funding Acknowledments: NSF y grant IOS-1655113

FCOI Declarations: None

O24-NON-WEIRD HUMAN CHEMOSENSORY SCIENCE

MONDAY, 6:00 PM - 8:00 PM

Non-WEIRD Human Chemosensory Science

Maria G Veldhuizen[1], Valentina Parma[2]

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Big scientific questions related to the chemical senses are being investigated by a community of chemosensory scientists in varying degrees of collaborations. Such problem-solving is unquestionably rooted in the culture of the societies those scientists live in. The chemical senses may be most acutely affected by culture, environment, social race and geography. As a result, most chemosensory knowledge is biased towards Western, educated, industrialized, rich and democratic (WEIRD) populations and research areas. It is a missed opportunity to not conduct more inclusive and collaborative research to solve complex chemosensory problems, as progress demands diverse perspectives and the accumulation of unbiased big data. In this symposium we propose themes in literature, methods and approaches that provide advancements in chemosensory science that can be widely and cross-culturally applicable. How can we use olfactory testing flexibly, for example for screening during a pandemic? How does culture shape odor awareness and, more in general our (chemo)sensory perception? How can we link basic scientific chemosensory discoveries to the lived experience of patients, in ways that make patients feel heard and reinforces confidence in science?

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FCOI Declarations: None

O25-NON-WEIRD HUMAN CHEMOSENSORY SCIENCE

MONDAY, 6:00 PM - 8:00 PM

Local and global consequences of the Anthropocene on olfaction

KC Hoover

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Human sensory ecology has experienced unprecedented disruption during the Anthropocene. Olfactory dysfunction is a critical concern because there are no clinical interventions, reliable data on incidence, or estimates of health costs—the latter despite known impacts to social, mental, and physical health. Pollution and respiratory illnesses are the primary culprits of contemporary olfactory dysfunction, but structural, demographic, and environmental injustices exacerbate disparities in health outcomes based on socio-economic status. Hunter-gatherers do not experience the age-related visual and auditory functional decline associated with non-traditional societies and there are no data yet on age-related olfactory decline. There are minimal data on olfactory functioning outside clinics and labs and clinical and lab data are mostly from western societies. Finally, there are minimal data on the role of genetics in producing variation in olfactory ability. While there may be genetic differences among groups, lifestyle is a more obvious culprit. I will explore these topics and smelling in the Anthropocene by taking a holistic perspective that includes evolutionary sensory ecology, genetics, and social structure.

Funding Acknowledments: US National Science Foundation Award #1550409

FCOI Declarations: None

O26-NON-WEIRD HUMAN CHEMOSENSORY SCIENCE

MONDAY, 6:00 PM - 8:00 PM

Olfactory testing in a non-WEIRD population in Africa requires new norms, culturally appropriate odors and consideration of endemic pathologies

Patrick Balungwe Birindwa[1,2], Caroline Huart[2], Ghislain Bisimwa[1], Richard Matanda[3], André Mouraux[2], Philippe Rombaux[2]

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The objectives of present study were 1) to assess applicability of the sniffin'Sticks test in the population of south-Kivu (DR Congo) 2) to develop a culturally adapted version with normatives values and 3) to evaluate the prevalence of different étiologies of olfactory dysfunction as observed in a sub-saharan African population. Matérials and methods In a first study, 157 volunteers were tested with the original Sniffin'Sticks test. Based on these results, we selected odors that were poorly recognized in the identification test and we remplaced them by culturally adapted odors. In a second study, we assessed the modified version of the Sniffin'sticks test in 150 volunteers and defined normative values. In a third study we used this adapted version in 116 consecutives patients with an olfactive disorder to evaluate the prevalence of differents etiologies of olfactives dysfunction. Results In the first study we found that olfactory function (threshold-discrimination-Identification: TDI score) significantly decreased with age and was better in females. Five odors were poorly recognised and were remplaced by culturally adapted odors. In the second study, we found that this adapted version led to higher rate of correctly identified odors. We defined normatives values for the South-Kivu population. In the third study we observed that in our study population hyposmia predominated when the cause was upper repiratory infection, whereas anosmia did when the cause was non-infectious, congenital or idiopathic. Conclusion This adapted version of the Sniffin'Sticks test is culturally adapted to the South-Kivu population. The normative values will provide the basis fo clinical evaluation of pathologic subjects. In our study population, upper respiratory infection were the main cause of dysosmia. the anosmic cases we observed tended to be non-infectious and congenital in nature or idiopathics suggesting that there existed other etiological factors which require futher investigation.

Funding Acknowledments: This study was supported by the Universite Catholique de Louvain

FCOI Declarations: None

O27-NON-WEIRD HUMAN CHEMOSENSORY SCIENCE

MONDAY, 6:00 PM - 8:00 PM

Moving from researcher-centric methodologies to patient-inclusive chemosensory research

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Across the social and biological sciences attention has shifted to how participants may be included as equal partners in establishing research questions, designing research, and disseminating findings. The rationale touches on ethics but also on results; co-produced research has been found to be more meaningful to patients and translates into practice more quickly and effectively. In the UK, co-produced research is now not simply an option, but a requirement for many publicly funded research streams. Chemosensory research not only lends itself to co-production, but it makes sense in other ways. As we have argued in relation to food play research in those with altered eating, the presence and pungency of food evokes the viscerality and lived experience of the food encounter, illuminating it as no focus group could. With reference to our experience of employing the food play methodology and multi-sensory methods, I will explore the value of co-produced research 'beyond talk'.

FCOI Declarations: None

O28-NON-WEIRD HUMAN CHEMOSENSORY SCIENCE

MONDAY, 6:00 PM - 8:00 PM

Global Commonalities in Social Odor Awareness from a Large-Scale Dataset: Study Across 44 Countries

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Smells are very important in the social context and were shown to play numerous roles in human communication. However, the significance of olfaction, consciousness of olfactory sensations and the extent to which people are affected by odors in everyday social life often varies between individuals. Existing literature enabled us to identify certain individual and cultural predictors that seemed to be related to attitudes toward social/personal odors and could help explain the previously observed variance in social odor awareness: gender, age, material situation, education and preferred social distance (individual-level predictors) and Human Development Index, population density and average temperature (country-level predictors). Here, I will present the results of the work of our cross-cultural group in 52 study sites from 44 countries from all over the world. Our large-scale analysis comprised 10,794 male and female participants aged between 17 and 88 years. The subjects completed paper-and-pencil questionnaires that included 6 questions on odor awareness in social situations derived from Odor Awareness Scale (Smeets et al., 2008). Our multilevel regression models showed that the individual characteristics were more strongly related than country-level factors to self-reported odor awareness in different social contexts. We found three statistically significant predictors of odor awareness - gender, age and education. Although there was

some cross-cultural variance in social odor awareness, the main differentiating role was played by the individual differences. This suggests that people living in different cultures and different climate conditions may still share some similar patterns of odor awareness if they share other individual-level characteristics.

Funding Acknowledments: This work was supported by the Polish Ministry of Science and Higher Education Iuventus Plus grant # IP2014 043773 to AS and other funds to different members of the Cross-Cultural Research Group.

FCOI Declarations: None

O29-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Do Fats and Carbohydrates in the Diet Modulate Peripheral Olfaction?

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Lots of research establishes a connection between food intake and olfaction yet it remains unclear which specific olfactory areas and food attributes contribute to this connection. Here, we studied whether diets with varying amounts of carbohydrate and fat but the same caloric content can modulate peripheral olfactory processing, determined by odorant discrimination and electro-olfactogram (EOG) recordings. We placed 48 adult male mice for 17 weeks on one of four diets: high-carbohydrate low-fat (HCLF), low-carbohydrate high-fat (LCHF), equal carbohydrate equal fat (ECEF) or standard chow as control (Chow). Mice fed the ECEF diet had the highest body mass compared to the other groups. The ECEF and LCHF groups had higher fed blood glucose levels than did the other two groups; the LCHF group had the lowest fasted blood glucose. We performed an odorant habituation/dishabituation test by successively presenting odorant A then B four consecutive times each separated by a 3-min intertrial interval. Odorants used were heptaldehyde/hexanal and ethylbutyrate/valeric acid. Based on odorant investigation time as an indicator of odor novelty, we found that all mice were able to discriminate between the two odorant sets presented. However, only the chow group showed habituation to ethylbutyrate by decreasing investigation time between presentations 1 and 4. EOGs recorded from the olfactory epithelium showed that ECEF-fed mice had the highest peak amplitude of all diet groups; the LCHF group had the lowest peak amplitude. Our results indicate that different diets have different effects on metabolism but there was no indication from this experiment that dietary fat per se alters olfaction. Collectively, these data point to a more intricate connection between food composition, body weight and olfactory perception.

Funding Acknowledments: R01DC-016647 JR T32DC-000014 DA R21DC-018358 FG R01DK-124179 MT

FCOI Declarations: None

O30-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Volatile-Enhanced-Saltiness: A Simple Method to Identify Active Volatiles

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Retronasal perception of some volatiles can enhance taste sensations. We present a rapid psychophysical method to identify foods that contain taste-enhancing volatiles using volatile-enhanced-saltiness as an example.

Method: pinch nostrils closed, put food in the mouth, chew and swallow it, rate saltiness; open the nostrils and rate saltiness again. Ratings used the GSIS, (Global Sensory Intensity Scale): 0=no sensation, 100=most intense sensation of any kind ever experienced. Saltiness enhancement quantification: (nostrils open salty - nostrils closed salty)/ nostrils closed salty.

Experiments: In a pilot study, subjects (N=14) sampled 39 foods. Those that produced the best salt enhancement were selected for evaluation with a larger group (N=55). Subjects sampled the foods as well as an NaCl solution.

Results: T-tests (with Bonferroni corrections) revealed significant increases ($p = 0.05$) in the saltiness of pinto beans, chocolate/peanut butter candies, ham, potato chips, Parmigiano cheese, clamato juice, cheddar cheese, clam juice and olives (order of decreasing effect); saltiness of the 0.2 M NaCl control solution did not increase. Volatiles known to be in the foods in which saltiness increased can be tested in a pure NaCl solution to determine which produced the enhancement.

Summary: (1) Volatiles that enhance NaCl can be used to enhance the saltiness of any food that contains some salt. (2) volatiles that enhance saltiness may be able to enhance saltiness perception in patients with damage to taste nerves. (3) The identification of foods/beverages that contain volatiles capable of enhancing saltiness with this "nose bump" method requires no chemical analyses and so can be used by investigators who do not have access to the equipment required for identification of volatiles.

Funding Acknowledments: University Funds

FCOI Declarations: None

O31-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Effects of Dietary Fat Intake on Fatty Acid Signaling in Mouse Taste Cells

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The pathways that underlie the pre- and post-ingestive recognition of dietary fat and their regulation have been of increased interest because of the link between dietary fat intake and obesity. To this end, we have begun to explore if the pathways that underlie our ability to taste fat (e.g., fatty acids) are altered by diet in mouse models. Our data show that mice can taste both saturated fatty acids (SFAs) and unsaturated fatty acids (UFAs) and do so by different transduction pathways. To determine the ability of high fat diets to alter fatty acid pathways, we compared mice on a control low fat (10%) diet (CD) and a high unsaturated fat (60%) diet (HUFD; 3.3 UFA: 1 SFA). We performed qPCR to measure expression of elements of the UFA (linoleic acid; LA) transduction pathway in mice from the two diet groups. Notably, changes in CD36 expression were observed on the HUFD only. Using whole cell patch clamp recording we observed increased inward currents elicited by LA in taste cells from mice on the HUFD for 8 weeks. The increased current was shown to be through TRPM5 channels, as blocking of these channels resulted in similar current amplitudes between control and HUFD taste cells. Interestingly, these HUFD-induced increases in inward currents were independent of CD36 activation. CD36 inhibition by sulfo-N-succinimidyl oleate (SSO) did not block the changes in LA-induced currents. Furthermore, the increased inward currents induced by LA appeared to be dependent, in part, on the specific type of fatty acids present in the diet. Mice fed a high saturated fat diet (60% fat; 10 SFA:1 UFA) for 8 weeks did not show significant increases in inward currents elicited by LA. Our initial data support the concept that fat taste pathways may be altered in response to specific dietary fat intake.

Funding Acknowledments: Supported by NIH grant R01DC013318 (tag)

FCOI Declarations: None

O32-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Olfactory Sensitivity and Food Neophobia: a Psychophysical Study among Older Children

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Food neophobia, i.e., rejection or avoidance of novel foods, could have been an adaptation that reduced chances for food poisoning in childhood in our distant evolutionary past. However, currently it is a problem that affects quality of diet and healthy food preferences. Researchers identified some determinants and correlates of this issue that include also sensory sensitivity, but the studies in the area are scarce and limited to certain age groups. Here, we examined the relationship between food neophobia, odor identification and odor pleasantness assessments in older children. The study comprised 257 girls and 253 boys aged 15–17 (M=15.98, SD=0.82) tested during group sessions at different schools in Poland. The teenagers completed a questionnaire and a psychophysical test of odor identification abilities. Within the questionnaire part, the teenagers completed a translated Food Neophobia Scale (Pliner & Hobden, 1992) that consists of 10 questions, each measured on a 7-point agree-disagree scale. The psychophysical testing involved a self-administered smell test for children (Schriever et al., 2018) in participants' native language. In addition to identifying each smell in a cued identification task, the subjects were asked to rate pleasantness of each smell using a percentage scale (0–100%). We found that odor identification score was slightly, but significantly related to food neophobia (r=-.12, p=.01) and averaged odor pleasantness assessments (r=-.22, p<.001). Our results mirror the previous findings in adults and young children - it seems that the reduced variance in consumed food predicts decreased olfactory expertise regardless of age.

Funding Acknowledments: The project was funded by the Polish National Science Centre grant UMO-2016/22/E/HS6/00118 to MK. During the project, DC and AS were supported by the University of Wroclaw funds.

FCOI Declarations: None

O33-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Plasticity of Retronasal Odor Perception in Young Children

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Flavor perception is a key factor in dictating food choice, which directly relates to health outcomes such as obesity and type II diabetes. Between 2 and 6 years of age, children experience changes in food attitudes. This project examines the potential contribution of gustatory and and retronasal olfactory perception to these behaviors. Although taste preferences are stable from birth, there is no knowledge of the development of retronasal smell perception, partly due to the

difficulty in assessing sensory function in toddlers. Thus, the primary goal of this study is to implement a novel protocol for assessing flavor preference in toddlers to investigate developmental changes in retronasal odor perception. Subjects were recruited and tested in the local community. Young children (n=22) and one of their parents (n=24) were asked to drink 8 solutions consisting of clear liquids with either a taste or an odor compound, or plain water. Solutions were presented in cups with lids and straws to prevent orthonasal recognition. Participants rated the solutions on a 1–5 pictorial liking scale, and reactions were recorded with a camera to assess facial/vocal responses. Stimuli consisted food and nonfood odorants. High concentrations of sweet and bitter tastes were used as positive control. Ratings from all solutions were analyzed to determine perceived flavor intensity and valence. We predicted that retronasal olfaction undergoes developmental changes, while taste remains stable. We found that taste intensity and valence, as well as odor intensity did not change, but there was more variability in valence ratings for odors in children compared to adults. This suggests that the subjective aspects of retronasal odor perception differ between children and adults and can potentially be modified by experience.

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FCOI Declarations: None

O34-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Changes in splicing and neuromodulatory gene expression programs in sensory neurons with pheromone signaling and social experience

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How sensory experience alters gene regulation to modify behaviors remains unknown. We use fly courtship as a model to study this question as social cues such as pheromones affect sex-specific behaviors governed by the function of *fruitless*^{M} (*fru*^{M}). Social experience through pheromone dependent activity in ORNs regulates enrichment of active chromatin marks around *fru* gene, leads to *fru*^{M}-dependent changes in neuronal responses, and increases male courtship competitive advantage. We hypothesize that social experience and pheromone signaling dependent modification of Fru^{M} function, changes the expression of downstream genes involved in neuromodulation, modifying neuronal sensitivity and courtship behaviors. To identify social experience and *fru*^{M} dependent changes in gene expression in ORNs, we performed antennal RNA-seq from wild type males raised in groups, in isolation, or mutants for pheromone receptors (*Or67d* and *Or47b*) and *fru*^{M}. We found that loss of ORN signaling led to exon specific differential regulation of *fru*^{M} suggesting effects of *fru* chromatin states on *fru* splice patterns in response to social experience and pheromone signaling. Consistent with previous studies of Fru^{M} activity, we found that social experience and pheromone signaling alter the expression of Fru^{M} targets such as many ion channel gene families and neurotransmitter receptors. Genes involved in metabolism of Juvenile hormone, an internal age-related cue shown to regulate ORN responses and maturation of courtship behaviors, were also differentially regulated. Our results provide insights into the fundamental molecular mechanisms by which sensory experience drive behavioral modulation, by altering chromatin and splice patterns of key transcription factors critical for determining neural circuit structure and function.

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FCOI Declarations: None

O35-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

The Recovery of Neural Taste Responses Following Axotomy Is Dependent on IL-1 Receptor Signaling

Guangkuo Dong, Schuyler Kogan, Natasha Venugopal, Eddy Chang, Lianying He, Daniel Linder, Lynnette P McCluskey

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Mechanisms responsible for sensory target cell regeneration following peripheral nerve injury are not well understood. The master regulatory cytokine, IL-1, has both positive and negative effects in other injured neural systems in addition to its canonical role in inflammation. Members of the IL-1 signaling family, including the IL-1 receptor (IL-1R), IL-1R accessory protein, and ligands IL-1a and IL-1b are expressed in fungiform taste buds and the anterior lingual epithelium. We tested whether IL-1 signaling is needed for regeneration and recovery of neurophysiological responsivity following unilateral chorda tympani (CT) nerve sectioning. In wild-type C57BL/6J (B6) mice the CT and fungiform taste buds regenerated and responded normally to salt, sweet, bitter, sour and umami taste stimuli by day 18–21 post-sectioning. In contrast, IL-1 receptor knockout (IL-1R KO) mice exhibited minimal CT responses to tastants even eight weeks after injury. Surprisingly, IL-1R mRNA expression increased in the lingual epithelium of B6 mice at the same time. The CT nerve regenerated in both strains, but taste bud regeneration and reinnervation was delayed by over four weeks in the absence of IL-1R. The dynamics of taste progenitor cell proliferation were also affected by IL-1R KO. The number of Ki67+ cells in the apical papilla wall was initially reduced

in B6 but not IL-1R KO mice. However by day 32–34 post-injury this trend was reversed as the number of Ki67+ cells was significantly higher in the perigemmal, apical and basal papillae regions in B6 but not IL-1R KO mice. By 8 weeks after injury the proportion of type I, II, and III cells was not significantly different in the two strains of mice. These results demonstrate the requirement for IL-1 signaling in the efficient regeneration of taste buds and the return of CT taste responses after axotomy.

Funding Acknowledgments: NIDCD RO1DC016668
FCOI Declarations: None

O36-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Deciphering the Cell Surface Codes Underlying the Assembly of Drosophila Olfactory Circuits

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The Drosophila olfactory system provides an excellent model to study how complex neuronal circuits are assembled. In Drosophila, each olfactory receptor neuron (ORN) class exclusively expresses a unique olfactory receptor (OR) gene and target each class-specific and uniquely positioned glomerulus in the antennal lobe. How ORN axon terminals are organized into these dedicated structural compartments is not well understood. Through transcriptome profiling of the antennal tissues during development and RNAi screen, we identified two protein subfamilies belonging to the Immunoglobulin Superfamily, Beats and their heterophilic binding partners Sides, as novel regulators of ORN glomerular organization. Many Beats and Sides are expressed at low levels at early pupal stages but increase their expression levels later. Beats and Sides are also differentially expressed across ORN classes, making them good candidates for encoding the ORN class-specific cell surface codes to mediate neuron-neuron recognition. Perturbing the functions of many Beats and Sides in all ORNs starting early in development or a subset of mature ORNs at later stages leads to diverse local defects of ORN glomerular organization, associated with the expanding, split, or flipped glomerular morphology. Binding Beat-Side pairs are co-expressed in the same class of ORNs and knockdown of either member of these interacting pairs could lead to similar ORN axonal disorganization. These defects are not likely resulted from synaptic mismatching, but rather the loss of axonal adhesion. Our data suggest the context-dependent control of ORN glomerular organization by Beat/Side combinatorial codes, and bring new insights into how diverse neuronal populations are coordinated into hardwired circuits.

Funding Acknowledgments: NSF IOS-2006471 PV
FCOI Declarations: None

O37-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

The function of EGR4 in development of the peripheral gustatory system

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Early Growth Response 4 (EGR4) belongs to the EGR family of zinc-finger transcription factors and has a critical role in the development and differentiation of several cell types such as spermatogonia, dorsal root ganglia (DRG) neurons, and others. During our investigation of the genes important for the development of geniculate ganglion neurons, EGR4 was identified as a gene enriched in Phox2b-positive oral sensory neurons. Its function in the gustatory system is currently unknown. To this end, we performed fluorescence *in situ* hybridization (FISH) and immunolabeling for EGR4 in the geniculate ganglion. These experiments demonstrated that EGR4 mRNA and protein were absent at postnatal day 3 (P3). However, both EGR4 mRNA and protein were observed by P10 and were robustly expressed in the adult geniculate ganglion, indicating that EGR4 expression was initiated between P3 and P10. To evaluate the role of EGR4 in postnatal geniculate neurons, *EGR4*-/- mice were compared to *EGR4*+/+ mice. *EGR4*-/- mice have a significant reduction in the expression of the chemosensory fate-determinant Phox2b in adulthood, as well as a reduction in genes selective to subpopulations of oral sensory neurons. We also found severe deficits in chemosensory innervation of taste buds in both Fungiform and Circumvallate papillae in *EGR4*-/- mice as compared to *EGR4*+/+ mice. These ongoing studies suggest that EGR4 plays an integral role in the cell fate determination of oral sensory neurons in the geniculate ganglion and their innervation of the taste buds.

Funding Acknowledgments: NIDCD R01DC015799 BAP
FCOI Declarations: None

O38-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Identification of New Intermediate Taste Cell Populations Suggests a Role for Notch Signaling in Taste Cell Fate Decisions in Mouse Circumvallate Papilla Taste Buds

Dany Gaillard[1], Eric D. Larson[2], Lauren A. Shechtman[1], Trevor Isner[1,3], Theresa M. Keeley[4], Austin E. Gillen[5], Peter J. Dempsey[6], Linda C. Samuelson[4], Linda A. Barlow[1]

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In adult mice, taste cells renew frequently to preserve taste function. SHH^+ post-mitotic taste precursor cells arise from $LGR5^+$ progenitors and differentiate into Type I (glial-like), II (sweet, bitter, umami) and III (sour) taste cells. Using 10x Genomics single-cell RNA-sequencing of mouse circumvallate papillae and trajectory inference analyses, we established a working model of the entire taste lineage. Further, we have identified two previously unknown lineage steps in Type II and III cell differentiation: 1) Type II/III intermediate precursors and 2) immature Type III cells. Our RNAseq data also suggest that Notch pathway signaling iteratively regulates progenitor cells and taste cell fate. Specifically, Notch receptors are prevalent in progenitor subpopulations, and within taste buds, are present in SHH^+ precursors and Type I cells. Based on our observation of Notch ligands *Dll1* and *Dll4* expressed in Type II/III precursors and immature Type III cells, respectively, we hypothesized these cells signal to SHH^+ precursors and Type I cells via NOTCH to promote production of new Type I cells. To test this, organoids generated from *Lgr5*+ lingual progenitors were treated with a Notch inhibitor (DAPT). Consistent with our hypothesis, Notch inhibition led to reduced Type I cells, with increased Type II and III cell differentiation. Organoids were also treated with a Notch pathway activator (valproic acid -VPA) predicted to drive excess Type I cells. However, unexpectedly, VPA blocked differentiation of all taste cell types, suggesting broad Notch activation in organoids promotes taste stem cell maintenance, supporting a model where Notch regulates several steps of the taste lineage. Molecular genetic experiments in mice are underway to test an iterative model of Notch function in taste cell renewal.

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FCOI Declarations: None

O39-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

ALK3-mediated BMP Signaling regulates Mesenchymal-Epithelial interactions to promote Taste Papilla Development through Secretory Factors.

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We have previously reported that conditional knockout of type I BMP receptor *Alk3* (*Alk3*^{cKO}) in mouse tongue mesenchyme (*Wnt1-Cre* driven) resulted in an absolute absence of sonic hedgehog $(Shh)^+$ taste papilla placodes at E12.0. To explore the mechanisms of how ALK3-mediated BMP (ALK3-BMP) signaling in the tongue mesenchyme regulates the taste papilla development, bulk RNA-Seq analysis was performed. Our data demonstrated that many more differentially expressed genes (*Wnt1-Cre*/*Alk3*^{cKO} versus Cre-/*Alk3*$^{fx/fx}$ littermate controls) were detected in the epithelium than those in the mesenchyme of E12.0 tongue. The development of Shh^+ taste papillae was inhibited when E12.0 wild type tongues were co-cultured with the *Wnt1-Cre*/*Alk3*^{cKO} mutant tongue mesenchyme indicating an enhanced secretion of inhibitory factors from the *Wnt1-Cre*/*Alk3*^{cKO} tongue mesenchyme. Further, Shh^+ taste papilla development was suppressed in E12 + 2 day wild type tongue cultures fed with mesenchyme-derived conditioned media from *Wnt1-Cre*/*Alk3*^{cKO} mutants, but not *Cre-*/*Alk3*$^{fx/fx}$ littermate controls, further confirming an increased level of inhibitory secretory factors from *Wnt1-Cre*/*Alk3*^{cKO} tongue mesenchyme. To identify the potential secretory factor(s), Western blot was performed on the mesenchyme-derived conditioned media isolated from the *Wnt1-Cre*/*Alk3*^{cKO} mutants and *Cre-*/*Alk3*$^{fx/fx}$ littermate controls. We detected NBL-1, a known secretory protein, at a significantly higher level in *Wnt1-Cre*/*Alk3*^{cKO} tongue mesenchyme-derived conditioned media compared to the *Cre-*/*Alk3*$^{fx/fx}$ littermate control group. Together, our data suggest that ALK3-BMP signaling in the tongue mesenchyme controls the production and secretion of mesenchymal factors that promote epithelial cell differentiation toward taste papilla development.

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FCOI Declarations: None

O40-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Probing Rodent Behaviors through Respiration Patterns

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Emotional states including joy, anger, and fear are associated with distinct autonomic respiration patterns in humans.

Diverse respiration patterns are evident in rodents, but the relationship between breathing and behavioral states remains understudied. Here we monitored mouse respiration via intranasal pressure changes during an array of behaviors: slow wave sleep, quiet wake, grooming, rearing, odor investigation, struggling and immobility during tail suspension test, freezing and locomotion during auditory conditioned fear retrieval, and freezing and locomotion during innate fear response to a synthetic predator odor. Breathing bouts that specifically correspond to each behavior were analyzed through a MATLAB toolbox, BreathMetrics, to acquire a detailed quantitative analysis (up to 24 parameters for each bout). Following a factor analysis and multiple iterations of principal component analysis (PCA), we identified 8 respiratory parameters to effectively explain the data. We then employed unbiased k-means clustering on the respiratory data in PC space to identify underlying trends in the data. Four distinct clusters of respiration patterns were mapped to different behaviors such as investigation, grooming, and immobility. Notably, two immobility clusters emerged with one predominantly defined by sleep and the other by freezing during predator odor exposure. Surprisingly some visually well-defined behaviors (such as freezing during fear retrieval and immobility during tail suspension test) showed more variations in breathing and were not assigned to a single cluster. These data demonstrate characteristics and consistency of respiratory patterns during defined behaviors. We will use supervised machine learning to determine how effectively respiration patterns may help to probe rodent behaviors.

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FCOI Declarations: None

O41-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Role of Notch signaling in the apical vs basal neuronal cell fate determination in the Vomeronasal organ.

Raghu Ram Katreddi, Ed Zandro M Taroc, Jennifer M Lin, Paolo E Forni

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The Vomeronasal organ (VNO) is a part of accessory olfactory system (AOS) that plays a primary role in the detection of pheromones that trigger a spectrum of sexual and social behaviors. The mouse VNO has two main classes of vomeronasal sensory neurons (VSNs) - 1) VSNs in the apical zone of the vomeronasal epithelium that express V1R receptors, Gai2 G-protein subunit and project their axons to the anterior (apical) portion of the accessory olfactory bulb (AOB) and 2) VSNs in the basal zone that contain V2R receptors, Gao subunit and project to the posterior (basal) portion of the AOB. Both these VSN types are formed from a common pool of stem cell population. However, mechanisms involved in apical and basal VSN cell fate determination are not fully understood. Till now, Bcl11b is the only transcription factor known to play a role in the apical vs basal VSN dichotomy. To address this question, we obtained VNO single cell RNA sequencing data, using 10x genomics, from adult C57B6 wildtype male mice. We used Seurat, R package for quality control and analysis of the data. From the initial analysis, we identified notch signaling related genes, specifically Notch1 receptor and Dll4 which is a notch 1 receptor ligand in neuronal precursor clusters prior to the VSN dichotomy. Preliminary studies also showed the presence of Notch1 and Dll4 positive cells in the neonatal murine VNO. Gain and loss of function studies related to Notch signaling may further help in understanding the role of notch signaling in apical vs basal cell fate determination.

Funding Acknowledments: This project is supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health under the Awards R15-HD096411 (P.E.F) and R01-HD097331/HD/NICHD (P.E.F), and by the National Institute of Deafness and Other Communication Disorders of the National Institutes of Health under the Award R01-DC017149 (P.E.F).
FCOI Declarations: None

O42-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Modulation of Olfactory Output Neurons Affects Whole-Body Metabolism

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The voltage-gated potassium channel Kv1.3 is a large driver of cellular excitability in the olfactory bulb (OB) and in peripheral tissues. Global *Kv1.3*-/- mice exhibit a "Supersmeller" phenotype, increased metabolism, and resistance to diet-induced obesity (DIO). Direct delivery of Kv1.3 blockers to the OB of wildtype mice confers an increase in metabolism, suggesting a relationship between olfaction and energy balance. We generated a conditional CRISPR knockout of *Kv1.3* in mitral and tufted cells (M/TCs). With this, we circumvent peripheral and hypothalamic Kv1.3 contributions. We bred Tbx21-cre mice to floxed Cas9 mice and engineered single guide RNA (sgRNA) to be delivered using adeno-associated virus (AAV). Transduction patterns of AAVs 2, 3, 5, 8, and 9 were mapped; AAV9 showed the highest preference for M/TCs. Tbx21-Cas9-GFP progeny

were then injected with AAV9-hSyn-mCherry-U6-sgRNA to achieve effective co-labeling of Cas9 and sgRNA (Mitral-67%, Tufted- 32%). Whole-cell recordings were performed to compare MCs of Cas9$^+$ (CRISPR mice) vs. Cas9- (control) littermates. On average, MCs of 'CRISPR mice' had a less negative resting membrane potential, and the current needed to evoke action potentials (APs) was lower. The APs of CRISPR mice have faster rise kinetics (time to peak, time to maximum slope) and slower decay kinetics, consistent with a loss of potassium channel conductance. CRISPR mice were resistant to DIO and glucose insensitivity vs control littermates, as determined by glucose tolerance test, *in vivo* NMR, and post-mortem fat pad analysis. CRISPR mice show increased odor discrimination in a habituation/dishabituation assay compared to control littermates. Our data show that CRISPR editing tools may be useful to link the enhanced excitability of OB output neurons to energy balance.

Funding Acknowledgments: NIDCD R01DC013080 DF NSF Graduate Research Fellowship 2017240762 LK USDA NIFA Predoctoral Fellowship 2019–07151 LK

FCOI Declarations: None

O43-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Role of the Gut Microbiome in Dietary Olfactory Loss

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It is well documented that a fatty diet causes a shift in gut microbiota, systemic inflammation, and neuroinflammation. An increase in the *Firmicutes* to *Bacteroidetes* ratio and an increase in *Actinobacteria* in fat-fed mice are typically reported. We have previously found that mice fed a moderately high fat (MHF, 32% kcal from fat) diet display a loss of olfactory sensory neurons (OSNs) with deficits in olfactory perception. The mechanism of the OSN loss remains unknown. If MHF-challenged mice are pair-fed (isocaloric to control fed mice), they show an intermediate metabolic phenotype between CF and MHF *ad libitum* fed mice, yet loss of OSNs remains. We hypothesize that the diet induces a state of dysbiosis of the gut microbiome, which leads to neuroinflammation, causing OSN loss. To initially explore this hypothesis, mice were treated for 3 months with the following dietary treatments: CF *ad libitum* (CF), MHF *ad libitum* (MHF adlib), or MHF isocalorically matched to CF mice (MHF paired). In analyzing preliminary reads of fecal-collected bacteria, there was a significant dietary effect on the *Firmicutes* to *Bacteroidetes* ratio (ratios: CF=1.24, MHF paired=2.91, MHF adlib=4.18; Kruskal-Wallis $p<0.01$). The MHF adlib mice had a higher *Firmicutes* to *Bacteroidetes* ratio than CF mice ($p<0.01$), but not higher than that of the MHF-paired mice (Dunn's multiple comparison). There was a significant dietary effect on the percent *Actinobacteria* (CF=0.46%, MHF paired=5.33%, MHF adlib=10.53%; Kruskal-Wallis $p<0.01$). The MHF adlib mice had a higher percent of *Actinobacteria* than CF mice ($p<0.05$), but not MHF paired mice (Dunn's). In conclusion, the MHF-paired mice allowed us to investigate the effects of a fatty diet when not overconsumed and these mice had a gut microbiome not different than that of CF mice.

Funding Acknowledgments: This research was supported by the Chemosensory Training Program (CTP) T32 DC000044 (AML) from the National Institutes of Deafness and Communication Disorders (NIDCD/NIH), the Brenda Weems Bennison Endowment (AML), and the Robert B. Short Scholarship in Zoology (AML).

FCOI Declarations: None

O44-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Reports of Taste, Smell, and Sleep Quality in Individuals with Alcohol Use Disorder During COVID-19

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Over 12% of the US population reports taste or smell (chemosensory) dysfunction. Patients with severe alcohol use disorder (AUD) reported to suffer with inability to discriminate taste and smell. Sleep disturbances are ubiquitous in AUD, there are reports on associations between sleep quality, and chemosensory dysfunction. The aim of this analysis was to investigate reports of chemosensory dysfunction and sleep quality, if any, in AUD after the first four weeks of the start of this ongoing longitudinal COVID-19 impact study (conducted approximately weekly). AUD and non-AUD participants were asked to complete a series of online surveys for 24 months. Taste and smell data are collected using a VAS self-rating online questionnaire (0–100: higher score, better sense of taste/smell). Of a total of 171 there were 73 AUD (39 males/34 females; 45.3 ± 14.5 years) and 98 non-AUD subjects (44 males/54 females, 45.3 ± 14.6 years). 10% of AUD subjects (65% males) reported taste and smell scores of 75 or below, and 8% of non-AUD subjects showed similar taste and smell scores. There were no significant correlations between sleep quality, taste and smell measures in

both AUD and non-AUD groups. Chemosensory impairment was not likely an impact of COVID infection as only 1 AUD subject reported to be SARS-CoV2-positive, while 12 of these individuals complained for fever, cough, sore throat, or runny nose for more than one day within the previous month. Our preliminary results suggest that there is no correlation between taste, smell, and sleep quality in this cohort. These results must be taken with caution for a possible under-reporting of chemosensory perception and a known COVID diagnosis. Future studies should include psychophysical measures in this population with quantitative assessment of taste and smell.

Funding Acknowledgments: This work is supported by National Institute on Alcohol Abuse and Alcoholism

FCOI Declarations: None

O45-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

HSV-1 infection in the olfactory epithelium and spread in the brain.

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Alzheimer's disease (AD) is a neurodegenerative disorder that affects 1 in 9 Americans over 65 years of age and is the 6th leading cause of death. Identifying the contributory pathological processes in early disease constitutes a major public health issue. Recently, Herpes Simplex Virus type 1 (HSV-1) has been proposed as trigger for AD, interacting with genetic and environmental factors to potentiate the disease. While HSV-1 can be found postmortem in AD patients' brain, most natural HSV-1 transmission is sporadic and asymptomatic. Thus, it is impossible to trace back the initial infection time, entry and the spread pattern across the brain. The ability of HSV-1 to infect the central nervous system has been demonstrated using different rodent models, but the spread pattern is highly variable depending on the viral strain, host and route of inoculation. The olfactory epithelium (OE) is a potential route of entry for HSV-1 since the olfactory and trigeminal nerves provide direct access to the brain, and olfactory deficits are common symptoms in AD. Here we aimed at identifying the spread pattern and the elicited immune response of HSV-1 strain McKrae after intranasal inoculation in C57BL6 mice (2.10^6 PFU, 15 µL in each nostril). RT-qPCR revealed the presence of HSV-1 DNA in the OE, olfactory bulb (OB) and brain. Immunostainings showed sparse HSV-1 antigen presence in the OE, strong labelling in the hypothalamus and brainstem, but surprisingly no HSV-1 antigen was detected in the OB. Iba1 staining suggested increased monocytes/microglia recruitment in all regions tested positive for HSV-1 DNA presence. We hypothesize that HSV-1 elicits a strong immune response in the OE, preventing viral spread to the OB. However, HSV-1 presence in the brainstem suggests a spread through trigeminal fibers.

Funding Acknowledgments: NIDCD DC014253 DR NIDCD DC000566 DR

FCOI Declarations: None

O46-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Chronic, treatment-refractory nasal obstruction without obvious anatomical deformity: It may be a trigeminal problem

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Chronic nasal obstruction (CNO) is one of the most common complaints in ENT practice. For clinicians, patients with anatomically unexplained CNO that is refractory to medical treatment pose a challenge for the diagnosis as well as the treatment. CNO may result from an alteration of the afferent neural pathways responsible for airflow perception such as the trigeminal system. The aim of this study is to assess whether the sensitivity of this intranasal trigeminal system reflects the complaint of nasal obstruction in people with anatomically unexplained CNO.

Methods: A retrospective cross-sectional study of 143 patients with anatomically unexplained CNO and 58 healthy volunteers, between 18 to 80 years old, was carried out. Nasal patency was assessed by means of rhinomanometry (RM) and susceptibility of the intranasal trigeminal system was examined using the trigeminal lateralization task (TLT).

Results: TLT scores were significantly lower in CNO patients compared to controls ($p<0.001$), but no group difference for RM scores were observed. TLT allowed to identify CNO patients with an efficacy of the area under the curve (AUC) of 0.78, while the value for RM was at chance level (AUC=0.47). CNO patients showed normal reaction to

vasoconstrictive agents with significantly lower RM values after Xylomethazoline application.
Conclusion: Results suggest that reported nasal obstruction in CNO patients without any obvious anatomical obstacle and resistant to medical treatment may be linked to a deficient perception of nasal airflow by the trigeminal system rather than physical obstruction. In this subset of CNO patients, assessment of trigeminal sensitivity more adequately reflects the reported obstruction than nasal resistance assessment.
Funding Acknowledments: This study was supported by Mitacs Globalink scholarship (IT13349 CMB) and the Fonds de Recherche du Québec – Santé (JF).
FCOI Declarations: None

O47-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Coadaptation of the Chemosensory System with Voluntary Exercise Behavior in Mice

Quynh Anh T. Nguyen[1], David Hillis[2], Sayako Katada[3], Timothy Harris[2], Crystal Pontrello[4], Theodore Garland, Jr.[1,2,5], Sachiko Haga-Yamanaka[1,2,4]

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Ethologically relevant chemical senses and behavioral habits are likely to coadapt in response to selection. As olfaction is involved in intrinsically motivated behaviors in mice, we hypothesized that selective breeding for a voluntary behavior would enable us to identify novel roles of the chemosensory system. Voluntary wheel running (VWR) is an intrinsically motivated and naturally rewarding behavior, and even wild mice run on a wheel placed in nature. We have established 4 independent, artificially evolved mouse lines by selectively breeding individuals showing high VWR activity (High Runners; HRs), together with 4 non-selected Control lines, over 88 generations. We found that several sensory receptors in specific receptor clusters were differentially expressed between the vomeronasal organ (VNO) of HRs and Controls. Moreover, one of those clusters contains multiple single-nucleotide polymorphism loci for which the allele frequencies were significantly divergent between the HR and Control lines, i.e., loci that were affected by the selective breeding protocol. These results indicate that the VNO has become genetically differentiated between HR and Control lines during the selective breeding process. Although the role of the vomeronasal chemosensory receptors in VWR activity remains to be determined, the current results suggest that these vomeronasal chemosensory receptors are important quantitative trait loci for voluntary exercise in mice. We propose that olfaction may play an important role in motivation for voluntary exercise in mammals.
Funding Acknowledments: UCR Initial Complement fund to S.H.Y. NSF grant DEB-1655362 to T.G.
FCOI Declarations: None

O48-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Long-term Eating Behavior in Metabolic Surgery

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Metabolic surgeries, such as Sleeve Gastrectomy (SG) and Roux-Y-Gastric Bypass (RYGB), are the most effective treatment for severe obesity. Both SG and RYGB surgeries are associated with decreased food cravings, reduced influence of emotions and external food cues on eating behavior, and remission of food addiction signs during the first months post-surgery. However, it remains unclear whether these changes in eating behavior last beyond one year after surgery. Using a cross-sectional study design, we assessed food cravings and behavioral aspects of food consumption (restraint, emotional and external eating, and food addiction) in 23 participants before metabolic surgery (PRE-surgery; 43.6 ± 11.3 years) and 36 participants after the first postoperative year (3.5 ± 1.6 years; range 1.1- 6.9 years) (> 1-year POST-surgery; 43.3 ± 9 years). Participants completed three validated questionnaires: 1) Food Craving Inventory, 2) Dutch Eating Behavior Questionnaire, and 3) Yale Food Addiction Scale, and we compared their responses to those of a historical group evaluated before and after a few months from surgery. Although the influence of external food cues on eating behavior was decreased in the > 1-year POST-surgery compared to the PRE-surgery group ($p=0.02$), the frequency of food cravings ($p=0.83$), the influence of emotions on eating behavior ($p=0.27$), and the percentage of participants with food addiction signs ($p=0.75$) were similar between these two groups (and comparable to our historical values obtained before surgery). The findings of this pilot study suggest that the improvements in eating behavior observed in the first year after metabolic surgery are not long-lasting. However, longitudinal studies are needed to confirm these results.

Funding Acknowledgments: This project was supported by the USDA National Institute of Food and Agriculture Hatch Project number 698–921 MYP.
FCOI Declarations: None

O49-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Examining the Feasibility of Olfactory Components in Virtual Reality Research Tools

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In our research using a virtual reality (VR) buffet environment to measure the effects of genomic risk information on parents' food choices for their children, we implemented a food odor to enhance participants' subjective presence in the virtual environment. Given the potential promise of olfactory stimuli for future research related to genomics and eating behavior, we aim to explore whether and when participants in VR environments attend to olfactory stimuli. Past research suggests that people under high visual perceptual load (VPL) can fail to notice odors. Our pilot study examined the role of olfaction in a VR-based buffet restaurant environment. French fry scented oil was delivered while participants prepared food in the VR Buffet. About 20% of individuals perceived the olfactory stimulus, 80% of whom correctly identified the smell and were more likely to choose french fries from the VR Buffet Those individuals who were more engaged in the VR Buffet perceived the olfactory stimulus more readily. These results provided information on the feasibility and variability of smell perception in a VR environment. Our follow-up study will administer food odors in high- vs. low-VPL VR environments, with interactivity varied in the high-VPL condition. We will assess the perception of the odor and predictors of odor perception. Knowledge gained from this research will inform future VR-based research methods for genomics and chemical senses research.
Funding Acknowledgments: This work is supported by the National Human Genome Research Institute and National Institute on Alcohol Abuse and Alcoholism
FCOI Declarations: None

O50-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Olfactory-trigeminal Masking Effects

Iryna Ruda[1], Franziska Sonja Müschenich[3], Jessica Freiherr[1,2]

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Within this research the masking behavior of a mixture consisting of eucalyptol and ammonia on a behavioral and neural level is explored. In Study 1 we established that eucalyptol has the potential to mask aversive odors, though, trigeminal enhancement can still be amplified and has to be prevented. In Study 2, we investigated the underlying neural network. A pleasant olfactory-trigeminal perception of the final product is an essential requirement for successful malodor coverage; however, half of the participants rated the mixture as pleasant while the other half rated it as unpleasant. These group differences were also demonstrated on the neural level. In the *unpleasant group*, activation in the anterior insula and SII was interpreted as evidence for an attentional shift towards the potentially threatening ammonia within the mixture and for trigeminal enhancement. The latter was observed on the behavioral level in the first study. In the pleasant group, *no activation* was statistically significant. Further, the piriform cortex, anterior midcingulate gyrus, inferior frontal gyrus, anterior insula were involved with regards to the all odors contrast and all participants. Observing the signal intensity in those areas, we discovered two peaks: an expected peak with a maximum at 8 seconds after stimulus onset and a second unexpected peak at 24–26 seconds after stimulus onset. Ongoing analyses hint towards a correlation of this later peak with perceptual ratings or a delayed trigeminal response. Our results highlight that a reliable olfactory and trigeminal masking of ammonia by means of eucalyptol was not possible. The complex mixture processing of olfactory-trigeminal stimuli, which could lead to a painful sensation, complicates the development of an efficient masking tool.
Funding Acknowledgments: intramural Funding at Friedrich-Alexander-University Erlangen-Nuremberg
FCOI Declarations: None

O51-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Gli3 is a modifier of Sox10 in olfactory ensheathing cell formation.

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Olfactory ensheathing cells (OECs) are population of Schwann like glial cells that that ensheath the axons of olfactory neurons, vomeronasal neurons and terminal nerve. For several decades the OECs were believed to be of placodal origin, however, a series of studies in chick, fish and mice

have proven that, like the Schwann cells, the OECs are neural crest derivatives. Sox10 is a transcription factor with a key role in neural crest cell survival and in the establishment melanocyte and glial cell lineage. In line with this, previous studies have shown that the transcription factor Sox10 is also required for the correct formation of OECs. Sox10 loss of function compromises the formation of a functional olfactory system. We recently found that also Gli3 loss-of-function is not compatible with formation of OECs. It has been earlier shown that Gli3 can act as a modifier for Sox10 affecting melanocyte formation. To test the effects of Gli3 as a modifier of Sox10 in OECs formation we analyzed mouse models carrying homo and heterozygous Gli3 null mutation $Gli3^{Xt}$ and mice carrying the Gli3 hypomorph mutation $Gli3^{Pdn}$ alone or in combination with a Sox10null(+/-) allele. We also utilized Sox10Cre with $Gli3^{Flx/Flx}$ mice to test the conditional loss of Gli3 in cells of neural crest lineage. Our data suggest an important dose dependent role for Gli3 in controlling OEC specification shedding a new light on genetic interactions between Gli3 and Sox10 in the development of a functional olfactory system of mammals.

Funding Acknowledments: Grant Number: 1R01DC017149-01A1 (Forni, PE) Grant Number: 1R01HD097331-01 (Forni, PE) Grant Number: 1R15HD09641101 (Forni, PE)
FCOI Declarations: None

O52-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

EVC2 is an Essential Regulator for Taste Papilla and Taste bud Formation

Zhonghou Wang[1,2], Honghao Zhang[3], Yuji Mishina[3], Hong-Xiang Liu[1,2]

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Mutations of Evc2 gene were identified in patients with Ellis-van Creveld syndrome that is a rare genetic disorder characterized by short limb dwarfism, polydactyly, abnormal development of fingernails as well as regional loss of taste papillae. EVC2 has been reported to be a component of Hedgehog (HH) signaling that is important in taste organ formation and maintenance. To demonstrate the roles of EVC2 in taste papilla development and taste bud maintenance, thorough phenotypic analyses were performed in *Evc2* knockout mice at multiple (embryonic and postnatal) stages. We found overlap but distinct phenotypes resulted from *Evc2* deletion compared to other HH signaling disruptions. The tongue formed in *Evc2* knockout embryos similarly to the littermate controls at E12.5, which is different to the absence of tongue resulted from HH signaling disruption (e.g., Cyclopamine). At E12.5-E15.5 when taste papillae form, *Evc2* null mutants had a significantly increased number and size of taste papillae with normal innervation. At E18.5 when early taste buds emerge, we observed enlarged and flatten fungiform papillae in the medial zones of the tongue along the median furrow, an increased number of taste buds and epithelial hyperplasia in *Evc2* knockout mice compared to the littermate controls. In the rarely survived postnatal (3 weeks) *Evc2* knockout mice, a loss of taste buds, transformation of fungiform to filiform papillae and mis-oriented filiform papillae were frequently seen. Overall, we provide evidence that *EVC2* plays essential roles in regulating the development of taste papillae and taste buds in a stage- and tongue region-specific manner.

Funding Acknowledments: R01DC012308 to HXL NIDCR NIH R01DE020843 to YM R03DE027456 to HZ
FCOI Declarations: None

O53-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

Hatchling earthworms, *Eisenia hortensis*, avoid allyl isothiocyanate (AITC) at lower concentrations than adolescents or adults

Hannah G. Watson, Leonardo Silenzi, Andrew T. Ashchi, Colleen Riley, Izzy Nelson, Glenn S. Marrs, Wayne L. Silver, Cecil J. Saunders

Wake Forest University, Winston-Salem, NC, USA

Although earthworms have been studied for centuries, little is known about how they sense stimuli in their environment. We are interested in the development of sensory structures which purportedly detect environmental chemical stimuli in *Eisenia hortensis*. The earthworm literature speculates that receptor cells responsible for detecting chemical stimuli are clustered in structures known as epidermal sensory organs (ESOs). Last year we presented scanning electron microscopy (SEM) and fluorescent confocal microscopy (FCM) data characterizing ESOs, which are clusters of ciliated cells, at various stages of earthworm development. We found that both the number and size of ESOs increased as the earthworm aged. We now report that the ability to detect irritants also changes as the earthworm ages. Using a behavioral assay called the burrowing assay we have now demonstrated that hatchling earthworms are significantly more sensitive to AITC than either adolescents and adults (two-way ANOVA $F[2,82]=3.7522$, AITC concentration $p<0.05$, age $p<0.05$, interaction $p=0.2944$). In the burrowing assay, earthworms are placed in cups containing either control soil or soil treated with different concentrations of AITC. Burrowing into the soil denotes that the earthworm was not repelled by AITC while leaving the cup denotes that they were repelled by AITC. We postulate that hatchling earthworms are

more sensitive to AITC because they lack a fully developed cuticle allowing AITC better access to the ESOs. We are currently using antibodies against neurofilament-L, -M, -H, villin, HRP, and PLC, as well as phalloidin to better define the subdermal structure of the ESOs. Finally, we will present 3D renderings of the epidermal sensory organ and estimate the number of cells that constitute the organs.

Funding Acknowledments: Work supported by NSF IOS1355097 to ECJ, WFU Center for Molecular Communication grant to WLS and CJS, and WFU Funds from Provost, Undergraduate Research for Creative Activities Center (URECA)and Department of Biology.

FCOI Declarations: None

O54-POSTER SESSION #1

MONDAY, 6:00 PM - 8:00 PM

An Investigation into Plume-guided Odor Search by Octopuses

Willem L Weertman[1,4], David Scheel[1], Venkatesh Gopal[2], David H Gire[3,4]

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Octopuses use odor cues to sense mates, prey, and predators but it is unknown if octopuses can actively track odor plumes. Due to their unique body plan and neural architecture, it is not immediately clear what strategies octopuses would use to actively track odors. Cephalopods appear to lack a clear olfactory bulb analog and do not have glomeruli. They most likely use different strategies for integration of chemosensory information from arthropods and vertebrates. Recently it was shown that octopuses have a unique class of chemoreceptors in their suckers capable of detecting both hydrophilic and hydrophobic molecules. Additionally, another recent study demonstrated that isolated octopus arms react to both hydrophilic and hydrophobic molecules. Using a wide, shallow, and long turbulent flume in an open circuit seawater system we investigated the ability of octopuses to track food odors under dark conditions. Using the open source markerless pose estimator DeepLabCut, we tracked octopus trajectories. We present data showing that octopuses actively use odor plumes to find food. Additionally, we employ kinematic analysis of octopus arm and body motion relative to presumed plume contact to investigate the role of the arm chemosensory system in plume tracking. We find that the octopus arm chemosensory system appears to play a role in plume-guided odor search. Our results suggest that in contrast with organisms employing centralized olfactory pathways the octopus likely uses distributed chemosensory pathways to localize odor sources. Further study of the sensory system in octopus arms may lead to novel approaches for understanding distributed information processing and control of complex, hyper-redundant systems.

Funding Acknowledments: University of Washington, Beatrice Crosby Booth Endowed Scholarship (FHL), Alan J Kohn Endowed Fellowship (FHL)

FCOI Declarations: None

O55-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Glucose and Fructose Differentiation Does Not Require Canonical Type II Cell Signaling

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It has been previously shown that mice lacking the canonical sweet taste receptor, T1R2+T1R3, are still able to behaviorally discriminate between glucose and fructose, responding more positively to the orosensory properties of glucose over fructose after extensive sugar experience (Schier *et al*. 2019). With this in mind, we used B6 wildtype (n=9) and IP_3R3 KO (n=8) mice to determine if IP_3R3, which is a member of the canonical taste pathway in type II taste cells, is necessary for glucose and fructose differentiation. To allow the mice to associate the oral and post-oral effects of each sugar, we used a single bottle paradigm in which mice were presented with one of 6 sugar stimuli a day (30 minutes; 0.316, 0.56, 1.1M glucose or fructose) across 24 days. Before and after the single bottle phase, mice were presented with randomized 10-s trials of glucose or fructose (0.316, 0.56, 1.1M) in brief access taste tests in order to measure baseline and experience-driven taste responses to glucose and fructose. In the pre-test, B6 wildtype mice licked similarly to both glucose and fructose ($p = .86$) whereas the IP_3R3 KO mice licked significantly more for fructose over glucose ($p = .04$). After the single bottle sugar experience, both B6 WT and IP_3R3 KO mice licked more for glucose over fructose (p's $<.05$). This suggests IP3R3 is not necessary for glucose and fructose differentiation. These data support previous findings that the acquired relative avidity for glucose does not require the function of the canonical sweet signaling pathway.

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FCOI Declarations: None

O56-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

A time course of the number of taste buds and their reinnervation with P2X3-expressing fibers in fungiform and circumvallate papillae after gustatory nerve transections in the C57BL/6J mouse.

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Following taste nerve transections in mice, taste bud populations decrease but do not completely degenerate. Here, we assessed whether the remaining taste buds become reinnervated with gustatory nerve fibers over time. Adult C57BL/6J mice (n=4–5, both M/F per group) underwent bilateral chorda tympani (CT) or glossopharyngeal (GL) nerve transection and were assigned to groups with survival times of 2, 4, 8, or 12 weeks. The circumvallate papilla (CV) and ~1mm of anterior tongue tissue (taken from within 2mm of the tip of the tongue) were sliced at 30µm and processed using immunofluorescence to visualize both cytokeratin 8 (taste buds, TBs) and P2X3 (taste nerve fibers). After CT transection (CTX), the number of fungiform (FF) papillae decreased. The proportion of FF with TBs decreased within 2 weeks, and continued to decrease across all timepoints. After GL transection (GLX), the number of TBs visible per CV slice decreased significantly and remained consistently low across the 12 weeks. For both FF and CV tissues, the taste buds that did remain were more likely to be reinnervated by P2X3-positive fibers as time progressed. Both fields showed almost no P2X3 after 2 weeks, but P2X3 label was present at higher rates across timepoints. For FF tissue, almost all remaining TBs were reinnervated by week 12. In the CV, reinnervation occurred quickly with ~40% of TBs present containing P2X3-expressing fibers by 4 weeks, but little additional P2X3 label appeared by 12 weeks. Because TB number remained low, even after 12 weeks CTX mice had on average <10% innervated TBs in FF compared to intact tissue; GLX mice had <15% innervated TBs in the CV. Whether these reinnervated taste buds are sufficient to provide functional information to the brain to drive taste-guided behavior remains to be determined.

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FCOI Declarations: None

O57-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

HC²I: Human-Computer Chemosensory Interfaces

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We propose a new class of emerging interfaces within the field of human computer interaction: human-computer chemosensory interfaces (HCCI), which leverage direct modulation of the human chemical senses to provide new experiences for users. Within this category, we specifically present two new chemesthetic interfaces. The first provides temperature illusions that use low-powered electronics and enables the miniaturization of simple warm and cool sensations. Our illusion relies on chemically stimulating the intranasal trigeminal nerve's thermoTRPs. The second is a novel, intranasal chemesthetic device that creates lateralizable/stereo-smell sensations, i.e., directional information about the concentration of a gas or odor, by rendering the readings of external gas sensors as trigeminal sensations using electrical stimulation of the user's septum. We propose that electrically stimulating the trigeminal nerve is an ideal candidate for stereo-smell rendering and may have promise as an assistive technology for people with anosmia.

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FCOI Declarations: None

O58-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Relative Contributions of TRPM4 and TRPM5 to Fatty Acid Signaling in Type II Taste Cells Varies Across the Estrous Cycle

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Taste receptor (Type II) cells play central roles in taste transduction cascades involving sweet, fat, umami, and bitter substances. Transient Receptor Potential channel type Melastatin (TRPM) subtypes 4 and 5 are highly expressed in Type II cells. Previously, we have shown that fat taste functions in a sexually dimorphic manner using molecular, cellular, and behavioral assays, and that subtype of estrogen receptor (ER) proteins were most highly expressed in Type II cells. The goal of this study was to investigate the mechanisms that contribute to sex differences in taste cell activation. Female mice in proestrus (high estradiol; E2) and late estrus (low E2) phases of the estrous cycle and males were used for all experiments. We found that estradiol enhanced fatty acid (FA) responsiveness in Type II cells consistent with ER expression patterns. Using *Trpm5* deficient mice, both males and females in estrus phase had significantly reduced FA responses, which was not true of females in proestrus phase. This suggested that there might be E2-dependent and TRPM5-independent FA signaling in Type II cells. In PLCβ2-GFP mice, the TRPM4 channel blocker (9-phenanthrol) and TRPM5 channel blocker (triphenylphosphine oxide) partially reduced FA taste cell responses and the combination of both blockers abolished FA responses. We blocked the activity of TRPM4

in the *Trpm5*-null mice and the additional TRPM4 inhibition significantly reduced the inward current only from females in proestrus phase, suggesting that TRPM4 activity is more pronounced in females during conditions of high E2. Taken together, our data show novel pathways by which TRPM4 and TRPM5 activity are modulated by sex and vary across the estrous cycle in females.
Funding Acknowledments: NIH DC013318 TAG
FCOI Declarations: None

O59-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Imaging the mechanosensory responses of the molecularly defined T2 class of mouse geniculate ganglion neurons *in vivo*

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Geniculate ganglion neurons transmit gustatory information from taste buds to the brain. Some of these neurons are also reported to convey tactile sensation. Gustatory neurons of the mouse geniculate ganglion comprise 3–5 transcriptionally distinct groups; those of the smallest group, T2, express the mechanosensitive ion channel, Piezo2, and other mechanosensory markers. Furthermore, the peripheral fibers of T2 neurons do not enter taste buds, and instead, terminate near the apical surface of fungiform papillae. To test if T2 neurons respond to tactile stimulation, we imaged geniculate ganglion neurons *in vivo* in *Mafb*-mCherry-Cre mice expressing the Ca^{2+} indicators, GCaMP3 or GCaMP6. We imaged ganglia while stimulating the dorsal surface of the tongue with a vibrating metal probe, focal puffs of air, stroking with a nylon bristle brush, and constant pressure with a small rod. The majority of T2 neurons (21 of 25; n=5 mice) showed repeatable responses to these stimuli. Neurons responding to brushing also responded to vibration of a grit-coated metal probe. Constant pressure with the same probe (without vibration) did not elicit responses. We also looked for responses to taste stimuli. Of a total of 44 mCherry+ T2 neurons recorded (n=12 mice), none responded to any taste stimuli. Importantly, adjacent mCherry-negative neurons (331 gustatory neurons) did respond to taste stimulation. Lastly, we asked whether other gustatory neurons in the same ganglion are mechanosensitive. Of 225 taste-responsive neurons (n= 5 mice), only 2 responded to both chemical and mechanical stimuli. Thus, the geniculate ganglion appears to contain separate populations of neurons dedicated to detecting either chemical (i.e. taste) or mechanical (e.g. texture) stimuli within the oral cavity.
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FCOI Declarations: None

O60-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Gustatory Cortex Responses Evolve with Incidental Taste Experience

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Experience has been widely shown to impact learning and sensory perception. In the field of taste, familiarity with taste stimuli that later become the conditioned stimulus (CS) has long been known to reduce the strength of aversion learning when subsequently pairing with gastrointestinal illness (unconditioned stimulus; US). Recently, we have demonstrated that even experience with "incidental" (i.e., non-CS and non-US) stimuli can also influence later learning: specifically, rats made familiar to salty and sour tastes developed a stronger learned aversion to novel sucrose. This work suggests that incidental taste experience changes the neural dynamics underlying the taste. Here, we begin to explore this possibility by evaluating how taste responses in gustatory cortex (GC) change over three days of incidental taste exposure. Our results demonstrate that GC taste responses become more discriminable across taste exposure sessions. Additionally, we show an increase in correlations between firing rates and palatability with more taste exposure, suggesting that taste exposure enhances palatability coding in GC. Lastly, a preliminary analysis also suggests that taste exposure also enhances the discriminability of a novel taste in addition to the prior exposed tastes. Overall, these findings begin to characterize the impact of familiarity on neural dynamics of taste processing and give insight into how incidental taste experience impacts future learning.
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FCOI Declarations: None

O61-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

What does the taste system tell us about the nutritional composition and toxicity of foods?

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One distinctive feature of the human taste system is that it categorizes food into a few taste qualities—e.g., sweet, salty, sour, bitter and umami. Here, I examined the functional significance of these taste qualities by asking what they tell us about the nutritional composition and toxicity of foods. I collected published data from raw and unprocessed foods—i.e., fruits, endosperm tissues, starchy foods, mushrooms and meats. Sweet taste is thought to help identify foods with a high caloric or micronutrient density. However, the sweetest foods (fruits) had a relatively modest caloric density and low micronutrient density, whereas the blandest foods (endosperm tissues and meats) had a relatively high caloric and high micronutrient density. Salty taste is thought to be a proxy for foods high in sodium. Sodium levels were higher in meats than in most plant materials, but raw meats lack a salient salty taste. Sour taste is thought to signify dangerous or spoiled foods. While this may be the case, it is notable that most ripe fruits are acidic. Umami taste is thought to reflect the protein content of food. I found that free L-glutamate (the prototypical umami tastant) concentration varies independently of protein content in foods. Bitter taste is thought to help identify poisonous foods, but many nutritious plant materials taste bitter. Fat taste is thought to help identify triglyceride-rich foods, but the role of taste versus mouthfeel in the attraction to fatty foods is unresolved. These findings indicate that the taste system provides incomplete or, in some cases, misleading information about the nutritional content and toxicity of foods. This may explain why inputs from the taste system are merged with inputs from the other cephalic senses and intestinal nutrient-sensing systems.

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O63-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Associations Among Fatty Food Sensations, Diet, and Expectorated Emulsions

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Saliva influences chemical and textural sensations, yet details and sources of individual variability for these phenomena are still lacking. In this study, we investigated fatty sensations, dietary habits, and saliva's emulsifying properties. Through a remote tasting and spitting protocol, participants were asked to discriminate among and rate sensory properties of fatty candies with varying concentrations of added linoleic acid (LA). Additionally, participants swished and expectorated an oil/water mixture, and the size of the expectorated sample's fat layer was visually analyzed. Dietary habits were also analyzed. Sensory ratings of fatty candies indicate differences based on successful completion of a LA discrimination task. Successful discriminators showed increasing fattiness and a trend for increasing bitterness with increasing LA concentration. Unsuccessful discriminators showed only increasing bitterness with increasing LA concentration. No correlations were observed among sensory ratings and diet or expectorated emulsion fat layer size. However, at 0 sec, larger fat layers were observed for those with greater dietary protein intake, as well as for individuals who passed the LA discrimination task. At 30 sec, greater fat layer size associated with greater solid fat and protein intake. Finally, larger changes in fat layer size overtime associated with lower solid fat intake, and changes were greater in those who passed the LA discrimination task. Overall, results indicate dietary protein and fat associate with salivary emulsifying effectiveness, and that ability to discriminate fatty acid taste sensation may correlate with the sensory quality experienced from fatty acids.

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O64-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Salivary Proteins Do Not Appear to Contribute to Cyclic Changes in Food Intake in Female Rats

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We have demonstrated that subsets of salivary proteins (SPs) alter diet acceptance and taste responsivity. There is evidence that hormone profiles alter salivary protein expression for some SPs. While our lab has demonstrated several examples of diet-driven changes in salivary proteins in males, we have not explored these changes in females nor have we examined the effect of estrus on SP expression. We hypothesized the expression of SPs would vary with the estrous cycle and this may alter diet acceptance. To test this, we first examined the feeding patterns and SP expression in female rats following exposure to a control diet. We tracked the estrous cycle with daily vaginal smears. All rats were maintained on the diet for up to 4 weeks. During the 4 weeks, animals were trained for saliva collection and we collected saliva daily for 3 cycles. Rats displayed estrous-related decreases in meal size ($p < .001$) and rate of feeding ($p < .001$) as well as an estrous-related increase in meal number ($p < .001$). There were no significant differences in expression of SPs across the estrous cycle suggesting SPs did not contribute to these behavioral changes. In later studies, we found that when females are offered a diet containing quinine, they reduce intake of the

bitter diet for twice as long as males typically do (8 days vs 4 days). The increase in diet acceptance in males is correlated with the upregulation of a subset of SPs. We are currently examining the changes in SPs in females on a bitter diet to explore whether or not diet-induced changes in SPs are on the same time scale as they are in males.
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O65-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Habitual exposure to trigeminal stimuli and its effects on the processing of chemosensory stimuli

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Objective- Our objective was to compare brain responses to trigeminal and olfactory stimuli in frequent and non- frequent gum chewers in order to explore whether habitual exposure to trigeminal stimuli affects their central-nervous processing. **Methods-** In healthy subjects, fMRI brain scans were obtained for 20 frequent gum chewers (GC) and 20 non- frequent gum chewers (N'GC), in response to four odorous stimuli; 2 'trigeminal' (peppermint and spearmint) and 2 non- trigeminal or 'olfactory' (cherry and strawberry). During measurements, subjects reported intensity and pleasantness ratings for all stimuli. In addition, a test for general trigeminal sensitivity test (lateralization test) and an odor threshold test were performed. Brain activations in response to individual odors were investigated for the total study population followed by group wise (GC and N'GC) analysis separately for responses to trigeminal (peppermint + spearmint) and olfactory (cherry + strawberry) odors. **Results-** (1) The GC group exhibited higher trigeminal sensitivity compared to the N'GC group. (2) Olfactory odors activated bilateral insular cortex and amygdala. Apart from olfactory areas (amygdala, insular cortex), trigeminal odors also produced activations in right thalamus and right substantia nigra. (3) In the GC group, olfactory odors produced higher bilateral insular cortex activation than in N'GC group, but no such differences were observed for trigeminal odors. **Conclusion-** GC subjects appeared to be more responsive to trigeminal chemosensory stimuli. However, this did not directly translate into differences in central-nervous activations to trigeminal stimuli; instead, the use of chewing gum was associated with stronger brain activation towards olfactory stimuli.
Funding Acknowledments: no specific funding received
FCOI Declarations: None

O66-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Polymorphisms of T2R38 Bitter Taste Receptor and Oral Diseases in Thai Dental Patients

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Objectives: Human bitter taste receptor type 2 member 38 (T2R38) polymorphisms cause alterations in specific compounds' perceived bitterness. T2R38 also plays a role in host innate immune functions. Gingival epithelial cells expressing T2R38 respond to cariogenic and periodontal pathogens (in vitro). We evaluated the association between T2R38 genotypes and oral diseases in adults patients seeking dental care at Khon Kaen University Dental Hospital in Thailand.
Methods: DNA was extracted from whole saliva. Single nucleotide polymorphisms (SNPs) of T2R38 gene (rs713598, rs1726866, and rs10246939) were determined using real-time PCR, SNP genotyping assays. A calibrated dentist performed oral examinations to measure clinical periodontal parameters and decayed, missing, and filled teeth (DMFT). Periodontal disease was defined as having one site with probing depth (PD) ≥5 mm.
Results: 238 patients (19-75y, male=46.6%) were included. Two haplotype: PAV (67.2%) and AVI (32.8%) were found; resulting in 3 common diplotypes: PP (46.0%), PA (42.4%), and AA (11.6%). The three diplotypic groups were similar in age, gender, socio-economic indicators, oral self-care, and number of remaining teeth. The odds of having periodontal disease was lower in AA (OR=0.3; CI: 0.1,0.9) and PA groups (OR:0.6; CI: 0.3,1.1) than PP group. PA tended to have less (OR=0.6; CI: 0.3,1.3), while AA tended to have more (OR=5.0; CI:0.6, 39.2) caries experience when compared with PP, but the results were not statistically significant. Conclusion: AA was associated with decreased risk for periodontal disease. There was no association between T2R38 genotype and caries in Thai adults in this study.
Keywords: T2R38, bitter, genetics, caries, periodontitis
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FCOI Declarations: None

O67-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

The Utility of a Human Fungiform Taste Cell Line as a Model System for Exploring Fatty Acid Signaling

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Taste transduction pathways have been well studied in rodents but cellular and molecular studies in humans have been rare because of the relative unavailability of human taste cells. Recently, attempts to develop human taste cell lines holds promise for expanding these mechanistic studies to further understand taste transduction pathways in human cells. In this study, we utilized an immortalized human fungiform taste cell line (HuFF) to determine if they are functionally comparable to primary taste cells, and if this cell line can be used as a model to study long chain fatty acid (LCFA) taste transduction. Gene expression studies indicated the presence of components for LCFA taste pathway, including TRPM5, GPR120, CD36, and PLCβ2. Calcium imaging experiments were performed on HuFF cells and DHA ($C_{22}H_{32}O_2$), EPA ($C_{20}H_{30}O_2$), AA ($C_{20}H_{32}O_2$), and LA ($C_{18}H_{32}O_2$) all elicited similar intracellular calcium responses to those observed in rodent. LA induced a dose-dependent calcium responses in a similar effective concentration range seen in rodent taste cells, and it also induced depolarization of the HuFF cells. To investigate the mechanisms of gustatory recognition of LCFA in HuFF cells, pharmacological approaches were performed. Blocking G-protein activation using GDP-ß-S inhibited membrane depolarization and inward currents induced by LA, suggesting G-protein activation was coupled with LCFA transduction. In addition, the intracellular calcium responses stimulated by LA were significantly reduced by antagonists of TRPM5, PLCβ2, and CD36, which indicated close parallels between LCFA signaling pathway in rodent and human taste cells. Together, it appears HuFF cells may provide a useful model for studying fatty acid signaling in a human model and may yield similar utility for other tastants.

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FCOI Declarations: None

O68-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

The Contribution of Lateral Hypothalamus to Cortical Palatability Coding

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As part of the dynamic taste-evoked response, GC ensembles enter a state that reflects the hedonic value of the taste (palatability); this transition both predicts and drives consumption behaviors. The lateral hypothalamus (LH), which was first recognized to be involved in the driving of feeding behavior years ago, also encodes palatability as part of taste responses with dynamics that dovetail nicely with those observed in GC (Li et al., 2013). LH in fact contains two types of palatability-related taste responses—one that responds strongly to pleasing tastants (positive palatability neurons, LH-P+) and the other to aversive tastants (LH-P-). Our own data and theoretical work on metastable dynamics provide reasons to predict that the reciprocal connections known to link LH to GC almost certainly contribute to the dynamics of neural activity involved in the computation of palatability. Here, we test this hypothesis, investigating the contribution of LH to cortical palatability information using multi-site electrophysiological recordings and optogenetics in behaving rats. We recapitulate our 2013 finding that there are two taste-responses in LH with opposing correlations to palatability, and then go on to show that the onset of palatability-related firing in LH reliably couples with that in GC. Optogenetic inhibition of GC-projecting LH terminals reduces the magnitude of palatability-related firing in laser-on trials within the palatability epoch (700-1000ms post taste delivery). Thus we demonstrate functional connectivity between LH and GC for the first time.

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FCOI Declarations: None

O69-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Taste Bud Innervation in Mouse Models of ALS

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Amyotrophic lateral sclerosis (ALS) is a debilitating and fatal disease characterized by motor neuron degeneration. Taste sensation may be impaired in ALS patients (Pelletier et al., 2013), raising the possibility that non-motor systems are also impacted by the disease. To study this possibility further, we examined whether mouse models of ALS exhibit peripheral taste deficits. We used $SOD1^{G93A}$ and $TDP43^{A315T}$ mouse models that employ overexpression of mutated genes associated with ALS in humans. Age-matched, littermate wildtype mice served as controls. At 3–5 months of age, anterior tongues and geniculate ganglia (GG) were collected, cryosectioned, and immunostained. GG were assessed for total number of neurons (labeled with Tuj1) and number of oral sensory neurons (labeled with Phox2b) in wildtype (n=8), SOD1 (n=5) and TDP43 (n=4) mice. Taste innervation was measured using the percent of pixels within the

taste bud (delineated with cytokeratin-8 labeling) that contained labeling for Tuj1 or P2X3 (a selective label of neurons from the GG) in wildtype (n=8), SOD1 (n=3), and TDP43 (n=4) mice. There was no significant difference in the number of GG neurons among genotypes, suggesting that geniculate neurons are not lost in these ALS models. Taste bud size did not significantly differ among genotypes, but there was a significant difference in the percent of taste bud volume occupied by Tuj1+ staining, with TDP43 animals having the lowest innervation values. Taste bud innervation did not significantly differ among groups when P2X3 labeling was evaluated, possibility because of a higher variability in labeling quality with P2X3 antibodies. While further studies are warrented with additional mice, the number of fibers that innervate fungiform taste buds may be diminished in the TDP43 mouse model of ALS.

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FCOI Declarations: None

O71-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

The Contribution of Volatiles to the Flavor of Pediatric Medicines

Julie A. Mennella[1], Sara Snell[1], Jade Uffelman[1], Jennifer Chapman[2], Joel Mainland[1], Elizabeth D. Lowenthal[2]

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Objectives. Most children at some point require medicine. But not all will accept its flavor, which can lead to nonadherence, worsening of disease, and higher health care costs. Such personal variation is a hallmark of human perception. We took an adult sensory approach to systematically determine the degree of individual differences and the contribution of volatiles in the palatability of a variety of liquid formulations of pediatric medicines.

Methods . Trained adult panelists (N=146) used validated psychophysical tools (gLMS) to rate the flavor and palatability of a variety of pediatric liquid formulations used for the treatment of children with HIV (Kaletra®), bacterial infections (clindamycin), and inflammation (prednisone, dexamethasone). Panelists rated each medicine under two conditions: when nostrils were pinched closed and when open. Testing was repeated for a subset several months later to determine reliability.

Results. Consistent with clinical reports, there was variability and hedonic ratings ranged from strongest imaginable dislike to strong like. Panelists were consistent in ratings of each medicine (Ps<0.001) and the more they disliked its taste, the more bitter it tasted. However, how they rated one medicine did not relate to another. While palatability ratings of Kaletra® and prednisone did not differ under the two conditions, the palatability of clindamycin and dexamethasone increased slightly but significantly (Ps<0.001) when tested with nostrils pinched, indicating that flavor volatiles attenuated its palatability.

Conclusions. The highly personal nature of the chemical senses underlies why a given medicine is not accepted by every patient. In addition to taste-reactive ingredients, flavor volatiles contribute to the palatability of some, but not all, medicines.

Funding Acknowledments: NIDCD R01011287 JM EL

FCOI Declarations: None

O72-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Stimulus osmolarity regulates Cl channel activity in mouse lingual epithelium

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Taste stimuli range from being extremely hypoosmotic to hyperosmotic, yet we have little understanding as to how the stimulus environment impacts gustatory function. Volume regulatory responses are important mechanisms for cell function and regulation involves movement of ions or solutes. A common ion associated with volume regulation is Cl in a variety of transporting epithelia. It has also been established that the rodent lingual epithelium activates a Cl conductance under non-isoosmotic conditions. To determine the effect of osmolarity on lingual Na transport in mice we have used an Ussing chamber to study the NaCl-induced transepithelial short circuit current (Isc). 100 mM NaCl solutions with varying osmolarity (200, 1000 mOsm) were applied to the mucosal side. The serosal side was bathed in KH buffer in the presence or absence of Cl channel blockers (DIDS or NPPB). Serosal buffer varying in osmolarity (260 [hypoosmotic], 310 [isosmotic], 410 mOsm [hyperosmotic]) were made by adding mannitol or water. Osmotic stimuli that deviated from isoosmotic resulted in Cl conductance changes in lingual epithelia. Voltage-gated Cl channels were significant contributors to osmotic-induced Isc in fungiform epithelia under non-isoosmotic conditions, as DIDS significantly reduced Isc. Ca^{2+}-activated Cl channels were significant contributors only under hypoosmotic serosal conditions, as NPPB significantly reduced Isc when serosal buffer was 260 mOsm. In circumvallate, both voltage-gated and Ca^{2+}-activated Cl channels were significant contributors to osmotic induced Isc under normal isoosmotic conditions, as DIDS and NPPB significantly reduced Isc. Overall, it appears stimulus osmolarity affects peripheral gustatory function

owing, in part, to a contribution of transcellular changes in Cl conductance.
Funding Acknowledgments: university funds
FCOI Declarations: None

O73-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Investigating Taste Neophobia and Multisensory Integration in the Gustatory Cortex

Martin A. Raymond, Stephanie M. Staszko, Max L. Fletcher, John D. Boughter

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As our understanding of the anatomy and physiology underlying taste steadily advances, a great deal remains to be learned about the mechanisms of its central processing. Particularly, the role of the gustatory cortex in taste-guided behaviors remains obscure. Behavioral evidence suggests a strong contribution to taste-guided learning, and electrophysiological studies have found evidence suggesting roles in representing expectation and multi-sensory integration. In this study, we attempt to expand on those findings; we conducted chronic calcium imaging of cells in the gustatory cortex of 9 mice via implanted lenses and head-mounted miniscopes. Neural activity was observed in response to a variety of stimuli and behaviors, including basic responses to tastes, odors, and thermal stimuli, as well during a paradigm modeling neophobia. This neural activity was then correlated with the concurrent stimulus presentations. We are analyzing this data with a focus on identifying patterns of change in the cellular responses associated with increasing experience with various stimuli in an attempt to better understand the physiological underpinnings of taste neophobia. Additionally, we are conducting cluster analysis of activity in populations of cortical neurons in order to better understand the representation of multi-modal stimuli in the gustatory cortex, assessing whether thermal stimuli elicit activity in populations of cells that overlap with neurons activated by taste and/or odor stimulation. It is our expectation that this analysis will allow us to contribute to a better understanding of the gustatory cortex as a sensory processing apparatus.
Funding Acknowledgments: NIDCD DC016833 JB
FCOI Declarations: None

O74-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Bottom-up and Top-down Connectivity of the Insular Gustatory Cortex in Newborn Rats

Margarett L Roddenbery[1], Joost X Maier[2]

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From the moment animals are born, bottom-up processing streams carry natural inputs from the tongue to the brainstem, but it is unclear whether this input reaches the gustatory thalamocortical system at birth. The aim of this project is to understand the anatomical connectivity between the granular insular cortex (primary gustatory cortex) and the rest of the brain. Specifically, whether the gustatory cortex receives bottom-up and/or top-down inputs at the time of birth. We tested this by injecting a retrograde tracer (cholera toxin subunit B, linked to GFP) into the insular cortex of rat pups shortly after birth (P1 or P4). After one week, the animals were euthanized, and their brains fixed with 10% formaldehyde followed by 30% sucrose, and then sliced and mounted on slides. Each slide was analyzed under an epifluorescence microscope to visualize GFP labeled soma and axons. We analyzed data from 3 rat pups in which tracer injection was confined to insular cortex. We found labeled cell bodies in the gustatory thalamus (ventral posteromedial nucleus), suggesting bottom-up gustatory inputs potentially reaching the cortex at the time of birth. We also found—albeit less consistently—labeled cell bodies in several extra-gustatory systems, including the amygdala, indicating potential top-down connectivity. In summary, the developing gustatory cortex appears to differ from other developing sensory systems in that natural sensory inputs reach the cortex by the time of birth, and that cortical sensory processing may be influenced by top-down influences. Currently, we are determining the contribution of cortical layers and subdivisions within the gustatory cortex to observed connectivity patterns.
Funding Acknowledgments: NIDCD R01 016063 and Wake Forest School of Medicine
FCOI Declarations: None

O75-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Glial-like type I cells cooperate functionally with chemosensory taste cells

Yuryanni A. Rodriguez[1], Jennifer K. Roebber[2], Gennady Dvoryanchikov[1], Vivien Makhoul[3], Stephen D. Roper[1,2,3], Nirupa Chaudhari[1,2,3]

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In taste buds, type I cells resemble glia, ensheathing type II and III chemosensory cells. Although these cells are the most numerous, there are few functional studies on them. We tested the hypothesis that type I taste bud cells cooperate functionally with chemosensory cells and afferent fibers in the manner of neuronal/glial tripartite synapses. ATP and 5HT are transmitters secreted from type II and III taste bud cells, respectively. We used *Gad2*-Cre to express the genetically encoded Calcium indicator, GCaMP3, selectively in type

I taste bud cells. We tested if type I cells, dissociated from circumvallate (CV) or fungiform taste buds, responded to bath-applied ATP (10–40μM), 5HT (200nM) or taste stimuli (5μM cycloheximide, Chx; 1mM denatonium, Dn). ≈75% of GCaMP+ cells showed robust Ca^{2+} mobilization to ATP. None responded to 5HT or bitter stimuli. Next, we examined intact taste buds in ≈100μm slices of CV. GCaMP+ type I cells in their native environment within the bud also responded to bath-applied ATP (10–100μM). We next asked if ATP secreted endogenously by type II cells in response to taste stimulation could also activate type I cells. We bath-applied bitter tastants: Chx (5–30μM), Dn (3mM), and quinine (0.3mM) to lingual slices. GCaMP-expressing cells responded robustly to tastants, suggesting that type I cells in intact taste buds respond secondarily to tastant-evoked ATP secretion by type II cells. The response of type I cells to Chx decreased substantially in the presence of apyrase (10U/ml, to degrade extracellular ATP), or purinergic inhibitors: Suramin (50–150μM) and PPADS (10μM). Our results are consistent with the hypothesis that type I cells sense the activation of chemosensory type II cells and may contribute to the sensory output of taste buds.

Funding Acknowledments: NIH/NIDCD grant ROI DC 006308

FCOI Declarations: None

O76-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Sweetness Perception in Habitual and Non-habitual Users of Low-calorie Sweeteners - a Pilot Study

Clara Salame[1], Sara Petty[2], Ayah Albareedi[2], Gwendoline Balto[2], Ying Yang[2], Blair Rowitz[2,3,4], M. Yanina Pepino[1,2]

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Although previously considered metabolically inert, growing evidence suggest that low-calorie sweeteners (LCS) have potential detrimental effects on glucose control. A plausible mechanism by which LCS might do so is by altering sweetness perception because taste perception can affect glucose metabolism. The objective of this study was to test the hypothesis that habitual LCS consumption is associated with decreased sweetness sensitivity and decreased intake of added sugars. Habitual (n=8) and non-habitual (n=16) consumers (i.e. >5 or <1 diet soda or LCS equivalent product per week) completed a battery of tests. We assessed glucose detection thresholds using a 2-alternative forced-choice staircase procedure, sweet taste intensities of suprathreshold concentrations using the general labelled magnitude scale, sweet preferences using the Monell 2-series, forced choice tracking procedure, and cravings for sweet foods and sugar intake using validate questionnaires. Compared to non-habitual, habitual LCS consumers had a higher glucose detection threshold (33.9±7.1 vs 61.4±9.9 mM, $p<0.04$) and tended to consume more added sugars, particularly sucrose ($p=0.05$) in the past month. However, groups did not differ in their frequency of food cravings, sweetness intensity perception or most preferred glucose or sucralose concentrations. These preliminary data partially support our hypothesis of a reduced sweetness sensitivity in habitual LCS consumers, whom, on average, required an 80% increase in glucose concentration to detect a taste compared to non-habitual consumers. However, sweetness intensity perception at suprathreshold concentrations was not different between the groups. Far from displacing caloric sweeteners in the diet, habitual LCS consumption was associated with higher added sugar intake.

Funding Acknowledments: This research was funded in part by the American Diabetes Association grant 1-19-ICTS-092 (MYP) and by a fellowship from the USDA National Institute of Food and Agriculture National Needs Predoctoral training grant in Nutrition & the Gut Brain Axis:Implications for development and healthy aging 2019-38420-28973 (CS).

FCOI Declarations: None

O77-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Inbred Mouse Strain Differences in Postoral Sugar Appetition

Anthony Sclafani[1], Mirna Nashed[2], Bruneskidvi Jean-Philippe-Morisset[2], Eli Berglas[2], Ion Carata[2], Alexander Castillo[2], Matthew Roland[2], Shameer Riaz[2], Rachel Pines[2], Richard Bodnar[2]

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Inbred mouse strains differ in their sweet taste sensitivity and in their response to the postoral appetite-stimulating (*appetition*) actions of sugars. Sweet-sensitive (SEN) C57BL/6, FVB and SWR strains show strong sweetener preferences but differ in their experience-induced changes in fructose preference. All three strains prefer a 0.1% sucralose + 0.1% saccharin (S+S) mixture to 8% fructose (F) in an initial 48-h choice test, but after separate 48-h experience with S+S and F, FVB and SWR, but not C57BL/6 mice switch their preference to F based on the sugar's postoral appetition actions. We measured the preference response of food-restricted sweet subsensitive (SUB) strains, 129P3

and DBA/2, to F vs. S+S because they previously displayed stronger F-conditioned flavor preferences than C57BL/6 mice. Both SUB strains preferred S+S to F in an initial 48-h choice test. Following separate experience with F and S+S, 129P3 mice still preferred S+S while DBA/2 mice now equally preferred F and S+S. Yet, after experience with 8% glucose (G) and S+S, both SUB strains strongly preferred G to S+S, which has been observed in other SEN (C57BL/6, SWR, FVB) and SUB (BALB) strains. An outlier SEN strain, CAST/EiJ continued to prefer S+S to F and to G after experience with the nonnutritive (S+S) and nutritive (F,G) sweeteners. Further studies of the differential response of inbred strains to sweetener experience may help identify the postoral sensors responsible for glucose and fructose appetition.

Funding Acknowledments: Research Foundation of the City University of New York

FCOI Declarations: None

O78-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Mechanisms of Carbon Dioxide Detection in the Earthworm *Eisenia hortensis*

E Jordan Smith, Jen L Ryan, Wayne L Silver, Cecil J Saunders

Wake Forest University, Winston-Salem, NC, USA

Carbon dioxide (CO_2) is a critical biological signal which, as a byproduct of respiration, indicates the presence of other living organisms. The earthworm *Eisenia hortensis* lives in subterranean burrows containing high levels of CO_2 and respires through its skin. Despite the ecological and agricultural importance of earthworms, relatively little is known about how they make decisions in their environment, including their response to elevated levels of CO_2. Because CO_2 is noxious at high concentrations, we designed a novel assay, the exudate assay, to gauge CO_2 aversion in this species. In the exudate assay, an earthworm is placed in a sealed container and exposed to varying concentrations of CO_2 for one minute, and the amount of exudate secreted in that time is recorded, as earthworms secrete exudate in response to noxious stimuli. These experiments were repeated after exposure to several blockers for molecules with potential involvement in CO_2 detection, including carbonic anhydrase, guanylate cyclase, TRPA1 channels, and acid sensing ion channels. We found that earthworms secrete significantly more exudate in response to CO_2 in a dosage-dependent manner ($p=2.04e-05$, one-way ANOVA), and this response is muted by the general carbonic anhydrase inhibitor Acetazolamide ($p=0.037$, Tukey's HSD) and the calcium channel blocker Ruthenium Red ($p=0.0091$, Tukey's HSD). qPCR was used to evaluate comparative amounts of TRPA1 and carbonic anhydrase throughout the earthworm, and the exudate assay was further used to gauge aversion to various acids. These data contribute to our understanding of the mechanisms earthworms use to detect CO_2 and provide yet another example of how chemosensory molecular mechanisms are highly conserved among metazoa.

Funding Acknowledments: Center for Molecular Signaling and the Department of Biology at Wake Forest University

FCOI Declarations: None

O79-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Medication Effective in Reducing Pain and Taste Complaints in Patients with Burning Mouth Syndrome (BMS)

Nan Su[1], Renee Poon[1], Cassandra Wang[1], Mark Darling[2], Miriam Grushka[1,3]

[1]Dr. Miriam Grushka Oral Medicine Specialist, Toronto, ON, Canada, [2]Department of Pathology and Laboratory Medicine, Schulich School of Medicine and Dentistry, University of Western Ontario, London, ON, Canada, [3]Adjunct Visiting Lecturer,Tuft University, Medford, MA, USA

Objective: BMS has been found in previous studies to be associated with oral burning pain that typically increases over the day, often associated with taste phantoms (especially metallic and bitter) and decreased taste sensitivity to suprasaturated tastes, especially salt and bitter. With appropriate medication, subjective pain intensity is decreased, and taste is improved. This study reviews medications reported by BMS patients to be most effective in reducing pain and improving taste.

Methods: A retrospective chart review was conducted at a private oral medicine clinic. Only patients diagnosed with primary BMS, who at their follow-up appointment reported pain improvement, were included. Medication reported to be effective was collected.

Results: Thirty-nine BMS patients, 31 females and eight males, age 56.1± 9.4 years were included in the study. Eight patients reported decreased pain and other symptoms without medication. Two improved with only clonazepam and one with only amitriptyline. One patient improved with zinc and alpha lipoic acid. One patient improved with amitriptyline, pregabalin and gabapentin. Two improved with gabapentin, pregabalin and zinc. Twenty-three patients used a combination of clonazepam and another medication(s), including gabapentin, pregabalin or amitriptyline. One patient improved with a soft custom tray. Dosages reported were clonazepam 0.25–0.5 mg/d, gabapentin 100–300 mg up to tid, pregabalin 25–75 mg up to tid, amitriptyline 5–20 mg/d, alpha lipoic acid 600 mg/d, zinc gluconate 50 mg/d. Conclusion: This study suggests that there is no single regimen in treatment of the pain and taste complaints of BMS. However, clonazepam, with one or more adjunctive

medication remain the most effective treatment to reduce pain and other features in BMS.
Funding Acknowledgments: None
FCOI Declarations: None

O80-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Molecular Mechanisms of Chemosensory Plasticity

Hayeon Sung, Anoumid Vaziri, Monica Dus

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Earlier work in humans and more recent studies in animal models have shown that diet composition changes the perception of taste modalities such as sweet, salty, and bitter. We previously reported that in the fly D. melanogaster high levels of dietary sugars irreversibly blunt sweet taste by lowering the responses of the taste cells to sweet stimuli. We discovered that these changes in sweet taste were caused by the action of the epigenetic regulator Polycomb Repressive Complex 2.1 (PRC2.1) and the metabolic enzyme O-GlcNAc Transferase, which repress a neurodevelopmental program required for normal taste function. To understand how this neurodevelopmental program affects chemosensory plasticity, we have been studying the effects of specific components on neuronal morphology and physiology using the exquisite tools of the fly model. Together, the result of these ongoing studies will uncover the molecular mechanisms that underlie diet-induced chemosensory plasticity and catalyze research in mammals.
Funding Acknowledgments: NIH R00 DK-97141 MD NIH 1DP2DK-113750 MD
FCOI Declarations: None

O81-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Tyrosine Hydroxylase is expressed in a subset of oral sensory neurons and taste receptor cells

Tao Tang, Brian Pierchala

Indiana University, Indianapolis, IN, USA

Tyrosine Hydroxylase (TH) is the rate-limiting enzyme required for catecholamine synthesis. Whether catecholaminergic neurons participate in the transmission of gustatory information is unknown. To identify unique subpopulations of geniculate ganglion (GG) oral sensory neurons we are examining their neurotransmitter phenotypes. Immunolabelling with a TH antibody demonstrated that only a small population, about 8% of GG neurons, express TH. The majority of these TH-positive neurons also expressed Phox2b, which is selectively expressed in oral sensory GG neurons. To determine whether mRNA expression of TH was similar immunolabelling, FISH was performed with probes to TH and Phox2b. A small subset of neurons robustly expressed TH, and a larger population expressed low levels of TH. We also evaluated TH expression using TH-CreER; Rosa26^{Tomato} reporter mice in which RFP is expressed in TH neurons after tamoxifen administration. Approximately 10% of GG neurons were RFP+, similar to the immunofluorescence data, suggesting that neurons expressing low levels of TH mRNA don't translate detectable amounts protein. Interestingly, taste buds (TBs) in circumvallate papillae, foliate papillae, and the soft palate all contained TH+ fibers, whereas TBs in fungiform papillae did not. Importantly, TH+ axons projected along the chorda tympani, suggesting that these fibers selectively innervate foliate TBs. During this analysis we discovered a small number of TB cells that were TH+ and were only present in 12% of fungiform papillae. These TH+ cells do not express Car4 and do not have the unique morphology of type I cells, suggesting they may be type II cells. Overall TH expression identified a rare taste receptor cell, along with a population of GG neurons that selectively innervate TBs in the posterior tongue.
Funding Acknowledgments: National Institute on Deafness and Other Communication Disorders (NIDCD) grant R01 DC015799 to BAP.
FCOI Declarations: None

O82-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

3D cultivation of human progenitor-like tongue cells resembling taste bud like structures *in vitro*

Elena von Molitor[1], Paul Scholz[2], Katja Riedel[2], Michael Krohn[2], Mathias Hafner[1], Rüdiger Rudolf[1], Tiziana Cesetti[1]

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Mostly taste research is based on animal lingual preparations, however, interspecies differences question the transferability of the results to human. Taste progenitors located in the taste bud, constantly give rise to mature taste cells. Thus, to better investigate human gustation mechanisms, we have previously successfully isolated human tongue progenitor-like cells (HTPs) from fungiform papillae. The molecular analysis of the primary cultures confirmed a progenitor phenotype. Furthermore cultivation in 2D with FCS-enriched medium prompted their differentiation into

denatonium benzoate and saccharine sensitive cells. Based on these findings and their short lifespan we established a method to immortalize HTPs. The aim of our cultivation experiments was to optimize HTP cultivation to better resembling a taste bud like *in vivo* environment. This may be crucial for their maturation into taste cells sensitive to different taste modalities. HTPs were grown in 3D culture as spheroids or in Dynarray chips. HTPs were unable to form compact spheroids by themselves, even upon addition of basement membrane extract (BME) or matrigel. Instead, when co-cultured with a human-derived tongue cell line (HTC), they formed roundish and compact spheroids, in which the two cell populations segregated over time: HTC cells formed the core, surrounded by HTPs, and a bud like structure. Conversely, in collagen-coated chips, HTPs grew either as monoculture or co-culture. In the co-culture, HTPs filled the core of the cavity, enwrapped by HTC cells. Further immunostaining revealed few apoptotic and some proliferating cells throughout the spheroids and the chip. Taken together, these experiments show that the human tongue progenitor-like cell line HTP can be grown as 3D cultures that might mimic the taste bud niche.

Funding Acknowledgments: This work was funded by the German Federal Ministry of Education and Research (BMBF) as part of the Innovation Partnership M2Aind, project M2OGA (03FH8I02IA) and BRAIN AG.

FCOI Declarations: KR, PS, MK are employees of BRAIN AG, Zwingenberg.

O83-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Structural Remodeling of Peripheral Taste Neurons

Zachary D. Whiddon, Jaleia B. Marshall, Aaron W. McGee, Robin F. Krimm

University of Louisville School of Medicine, Louisville, KY, USA

Taste neurons receive information from taste-transducing cells that undergo continual turnover. Given that taste neurons must connect with new cells, we asked if they undergo structural remodeling over time using intravital imaging. Because the half-life of taste-transducing cells is 10 days, we speculated that half of the arbors (portion of the peripheral taste axon that innervates the taste bud) would remodel within 10 days in order to form connections with new cells. So, we sampled arbor structure every 12 hours for 10 days. Since synapses occur on distal (terminal) branches of the arbor, we quantified the change in the number of terminal branches over time. We found that all arbors altered their complexity by adding or pruning terminal branches within the first 5 days, and 19 of 31 arbors changed terminal branch number in the first 24 hours. On average 1 terminal branch was gained or lost every 16.0 hours. Given this surprising speed, we imaged arbors at 4 hours for 12 hours. We found that 42.4% of arbors gained or lost a terminal branch more than once in a 12-hour period. and that a terminal branch was gained or lost once every 6.8 hours. This finding indicates terminal branches remodel much faster than would be predicted by taste bud cell turnover. To investigate if terminal arbor size is altered over time, we measured the volume the arbor occupies within the taste bud (convex hull). Minimum hull volume predicts maximum hull volume (R^2=0.937), indicating that arbor size does not change over the full dynamic range in 10 days. Lastly, we examined 18 arbors in 36 taste buds every 10 days for 50 days and no arbors were gained or lost. Together these data demonstrate that terminal arbor number is stable, but arbor structure is plastic, with terminal branches undergoing rapid continuous remodeling.

Funding Acknowledgments: NIDCD F31 DC019050-01 ZW

FCOI Declarations: None

O84-DEVELOPMENT OF CHEMOSENSATION AND PERCEPTION

TUESDAY, 10:00 AM - 12:00 PM

Development of chemosensation and perception

Arianna Maffei[1], Hillary Schiff[1], Claudia Lodovichi[2], Joost Maier[3], Bianca Jones Marlin[4]

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Postnatal development typically represents a period of heightened plasticity during which experience and learning refine neural circuits. There is surprisingly little information about how chemosensory experience may influence neural circuit function and limited knowledge about the mechanisms regulating postnatal plasticity of gustatory and olfactory circuits. Emerging research has recently begun to address these questions directly. This symposium will bring together researchers investigating postnatal development of gustatory and olfactory systems, and will showcase novel results highlighting the importance of early experience and learning in neural circuits for chemosensory processing. The topics covered in the presentation cover a broad range of topics including investigation of homeostasis and neurogenesis in the olfactory bulb (Dr. Claudia Lodovichi, University of Padova), postnatal development in the neural circuit from the bulb to the piriform cortex (Dr. Joost Maier, Wake Forest University), epigenetic regulation of olfactory cues (Dr. Bianca Jones Marlin, Columbia University), and discussion

of a newly identified critical period for experience-dependent plasticity in the gustatory cortex (Dr. Hillary Schiff, Stony Brook University). As research in this field gains a foothold, this symposium will offer an invaluable opportunity for assessing the state of the field, highlight important open questions and suggest possible directions for future work.
Funding Acknowledments: NIDCD DC013770 to AM NIDCD DC018485 to HCS
FCOI Declarations: None

O85-DEVELOPMENT OF CHEMOSENSATION AND PERCEPTION

TUESDAY, 10:00 AM - 12:00 PM

Cl homeostasis and neurogenesis in the olfactory system.

Andrea Maset[1,2,3], Luisa Galla[3,4], Simona Francia[1,5], Olga Cozzolino[6,7], Paola Capasso[8], Rosa Chiara Goisis[3,4], Gabriele Losi[3,4], Angelo Lombardo[8,9], Gian Michele Ratto[6,7], Claudia Lodovichi[1,2,3,4]

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Neuronal information processing results from the interplay between excitation and inhibition. Mounting evidence indicates that inhibition is essential in shaping spontaneous and evoked activity. Consistent with this prime role, alterations of inhibitory circuits exert a key role in the etiopathogenesis of several neurological diseases. The polarity of the responses (hyperpolarization versus depolarization) elicited by GABA, the major inhibitory neurotransmitter of the brain, is, however, not univocal but depends critically on the intracellular Cl^- concentration that is regulated by specific Cl^- cotransporters, whose expression is developmentally regulated. Immature neurons express mostly NKCC1 that favors high intracellular Cl^- concentration and depolarizing responses. Mature neurons express mostly the cotransporter KCC2 leading to low intracellular Cl^- concentration, and inhibition. The majority of inhibitory interneurons are generated during embryonic life, but a niche of neurogenesis persists in postnatal life in most mammals including human infants. These postnatally generated inhibitory interneurons are thought to play a key role in postnatal developmental plasticity, which is essential for normal brain development. Alterations of this process could therefore account for sensory and cognitive dysfunctionalities associated with neurodevelopmental disorders. Combining 2 photon imaging, electrophysiology, and quantitative anatomy, we have analyzed the impact of Oligophrenin 1 (OPHN1), a gene associated with intellectual disability- autism, on postnatal neurogenesis of forebrain GABAergic inhibitory interneurons, in mice carrying a null mutation in OPHN1. Here, I will present the results we found and the new research lines that emerged from these results.
Funding Acknowledments: Telethon GGP19281
FCOI Declarations: None

O86-DEVELOPMENT OF CHEMOSENSATION AND PERCEPTION

TUESDAY, 10:00 AM - 12:00 PM

A Critical Period for the Development and Expression of Sucrose Preference

Hillary C Schiff, Maria Isaac, Alfredo Fontanini, Arianna Maffei

SUNY - Stony Brook Department of Neurobiology & Behavior, Stony Brook, NY, USA

Taste preferences are critical for survival as they direct consummatory behavior toward nourishing food and away from harmful substances. At the transition from relying on mother's milk to foraging for food, animals experience a variety of new tastes and learn relevant information associated with consuming them. It is believed that these experiences shape the regions of the brain involved in taste processing during this postnatal period, thereby influencing gustatory preferences throughout life. The effects of early experience on taste preference and the maturation and function of the gustatory cortex (GC) have not yet been the subject of investigation. Here, we report that taste experience at weaning, but not in adulthood, affects preference for sweet tastes later in life. Using a brief access test, we observed that sucrose preference is enhanced in mice following exposure to a variety of tastants at weaning compared to mice exposed only to water and chow. Mice undergoing the same exposure at 8 weeks did not show differences in sucrose preference compared to their naïve littermates. The change in sucrose preference did not depend on familiarity with sucrose. Early exposure affected the maturation of inhibitory circuits in GC, marked by an acceleration of the association of parvalbumin expressing (PV^+) neurons with perineuronal nets (PNNs) and an increase in the frequency of spontaneous inhibitory currents (sIPSCs) onto excitatory neurons. Enzymatic degradation of PNNs locally in GC in adult mice restored sensitivity to taste exposure. These results point to the presence of a critical period when experience may cause long-term changes in

taste preference and to a central role for PV^+ neurons and their association with PNNs in the experience-dependent modulation of taste preference.
Funding Acknowledgments: NIDCD F32-DC018485 HCS NIDCD R01-DC015234 AF & AM
FCOI Declarations: None

O87-DEVELOPMENT OF CHEMOSENSATION AND PERCEPTION

TUESDAY, 10:00 AM - 12:00 PM

Bridging the gap between innate and learned behaviors: A parent's role in promoting survival

Bianca Jones Marlin, Richard Axel

Columbia University in the City of New York, New York, NY, USA

My research investigates the relationship between the innate and the learned. I have examined how an organism unlocks an innate behavior at the appropriate time i.e.-maternal instinct, and how a traumatic experience is passed to subsequent generations via paternal lineage. Changes in gene expression, and consequent behavior, of a parent, may permit offspring to exhibit an inherited adaptation to the environment. This process, known as the transgenerational epigenetic inheritance of environmental information, remains a complex mystery. Novel experiments performed by myself and others have demonstrated that odors in the environment of a mouse associated with aversive consequences result in compensatory alterations in the olfactory system of their offspring. I combine neural imaging, behavior, and molecular genetics to understand the transfer of information inherent in neurons of the parent, through the gamete, to neurons of their offspring. Our goal is to uncover the process through which learning and emotion in one generation can be transmitted not culturally, but rather biologically through DNA. We believe understanding how a *learned* behavior in the parent can essentially become an *innate* behavior in the offspring will have profound implications in societal health and well-being.
Funding Acknowledgments: University funds, Simons Society of Fellows, EE Just
FCOI Declarations: None

O88-DEVELOPMENT OF CHEMOSENSATION AND PERCEPTION

TUESDAY, 10:00 AM - 12:00 PM

Early Postnatal Development of Information Processing in Bulbo-Cortical Circuits

Joost X. Maier, Zihao Zhang, D. Chad Collins

Wake Forest School of Medicine, Winston Salem, NC, USA

Most animals must start to interact with their environment long before neural circuits have fully matured. However, information processing in neonatal brains remains poorly understood. The rodent olfactory system offers a unique opportunity to study neonatal information processing given its experimental tractability and the importance of odor perception for survival in early life. We performed extracellular recordings of network-level local field potential activity in the piriform cortex of unanesthetized rat pups ranging in age from several hours to three weeks after birth. We found that neonatal olfactory (piriform) cortex exhibits highly structured spontaneous and odor-evoked oscillations (respiration-driven slow oscillations with nested spindle oscillations). Oscillatory activity patterns remain stable during the first two weeks of life, after which they undergo rapid, quantitative changes to a mature state. Simultaneous recordings from the olfactory bulb suggest that oscillations originate in the bulb, and acute lesions of bulbo-cortical connectivity suggest that they are sustained by corticofugal feedback projections. Thus, neonatal olfactory processing is characterized by stable network-level activity patterns, despite known changes at the cellular and molecular levels. Moreover, neonatal activity patterns share characteristics with activity patterns previously observed in adults, and are generated by overlapping neural circuits. These findings stand in contrast with previous findings from sensory neocortex, where neonatal information processing is characterized by developmentally transient circuits and activity patterns, and may reflect the integral role of olfaction in guiding adaptive behavior from the time of birth.
Funding Acknowledgments: NIDCD R01 016063
FCOI Declarations: None

O89-CHEMOSENSORY DYSFUNCTION IN COVID-19: BEHAVIORAL AND NEUROBIOLOGICAL FACTORS

TUESDAY, 10:00 AM - 12:00 PM

Chemosensory Dysfunction in COVID-19: Behavioral and Neurobiological Factors

Shima T Moein[1], Richard L Doty[2], Valentina Parma[3], Jonathan Overdevest[4], Carol Yan[5]

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In early March of 2020, reports appeared in the social media of many countries linking smell/taste loss to the spread of SARS-CoV-2. Such reports led to studies of the prevalence and reversibility of the smell loss of COVID-19 and the cellular mechanisms responsible for the loss. These studies have the potential to play a significant role in early COVID-19 detection and the development of preventative interventions and therapies for COVID-19. In this symposium, the olfactory and gustatory manifestations of COVID-19 will be reviewed. Dr. Parma will discuss how a global consortium approached this issue in COVID-19 patients in over 60 countries. She will address the prevalence of chemosensory loss and its continued presence in various groups of patients. Dr. Overdevest will present the evolution in investigations to identify molecular pathways that are dysregulated during COVID-19 infection through a histopathologic and transcriptomic evaluation of post-mortem nasal epithelium biopsies.As the pandemic continues despite containment and mitigation strategies, even a low percentage of patients with sustained smell loss and other problems may challenge health systems. Dr. Yan will discuss the implications of smell loss, its assessment, and its management in the clinic. Moreover, challenges for clinicians to minimize its long-term effects on physical and mental health, including quality of life, will be addressed.Finally, Dr. Doty will explain how machine learning techniques are being used to optimize the sensitivity of smell tests to detect COVID-19. Such tests have the potential to provide a sensitive and inexpensive means for detecting persons carrying SARS-CoV-2 early in the COVID-19 disease process, as well as for tracking their function over time.

Funding Acknowledments: IPM1000 STM

FCOI Declarations: Richard L.Doty is a consultant to Eisai Co, Merck Pharmaceuticals, the Michael J. Fox Foundation for Parkinson's Research, Septodont, Inc, and Johnson & Johnson; receives royalties from Cambridge University Press, Johns Hopkins University Press, and John Wiley & Sons; and is president of, and a major shareholder in, Sensonics International, a manufacturer and distributor of smell-and-taste tests, including the test used in this study. The remaining authors have no disclosures.

O90-CHEMOSENSORY DYSFUNCTION IN COVID-19: BEHAVIORAL AND NEUROBIOLOGICAL FACTORS

TUESDAY, 10:00 AM - 12:00 PM

Molecular Underpinnings of Olfactory Dysfunction Following SARS-CoV-2 Infection

Marianna Zazhytska[1], Albana Kodra[1], Daisy A. Hoogland[2], John Fullard[2], Hani Shayva[3], Arina Omer[2], Stuart Firestein[1], Peter D. Canoll[1], Panagiotis Rousos[2], Benjamin TenOever[2], Stavros Lomvardas[1], Jonathan B. Overdevest[1]

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Olfaction is a closely coordinated partnership between odorant flow and neuronal signaling. Disruption in our ability to detect odors, or anosmia, has emerged as a hallmark symptom of infection with SARS-CoV-2, and yet, decoding the mechanism behind this abrupt sensory deficit remains elusive. Patients with COVID-19 lack symptoms of nasal congestion and rhinorrhea present in many upper respiratory tract infections that result in a conductive reduction in an ability to perceive smells. To investigate the molecular underpinnings of SARS-CoV-2 related smell loss, we performed molecular analysis, including scRNAseq, RNA-FISH, and Hi-C on both human and syrian golden hamster olfactory epithelium. Here, we report that smell loss may be attributable to non-cell autonomous mechanisms that induce genomic compartment dysregulation and subsequent downregulation of critical signaling pathways responsible for production of olfactory receptors.

Funding Acknowledments: 3R01DC018744-01S1

FCOI Declarations: None

O91-CHEMOSENSORY DYSFUNCTION IN COVID-19: BEHAVIORAL AND NEUROBIOLOGICAL FACTORS

TUESDAY, 10:00 AM - 12:00 PM

A Worldwide Approach to Study Chemosensory Loss During COVID-19 Pandemic

Valentina Parma[1,2]

[1]Temple University, Philadelphia, PA, USA, [2]Monell Chemical Senses Center, Philadelphia, PA, USA

Smell and taste loss are among the symptoms, arguably the most predictive ones, of an active SARS-CoV-2 infection when compared to other viral respiratory infections. The Global Consortium for Chemosensory Research (GCCR) has studied smell, taste and chemesthesis manifestations since the beginning of the pandemic via self-reports and more recently via the use objective testing conducted with house-hold items. In this talk, I will focus on the main results produced by the GCCR collaborative effort with respect to the acute phase of COVID-19, as well as its early and longer-term recovery. The results suggest that the magnitude of the public health impact of smell and taste loss is potentially large, given the numbers of individuals who have been and will be infected with SARS-CoV-2 and those that report long-term chemosensory dysfunction. Future perspectives on how to address smell and taste loss in patients with COVID-19 and other viral illnesses is offered along with the future research endeavors of GCCR.

Funding Acknowledments: N/A

FCOI Declarations: None

O92-CHEMOSENSORY DYSFUNCTION IN COVID-19: BEHAVIORAL AND NEUROBIOLOGICAL FACTORS

TUESDAY, 10:00 AM - 12:00 PM

Treating COVID-19 Patients with Smell Loss in the Otolaryngology Clinic: Approach, Management and Prognosis

Carol H Yan

University of California, San Diego Division of Otolaryngology- Head and Neck Surgery, Department of Surgery, San Diego, CA, USA

A full year has passed since patients were first seen in their medical and otolaryngology clinics with reported acute onset and often profound smell and taste loss that were soon linked to the SARS-CoV-2 virus. While studies vary in their prevalence, roughly 50% of patients with COVID-19 are estimated to suffer from viral-induced chemosensory dysfunction with approximately 5–25% experiences some extent of persistent smell and/or taste loss. The widespread screening of COVID-19 has allowed for a heightened clinical awareness in the early onset of one's olfactory dysfunction with a known viral etiology. Despite the high spontaneous recovery rate, persistent smell loss and qualitative olfactory dysfunctions such as parosmias have developed in an unfortunate subset of COVID-19 patients. Thus, consideration for early onset therapy may be appropriate and physicians have the opportunity to recommend treatment options for acute and chronic COVID-19 associated olfactory loss. Preliminary studies have suggested efficacy with the use of olfactory training as well as topical and oral steroids for olfactory loss, and topical sodium citrate for qualitative olfactory symptoms. Early longitudinal data have also suggested that the increased severity of smell dysfunction and the female gender may predispose to long term olfactory loss. Perhaps equally as important as the therapeutic management of smell loss is the counseling provided and the understanding of the impacts of olfactory dysfunction on quality of life and mental health. In this symposium talk, we will review the literature and discuss the approach and management that an otolaryngologist might provide to patients suffering from acute and chronic COVID-19 related olfactory loss.

Funding Acknowledments: university funds
FCOI Declarations: None

O93-CHEMOSENSORY DYSFUNCTION IN COVID-19: BEHAVIORAL AND NEUROBIOLOGICAL FACTORS

TUESDAY, 10:00 AM - 12:00 PM

Machine Learning: A Path Toward Optimized Smell Tests for Screening COVID-19

Richard L Doty

Smell & Taste Center, Department of Otorhinolaryngology-Head and Neck Surgery, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA

Coronavirus Disease 2019 (COVID-19) continues to negatively impact families, health care facilities, and economies throughout the world. Among the symptoms of COVID-19 is a sudden decrease in smell function, making such dysfunction an early disease biomarker. Unfortunately, a significant number of persons with COVID-19 are unaware of their smell problem until being objectively tested. Practical, sensitive, and inexpensive smell tests have the potential for rapid identification of carriers of the SARS-CoV-2 virus responsible for this disease so that early quarantine and medical treatment can be instituted. In this study, we employed and evaluated eight sophisticated machine learning methods to identify unique multiple practical subsets of UPSIT odorant items sensitive to COVID-19 that can be used in sequential sets. As a trade-off between computing time and completeness of the search space, we modified a sequential selection strategy to consider at each iteration all combinations of 2–3 odorant features. AdaBoost, an ensemble learning method combining multiple decision trees, achieved the best performance in all metrics, with an accuracy of 94.1%, sensitivity (true positive rate) of 93.5%, and specificity (true negative rate) of 94.7%. Logistic Regression and k-Nearest Neighbor (kNN, k=3 with city block distance metric), and Linear Discriminant Analysis methods had a slightly worse performance than Adaboost. Based on these and other considerations, a minimum of 10 odorant items was needed to achieve >85% sensitivity and specificity.

Funding Acknowledments: IPM1000 STM
FCOI Declarations: A Potential conflict of interest: R.L.D. is a consultant to Eisai Co, Merck Pharmaceuticals, the Michael J. Fox Foundation for Parkinson's Research, Septodont, Inc, and Johnson & Johnson; receives royalties from Cambridge University Press, Johns Hopkins University Press, and John Wiley & Sons; and is president of, and a major shareholder in, Sensonics International, a manufacturer, and distributor of smell-and-taste tests, including the test used in this study. The remaining authors have no disclosures.

O94-MEET THE EDITORS OF CHEMICAL SENSES: POLICIES, PUBLISHING AND PUBLICIZING YOUR SCIENCE

TUESDAY, 1:30 PM - 2:30 PM

Meet the Editors of *Chemical Senses*: Policies, Publishing and Publicizing Your Science

Steven D. Munger[1]

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Chemical Senses is the premier journal focused on the science of smell, taste and chemesthesis in humans and other

animals. It is also the official journal of five scientific societies devoted to chemosensory science, including the Association for Chemoreception Sciences. This session will discuss the many advantages of publishing in your society journal, the journal's review and publication processes, and journal policies and new initiatives. After a short presentation by Editor-in-Chief Steven Munger, the session will include a Q&A session with a panel of the journal's executive editors - including Johan Lundström, Alan Spector, Susan Travers and Julie Mennella - will address questions from the audience and add their own perspectives.

Funding Acknowledments: Oxford University Press is the Publisher of Chemical Senses and supported the registration cost for SDM.

FCOI Declarations: SDM is the Editor-in-Chief of Chemical Senses.

O95-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

Effects on growth of regular smell and taste of milk during tube feeding of premature infants: a randomized clinical trial.

Friederike Beker[1,2], Helen G Liley[1,2], Ian Hughes[3], Sue Jacobs[4], Emily Twitchell[4], Judith Macey[1], Peter G Davis[4]

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Objective: Smells and tastes of food increase food anticipation, activate gut motility, and stimulate digestion and metabolism. Despite poor growth of many preterm infants in intensive care, smell and taste of milk with tube feeding is not generally considered part of their care. To determine the effect of smell and taste of milk with tube feeding on weight z-scores at discharge from hospital.

Methods: Randomized, non-blinded, superiority trial. Eligible infants were born at less than 29 weeks' postmenstrual age (PMA) and/or with a birth-weight of less than 1250g. Infants were randomly assigned to either smell and taste of milk with each tube feed or routine care without the provision of smell and taste of milk. Primary outcome was weight z-scores at discharge from hospital. Secondary outcomes included anthropometric measures at different time points, time to full enteral feeds and other health outcomes.

Results: Infants were randomized to treatment and control groups:196 and 200 infants, 51% and 52% male, mean (standard deviation) PMA at birth: 27.5 (2.2) and 27.6 (2.3) weeks, respectively. Median (interquartile range (IQR)) weight z-score at discharge were -0.7 (-1.75 - -0.05) and -0.92 (-1.63 - -0.31), for treatment and control groups, respectively, p=0.40. All anthropometric outcomes had a trend towards better growth in the treatment group and the difference in median (IQR) head circumference z-score at 36 weeks' PMA was significant: treatment -0.37 (-0.99;0.17) and control -0.61 (-1.26;0.09), p=0.04. All other feeding and health outcomes were not different between study groups.

Conclusions: Regular smell and taste of milk with tube feeding improves some nutritional outcomes in very preterm infants. It is a simple and inexpensive intervention with no apparent adverse effects.

Funding Acknowledments: The primary trial sponsor is Mater Misericordiae, contact: CEO Mater Research, Governance Office, email: research.governance@mater.uq.edu.au, phone: +61 7 3163 3769. This work is financially supported by Mater Foundation, the Mater Research Institute, the Department of Newborn Research at the RWH and the National Health and Medical Research Council (NHMRC) Program Grant (#1113902). PGD is supported by an NHMRC Practitioner Fellowship. The Royal Australasian College of Physicians and Paediatricians - Queensland Branch provided funding for statistical support.

FCOI Declarations: None

O96-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

COVID-19 Related Chemosensory Changes Are Comparable in Individuals With Self-Reported Obesity and Without Obesity

Surabhi Bhutani[1], Geraldine Coppin[2], Maria G Veldhuizen[3], Valentina Parma[4], Paule V Joseph[5]

*[1]San Diego State University, San Diego, CA, USA, [2]University of Geneva, Geneva, *, Switzerland, [3]Mersin University, Mersin, *, Turkey, [4]Temple University, Philadelphia, PA, USA, [5]National Institutes of Alcohol Abuse and Alcoholism and National Institute of Nursing Research, Bethesda, MD, USA*

Obesity has a negative impact on humans' ability to smell and taste. Disturbances in smell and taste emerged as the most prominent neurological symptoms of COVID-19, yet how chemosensory skills present in individuals with obesity with a positive COVID-19 diagnosis is unknown. We performed a secondary analysis of a cross-sectional global survey data (collected April 7th -November 4th, 2020) to compare self-reported chemosensory skills in participants with a respiratory illness reporting a positive (C19+; n = 5156) or a negative (C19-; n = 659) COVID-19 laboratory test, who also self-reported to be obese (C19+; n = 433, C19-; n = 86) or non-obese. Before COVID-19 illness, participants with obesity exhibit similar smell, taste, and chemesthesis perception as those without obesity. A greater decline in smell, taste, and chemesthesis was reported in C19+ participants,

compared to the C-19 group, with no difference between participants with obesity and without obesity. Of 68% of participants who reported recovery from respiratory illness symptoms (n=3431 C19+ and n= 539 C19-), post-recovery chemosensory perception did not differ in C19+ and C19- diagnosis, and by self-reported obesity. In C19+ participants with obesity, we observed a greater relative prevalence of non-chemosensory symptoms, including respiratory as respiratory and GI symptoms. Finally, we found that all chemosensory and other symptoms combined predicted the C19+ diagnosis in participants with obesity with a moderately good estimate (63% accuracy). Our data suggests that despite a presumed lower sensitivity to chemosensory stimuli, COVID-19 respondents with obesity experience a similar self-reported chemosensory loss as those without obesity, and in both groups self-reported chemosensory symptoms are similarly predictive of COVID-19.

Funding Acknowledments: None
FCOI Declarations: None

O97-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

The Uniqueness of Human Chemosensory Experience Measured Using a Comprehensive Remote Testing Procedure

Mackenzie E. Hannum, Cailu Lin, Desmond Jones, Lindsay L. Snyder, Lauren R. Colquitt, Joel D. Mainland, Danielle R. Reed

Monell Chemical Senses Center, Philadelphia, PA, USA

Sensory perceptions determine in part what we eat and drink, which in turn impacts our health. To understand sensory-based nutrition as a whole, we need to understand taste, smell, and chemesthesis on an individual basis. Typically, these three components are measured separately: that is, rarely in the same person. The development of an inclusive tool with remote capabilities is valuable for clinicians and researchers working to understand individual differences in chemosensory modalities. We developed the Monell Flavor Quiz (MFQ), which contains sensory stimuli that are known or suspected to be polarizing, meaning intense for some people and weak or barely perceptible for others. This study was designed for data collection at home and distributed worldwide (e.g., USA, Brazil, France) to 204 participants who were on average 33 years old, mostly female (N=135), and of European ancestry (N=141). Participants rated the intensity and liking for four taste stimuli (sucralose, NaCl, citric acid, and PTC), two chemesthetic stimuli (menthol and capsaicin), and six smell stimuli (galaxolide, guaiacol, β-ionone, trimethylamine, phenethyl alcohol, and 2-ethyl-fenchol). Participants accurately described the taste stimuli (e.g., 95% of participants rated NaCl as salty and sucralose as sweet), a quality control check for remote testing. Pearson's correlations were computed across all stimuli and ratings. Intensity ratings were more similar within a modality (e.g., within smell) than across modalities. Liking was less interrelated than intensity, with only 7 significant correlations overall ($\alpha<0.0006$) compared to 17 correlations, respectively. The results demonstrate the complexity and value of comprehensive testing for understanding individuals' sensorial experiences.

Funding Acknowledments: Monell Institutional Funds T32 DC000014 MEH.
FCOI Declarations: None

O98-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

Relieve Nasal Obstruction Symptoms through Modulation of Airflow via a Novel Nasal Aid

Kanghyun Kim, Zhenxing Wu, Alexander A. Farag, Bradley A. Otto, Kai Zhao

The Ohio State University, Columbus, OH, USA

Nasal obstruction affects around 13% of the population, or 30 million people in US. However, the subjective complaints of obstruction correlates poorly with objective findings (e.g. nasal resistance), leading to poor treatment outcome. Here, we report that re-directing nasal airflow through a novel nasal plug with an embedded diagonal air channel can surprisingly relieve nasal obstruction symptoms despite further airflow constriction, on two groups of patients: empty nose syndrome (ENS n=30) and inferior turbinate hypertrophy + septal deviation (septal-turb n=40). ENS is characterized by a paradoxical sensation of nasal obstruction, despite a wide-open nasal airway, which may lead patients to severe anxiety and even suicidal attempts. In contrast, "septal-turb" fits the traditional diagnosis of nasal obstruction with CT evidence of a constricted airway. Patients were instructed to insert the plugs in their nostrils and rotated them to two standard directions (up and down - in counter-balanced order) and then a self-oriented most "comfortable" direction. The two distinct patient groups (one being nose "too-wide", one being "too-narrow") both reported significantly improved symptoms compared to the baseline, especially in the self-oriented direction (ENS6q 16.8+-5.0 to 8.6+-4.6, septal-turb VAS, 5.7+-2.1 to 3.6+-2.6, all $p<0.05$), suggesting that the improvement depends on personalized airflow stimulation of critical nasal mucosa regions. Individual CT based computational fluid models confirm nasal plug effectiveness in re-directing airflow to targeted nasal regions. This finding may drastically challenge traditional thinking

of nasal obstruction as physical obstruction and may lead to novel therapeutic approaches based on optimal air/mucosa stimulation rather than on resistance.
Funding Acknowledments: NIH NIDCD R01 DC013626 NIH NIDCD R21 DC017530
FCOI Declarations: None

O99-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

The Longitudinal Correspondence of the Nasal Microbiome and Olfactory Function

Christina Kumpitsch[1], Sonja Lackner[2], Veronika Schöpf[3], Christine Moissl-Eichinger[1,4], Florian Ph.S Fischmeister[3,5]

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Numerous microorganisms inhabit the olfactory mucosa in the nasal cavity. Microbes have already been demonstrated to interact with all human body surfaces and are thus intertwined with human health and disease. From this, we infer that microbes might also interact with olfactory receptor cells in the nasal cavity and a shift in microbial composition may be associated with acquired anosmia. Here, we consider the idea that the nasal microbiome plays an important role in olfactory functioning per se and changes during the regain of olfactory functioning following a six-month daily smell training. Nasal microbiome of normosmic and anosmic participants were compared during six-month smell training via 16S rRNA gene sequencing. Six participants of each group which provided samples at three successive time points were selected for further metagenomic, metatranscriptomic, and metabolomic analyses. These microbiome features were then correlated with various physiological (e.g., olfactory functioning) and behavioral parameters (e.g., eating behavior). Anosmic participants significantly differed in richness as compared to normosmics and formed a subcluster within the group of normosmics. Although the general microbial composition was similar in both groups specific taxa were significantly associated with normosmics (*Ralstonia*) and anosmics (*Rickettsia, Cutibacterium, Abiotrophia*). Comparing the groups over time, fluctuations of microbial composition were observed. Understanding the olfactory mucosa's microbial community will increase therapeutic opportunities and possibly allow monitoring and predicting the success of smell therapy in the future based on biomarkers obtained from microbiota.
Funding Acknowledments: FWF - Austrian Science Fund (KLI 639)
FCOI Declarations: None

O100-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

Cerebellar decoding accuracy of real and imagined odors is associated with odor imagery ability and food craving intensity

Emily E Perszyk[1,2], Jessica Trinh[1,2], Jelena Djordjevic[3], Marilyn Jones-Gotman[3], Hedy Kober[2], Dana M Small[1,2]

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Mental imagery plays a key role in the generation and intensification of food cravings (Kavanagh et al. 2005). Since self-reported ability to imagine odors varies widely (Bensafi & Rouby 2007) and correlates with BMI (Patel et al. 2015), we tested the hypothesis that people with better odor imagery ability experience more intense food cravings. Odor imagery ability, craving intensity, and neuroimaging measures were collected in 10 participants with a range of BMI (data collection ongoing). Odor imagery ability was defined psychophysically as the extent to which imagining the smell of one odor impairs peri-threshold detection of a different odor (i.e., the interference effect; Djordjevic et al. 2004). Craving intensity ratings were obtained across 90 palatable food images and averaged for each participant. fMRI measured whole brain responses as participants smelled and imagined rose and cookie odors. A machine learning classifier was trained to differentiate rose vs cookie using voxel patterns evoked during real olfaction. The classifier was then tested for its accuracy to decode rose vs cookie using patterns evoked during imagined olfaction as our neuroimaging measure of odor imagery ability. Linear regressions revealed a positive relationship between the interference effect and craving intensity, indicating that individuals who imagine odors vividly experience stronger cravings. Both the interference effect and craving were also positively associated with cerebellar decoding accuracy. This work establishes a relationship between odor imagery ability, food craving intensity, and the fidelity of the olfactory neural code between real and imagined odors in the cerebellum. We conclude that these interim findings provide preliminary support for the involvement of odor imagery in food craving.
Funding Acknowledments: The Adi and Jerry Greenberg Foundation
FCOI Declarations: None

O101-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

Applying Olfactory Bulb Volume in the Clinic: Relating Clinical Outcome Measures to Olfactory Bulb Volume Using Convolutional Neural Networks

Elbrich M Postma[1,2], Julia MH Noothout[3,4], Wilbert M Boek[2], Thomas Hummel[5], Paul AM Smeets[1,3], Ivana Išgum[3,4,6], Sanne Boesveldt[1]

*[1]Division of Human Nutrition and Health, Wageningen University & Research, Wageningen, *, Netherlands, [2]Department of Otorhinolaryngology, Hospital Gelderse Vallei, Ede, *, Netherlands, [3]Image Sciences Institute, University Medical Center Utrecht, Utrecht, *, Netherlands, [4]Department of Biomedical Engineering and Physics, Amsterdam UMC – location AMC, University of Amsterdam, Amsterdam, *, Netherlands, [5]Smell and Taste Clinic, Department of Otorhinolaryngology, TU Dresden, Dresden, *, Germany, [6]Department of Radiology and Nuclear Medicine, Amsterdam UMC – location AMC, University of Amsterdam, Amsterdam, *, Netherlands*

The olfactory bulb (OB) plays a key role in olfactory processing; its volume is important for diagnosis, prognosis and treatment of patients with olfactory loss, e.g. due to a Covid-19 infection, neurodegenerative diseases or other causes. So far, measurements of OB volume have been limited to quantification of manually segmented OBs, which makes its application in large scale clinical studies infeasible. The aim of this study was to evaluate the potential of our previously developed automatic OB segmentation method for clinical measurements of OB volume. The method employs convolutional neural networks that localize the OBs and subsequently automatically segment them (Noothout et al., 2021). In previous work, we showed that this method accurately segmented the OBs resulting in a Dice coefficient above 0.8 and average symmetrical surface distance below 0.24 mm. Volumes determined from manual and automatic segmentations were highly correlated ($r=0.79$, $p<0.001$) and the method was able to recognize the absence of an OB. Here, we included MRI scans of 181 patients with olfactory loss from the Dutch Smell and Taste Center. OB volumes were computed from automatic segmentations as described above. Using a multiple linear regression model, OB volumes were related to clinical outcome measures. Age, duration and etiology of olfactory loss, and olfactory ability significantly predicted OB volume ($F(5, 172) = 11.348$, $p<0.001$, $R^2 = .248$). The results demonstrate that our previously described method for automatic segmentation and quantification of the OB can be applied in both research and clinical populations. Its use may lead to more insight in and application of the OB in diagnosis, prognosis and treatment of olfactory loss. We aim to extend our research to other populations of patients with olfactory loss.

Funding Acknowledments: This research was partly funded by an Aspasia grant of the Netherlands Organization for Scientific Research (NWO 015.013.052), awarded to SB
FCOI Declarations: None

O102-ORAL ABSTRACTS: HUMAN CHEMOSENSATION

TUESDAY, 3:00 PM - 5:00 PM

Less is More: Stimulus Removal in Olfactory-Visual Stimulation Increases Activation in Multisensory Brain Areas

Doris Schicker[1], Sonja Blankenagel[1], Claus Zimmer[2], Hans Hauner[3,4], Jessica Freiherr[1,5]

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Multisensory integration of visual and olfactory stimulation has been explored in the last years and multisensory brain areas have been identified. Experimental study designs often include alternating presentations of unimodal and bimodal stimuli and therefore the conditions cannot be regarded as independent. This could lead to effects of an expected but surprisingly missing sensory modality. In this work, we examined the effects of adding or removing a visual or olfactory food-related congruent stimulus in comparison to a bimodal stimulation using fMRI. To be able to get pleasantness-independent results, we used individually adapted attractive as well as aversive stimuli. We scanned middle-aged (41 - 64) as well as old (75 - 83) participants to examine age-related differences in processing. A fixation cross signaled the arrival of a stimulus. Whereas in the bimodal condition olfactory and visual stimuli were delivered simultaneously, in unimodal conditions only a visual or an olfactory stimulus was presented. Results reveal that the bimodal stimulus presentation leads to an additive integration of olfactory and visual brain areas. However, the removal of a stimulus modality leads to activations in additional brain areas. In case the visual stimulus is missing, the right posterior superior temporal gyrus shows higher activation. Removal of the olfactory stimulus leads to higher activation in the amygdala/hippocampus and the postcentral gyrus. No significant differences

between the age groups were established. Our results indicate that if an expected sensory stimulus is missing, brain areas are activated for the search of this stimulus. We thus conclude that careful attention must be paid to the design of a valid multimodal sensory experiment regarding those effects.
Funding Acknowledgments: This work was funded by a grant of the German Ministry for Education and Research (BMBF, grant no. 01EA1409A). No influence on the design, conduct, analyses, interpretation or publication of the trial exist. The preparation of this paper was supported by the enable Cluster and is cataloged by the enable Steering Committee as enable 41 (http://enable-cluster.de).
FCOI Declarations: None

O104-POLAK AWARD SYMPOSIUM

TUESDAY, 5:30 PM - 6:50 PM

Odor mixture representations favor a single stimulus component in cortical projections to the olfactory bulb

Joseph Zak[1,2], Venkatesh Murthy[1,2]

[1]Department of Molecular & Cellular Biology, Harvard University, Cambridge, MA, USA, [2]Center for Brain Science, Cambridge, MA, USA

Sensory systems are organized in a hierarchical manner. Early stages efficiently format transduced signals and successive processing steps perform more complex computations to extract relevant sensory representations. This feedforward hierarchy is broken early in the olfactory system, where dense feedback projections from cortical regions arrive at the olfactory bulb (OB). In fact, the descending inputs from the cortex to the OB outnumber the afferent inputs it receives from the sensory periphery. Therefore, revealing how these projections contribute to the coding of complex stimuli is necessary for understanding the sensory processing that takes place in both the OB and cortex. We virally expressed the calcium indicators in the piriform cortex and used multiphoton imaging to measure the stimulus-response properties of cortical projections to the OB in freely breathing mice. We used two odor delivery paradigms that each revealed surprising aspects of how odors, and their mixtures, are represented in cortical projections. First, monomolecular odors spanning a concentration range of more than three odors of magnitude, evoked responses in axon boutons that, as a population, increased with concentration. However, at the level of individual boutons, we observed odor responses that had complex, non-monotonic concentration dependence. We next imaged bouton responses to odor mixtures that contained between 2 and 14 components. Bouton responses were highly sublinear, and typically mirrored the response of a single mixture component. These results suggest that the piriform cortex may be providing highly demixed sensory information to the OB, dominated by individual odor components. Future studies will focus on how the nonlinear activity patterns in cortical projections are inherited by OB projection neurons.
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FCOI Declarations: None

O105-POLAK AWARD SYMPOSIUM

TUESDAY, 5:30 PM - 6:50 PM

Structural Basis of Odorant Recognition in Insect Olfactory Receptors

Josefina I del Mármol, Mackenzie Yedlin, Vanessa Ruta

Laboratory of Neurophysiology and Behavior, The Rockefeller University, NYC, NY, USA

Olfactory systems evolved to detect and discriminate an enormous diversity of odorants. To contend with this challenge, mammals and insects alike have converged on a combinatorial strategy that relies on large families of olfactory receptors (ORs), most of which exhibit broad receptive fields to allow a finite number of receptors to detect an almost infinite chemical world. How ORs achieve this remarkable flexibility in ligand binding remains elusive, as the structural characterization of ORs from any species has not yet been achieved. To address this question, we identified an OR from the primitive insect species *Machilis hrabei* that detects a variety of structurally diverse odorants, including the insect repellent DEET. Using cryo-electron microscopy, we determined the structure of this OR unbound and in complex with two distinct ligands—eugenol and DEET—providing the first structural snapshot of chemical recognition by an OR. These structures, together with functional data from calcium imaging and electrophysiology, reveal that both ligands bind to a common binding site through hydrophobic, non-directional interactions distributed throughout the binding pocket. Leveraging these insights, we were able to retune this receptor's selectivity for several odorants, shedding light on how an OR's receptive field is encoded in its primary amino acid sequence. Together, these studies shed light on the basic principles that allow olfactory systems to detect a vast diversity of odorants with a limited number of ORs.
Funding Acknowledgments: NIH-NIAID R01AI103171 VR
FCOI Declarations: None

O106-POLAK AWARD SYMPOSIUM

TUESDAY, 5:30 PM - 6:50 PM

In Vivo Calcium Imaging Identifies Functionally and Molecularly Distinct Subsets of Tongue-Innervating Mechanosensory Neurons

Yalda Moayedi[1], Shan Xu[2], Benjamin U Hoffman[1], Gregory J Gerling[2], Ellen A Lumpkin[1,3]

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Mechanosensory neurons in the mouth provide essential information for guiding food choice, feeding ability, and speech; however, little is known about what features they encode. To address this, we used in vivo calcium imaging of tongue-innervating trigeminal ganglia neurons in mice. Experiments were performed in male and female animals with n>3 animals/experiment. We investigated general features of tongue-innervating trigeminal neurons that respond to thermal and mechanical stimulation (e.g. pressure, fluid flow, temperature changes). Approximately 20% of responding neurons responded to pressure stimulation. We found that stimulus tuning of neurons correlated with cell body size, as in cutaneous sensory neurons. Large tongue-innervating neurons responded to pressure whereas small neurons responded best to temperature, or were multi-modal. To categorize mechanosensory neurons, we investigated responses to pressure application and brushing and found distinct subgroups that responded to brushing, pressure, or both. We developed an unbiased clustering approach to identify distinct mechanosensory response profiles. Pressure-responding neurons had three distinct response profiles to pressure: on-transient only, on- & off-transients, or sustained responses. Additional groups responded only to brushing or only to pressures in the nociceptive range. We next identified genetic markers to selectively label subsets of physiologically distinct groups of tongue-innervating trigeminal neurons. This enabled us to map physiological sensorineural properties to end-organ anatomy in the tongue. These studies lay the foundation to determine how oral mechanosensory neurons encode textural features of foods and contribute to oral functions.

Funding Acknowledgments: Berrie Foundation Initiative on the Neurobiology of Obesity (EAL) Thompson Family Foundation Initiative on Chemotherapy Induced Peripheral Neuropathy and Sensory Neuroscience (YM) and NIH NINDS R01NS105241 (GJG & EAL)
FCOI Declarations: None

O107-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

The catnip/silver vine response in domestic cats: I, an identification of a potent bioactive compound from silver vine leaves

Reiko Uenoyama[1], Masaatsu Adachi[2], Toshio Nishikawa[2], Masao Miyazaki[1],

*[1]Iwate University, Morioka, *, Japan, [2]Nagoya University, Chikusa, *, Japan*

Domestic cats exhibit a characteristic behavioral response on encounter with specific plants such as catnip (*Nepeta cataria*) and silver vine (*Actinidia polygama*). The response comprises chewing and licking the plants, face and head rubbing against the plants, and rolling over on the plants, whose biological significance had not been understood. This study aimed to establish a reliable and reproducible behavioral assay using a synthesized compound that could be controlled to elucidate the response in cats. Our studies started to purify bioactive compounds from silver vine leaves using liquid chromatography (LC) and cats. LC using a silica gel column gave two bioactive fractions; first fraction without iridoid compounds identified in previous studies carried out in 1950–1960 stimulated a more prolonged response than second fraction including them, suggesting that an important contribution of unidentified bioactive compounds in the first fraction. To identify unknown compounds, bioactive components were further purified by LC using C22 and C30 columns. GC/MS of the final bioactive fraction detected nepetalactol which had been missed in previous studies. Nepetalactol shares a similar structure with nepetalactone, a bioactive iridoid emitted from catnip, except for lactol and lactone moieties. In behavioral assays, not only domestic cats but also large felids, such as Amur leopards and Jaguars, exhibited face rubbing and rolling over in response to nepetalactol- impregnated filter paper. In conclusion, nepetalactol is the major component of silver vine to induce this potent response in Felidae species and useful to elucidate biological significances of this enigmatic response as a stimulant, as compared to plant materials that emit variable amounts of multiple volatile compounds.

Funding Acknowledments: (JSPS KAKENHI 17H06406 TN, 19H02896 TN, 18H04602 MM, and 20H04759 MM)
FCOI Declarations: None

O108-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Smell identification dysfunction in Wolfram syndrome can affect retronasal smell enhancement of taste intensity

Raul Alfaro[1], Tasha Doty[2], Tamara Hershey[2,3], Yanina Pepino[1,4]

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Wolfram syndrome (WFS) is a rare genetic disease with symptoms that include loss of vision, audition, and smell function. Recently, we found that the sense of taste was overall well conserved in WFS and that the olfactory dysfunction was related to smell identification and not due to olfactory insensitivity. Here we tested the hypothesis that retronasal smell perception is affected in WFS and interferes

with central integration processes that result in odor-induced taste enhancement. We evaluated participants with WFS (n=36, 18±7 years) and a healthy control group (HC n=22, 40±14 years). We assessed whole mouth taste intensity perception using the general Labeled Magnitude Scale and used solutions of sucrose with strawberry extract, citric acid with lemon extract, sodium chloride in a vegetable broth, and caffeine in coffee. Participants taste these solutions and rate taste intensities in two conditions: with and without noseclips. Partially supporting our hypothesis, we found a trend of an interaction between group and nose condition for the sucrose/strawberry extract solutions (P=0.06). That is, when using noseclips (i.e. retronasal off), taste intensity ratings were similar between the groups. However, when tasting these solutions without noseclips (i.e. retronasal on), participants in the HC group perceived an enhancement of sweetness that was totally blunted in participants with WFS. There were no other differences in taste intensity ratings between the groups for any of the other solutions. Because odor-taste congruency plays a key role in odor-induced taste enhancement, these preliminary findings suggest that the lack of enhancement of sweetness in sucrose by strawberry extract in participants with WFS might be due to an impairment in the quality of some retronasal smells.

Funding Acknowledments: This research was funded, in part, by the USDA National Institute of Food and Agriculture Hatch Project number 698–921 (MYP) and HD070855 "Tracking Neurodegeneration in Early Wolfram Syndrome" (TH).

FCOI Declarations: None

O109-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Circuitry and Function of the Nucleus of Lateral Olfactory Tract in Olfactory-guided Mouse Behaviors

Janardhan P. Bhattarai, Yun-Feng Zhang, Emma Janke, Wenqin Luo, Minghong Ma

University of Pennsylvania, Philadelphia, PA, USA

Olfactory cortical areas and their downstream structures are crucial for odor-guided behaviors. One such structure in the olfactory pathway is the nucleus of the lateral olfactory tract (NLOT), part of the cortical pallial amygdala, which receives direct inputs from the olfactory cortices including the anterior olfactory nucleus and tenia tecta (AON/TT). Recently, the rodent NLOT has been implicated in regulating olfactory-guided behaviors, but the underlying circuits and mechanisms are still elusive. To provide such insights, we combined multidisciplinary approaches including circuit tracing, ex vivo electrophysiology, optogenetics, in vivo fiber photometry, genetic ablation, and mouse behavioral assays. Anatomical tracing from the AON/TT neurons in novel NMBR-Cre knock-in mice (Cre expression under the control of the neuromedin B receptor gene, highly expressed in AON/TT neurons) revealed specific projection to the NLOT in the amygdala. In whole-cell patch-clamp recordings combined with optogenetic activation, we found that AON/TT neurons make excitatory monosynaptic connections onto NLOT neurons. In addition, *in vivo* fiber photometry experiments showed odorant and/or sniff-induced increases in calcium-dependent GCaMP7s fluorescent signals in AON/TT neuron terminals in the NLOT. Moreover, genetic ablation of glutamatergic (Vglut-1) neurons in the NLOT led to impairment in food finding and social odor discrimination as well as disruption of olfactory aversive behavior to a synthetic predator odor. These results suggest that the AON/TTàNLOT pathway play a critical in olfactory-guided behaviors.

Funding Acknowledments: NIDCD R21DC019193 to JPB NIDCD R01DC006213 to MM

FCOI Declarations: None

O110-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Bilateral Sensory Signals for Odor Source Localization in Freely-Moving Mice

Kevin A. Bolding[1], Daniel P. Leman[1,2], Jiayue Tai[1], Ian G. Davison[1,3]

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During sensory-guided navigation, animals constantly refine their ongoing movement through a series of dynamic, iterative sensory-motor algorithms. In natural contexts, odors form key navigational cues that signal food sources and social partners, offering an ethologically relevant window on motivated sensory search. While odor-evoked activity has been studied intensively in head-fixed animals and decision-making tasks, little is known about the nature of the dynamic sensory signals that guide freely moving animals during active sampling of their environment. Such data is critical to resolve whether animals navigate using comparison of signals across successive discrete 'sniff' samples, using instantaneous 'stereo' comparison across hemispheres, or employ both under different conditions. To overcome the challenges of measuring bilateral odor responses in unrestrained animals, we developed new miniaturized microscopy tools for large-scale visualization of neural activity, and used them to image both hemispheres of the main olfactory bulb in mice exploring odor sources in an open arena. Sensory-evoked activity was

detectable only within a restricted area of ~10 cm surrounding the odor source. Increasing proximity to the source activated additional glomeruli, revealing that spatial information is encoded by progressive recruitment of receptor pathways of varying affinity. A bias in directional preference for stimuli nearest the corresponding naris emerged in a subset of glomeruli at close proximity. These data suggest that animals may employ multiple strategies to localize odor sources during free exploration, initially comparing the degree of glomerular recruitment across time during early approach phases, and ultimately reading out a bilateral direction code at close proximity.

Funding Acknowledments: NIH/NIDCD R01DC017234 NSF IOS # 1755284

FCOI Declarations: None

O111-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Imaging Piriform Cortex in Awake Freely Moving Mice

Ian F Chapman, Max L Fletcher

University of Tennessee Health Science Center, Memphis, TN, USA

Decades of electrophysiological and optical imaging studies have long established the piriform cortex (PC) as critical to the formation of odor objects and processing of odor experience. However, many of these studies were performed on anesthetized animals, with anesthesia known to significantly alter PC coding. Recent studies have explored PC coding in awake mice using freely moving electrophysiological recordings or head-fixed 2-photon calcium imaging. These experiments have led to new revelations about the sparse and spontaneous nature of PC odor coding in awake animals. To expand upon previous awake PC recordings, we have collected calcium recordings from large sets of PC neurons in freely behaving mice utilizing head-mounted miniaturized microendoscopes and stereotaxically implanted GRIN lens. Tracking the same cell populations in individual mice over repeated sessions and days, our current work focuses on how PC cells respond to novel and repeatedly presented odorants under these situations and how these responses change with different forms of olfactory experience. As behavior is also recorded during all imaging sessions, we find populations of PC cells that respond during specific aspects of odor-guided and exploratory behavior. Overall, our findings aim to advance our understanding of how PC ensembles relate to behavioral responses during odor experience.

Funding Acknowledments: This work was funded by a National Institutes of Health Grant to MLF [NIDCD R01 DC013779].

FCOI Declarations: None

O112-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

The effects of prior diseases on the change of taste and smell in the COVID-19 patients: based onGlobal Consortium for Chemosensory Research (GCCR) study

Jingguo Chen[1], Qifan Ren[2], Baibing Mi[3], Kang Zhu[1], Valentina Parma[4], Xiaoyong Ren[1]

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Objectives: In this study, we propose to mine the GCCR database to capture the features of the prior diseases on the change of taste and smell in the COVID- 19 patients.

Methods: The study information and detailed research plan are available on OSF individual homepage (https://osf.io/ax3p5/). We used mixed linear regression models to test our hypothesis and the p-value of interaction will be concerned.

Results: Overall, we got the final sample (n=26468), the final samples included 12438 participants, who were diagnosed with COVID-19. In the 12438 participants, the prior conditions were following: 1985 patients reported high blood pressure, 2046 patients reported obesity, 1368 patients reported they had lung disease (asthma/COPD), 1104 patients reported they had chronic sinus problems, 3562 patients reported they had seasonal allergies/hay fever. Multivariate regression analysis found that for patients with chronic sinusitis with COVID-19, the degree of smell and taste disorder is higher than that of patients with non-chronic sinusitis. Chronic sinusitis and COVID-19 have an interactive effect on smell disorder ($P<0.05$), the status of state and other prior diseases will overestimate. The impact of COVID-19 on the degree of smell/taste loss, the recovery degree of smell/taste of patients with seasonal allergies/hay fever, were statistically significant in the three calibration models ($P<0.05$). Conclusion: COVID-19 participants who had more or more than one prior disease, those participants have worse smell/taste loss than those participants who had not the prior disease. This study may help us understand the possible involvement of comorbidities in COVID-19 patients who lose smell or taste and raise the concern of chemosensory dysfunction and commodity with COVID-19.

Funding Acknowledments: This study was supported by the Fundamental Research Funds for the Central Universities (xzy012020046).

FCOI Declarations: None

O113-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Smelling through old noses via genetic and functional variations in extinct human lineages

Claire A de March#[1], Kara C Hoover#[2], Masashi Abe[3], Hiroaki Matsunami[1,4]

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#presenting authors. We have previously explored genetic and functional allelic variation in humans, Neanderthals, and Denisovans in OR7D4, which responds only to two compounds and has a clear link between genotype and perceptual phenotype.[1] We take a broader approach here and extend our study to the 30 odorant receptor proteins that we can study in the lab and that have known receptor-odor associations in humans.[2] We cataloged variants for three female Neandertals (Altai, Chagyrskaya, Vindija), one female Denisovan, and the male ancient human Ust'-Ishim (a contemporary to Altai Neandertal and Denisova in the Altai Mountains) using data produced by the Max Planck Institute Leipzig. We compared DNA sequence data across lineages to populations from 1000 Genomes to identify and compare genetic variations. We conducted a phylogenetic analysis of receptors to determine which groups were more closely related based on their pattern of variation. We monitored *in vitro* activation of receptors by odorant stimulations to determine if sequence variation resulted in functional differences. Finally, we modeled receptor structures exhibiting functional differences to determine how the variants altered the receptor function.[3] Finally, we examined odor response variation across lineages relative to odorant molecule qualities known to alter the human perception of intensity and pleasantness.[4] This has enabled us to recreate aspects of the olfactory world of these extinct lineages, to explore their olfactory universe, and compare them to us. 1. Hoover, K. C. *et al.* Global survey of variation in a human olfactory receptor gene reveals signatures of non-neutral evolution. *Chem. Senses* 40, 481–488, doi:10.1093/chemse/bjv030 (2015). 2. Zhuang, H., Chien, M. & Matsunami, H. Dynamic functional evolution of an odorant receptor for sex-steroid-derived odors in primates. *Proc Natl Acad Sci U S A* 106, 21247 - 21251 (2009). 3. de March, C.A., et al. "G protein-coupled odorant receptors: From sequence to structure." *Protein Science* 24.9 (2015): 1543–1548. 4. Keller, A. *et al.* Predicting human olfactory perception from chemical features of odor molecules. *Science* 355, 820–826 (2017).
Funding Acknowledments: NIH K99DC018333 CADM NSF #1550409 KCH NIH DC014423 and NIH DC016224 HM
FCOI Declarations: None

O114-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Analysis of Social Behaviours in Mice With Altered Accessory Olfactory Bulb Wiring

Sydney Fearnley[1,3], Neelima Vaddadi[1,2], Emilie Dumontier[1], Jean-Francois Cloutier[1,2,3]

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The accessory olfactory system controls social and sexual interactions in mice that are critical for their survival. Vomeronasal sensory neurons (VSNs) form synapses with dendrites of second order neurons in homogenously innervated glomeruli of the accessory olfactory bulb (AOB). Proper organization of the AOB circuitry ensures that phenotypic qualities of chemosignals detected by VSNs are represented into maps of glomerular activation. The accurate coalescence of VSN axons into glomeruli requires expression of members of the Kirrel family of cell adhesion proteins on these axons. We have shown that either ablating expression of Kirrel3 (*Kirrel3*$^{-/-}$), or specifically inhibiting Kirrel3 homophilic adhesion properties (*Kirrel3*$^{Q128A/Q128A}$), in mice leads to a disorganization of the glomerular layer in the accessory olfactory bulb. Here, we assess the performance of these two mouse models in behavioural assays involving social interactions. We find that *Kirrel3*$^{-/-}$ and *Kirrel3*$^{Q128A/Q128A}$ male mice display no change in a social preference test but have reduced male-male aggression. While *Kirrel3*$^{-/-}$ and *Kirrel3*$^{Q128A/Q128A}$ male mice showed no difference in a male-female urine preference test, urine dilution tests revealed increased detection thresholds to both male and female urine in these mice. In contrast, sensitivity to an attractive or aversive odorant was unchanged in *Kirrel3*$^{-/-}$ and *Kirrel3*$^{Q128A/Q128A}$ mice. Taken together, our results indicate that the reduced male-male aggression we observe in two separate Kirrel3 loss-of-function mouse models bearing alteration in the wiring of the accessory olfactory system is associated with decreased sensitivity to male urine chemosignals.
Funding Acknowledments: Natural Sciences and Engineering Research Council of Canada and Canadian Institutes of Health Research to JFC.
FCOI Declarations: None

O115-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Sommelier Training Results in Olfactory Bulb Volume and Cortical Thickness Changes

Gözde Filiz[1], Daphnée Poupon-Pourchot[1], Johannes A. Frasnelli[1,4], Sarah Banks[2], Pauline Fernandez[3]

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Brains continue their development via learning throughout the lifespan. We can observe the changes that occur from these developments via neuroimaging methods. This is especially prominent in specific professions such as Sommeliers who are experts in everything about wine, wine tasting and its pairing with food. Here we observed the plasticity in the brains of 17 Sommelier students and 17 students of other domains after 18 months training. We used Magnetic Resonance Imaging (MRI) to evaluate the effects of the sommelier training on morphometric measures of olfactory processing areas of the brain. Sommelier training affected morphometric measures specifically: first, the olfactory bulb of sommeliers grew significantly, but we could not observe any such change in the control group. Second, compared to controls, the sommeliers' right entorhinal cortex thickened after the training whereas other regions of interest's thickness decreased. Third, in contrast to the results on grey matter, we did not observe any significant results in white matter using Diffusion Weighted Imaging. While the volume increase in the olfactory bulb is in line of the literature on olfactory training, the non-linear results in the grey matter can be explained by "over-production pruning" model, while plasticity related changes occur fast at first, unused parts will be eliminated over time. The speed these changes occur with depend on the involved regions. In conclusion, our results show the effect of a real-life and ecological training on olfactory processing regions, strengthening the notion of neural plasticity in the olfactory brain.

Funding Acknowledments: -UQTR Research Chair in Chemosensory Neuroanatomy -Fonds de Recherche du Québec-Santé (FRQS) -Natural Sciences and Engineering Research Council of Canada (NSERC)

FCOI Declarations: None

O116-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Mouse Models of Anosmia Are Explored for Metabolic State Changes

Destinee N Gatlin[1,2], Jessica T Folsom[1], Henal N Sutaria[1], Ashley M Loeven[1], Chao Xie[4], Jeffrey R Martens[4], Debra A Fadool[1,2,3]

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We explored three mouse models [chemical ablation, naris-occlusion, and OSN-specific Bardet-Biedl Syndrome-1 ($Bbs1^{osnKO}$)] to discover if reduced gross odor sensitivity was linked to decreased metabolism. General anosmia was determined by fasted and non-fasted buried-cookie-assay and metabolic profiling was determined by placing mice in a Comprehensive Lab Animal Monitoring System for 10 days. In the first mouse model, OMP*tau*gfp male mice were lesioned with methimazole (MeZ) where mice were anosmic for up to 3 days (p=0.0003) and confocal imaging confirmed a complete loss of OSNs. MeZ-treated mice had a significant reduction in VO_2, daily caloric intake, and cumulative locomotor activity in the dark cycle. Metabolic parameters in the light cycle were unchanged. In the second mouse model, OMP*tau*gfp male/female mice were unilaterally cauterized early postnatally and then metabolically profiled as adults. Naris-occluded male mice displayed a reduction in respiratory-exchange-ratio (RER) in both the dark (p = 0.006) and light cycle (p = 0.01), whereas females showed no significant difference. Female naris-occluded mice significantly reduced their daily caloric consumption during the dark cycle (p=0.0016). Naris-occluded mice were not anosmic compared to that of sham littermates (p=0.2217). In the third mouse model, $Bbs1^{osnKO}$ mice showed no changes in ingestive behavior, locomotor activity, body weight, or VO_2 consumption. RER, however, was significantly lower (p=0.016). Furthermore, fasted $Bbs1^{osnKO}$ mice displayed signs of hypoanosmia (fasted: p = 0.0069; non-fasted: p=0.5927). Our results indicate complete or hypoanosmia affects food consumption, VO_2, or fuel utilization of fats (RER), whereas naris occlusion without gross olfactory deficit elicits sex-dependent changes in food consumption and RER.

Funding Acknowledments: NIDCD R01DC013080 DAF NIDCD R01DC009606 JRM

FCOI Declarations: None

O117-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Evaluation of TRP-channel and OR-channel Function in Anosmic and Hyposmic Individuals

Jeff Hage, Marion E Frank

UConn Health, Farmington, CT, USA

The mechanism behind the perception of olfaction has recently been indicated to be more complex than previously understood. It is known that the stimulation of olfactory receptors (OR) on olfactory sensory neurons that project to the olfactory bulb are primarily responsible for olfaction

[Sell, C (2014)]. However, recent studies have demonstrated that additional channels, the transient potential receptors (TRP), also play a significant role in odor perception [Venkatachalam, K and Montell, C (2014)]. Given that hyposmia (diminished sense of smell) and anosmia (complete absence of the sense of smell) are such prevalent and underreported issues [Howell, J et al (2018); Jarvis, B (2021)], this study aimed to determine whether disorders of olfaction affect the OR-channels and TRP-channels equally. It was observed that one anosmic individual perceived both OR-channel and TRP-channel stimulating odors at a significantly lower rate than control individuals. However, in the two hyposmic individuals tested, one perceived TRP-channel stimulating odors at a significantly lower rate than control but was comparable at perceiving OR-channel stimulators, whereas the other only showed a significant difference in detecting OR-channel stimulating odors.

Funding Acknowledments: UConn Dental School
FCOI Declarations: None

O118-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

From musk to body odor: decoding olfaction through genetic variation

Marissa L. Kamarck[1,2], Bingjie Li[3,4], Qianqian Peng[3], Fei-Ling Lim[5], Andreas Keller[6], Monique A. M. Smeets[7], Joel D. Mainland[1,2], Sijia Wang[3,8]

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The olfactory system combines input from multiple distinct receptors to represent odor information, but there are few explicit predictions relating olfactory receptor (OR) activity patterns to odor perception. To uncover these relationships we examined how genetic variants in individual receptors influence odor perception. We measured olfactory perception of ten odors in two populations: a discovery dataset of 1003 Han Chinese participants and a validation set of 364 participants from New York City. Associations between genotype and phenotype are consistent across the two populations and we replicated previous genotype-phenotype associations in both cohorts (beta-ionone/OR5A1 $p = 3.33x10^{-43}$; androstenone/OR7D4 $p = 1.21x10^{-7}$). Two new associations contribute to our understanding of olfactory coding. First, Galaxolide is a compound in the musk family that consists of at least four distinct classes of molecular structures that evoke a similar percept. We identified novel variants in OR4D6 associated with a specific anosmia to Galaxolide (discovery $p<2.59x10^{-25}$; validation $p<1.02x10^{-5}$), and our results suggest that multiple receptors contribute to create the "musk" percept. Second, trans-3-methyl-2-hexenoic acid (3M2H) is a key component of human underarm odor. We identified OR51B2 as novel receptor that (1) contains genetic variation that associated with perception of 3M2H (discovery $p<6.57x10^{-10}$, validation $p<9.60x10^{-8}$) and (2) is activated by 3M2H in a cell-based assay. This study provides important clues for how OR activation encodes odor information.

Funding Acknowledments: The discovery study was funded by Unilever R&D (the Netherlands). This work was also supported by the National Key Research and Development Project (Grant No. 2018YFC0910403), the National Natural Science Foundation of China (Grant No. 91631307), Shanghai Municipal Science and Technology Major Project (Grant No.2017SHZDZX01), CAS Youth Innovation Promotion Association/the National Institutes of Health (Grant R01 DC013339), and the National Center for Advancing Translational Sciences Clinical and Translational Science Award program (grant UL1 TR000043). The validation study was supported by National Institute on Deafness and Other Communication Disorders (Core Grant P30 DC011735).
FCOI Declarations: None

O119-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Neural Basis of Olfactory Functional Deficits in AD

Prasanna Karunanayaka[1,2,3], Lauren Spreen[4], Rommy Elyan[1], Jian-Li Wang[1,2], Qing X. Yang[1,4]

[1]Department of Radiology, Center for NMR Research, Penn State University College of Medicine, Hershey, PA, USA, [2]Department of Neural and Behavioral Sciences, Penn State University College of Medicine, Hershey, PA, USA, [3]Department of Public Health Sciences, Penn State University College of Medicine, Hershey, PA, USA, [4]Department of Molecular Biology, Pennsylvania State University College of Medicine, Penn State Milton S. Hershey Medical Center, Hershey, PA, USA, [5]Department of Neurosurgery, Penn State University College of Medicine, Hershey, PA, USA

INTRODUCTION: The use and interpretation of olfactory screening in clinical practice is limited by a lack of understanding, i.e., why is olfaction preferentially affected in neurodegenerative diseases, such as Alzheimer's disease (AD). Early olfactory deficits are known harbingers of cognitive decline in neurodegeneration. Currently, there are no testable models to explain these observations. As a first

step, this research proposes to investigate activity and connectivity patterns in brain networks subserving olfactory functions using olfactory fMRI. We hypothesize that olfactory fMRI will elicit activity in olfactory structures which are functionally connected to brain networks subserving memory processing.
METHODS: Nine healthy participants (mean age 30.44 ± 7.95 years; 5 females) took part in the olfactory fMRI study. All participants performed odor identification and N-back fMRI tasks using 5 odorants selected from the NIH Toolbox for Odor Identification. Image data were acquired on a 3T MRI scanner (Prisma fit, Siemens Medical) at the MRI core facility with a 64-channel head coil. fMRI data was processed in SPM12.
RESULTS: All participants had normal smell function (threshold mean 10.55± 1.39; identification mean 18.44 ± 0.88) when tested with the OLFACT. Both odor detection and odor discrimination tasks elicited significant activation in the primary olfactory cortex, entorhinal cortex/ hippocampus, visual cortex, inferior temporal gyrus, and dorsolateral prefrontal cortex (DLPFC).
DISCUSSION: Odor-identification and odor-memory recruit brain structures in both medial and inferior temporal cortex. They are involved in memory and affected earliest in neurodegeneration in AD. Thus, existing, and emerging therapeutic approaches could use olfactory measures as markers for the detection and prediction of AD progression.
Funding Acknowledments: AG02777,Department of Radiology, Penn State College of Medicine
FCOI Declarations: None

O120-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Neurological consequences of olfactory inflammation on olfactory bulb projection neurons

Brandon J LaFever[1], Sanae Hasegawa-Ishii[1,2], Fumiaki Imamura[1]

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Olfactory inflammation significantly impairs the functional and anatomical components of the olfactory system, specifically through the loss of olfactory sensory neurons. We have shown that olfactory inflammation induced by intranasal (i.n.) administration of lipopolysaccharide (LPS) results in atrophy, gliosis (microglial/astrocytic activation), and pro-inflammatory cytokine production in the olfactory bulb (OB), the first relay station of olfactory information in the central nervous system (CNS). This OB atrophy occurs primarily in the superficial layers which become significantly thinner than the deeper OB layers; these layers include the olfactory nerve layer, glomerular layer, and superficial external plexiform layer (sEPL). In this study, we investigate the impact of olfactory inflammation on the circuitry of OB projection neurons, mitral (MC) and tufted (TC) cells, by performing unilateral i.n. LPS administration to Pcdh21-CreER x ROSA26-YFP transgenic mice for 10 weeks. Thus far, we have assessed morphological changes to MC and TC somata, dendrites, and axon initial segments in the OB using immunohistochemistry. TC, but not MC, somata appear smaller in size following olfactory inflammation. The extension length of TC lateral dendrites in the sEPL of the ipsilateral OB appear to have decreased. Similarly, the axon initial segment of TCs appear less prominent in the ipsilateral OB when compared to MCs. This data suggests that olfactory inflammation specifically affects the intrabulbar microcircuits of which TCs are involved. The knowledge gained from this study will reveal major consequences of inflammation on the homeostatic functioning of olfactory neural circuits, as well as unveil a novel pathway of neuroinflammation from the periphery to the CNS.
Funding Acknowledments: NIDCD R01DC016307 FI
FCOI Declarations: None

O121-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

A Method to Detect and Quantify SARS-CoV-2 in Nasal Exhaled Breath

Gregory Lane[1], Guangyu Zhou[1], Danielle McCarthy[2], Torben Noto[1], Qiohan Yang[1], Christina Zelano[1]

[1]Northwestern University, Chicago, IL, USA, [2]Emergency Medicine, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

SARS-CoV-2 is assumed to spread through exhaled respiratory droplets and aerosols, but very little research has directly measured the virus in exhaled breath, and our understanding of the relationship between olfactory symptoms of COVID-19 and infectious shedding of the virus is limited. Whether there is any relationship between olfactory dysfunction and viral shedding in nasal exhalate is unknown. Here, we developed a device and a method for collecting and quantifying SARS-CoV-2 RNA in the exhaled breath condensate of COVID-19 patients. Our device is portable, inexpensive and simple enough to use that breath samples can be self-collected by patients in their homes. It has configurations for both oral and nasal breath collection, allowing for comparison of viral loads across the two breathing routes. This device can be used to determine whether there is a difference between oral and nasal shedding of the virus on breath, and to determine whether viral shedding on nasal or oral breath is related to chemosensory symptoms.

Funding Acknowledgments: This study was financially supported by a Catalyzer Award from The Institute for Global Health (to Christina Zelano).
FCOI Declarations: None

O122-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

A Quick Home Test to Objectify Olfactory Complaint: A Pilot Study

Cindy Levesque-Boissonneault[1,2], Nicholas Buissière[1], Frédérique Roy-Côté[1], Frank Cloutier[1], Marie-Eve Caty[2], Johannes Frasnelli[1]

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The current COVID-19 pandemic requires the use of safe olfactory testing protocols that can be applied on a large scale. To this end, we developed the Chemosensory Perception Test (CPT), a quick test carried out at home to objectify olfactory and gustatory complaints. Specifically, it assesses orthonasal and retronasal olfaction as well as gustation using common North American household items. This study aims to compare the CPT scores with the participants' initial olfactory complaint and with standardized testing. We hypothesized CPT scores to be significantly lower in participants having a subjective and/or objective olfactory dysfunction (OD). Participants were tested using the CPT and the University of Pennsylvania Smell Identification Test (UPSIT). They were divided in two groups according to initial olfactory complaint or UPSIT score. CPT olfactory scores (average orthonasal and retronasal scores) were compared between groups using t-tests; association between CPT and UPSIT scores was analyzed with Pearson's correlation coefficient. We obtained preliminary results from 26 participants: 15 participants (57.7%) had subjective OD and 14 participants (53.8%) showed objective OD according to UPSIT. Average CPT orthonasal (9.3 vs 6.3; $t(17.888)=5.594$, $p<0.001$) and retronasal (9.6 vs 6.1; $t(15.842)=3.985$, $p=0.001$) scores were significantly lower in participants who identified themselves as having OD. However, we did not find any significant difference when groups were divided into normosmia/microsmia according to the UPSIT. Nevertheless, average CPT orthonasal ($r=0.461$, $p=0.018$) but not retronasal scores were correlated with UPSIT scores. Our results suggest that the CPT is consistent with subjective and objective OD and can be used in the current context, especially in longitudinal study designs.

Funding Acknowledgments: Natural Sciences and Engineering Research Council of Canada (CRSNG), Fonds de recherche du Québec - Santé
FCOI Declarations: None

O123-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Trigeminal Effects on Binary Odor Mixture Perception

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The experience of smell is modulated by the trigeminal system and its interactions with the olfactory system, but how the trigeminal system affects olfactory perception is not fully understood. We have known for at least half of a century that the trigeminal system interacts with the olfactory system and influences the perceptual qualities of stimulants. However, neither the behavioral effects nor the underlying mechanisms have been systematically characterized. Given that almost all odorants stimulate the trigeminal nerve, some even at low concentrations, it is reasonable to postulate that the influence of trigeminal input is almost always at play in odor perception, especially for odorants that are mixtures of different molecules. In fact, most natural odorants are blends of many different monomolecular odorants. There is no satisfactory theory that predicts the perceptual qualities of even just a binary mixture, and some of the confounds may come from trigeminal stimulation. To address how trigeminal intensity may play a role in odor mixture perception, we trained rats with 4 different pairs of pure odorants of varying trigeminal intensities and asked them which pure odorant binary mixtures smell like while varying ratios of the two odorants systematically. We predicted that comparative trigeminal intensities of component odorants have an effect on overshadowing. Results show that the magnitude of difference in component trigeminal intensities may not predict the degree of overshadowing in binary mixtures. However, the data suggest that the component of higher trigeminal intensity is overshadowed by the trigeminally weaker odorant in a binary mixture.

Funding Acknowledgments: National Institute on Deafness and other Communication Disorders (NIDCD) R01 DC014367 and Lifelong Learning Machines (L2M) program at the Defense Advanced Research Project Agency/Microsystems Technology Office (DARPA/MTO) HR0011-18-2-0024 to L.M.K.
FCOI Declarations: None

O124-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Olfactory-related Quality of Life Adjustments to Smell Loss During the COVID-19 Pandemic

David T. Liu[1], Bernhard Prem[1], Gerold Besser[1], Bertold Renner[2,3], Christian A. Mueller[1]

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Objective: Previous studies provided the first evidence that the importance of olfaction decreases with the duration of smell loss. It is currently unknown whether the olfactory-related quality of life (QoL) also differs between patients with new-onset and persistent smell loss (longer than four weeks) during the coronavirus-19 (COVID-19) pandemic and patients with persistent postinfectious smell loss (PIOD) that were recruited before the pandemic.
Methods: This was a retrospective study that included 149 patients with self-reported olfactory dysfunction (OD). The olfactory-related QoL was measured using the Questionnaire of Olfactory Dysfunction (QOD). The QOD measures the degree to which patients (i) adjust and cope with smell loss (QOD-PS) and (ii) suffer from OD in general (QOD-NS). Self-perceived chemosensory function, demographics, olfactory function, and duration of smell loss were evaluated. Analyses of variance were used to depict differences in QoL-outcomes between different OD groups.
Results: All patients included during the COVID-19 pandemic reported an extensive loss of chemosensory functions smell, taste, and flavor perception. Retronasal testing revealed olfactory impairments in more than half of these patients. One-way analysis of variance and posthoc tests revealed that the QOD-NS was significantly higher in the new-onset OD group than the PIOD group. At the same time, the QOD-PS score was significantly higher in the PIOD and the persistent COVID-19 OD group compared to the new-onset OD group.
Conclusions: We showed that patients with persistent OD experienced better olfactory-related adjustment and lower QoL-impairment than those with recent-onset OD, suggesting that the olfactory-related QoL might change as a function of time after symptom onset.
Funding Acknowledments: University funded
FCOI Declarations: None

O125-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Odor Fingerprinting and Effective Discrimination of Chinese Liquors Using a Cell-Based System

Weihong Liu[1,2], Yu Zheng[2], Chen Zhang[2], Hanyi Zhuang[2], Yingjian Liu[1,2]

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Chinese liquors are distilled alcoholic beverages with unique aromas characterized by a plethora of volatile compounds. Regrettably, counterfeit products with the years of ageing exaggerated or made with harmful ingredients have plagued the Chinese liquor market. Since the complex brewing technique and the ageing process are associated with variations in the composition of volatile compounds, characterizing a given liquor's odor profile may be useful in liquor quality control or authentication. In this study, we employ a cell line expressing complete mouse and human odorant receptor repertoires to generate odor response fingerprints of liquors. We found a diverse array of ORs, such as MOR23-1, MOR271-1, and MOR256-17, which are known receptors for ketones, carboxylic acids, and aldehydes, as well as a group of newly deorphaned ORs, that were strongly and differentially activated by 4 types of liquors. Notably, a pronounced difference in receptor activation profile was seen between the strong-aroma liquor, Wuliangye, and the soy sauce-aroma liquor, Moutai. To identify the volatile compounds involved, we tested the responding ORs against candidate compound pools defined by GC/MS and known receptor-ligand pairs. We were able to identify receptor-ligand pairs that are unique to each type of liquor and those that are produced during the ageing of Moutai. In the future, we hope to extend the methodology to quantitatively characterize the odor response fingerprint of liquors of different brands, regions, and ages in order to discriminate them from each other and against counterfeits of inferior quality. Our work represents a proof of concept for the direct use of ORs in the discrimination of liquors and the authentication of liquor age that may be valuable at both the manufacturer and the consumer levels.
Funding Acknowledments: Beijing Association for Science and Technology, Jinqiao Project Seed Fund, WL
FCOI Declarations: None

O126-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Case Study: Consequences of gaining olfactory function after life-long anosmia.

Coralie Mignot[1], Robert Pellegrino[2], Charalampos Georgiopoulos[1,3], Antje Haehner[1], Thomas Hummel[1]

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We present a rare case of a patient who has gained her smell after life-long anosmia. The woman (age of 25 years; right-handed) presented herself with suspected congenital olfactory dysfunction. She emphasized that her "new sense"

is an annoyance to her with most odor sensations being unpleasant. During the recent olfactory recovery period (~18 months) she also experienced some olfactory phantoms. Gustatory function remained unchanged over the years although, with recovery of the sense of smell, retronasal aromas became more pleasant. An ENT medical examination showed the following: mucosa free of irritation/reddening, no secretion, no polyps, olfactory cleft on both sides free, slight septal deviation to the right, and no pronounced turbinate hyperplasia. Based on the "Sniffin' Sticks" TDI score (T 1, D 6, I 5) she was diagnosed with orthonasal functional anosmia. During testing she mentioned to vividly perceive a number of odors. In a test on retronasal olfactory function with "taste powders", the patient reached a score of 15/20 which suggests hyposmia. Objective olfactometry using electroencephalography-derived olfactory event-related potentials showed clear cerebral responses for left and right-sided stimulation with hydrogen sulfide ("rotten eggs-like" odorant) and phenylethyl alcohol ("rose-like" odorant) which suggests an intact olfactory function. Magnetic resonance imaging (MRI) structural scans revealed that the olfactory sulcus in the plane behind the eyeballs was of almost normal depth on the right side, but clearly flattened on the left. The olfactory bulbs were not clearly distinguishable on either side. All in all, the current case study represents a rare incidence of olfactory recovery after life-long anosmia.

Funding Acknowledments: Dresden University

FCOI Declarations: None

O127-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Olfactory-cognitive index distinguishes involvement of frontal lobe shrinkage, as in sarcopenia from shrinkage of medial temporal areas, and global brain, as in Kihon Checklist frailty/dependence, in older adults with progression of normal cognition to Alzheimer's disease

Takaki Miwa, Osamu Iritani, Shigeto Morimoto

*Kanazawa Medical University, Kahoku, *, Japan*

Aim: Olfactory impairment as a prodromal symptom, as well as sarcopenia, frailty and dependence as geriatric syndromes, is often associated with cognitive decline in older adults with progression of Alzheimer's disease. The present study aimed to evaluate the associations of olfactory and cognitive decline with these geriatric syndromes, and with structural changes of the brain in older adults.

Methods: The participants were 135 older adults (47 men and 88 women, mean age 79.5 years), consisting of 64 with normal cognition, 23 with mild cognitive impairment and 48 with Alzheimer's disease. Olfactory function was evaluated by the Open Essence odor identification test. Shrinkage of the regional brain was determined by magnetic resonance imaging.

Results: Logistic regression analysis with Open Essence, Mini-Mental State Examination, age and sex as covariates showed higher olfactory-cognitive index (|coefficient for Open Essence (a) / coefficient for Mini-Mental State Examination (b)|) in participants with sarcopenia, and lower values of (|a/b|) in participants with Barthel Index dependence, Kihon Checklist frailty, Lawton Index dependence and support/care-need certification as objective variables. Logistic regression analysis adjusted by age and sex also showed significant shrinkage of the frontal lobe in participants with AWGS sarcopenia, especially in women, and shrinkage of the medial temporal areas and global brain in participants with Kihon Checklist frailty/dependence.

Conclusions: Olfactory-cognitive index (|a/b|) might be a useful tool to distinguish involvement of frontal lobe shrinkage, as in sarcopenia from shrinkage of the medial temporal areas, and global brain, as in frailty/dependence, in older adults with progression of normal cognition to Alzheimer's disease.

Funding Acknowledments: Grant-in-Aid for Scientific Research C (No.16K11219) by Ministry of Education, Culture, Sports, Science and Technology, Japan.

FCOI Declarations: None

O128-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Functional Connectivity of Human Primary Olfactory Amygdala Subregions

Torben Noto, Guangyu Zhou, Qiaohan Yang, Greg Lane, Christina Zelano

Northwestern University, Chicago, IL, USA

The amygdala receives direct projections from the olfactory bulb, making it part of primary olfactory cortex. However, the amygdala has mostly been considered as a brain region involved in implicit learning, threat responses and emotion. A detailed body of research has elucidated many of the amygdala's functional circuits, but far less is known about the amygdala's role in olfaction. The amygdala is comprised of many sub-nuclei, just three of which receive direct input from the olfactory bulb. These include the Medial Amygdala, Cortical Amygdala, and the Periamygdaloid Complex. The specific olfactory process(es) that each olfactory subregion of the amygdala performs is unclear, particularly in humans. Here we use functional neuroimaging to explore whole-brain connectivity patterns between each olfactory amygdala subregion and the rest of the brain. Our goal was to define both the common and unique functional networks of the three olfactory amygdala subregions. Results showed that all three olfactory amygdala

subregions share connectivity with piriform cortex, hippocampus, and other areas of the amygdala. This analysis also revealed functional networks unique to each olfactory amygdala subregion. The cortical and medial nuclei of the amygdala were functionally connected to parietotemporal auditory areas and medial frontal cortex, while the periamygdaloid complex was functionally connected with the FFA and anterior pons. These findings can be used to form testable hypotheses about the olfactory role of each amygdala subregion.
Funding Acknowledgments: This study was financially supported by the National Institutes of Health Grants (NIDCD) R00-DC-012803, R01-DC-016364, and R01-DC-018539 (to Christina Zelano).
FCOI Declarations: None

O129-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Prevalence and Correlates of Parosmia and Phantosmia among Smell Disorders

Robert Pellegrino[1], Joel D. Mainland[1,2], Christine E. Kelly[3], Jane K. Parker[4], Thomas Hummel[5]

*[1]Monell Chemical Senses Center, Philadelphia, PA, USA, [2]Department of Neuroscience, University of Pennsylvania, Philadelphia, PA, USA, [3]Abscent, Hampshire, *, United Kingdom, [4]Department of Food and Nutritional Sciences, University of Reading, Reading, *, United Kingdom, [5]Smell & Taste Clinic, Dept. of Otorhinolaryngology, TU Dresden, Dresden, *, Germany*

Evidence is emerging that along with many quantitative olfactory disorders (e.g., reduced odor sensitivity) individuals experience qualitative disorders (e.g., odor distortion); however, the distinct features of parosmia (e.g., distorted odor with a known source) and phantosmia (e.g., distorted odor without a known source) have not been determined leading most studies to classify them together. From a survey in a large population with an olfactory disorder (N = 2031), we report that qualitative disorders are common to smell impairment (46%) with patients reporting either parosmia (19%), phantosmia (11%), or both (16%). In comparison to quantitative disorders, respondents with parosmia were more likely to be female, young, and suffer from post-viral olfactory loss (p <0.001), while respondents with phantosmia were more likely to be female and middle-aged (p <0.001) with higher incidence of traumatic impact than parosmic respondents (p <0.01). A higher prevalence of qualitative disorders was observed during the recovery phase (3 months to a year, p <0.001). Additionally, we show the frequency and duration of distortions negatively impacts quality of life, with parosmia showing a higher range of severity than phantosmia (p <0.001). Previous research has lumped these qualitative disorders together, but our results shows they have distinct patterns of demographics, medical history, and losses to quality of life.
Funding Acknowledgments: T32 DC00014 RP
FCOI Declarations: None

O130-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Q-Powders - a quick test for screening retronasal olfactory disorders with tasteless powders

Michal Pieniak[1,2], Anna Oleszkiewicz[1,2], Marie Klockow[1], Ayaho Yoshino[1,3], Antje Haehner[1], Thomas Hummel[1]

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Objective(s): To investigate the clinical utility of q-Powders - a retronasal identification screening test.
Methods: A total of 156 subjects (92 females, mean age: 54.5 years ± 17.3 years) completed a 3-item q-Powders retronasal identification test and a 16-items Sniffin' Sticks orthonasal identification test. We analyzed whether the q-Powders test could differentiate between subjects with normosmia and subjects with an olfactory disorder.
Results: Our data indicated that subjects with an olfactory disorder scored lower in the q-Powders test than subjects with normosmia. The analyses revealed q-Powders test sensitivity of 84% and a test specificity of 64.9% with a score of 2 points taken as a cutoff for olfactory disorders. Conclusion: A short 3-item q-Powders retronasal test may be used for screening purposes in nonspecialized clinical centers or in clinical research.
Funding Acknowledgments: N/A
FCOI Declarations: None

O131-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Long-Term Follow-Up of Olfactory Dysfunction in COVID-19 Patients

Bernhard Prem[1], David T. Liu[1], Gerold Besser[1], Gunjan Sharma[1], Laura E. Dultinger[1], Sissy V. Hofer[1], Martina M. Matiasczyk[1], Bertold Renner[2,3], Christian A. Mueller[1]

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Background: Olfactory dysfunction (OD) is a common symptom of COVID-19 with a prevalence of 5 to 98 percent according to geographical region and method of evaluation. Although recovery is reported within the first month in many cases, long-term observations are rare. Therefore, we aimed to assess the course of chemosensory function in COVID-19 patients within three to six months after the infection with SARS-CoV-2.
Methodology: Sixty-two patients (43f and 19m; mean age/SD: 40.513.6 years; range: 18–68 years) with SARS-CoV-2 infection and subjective OD participated in this single-center study. At first, patients performed questionnaires and chemosensory tests at home, and then, further psychophysical tests were performed at the clinic.
Results: Three to six months after the acute infection 80% still showed some degree of OD by applying orthonasal olfactory test ("Sniffin' Sticks / TDI"). After a mean interval of 219.1 days (SD 67.6; range: 113–330) between first day of OD and follow-up testing, the mean TDI score was 26.8 points (SD 5.5; range 5.0–37.5). Furthermore, 64.5% reported improvement, 6.5% deterioration and 29% no change of OD until follow-up.
Conclusions: The prevalence of persisting OD associated with SARS-CoV-2 may be higher than expected. Moreover, subjective assessment of chemosensory function seems to improve, but reconvalescence fails to appear in the majority.
Funding Acknowledments: We thank the mayor of the city of Vienna for supporting the project with "Stiftungsfonds zur Foerderung der Bekaempfung der Tuberkulose und anderer Lungenkrankheiten". Furthermore, we thank S.Seyferth for manufactured candies as well as Frey&Lau GmbH for providing the aromas.
FCOI Declarations: None

O132-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Molecular Determinants of Olfactory Receptor Antagonism

Kevin Ryan[1,2,3], Min Ting Liu[1,2]

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Odorant agonists create characteristic patterns, or codes, of activated odorant receptors (OR) in the mammalian nose. Recent advances show that antagonists in synthetic mixtures commonly modulate the code by countering activation by agonists in the mixture. Using calcium imaging on dissociated mouse olfactory sensory neurons (OSNs), we carried out a study to probe the molecular determinants of odorant antagonists. We examined odorant antagonism by functional group (aldehyde, alcohol and carboxylic acid) and by carbon chain (n-octyl and the conformationally restricted 2-cyclohexylethyl). For example, using 1-octanol as a designated agonist, n-octanal was compared to 2-cyclohexylethanal (functional group constant, carbon chain varied) as antagonist and, separately, to 1-octanol (functional group varied, carbon chain constant). Used analogously in the study were: 1-octanoic acid, 2-cyclohexylethanoic acid and 2-cyclohexylethanol. Odorants were tested in pairs, and cellular responses consistent with OR antagonism were tallied. Both molecular features were able to provide the structural determinant for antagonism, but with differences in the frequency, susceptibility and extent of apparent antagonism. Among the three functional groups, the one most likely to function as an antagonist was the carboxylic acid, and OSNs exhibiting narrow tuning in favor of aldehydes were the most susceptible to antagonism. Other trends found in the study will be described.
Funding Acknowledments: The U. S. Army Research Laboratory and the U. S. Army Research Office, grant number W911NF-13-1-0148 to K.R.
FCOI Declarations: None

O133-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Contributions of Chemical Structure and Perceptual Quality to Odor Encoding in the Human Brain

Vivek Sagar, Thorsten Kahnt

Northwestern University, Chicago, IL, USA

The human olfactory system transforms chemical information from odor molecules into percepts. Neural activity patterns in primary olfactory areas discriminate between odor stimuli, but it is unclear which features of odors are encoded in these brain regions. Here we examine the contribution of chemical structure and perceptual quality to odor encoding in different olfactory areas using functional magnetic resonance imaging (fMRI) and computational modeling. We recorded 24 hours of fMRI data from individual human subjects (N=3) while they repeatedly smelled 160 monomolecular odors. First, we used representational similarity analysis (RSA) to quantify the encoding of perceptual and chemical properties in major olfactory areas. We observed significant differences in encoding of perceptual and chemical information across these areas and found perceptual quality as the dominant feature of odor encoding. We then tested whether odor-evoked fMRI responses can be described by an encoding model consisting

of a linear combination of specific perceptual and chemical basis functions. Our results show that prediction accuracy for these encoding models is significant in several olfactory areas, including the piriform cortex, amygdala, and orbitofrontal cortex. We also used cluster analysis on the perceptual feature weights and observed a topography of perceptual encoding that differs along anatomical areas and was qualitatively similar across subjects. Our results reveal the tuning properties of neuronal ensembles in the human olfactory cortex.

Funding Acknowledgments: R01DC015426 TK 2T32MH067564 VS
FCOI Declarations: None

O134-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

The Olfactory Pathway Preserves Sensory Transmission During Sleep

Mary Schreck[1], Liujing Zhuang[1], Emma Janke[1], Andrew H. Moberly[1], Jay A. Gottfried[1], Daniel W. Wesson[2], Minghong Ma[1]

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A hallmark of sleep is an increased threshold in response to sensory stimuli. The control of sleep/wake state-dependent perception is thought to occur by means of the thalamic gate, although it is challenged by recent work. Unlike other sensory modalities, olfactory information can gain access to primary and secondary olfactory cortices without a thalamic relay. Odor perception is controlled by sleep/wake states, yet how this is accomplished remains to be determined. Here we address this question via optogenetic activation of olfactory sensory neurons (OSNs) to ensure consistent peripheral inputs across different brain states. Meanwhile, local field potential (LFP) recordings were simultaneously obtained along the ascending olfactory pathway at multiple sites—olfactory bulb (OB), anterior piriform cortex (APC), and orbitofrontal cortex (OFC)—in freely behaving mice. Surprisingly, evoked LFPs in sleep states (both REM and NREM) are larger in amplitude and contained greater gamma band power within all recorded regions as well as enhanced cross-region coherence than in wakefulness. LFPs in the mediodorsal thalamus (MD) also show larger responses during sleep. Additionally, single units in the OB and APC do not show a significant reduction in stimulation evoked responses during NREM sleep compared to wake. These findings suggest the lack of a central gate in the olfactory pathway. Differential respiratory patterns may work as a peripheral gate which physically regulates olfactory input during sleep.

Funding Acknowledgments: NIDCD R01DC006213 MM NIMH T32 MH017168 MRS NIDCD F31DC017054 MRS
FCOI Declarations: None

O135-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Olfactory Neuronal Damage in Central Neurological Disorders and Post-Upper Respiratory Infection Hyposmia

Hideaki Shiga[1], Koichi Okuda[2], Junichi Taki[3], Naoto Watanabe[4], Hisao Tonami[4,5], Seigo Kinuya[3], Takaki Miwa[1]

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In this study, we aimed to determine whether the assessment of olfactory neuronal damage with ^{201}Tl-based olfactory scintigraphy is useful for distinguishing patients with olfactory dysfunction due to central neurological disorders from those with post-upper respiratory infection hyposmia and healthy volunteers. Twenty-seven subjects were enrolled in this study from July 2010 to November 2019 (16 women and 11 men; age, 33–71 years; ten patients with central neurological disorders, including six with idiopathic Parkinson's disease; ten patients with post-upper respiratory infection hyposmia; and seven healthy volunteers). Imaging factors indicating olfactory neuronal damage, such as nasal ^{201}Tl uptake ratio in the olfactory cleft, diffusion of nasally administered ^{201}Tl to the olfactory bulb, and olfactory bulb volume, were determined for each subject. These three imaging factors were significantly reduced in all patient groups in comparison to healthy volunteers. In particular, the nasal ^{201}Tl uptake ratio in the olfactory cleft was significantly higher in the central neurological disorder group than in the post-upper respiratory infection group ($P = 0.0001$, Mann-Whitney test). ^{201}Tl diffusion to the olfactory bulb and olfactory bulb volume were not significantly different between the patient groups with olfactory impairment. Our results signify that the nasal ^{201}Tl uptake ratio in the olfactory cleft is useful to differentiate olfactory dysfunction due to central neurological disorders from hyposmia associated with an upper respiratory infection.

Funding Acknowledgments: This study was funded, in part, by JSPS KAKENHI Grant Number JP17K11369 to HS, and Grant for Collaborative Research from Kanazawa Medical University (C2020-1) to HS and TM.
FCOI Declarations: None

O136-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Olfactory bulb atrophy in early-stage Parkinson's disease

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Objective: To investigate whether there is olfactory bulb (OB) atrophy in early-stage Parkinson's disease (PD). Introduction: Hyposmia has been reported to occur in the majority of early-stage PD patients. Postmortem studies show that the OB is highly affected by Lewy pathology. However, whether there is OB atrophy in early-stage PD is not clear.
Methods: 28 idiopathic H&Y stage-1 PD patients and 22 age/sex-matched healthy controls (HC) participated in this study. The smell functions (smell threshold and smell identification) of each nostril were assessed. High resolution T2W MRI of OB was conducted on a 3 T scanner with a 64-channel coil. OB volume was measured via manual segmentation by two raters blinded to patient status and smell function scores. Analysis of OB volume was performed with both absolute as well as intracranial volume (ICV) normalized volumes.
Results: There was significant OB atrophy in PD compared with HC with age and sex as covariates. There were no significant differences between left and right side in smell functions or OB volumes in either group. No significant difference was observed between the early- and late-onset side OB volumes in PD. OB atrophy was significantly correlated with smell deficits and motor deficits in PD. Conclusion: There is significant OB atrophy in early-stage PD.
Funding Acknowledments: This study was supported by the NINDS R01NS099630.
FCOI Declarations: None

O137-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Distribution of Calretinin and lhx5- and lhx2a-driven GFP in Zebrafish Transgenic Reporter Lines Sheds Light on Olfactory System Evolution in Teleosts

Lydia Waner[1], Liam O'Leery[1], Baylee A Porter[2], Thomas Mueller[1]

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Zebrafish is an increasingly popular teleostean model system for neural mechanisms of olfaction, however, its central olfactory systems have remained anatomically ill-understood. This is because the zebrafish telencephalon shows an outwardly-grown (everted) morphology specific to the large group of ray-finned fish. In terms of evolution, homology, and functional organization, the everted telencephalon is hard to compare with the evaginated forebrains of mammals like mice and humans. To gain insights into the evolution and development of the olfactory system, we analyzed the distribution of calretinin, parvalbumin, otpa-protein, and GABA in both developing and adult zebrafish of the transgenic lines Tg(lhx5:GFP), Tg(vGlut2a:GFP), and Tg(lhx2a:GAP-YFP). In the latter GFP olfactory bulb neurons axons form the lateral olfactory tract (lot) that projects into olfactory pallial territories. In zebrafish, the lot specifically innervates the posterior ("Dp") and ventral most lateral aspects of the dorsolateral zone ("Dlv"). Comparing the GFP distribution in Tg(lhx5:GFP) with Tg(lhx2a:GFP), our analyses reveal that the projection sites are more complexly organized than previously thought. In line with our previously published framework of the zebrafish amygdala, we redefine both territories often labeled as "Dp" and "Dlv." The differential expression of lhx5-driven GFP confirms that these territories most likely correspond to the nucleus of the lateral olfactory tract (nLOT), whereas one previously overlooked territory should be considered homologous to the lateral pallium (mammalian entorhinal cortex). Altogether, our results explain key aspects of olfactory systems organization in this important model system drastically facilitating comparability to mammalian models of olfaction.
Funding Acknowledments: The research was supported by the Cognitive and Neurobiological Approaches to Plasticity (CNAP) Center of Biomedical Research Excellence (COBRE) of the National Institutes of Health under grant number P20GM113109. Moreover, the Human Frontier Science Program (HFSP) funded the research under the grant number RGP0016/2019.
FCOI Declarations: None

O138-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Unusual Structural Pattern of the Anterior Skull Base in Congenital Anosmia

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Objective: To identify the morphological pattern of anterior skull base surrounding olfactory bulb in individuals with isolated congenital anosmia (ICA).
Methods: We acquired T2 weighted magnetic resonance images from individuals diagnosed with ICA (n=31) and age, gender matched healthy control (n=62). We compared the depth and width of olfactory fossa, angle of fovea ethmoidalis as well as angle of lateral lamella of cribriform plate between both groups. We further performed subgroup analyses based on presence or absence of olfactory bulb, to

check if the morphological changes of anterior skull base related to the presence of olfactory bulb within ICA.
Results: Individuals with ICA exhibited a flattened ethmoid roof and shallower olfactory fossa when compared to healthy control. Further, absence of olfactory bulb was found to be associated with a higher degree of flattening of the ethmoid roof and shallow olfactory fossa. Conclusion: Individuals with ICA have an unusual pattern of structural variation in anterior skull base surrounding olfactory bulb, which can be used as a diagnostic marker of congenital anosmia. The structure of the anterior skull base seems to be mirrored in the observed reduction of the olfactory bulb.
Funding Acknowledments: grants
FCOI Declarations: None

O139-POSTER SESSION #3

WEDNESDAY, 9:00 AM - 11:00 AM

Short-term impacts of mild traumatic brain injury on olfactory perception

Coline Zigrand[1,3], Benoit Jobin[1,2,3], Fanny Lecuyer Giguère[2,4], Benjamin Boller[1,3], Johannes Frasnelli[2,5]

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Introduction: Olfactory dysfunction (OD) is a well-established consequence of traumatic brain injury (TBI). Most of the studies reported OD in patients with moderate and severe TBI in the acute phase. However, inconsistent results have been found on OD in patients with mild traumatic brain injury (mTBI). This study aims to investigate olfactory perception in patients with mTBI in the acute phase.
Method: We measured olfactory capacities in 41 (23 men) patients with mTBI between 2 and 4 weeks following their trauma. Their scores were compared to those from 51 (25 men) healthy controls (HC). More specifically, we administered an established olfactory test (Sniffin'Sticks). Then, to measure odor detection (yes/no paradigm) and olfactory perception (pleasantness, intensity and top down modulation by the label effect) we used an olfactometer. During this experiment, we presented each participant with 4 common odors for a total of 16 administrations.
Results: We did not observe any group difference in the results from the Sniffin'Sticks test. However, mTBI patients had more difficulty detecting odors than controls (p = .001). Interestingly, however, they perceived odorants as significantly more intense (p = .015) on average. Furthermore, depending on the odorant (interaction odor * group: p = .001), mTBI patients perceived odors as less pleasant. The label effect was equal between HC and patients with mTBI. On average using a positive label rendered odors 1.23 points more pleasant than a negative label on a 10-point scale. Conclusion: These findings show that patients with mTBI suffer from altered olfactory perception in the first weeks following their trauma. However, established olfactory tests such as the Sniffin'Sticks test may be less sensitive to these subtle changes.
Funding Acknowledments: This work was supported by the Fonds de Recherche du Québec: 173002 - Santé [Chercheur Boursier Junior 1 (JF)] and the Research Center of Sacré-Coeur Hospital: 173000.
FCOI Declarations: None

O140-ORAL ABSTRACTS: OLFACTION I

WEDNESDAY, 11:00 AM - 12:30 PM

Machine Learning Ideations to Map Odorant Activity in Olfactory-Receptor Odorant Interactions

Chiquito J Crasto[1], Roshan Thilakarathne[2], Neranjan Perera[3], Anuththara H Lokubandara[2]

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We explored the mechanistic underpinnings of olfactory receptor (OR)-odorant interactions from a novel perspective—that of the odorant. We leveraged machine learning methodologies [1, 2] to study the electronic-structural features of odorants that interact with ORs resulting in ranges of activation from strongly activating to non-activating. To train our system, we accessed the results of the comprehensive combinatorial experimental functional analysis of the interactions 62 olfactory receptors and 63 odorants [3]. Our machine learning process used neural networks, which extracted electronic specific features from the functional analysis study complementarily related features in olfactory receptors. We used three neural networks: a Graph Attention Neural Network (GANN) that mapped an odorant's atomic connectivities from its positional coordinates; a deep neural network (DNN) that comprehensively extracted bond distances, angles, and torsional angles by determining an odorant's Z-matrix; and, a DNN that extracted electronic features of bonded and surrounding atoms within an odorant from the ^{13}C, ^{15}N, and ^{31}P NMR chemical shifts, theoretically determined using *ab initio* Density Functional Theory (DFT)-determined methods [4]. The output of each neural network channel was fed into a common set of dense layers where the last four neurons classify the ranges of excitations (Strong, Medium, Weak, None). The training set determined using this experimentally determined odorant behavior was then used on a test

set of 210 odorant molecules stored in the OdorDB database of SenseLab (https://senselab.med.yale.edu/OdorDB). We will present clusters of odorants from this test set with associate likelihoods of strengths of activation.
Funding Acknowledments: NA
FCOI Declarations: None

O141-ORAL ABSTRACTS: OLFACTION I

WEDNESDAY, 11:00 AM - 12:30 PM

Modulation of the peripheral olfactory response by trigeminal agonists

Federica Genovese, Emylette Cruz Cabrera, Marco Tizzano, Johannes Reisert

Monell Chemical Senses Center, Philadelphia, PA, USA

The olfactory epithelium (OE) contains both olfactory sensory neurons (OSNs) and trigeminal fibers, one detecting odorants and the other irritants. However, it is unclear if these two chemosensory systems interact. Using electro-olfactograms (EOGs), we characterized responses to odorants with different trigeminal potencies in wild-type (WT) and knockout (KO) mice, which lack the chemosensory trigeminal receptors TRPA1 and TRPV1. The TRPA1 agonists, allyl-isothiocyanate (AITC), and cinnamaldehyde (CNA) showed reduced EOG responses in KO compared to WT mice. No significant differences were observed in response to the odorants pentyl acetate (PA), β-phenyl ethyl alcohol (PEA), both with low trigeminal potency, and the TRPM8 agonist, menthol. Furthermore, brief activations of peptidergic trigeminal fibers by strong trigeminal agonists (AITC and CO_2) induced a progressive decrease of OSN responses to a pure olfactory stimulus (PEA). Such modulation is lacking in KO mice and also in the WT when stimulating trigeminal fibers with menthol. Interestingly, when stimulated with CNA or PA, moderate TRPA1 agonists, PEA responses in WT were increased compared to the KO. We conclude that irritants can modulate EOG responses. We determined that the trigeminal and olfactory systems interact in the OE, with the trigeminal system potentially having a bimodal modulation on olfactory responses. Strong trigeminal irritants cause a reduction of the odor response, while moderate trigeminal agonists might induce an enhancement. The relatively slow (minutes) temporal dynamics of the trigeminal modulation of olfactory responses, and the lack of any modulation by agonists of non-peptidergic fibers (menthol), suggest a mechanism of olfactory modulation mediated by TRPA1/V1 positive trigeminal peptidergic fibers.
Funding Acknowledments: R21DC018358 FG Monell institutional funds FG NIDCD R01DC016598 MT NIDCD R01DC016647 JR
FCOI Declarations: None

O142-ORAL ABSTRACTS: OLFACTION I

WEDNESDAY, 11:00 AM - 12:30 PM

Virtual Demonstration of Perceptual Antagonism and Selective Adaptation in Binary Odor Mixtures

Thomas P Hettinger, Marion E Frank

UConn Health, Farmington, CT, USA

Components of binary odor mixtures are equally identifiable if present at equal intensities. An imbalance in intensities leads to predominant identification of the more intense component, an antagonistic perceptual effect achieved by an increase in concentration of the dominant component or selective adaptation of the weaker component. We previously showed that selective adaptation of one component for 5 seconds was sufficient to allow identification of the non-adapted component. Antagonism was observed for all odor pairs with distinctly different odor qualities. Here we show that odor antagonism and selective adaptation can be demonstrated virtually with common food flavors. An example uses chocolate and lemon flavored instant puddings dispensed into 3 paper cups with loose-fitting lids. One cup contains chocolate pudding, a second cup contains lemon pudding and a third cup contains separate and equal amounts of both. The subject sniffs the adapting chocolate pudding for 5 seconds, and then sniffs the mixture for 2 seconds. The adapting pudding is perceived as "chocolate" and the test mixture is perceived as "lemon." When the adapting pudding is lemon, and the test mixture has the same 2 components, the adapting pudding is perceived as "lemon" and the test mixture is perceived as "chocolate." This shows that the quality of the odor mixture depends on component antagonism and selective adaptation. The same effects can be observed for various binary mixtures of other foods and flavors. Antagonism and selective adaptation appear to be nearly universal. Adaptation probably occurs in the receptors, while receptor antagonism is unlikely because it would have to be general for multiple distinct odors. Odor antagonism probably results from inhibitory circuits generated in the olfactory bulb.
Funding Acknowledments: UConn Foundation
FCOI Declarations: None

O143-ORAL ABSTRACTS: OLFACTION I

WEDNESDAY, 11:00 AM - 12:30 PM

A Feedback Mechanism Regulates *Odorant Receptor* Expression in the Malaria Mosquito, *Anopheles gambiae*

Sarah E Maguire[1], Ali Afify[1], Loyal A Goff[1,2], Christopher J Potter[1]

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USA, [2]The Department of Genetic Medicine, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Mosquitoes locate and approach humans ('host-seek') when specific Olfactory Neurons (ORNs) in the olfactory periphery activate a specific combination of glomeruli in the mosquito Antennal Lobe (AL). We hypothesize that dysregulating proper glomerular activation in the presence of human odor will prevent host-seeking behavior. In experiments aimed at ectopically activating most ORNs in the presence of human odor, we made a surprising finding: ectopic expression of an *AgOr (AgOr2)* in *Anopheles gambiae* ORNs dampens the activity of the expressing neuron. This contrasts studies in *Drosophila melanogaster*, the typical insect model of olfaction, in which ectopic expression of non-native ORs in ORNs confers ectopic neuronal responses without interfering with native olfactory physiology. To gain insight into this dysfunction in mosquitoes, RNA-seq analyses were performed comparing wild-type antennae to those ectopically expressing *AgOr2* in ORNs. Remarkably, almost all *Or* transcripts were significantly downregulated (except for *AgOr2*), and additional experiments suggest that it is *AgOR2* protein rather than mRNA that mediates this downregulation. Our study shows that ORNs of *Anopheles* mosquitoes (in contrast to *Drosophila*) employ a currently unexplored regulatory mechanism of OR expression, which may be adaptable as a vector-control strategy.

Funding Acknowledments: NIAID R01AI137078 CJP W81XWH-17-PRMRP CJP Johns Hopkins Malaria Research Institute Postdoctoral Fellowship SEM

FCOI Declarations: None

O144-ORAL ABSTRACTS: OLFACTION I

WEDNESDAY, 11:00 AM - 12:30 PM

Molecular Transport Explains Which Molecules Are Odorous

Emily J Mayhew[1], Charles J Arayata[1], Richard C Gerkin[2], Brian K Lee[3], Jonathan M Magill[1], Lindsey L Snyder[1], Kelsie A Little[1], Chung Wen Yu[1], Joel D Mainland[1,4]

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The number of molecules humans can smell is disputed, with published estimates ranging from 10,000 to infinitely many. Chemical space is vast, and we cannot resolve this dispute until we define the subset of chemical space that has an odor. We propose that molecules that can complete the transport process to reach olfactory receptors are generally odorous. Although physical transport is well-understood, a general classification model for odors has been elusive because the available data were both noisy and poorly curated. We generated a large and chemically diverse dataset of over 1,900 molecules, classified as odorous (84%) or odorless (16%) through a combination of literature- and web-scraping, human discrimination tasks, and chemical analysis. We additionally performed rigorous quality control on this dataset to correct errors in the data - both in odorous/odorless labels and in physicochemical features. When we used this quality-controlled dataset to train machine learning models, we found that features that drive transport of molecules to olfactory receptors (volatility and hydrophobicity) are sufficient to reliably classify novel molecules as odorous or odorless (AUROC = 0.97) and that use of additional molecular features does not significantly improve model accuracy. Applying our transport-based model to GDB17, a database of all possible small organic molecules (HAC ≤17), we estimate that over 30 billion possible compounds are odorous, 6 orders of magnitude larger than current estimates of 10,000. Remarkably, nearly all transport-capable molecules are odorous, suggesting broad collective tuning of olfactory receptors. Defining the boundaries of odor perception will enable design of experiments that representatively sample olfactory space and efficient search for novel odor compounds.

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FCOI Declarations: Joel D. Mainland received research funding from Ajinomoto Co., Inc.

O145-ORAL ABSTRACTS: OLFACTION I

WEDNESDAY, 11:00 AM - 12:30 PM

Physiological and Morphological Characterization of Antennal Lobe Neurons in Aedes aegypti

Pranjul Singh[1], Shefali Goyal[1], Smith Gupta[1], Sanket Garg[1,2], Arjit K. Gupta[1], Nitin Gupta[1]

*[1]Department of Biological Sciences and Bioengineering, Indian Institute of Technology, Kanpur, *, India, [2]Department of Economic Sciences, Indian Institute of Technology, Kanpur, *, India*

Antennal lobe, the primary olfactory center in insects, receives odor information from the olfactory receptor neurons. Projection neurons and local neurons are the two major functional classes of neurons in the insect antennal lobe. Using whole-cell patch-clamp recordings and post-hoc dye filling, we investigated the physiological and morphological properties of these two classes of neurons in the yellow fever mosquito, *Aedes aegypti*. We were able to observe the morphology of ~200 projection neurons and ~50 local neurons. Based on glomerular innervation, we found that projections neurons are majorly uni-glomerular but could also be bi- or multi-glomerular. Local neurons, on the

other hand, were found to be multi-glomerular in all cases, and their innervation patterns could be categorized as panglomerular, all-but-few, patchy, or continuous. We also performed immuno-histology against GABA and found some local neurons to be GABAergic. We extracted different electrophysiological features such as spike amplitude, spike half-width, spike adaptation, spike amplitude accommodation, and the size of after-hyperpolarization from the obtained recordings. Based on these parameters, we were able to classify a cell as a projection or local neuron with more than 80% accuracy. Our study provides a comprehensive characterization of the mosquito antennal lobe neurons and will serve as a foundation for understanding the olfactory processing in the mosquito brain.

Funding Acknowledments: This work was supported by the DBT/Wellcome Trust India Alliance Fellowship [grant number IA/I/15/2/502091] awarded to N.G.

FCOI Declarations: None

O146-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

Electrical Stimulation of the Trigeminal Nerve as a Novel Intervention to Improve Smell Function

Bernadette M. Cortese, Elise M. Gruber, Georgia H. O'Leary, Sarah M. Huffman, Lisa M. McTeague, Rodney J. Schlosser, Thomas W. Uhde, Bashar W. Badran

Medical University of South Carolina, Charleston, SC, USA

COVID-19 presented a renewed awareness of the importance of smell, including the striking impact of smell loss on daily functioning, as well as the lack of available evidence-based interventions to improve smell. While medical and surgical treatments exist for inflammatory-related smell loss, interventions to treat loss due to other etiologies are limited. Given the role of the intranasal trigeminal system in smell function, we conducted a proof-of-concept study to determine the effects of electrical stimulation of the trigeminal nerve (TNS) on sensitivity to phenyl ethyl alcohol (PEA) and guaiacol (GUA), 2 odorants with low and high trigeminal properties, respectively. TNS is an emerging form of "bottom-up" brain stimulation in which low-level electrical current is delivered to superficial trigeminal nerve branches innervating the face and forehead. Twenty healthy adults (8M/12F, 27±8.1 years old) were recruited from MUSC and the surrounding community to participate in this double-blind, placebo-controlled, pilot. PEA and GUA thresholds were determined at baseline, immediately post-intervention, and again 30-min post-intervention. In a randomized cross-over design, participants received active and sham TNS on separate visits. Results indicated a significant stimulation x odor x time interaction ($F[2,76]=3.56$, $p=.024$, $\eta_\rho^2=.093$). Detection of GUA, but not PEA, was significantly enhanced by active, but not sham, TNS (16% and 9% increase from baseline at the 1st and 2nd follow-up time points respectively). TNS is safe, noninvasive, inexpensive, and easy to administer, rendering it highly scalable. Future study should determine the full effects and durability of TNS on smell function across different stimulation parameters, odorants, and patient populations.

Funding Acknowledments: This research was supported by the Department of Psychiatry and Behavioral Sciences, Medical University of South Carolina (MUSC)

FCOI Declarations: BMC and BWB have pending patents on the methods described in this abstract that have been assigned to MUSC.

O147-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

Olfactory function reflects the integrity of the locus coeruleus inApoE ε4 carriers at risk for Alzheimer's Disease

Tracey H. Hicks[1], Chantal Dietzen[1], Abigail Albertazzi[1], Conner Frank[1], Aaron Jacobson[2], Claire Murphy[1,2]

[1]San Diego State University, San Diego, CA, USA, [2]University of California, San Diego, La Jolla, CA, USA

Specific brain areas are affected early in Alzheimer's Disease(AD) and the integrity of these areas can serve as biomarkers of early AD. Olfactory processing relies on many of these brain areas and holds promise as a biomarker. The earliest evidence of tau pathology, a characteristic of AD, appears in the locus coeruleus (LC). Tau-related atrophy in the LC can be observed before cognitive deficits are clinically identified. Atrophy in the LC reduces its widespread projections of norepinephrine, notably reducing projections to the olfactory bulb. Little is known about the relationship between integrity of the LC and olfactory function in AD. The ApoE ε4 allele is the most robust genetic risk factor for AD, thus carriers of the ε4 allele are a special population for studying preclinical biomarkers for AD. We examined olfactory function using the San Diego Odor Identification Test and the integrity of the LC using a scan at 3T in groups of older adult ApoE ε4 carriers and non-carriers. Importantly, the ApoE ε4 carriers, who had the greatest genetic risk for developing AD, showed a very strong positive relationship between olfactory function and LC signal intensity when controlling for age, gender, and estimated intracranial volume. The results suggest that olfactory function can reflect the early atrophy in the LC. Furthermore, these data suggest increased exploration into the LC in AD. The results add significantly to the premise that incorporating olfactory measures into a neuropsychological battery could increase the ability to identify patients with the highest risk of conversion to AD, without invasive measures. We thank the participants, the UCSD Center for fMRI, the SDSU Lifespan Human Senses Laboratory, and the UCSD Alzheimer's Disease Research Center.

Funding Acknowledgments: Supported by NIH grant AG062006-02 from the National Institute on Aging to CM and P50AG005131-35 (UCSD ADRC).
FCOI Declarations: None

O148-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

SCENTinel 1.0: development of a rapid test to screen for smell loss

Stephanie Hunter[1], Valentina Parma[1,2], Mackenzie Hannum[1], Maureen O'Leary[1], Robert Pellegrino[1], Nancy Rawson[1], Danielle Reed[1], Pamela Dalton[1]

[1]Monell Chemical Senses Center, Philadelphia, PA, USA, [2]Temple University, Philadelphia, PA, USA

Background: Commercially available smell tests are primarily used in research or in-depth clinical evaluations, but are too costly and lengthy for population surveillance in health emergencies like COVID-19. We developed the *SCENTinel 1.0* test which rapidly evaluates three olfactory functions (detection, intensity, and identification). We tested whether self-administering the *SCENTinel 1.0* test discriminates between individuals with smell loss or average smell ability (normosmics), and provides comparable performance as the validated and standardized NIH Toolbox® Odor Identification Test in normosmics.
Methods: Using Bayesian linear models and prognostic classification algorithms, we compared the *SCENTinel 1.0* performance of a group of self-reported anosmics (N=111, 47±13yo, F=71%,) and normosmics (N=154, 47±14yo, F=74%), as well as individuals reporting other smell disorders (e.g., hyposmia, parosmia; N=42, 55±10yo, F=67%).
Results: Ninety-four percent of normosmics met our *SCENTinel 1.0* accuracy criteria, while only 10% of anosmics and 64% of individuals with other smell disorders did. Overall performance on SCENTinel 1.0 predicted belonging to the normosmic group better than identification or detection alone (vs. anosmic: AUC=0.95, Sensitivity=0.72, Specificity=0.94). Odor intensity provided the best single-feature predictor to classify normosmics. Among normosmics, 92% met the accuracy criteria at both *SCENTinel 1.0* and the NIH Toolbox® Odor Identification Test. Conclusions: *SCENTinel 1.0* is a practical test able to discriminate individuals with smell loss and is likely to be useful in many clinical situations, including COVID-19 symptom screening.
Funding Acknowledgments: This research was supported by NIDCD T3200014 to MH and the RADx-rad grant U01DC019578 to PD and VP as well as Monell Institutional Funds.
FCOI Declarations: None

O149-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

Signs of Inflammatory Alterations in the Olfactory Bulb in Mouse Models of Multiple Sclerosis

Sema Kaya[1], Carsten Holzmann[2], Markus Kipp[1], Martin Witt[1]

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Olfactory dysfunction is one of the first symptoms of several neurodegenerative diseases, such as Parkinson's disease, Alzheimer's disease, ALS, epilepsy, and multiple sclerosis (MS). It can occur years before motor symptoms and cognitive decline become evident and is considered a clinical marker of the early stages of these diseases and their progression. Severe focal demyelination, gliosis and axonal damage are characteristic pathological signs in MS. The aim of this study was to investigate inflammatory responses and glial activity in the experimental autoimmune encephalomyelitis (EAE), cuprizone, and a combined cuprizone/EAE (cup/EAE) mouse model. While the EAE model is based on autoimmune responses, the cuprizone model is a toxic MS model. Both cause demyelination in the CNS. Four groups of animals (cup, EAE, cup/EAE, controls) were evaluated by immunohistochemistry. Paraffin-embedded sections of the olfactory bulb (OB) were immunohistochemically evaluated with antibodies against T cells (CD3, CD8), microglia (IBA1), astrocytes (GFAP), and olfactory marker protein (OMP). The density of T cells as well as glial cells was significantly increased in all models, highest in cup/EAE mice. These findings suggest that inflammatory and glial activity within the OB may be considered as possible causes of olfactory dysfunction in MS. Furthermore, a combination of toxic and autoimmune-based animal MS models may provide an alternative experimental approach for the analysis of olfactory dysfunction in MS.
Funding Acknowledgments: University funds
FCOI Declarations: None

O150-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

Smell test for screening COVID-19

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COVID-19, a rapidly spreading disease due to the SARS-CoV-2 virus, is continuing to cause a staggering loss of life and an overwhelming impact on families and economies throughout the world. Among the expressed symptoms of COVID-19, it is now well established that sudden decreased smell function is present early in the disease process of most patients with COVID-19, even occurring before the onset of fever, cough, headache, and shortness of breath in many cases. Here, we used a brief scratch and sniff smell test with 8 odorants along with PCR testing on 400 subjects who were screened for COVID-19. The results showed an area under the curve of 0.87 with a sensitivity of 0.90 and specificity of 0.37. This supports the potential of low cost quick smell tests for identifying the subjects infected by SARS-CoV-2.

Funding Acknowledments: IPM 1000 STM

FCOI Declarations: R.L.D. is a consultant to Eisai Co, Merck Pharmaceuticals, the Michael J. Fox Foundation for Parkinson's Research, Septodont, Inc, and Johnson & Johnson; receives royalties from Cambridge University Press, Johns Hopkins University Press, and John Wiley & Sons;and is president of, and a major shareholder in, Sensonics International, a manufacturer and distributor of smell-and-taste tests, including the test used in this study. The remaining authors have no disclosures.

O151-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

Parosmia: molecular triggers of distortions and insights into the underlying mechanism

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Parosmia is a triggered, qualitative olfactory disorder in which everyday smells become altered and unpleasant, often leading to loss of quality of life. Little is known about the underlying mechanisms, but the prevailing hypothesis is a mis-wiring of olfactory sensory neurons (OSNs) during regeneration, following widespread destruction as a result of post viral anosmia or brain injury. Coffee has been identified as one of the items most commonly reported as distorted, and we suggest that during regeneration of OSNs, selective detection of just the highly odour-active compounds present in coffee might result in an incomplete, and therefore distorted, perception of the coffee. The aim of this work was to investigate whether the distortions associated with parosmia are initiated by potent molecular triggers. A novel approach employing GC-Olfactometry (GC-O) was used to determine which of the aroma compounds present in coffee might be responsible for distortions and the sense of disgust experienced during parosmia. Gas chromatography separates the volatile components present in the headspace which can then be assessed by participants (N=45) as they elute from the column. Olfactory function was assessed using the full validated Sniffin' sticks test. Fifteen highly potent aroma compounds, falling into four distinct groups (thiols, pyrazines, disulfides and methoxypyrazines) were found to trigger distortions and disgust in coffee and in other chemically related foods (cocoa, meat). Parosmia symptoms were found to be independent of olfactory function and may occur in patients with an objectively normal olfactory function. The identification of molecular triggers provides evidence for peripheral causation of distortions in parosmia, but places constraints on the mis-wiring theory, which will be discussed.

Funding Acknowledments: University of Reading

FCOI Declarations: None

O152-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

Measured Olfactory Dysfunction and Dietary Intake: Results from the 2013–2014 National Health and Nutrition ExaminationSurvey (NHANES)

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We identified associations between measured olfactory dysfunction (OD) and dietary parameters in a nationally representative sample of US adults. In NHANES 2013–2014, 3,206 adults 40 and over completed a measured smell exam (8-item odor identification test) as well as a 24-hour dietary recall interview administered by trained interviewers. OD was defined as incorrect identification of 3 or more (out of 8) odors; severe OD was defined as incorrect identification of 5 or more odors. Diet quality was assessed using the Healthy Eating Index 2015 (HEI-2015), where higher scores indicate higher diet quality. Other dietary variables included 24-h energy intake, and % energy from fat, added sugar, and alcohol. Survey-weighted multiple linear regression models estimated independent associations between

OD and dietary variables. Models were stratified by sex, and adjusted for age, race/ethnicity, education, income, smoking and chronic disease status. The prevalence rates of OD and severe OD were 12.8% (95% CI: 10.8%, 15.2%) and 2.5% (95% CI: 1.9%, 3.5%), respectively; the average HEI-2015 score was 52.9 (0.7 SE). In men, severe OD was associated with lower energy intake with an adjusted mean difference of -403.9 (95% CI: -710.4, -97.3) between those with and without severe OD. In women, severe OD was associated with lower % of energy intake from alcohol with an adjusted mean difference of -1.71 (95% CI: -2.5, -0.95). No significant associations were observed with other dietary variables. These findings are generally consistent with the broader view that disrupted olfactory function often has meaningful dietary implications, a concern with increased public health relevance given the transient and persistent olfactory disruption observed with COVID-19 infections.

Funding Acknowledments: National Institute on Deafness and Other Communication Disorders

FCOI Declarations: None

O153-ORAL ABSTRACTS: OLFACTORY DYSFUNCTION

WEDNESDAY, 1:30 PM - 3:30 PM

Region-specific amyloid-β accumulation in transgenic mouse olfactory system with Alzheimer's disease-like pathology

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Alzheimer's disease (AD) is the most prevalent form of dementia. In addition to crucial AD symptoms, comorbid symptoms such as sensory-perceptual issues are often reported. In particular, deterioration of smelling sensation is observed in approximately 90% of AD patients. However, the pathophysiological basis behind olfactory decline remains elusive. The olfactory glomerulus in the olfactory bulb (OB) receives the first smell information from the olfactory epithelium (OE) in the olfactory processing. Thus, maintaining the olfactory sensory neurons (OSNs) and synapses in the olfactory glomerulus is essential for olfactory signaling. Although amyloid-β (Aβ), which is the toxic factors upregulated in AD, has been identified in the olfactory system, the pathology involving OSNs remains poorly understood. Herein, we demonstrate that the direct linkage between olfactory impairment and AD-related pathology using transgenic model mice (Tg). First, we found an increase in β-secretase expression coincided with an elevation of Aβ oligomers in the ventral region of the olfactory glomerulus. Next, the behavioral test indicated Tg showed reduced responses to a specific odorant group. These also did not physiologically activate the OSNs that propagate their axons to the ventral OB. Intriguingly, the region declined calcium intensity in Tg, which also displayed highly accumulated Aβ. Besides, OE's ectoturbinate was measured irreversible damage by the impaired neuronal turnover ratio from the basal cells to the matured OSNs connected to the ventral OB. The findings indicate that the olfactory system's regional damage may be closely related to the olfactory sensory neuronal deficits, which affect partial olfactory dysfunction correlates with Aβ accumulation during the early stages of AD.

Funding Acknowledments: Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2020R1A6A1A03040516).

FCOI Declarations: None

O154-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Visuo-Olfactory Social Affective Matching in Autism Spectrum Disorder and Typical Development

Javier Albayay[1], Valentina Parma[2,3]

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Prior research has shown that odor valence can guide decision-making in typically developing children (TD) by increasing the likelihood of choosing congruent social affective visual stimuli, following typical adult-like behavior. However, whether children with autism spectrum disorders (ASD) - characterized by impaired social interactions such as behavioral difficulties in facial emotion recognition - exhibit comparable visuo-olfactory affective matching strategies, remains unstudied. Here, we presented children with ASD (n = 16) and TD children (n = 187) with one of three odors (blank, rose, fish) prior to a forced-choice task (happy vs. disgusted face). Logistic regression analysis showed that odor identity, odor valence, and age were significant predictors of face choice in both groups. TD was characterized by affective matching strategies such that the likelihood of choosing a happy face decreased after smelling the fish odor and any unpleasant odor and tended to increase by the presence of pleasant odors. In the ASD group, the likelihood of choosing a happy face decreased following the fish and the rose odors and increased after smelling pleasant and unpleasant odors. The likelihood of choosing happy faces following the fish odor decreased with age. Importantly,

whereas the TD group judged the valence of the odors as adults typically would (fish as unpleasant, blank as neutral, and rose as pleasant), the ASD group judged more frequently the blank odor as unpleasant - which can be explained by the higher ambiguity associated with a neutral odor - and the fish odor as either pleasant or unpleasant. Our results replicate and extend previous findings on visuo-olfactory social affective matching in both ASD and TD children.

Funding Acknowledments: This work was supported by a scholarship from the National Research and Development Agency (ANID, Chile) PFCHA/DOCTORADO BECAS CHILE/2017 [72180384] granted to JA.
FCOI Declarations: None

O155-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Morphological trajectory of calcitonin gene related peptide (CGRP) neurons in the parabrachial nucleus of the mouse

Md Sams Sazzad Ali, Jinrong Li, Christian H. Lemon

University of Oklahoma, Norman, OK, USA

Calcitonin gene-related peptide (CGRP) is a marker of neurons in the parabrachial nucleus (PBN) involved with protective function. Recently, CGRP PBN neurons were evidenced to have some role in taste. However, a clear morphological pattern of distribution of CGRP positive neurons across the neural subdivisions of the PBN is lacking. Therefore, the aim of this anatomical study was to detail the morphological pattern of CGRP positive neurons in the PBN of the mouse. Adult heterozygote calca-cre mice of both sexes were used. Under anesthesia, we injected 1µL of Cre-dependent Adeno Associated Virus (AAV1) carrying mCherry fluorophore (pAAV-hSyn-DIO-mCherry) directly into the most rostro-dorsal part of the PBN. This resulted in robust mCherry expression in CGRP positive neurons in the parabrachial area. Labeled CGRP neurons densely populated the rostral dorso-externo-lateral subdivision of the PBN (elPBN). Moving caudally, there was a comprehensible centro-medial migration of labeled cells towards the medial side of the lateral PBN. In the caudal PBN areas, CGRP neurons merged through the cellular bridges in the waist area and appeared in the caudo-ventro-medial subregion. No labeled neurons were observed in the rostral to middle part of the medial PBN. In follow-up studies, we will evaluate whether there will be similar pattern of distribution of CGRP positive neurons in antipode direction (from caudal to rostral) after injection of the same AAV1 virus into the most caudo-medial part of the PBN. Projection targets will also be assessed. The present results initially describe the transition of CGRP neurons through the PBN and find these cells populate regions associated with protective processing that include nociception and taste (elPBN) and traditional gustatory areas (e.g., waist).

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FCOI Declarations: None

O156-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Study of the time course during the odor object quality processing

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The brain's mechanisms to categorize different odor objects have long been a research focus but less evidence on temporal view. Previous studies suggest that odor object processing may involve multiple neurological processes within the brain (i.e., temporal and spatial neuronal activation). However, there is limited evidence regarding temporally mediated mechanisms in humans, especially odor processing in millisecond time scale. It may be important because brain areas can play a different role at a particular activating time during sensory processing. Here, we focus on how the brain categorizes odors at specific times. Combined with multivariate electroencephalography (EEG) analysis, we found that similarly perceived odors induce similar EEG signals during 50-100ms, 150-200ms, and 350-400ms in theta frequency. We also found significance at 100-150ms and 350-400ms in gamma frequency. Moreover, these two frequencies were observed significantly at olfactory-associated areas, including the piriform cortex and orbitofrontal cortex. Our findings provide the essential evidence that specific periods may exist related to odor object quality processing during central olfactory processing.

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FCOI Declarations: None

O157-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

First *in vivo* evidence of the involvement of the noradrenergic system in age-related olfactory dysfunctions in healthy humans.

Sarah Brosse[1], Chloé Laurencin[1,2], Nicolas Costes[3], Inès Mérida[3], Bénédicte Ballanger[1]

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Aging is an inevitable biological phenomenon associated with olfactory deficits which have profound deleterious effects on quality of life. The changes that influence aging are complex involving structural, functional and biochemical modifications. Of interest, noradrenergic (NA) mechanisms have been implicated (Docherty, 2002). However, investigations of this latter system function in the brain have mainly been emerged from animal studies. Here, we took advantage of a newly developed PET radiotracer (Nahimi et al. 2015) binding α2-adrenoceptors (ARs) to investigate the role of the NA system across the life span and its relevance to the progressive decline of olfactory functions observed with time. Fifty-eight healthy volunteers (age range 20–78 years) underwent an olfactory screening including three main olfactory tests (threshold, discrimination, identification) and were scanned with [^{11}C]yohimbine during 90 minutes in a resting state on a PET-MR system. Three main results emerged. First, chronological age was negatively related to olfactory discrimination and threshold. Second, we identified increased [^{11}C]yohimbine binding with age in the bilateral insula, amygdala, anterior and medial orbital gyrus as well as the left subcallosal area and parahippocampal gyrus. Third, regional [^{11}C]yohimbine binding displayed a negatively correlation between α2-ARs availability and threshold performances in the bilateral insula, medial orbital gyrus, subcallosal area as well as the right amygdala and left parahippocampal gyrus while [^{11}C]yohimbine binding was negatively correlated to discriminatory performances in the left subcallosal area only. The present findings provide the first *in vivo* evidence that abnormalities in the noradrenergic system play a role in the age-related olfactory dysfunction.

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FCOI Declarations: None

O158-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

In Vivo Calcium Imaging of Accessory Olfactory Bulb Mitral Cells during Social Interactions

Spencer T Byers[1,2,3], Kevin J Monk[1,2,3], Ian G Davison[1,2,3]

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The vomeronasal system plays a pivotal role in guiding social behavior through the sensing of pheromones, but it is unclear how these behaviorally-relevant chemosignals are represented during naturalistic social interactions. Using miniature microscopes in animals expressing GCaMP6f in AOB mitral cells (the AOB's projection neurons), we recorded AOB glomerular activity during constrained and freely-moving social interactions. In constrained interactions, experimental animals investigated the facial or anogenital regions of anesthetized probe animals thereby allowing us to assess sensory-evoked responses to chemosignal-rich stimuli with high spatiotemporal precision. With this approach, we find that AOB glomeruli are differentially activated across sex, background strain, and location of contact on the probe animal's body. Similar specificity is observed during freely-moving social interactions where experimental and probe animals are awake and unrestrained. Although glomeruli express diverse stimulus selectivities, population activity is distinguishable across these features. Such distinct representations may support sex-specific behaviors either as part of a distributed, population code within the AOB and/or by establishing selective pathways to downstream areas. Additionally, we find that evoked activity does not accurately track rapid investigative behavior, but instead unfolds across an extended timecourse persisting up to tens of seconds following social contact. These dynamics suggest that the vomeronasal system may integrate sensory information over long timescales rather than mapping individual sensory events onto discrete behavioral responses. Together, these findings extend our understanding of how the AOB represents behaviorally-relevant chemosignals in support of social behavior.

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FCOI Declarations: None

O159-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Prefrontal Coupling with the Olfactory System During Selective Attention to Odors

Hillary L. Cansler[1,2], Estelle E. in 't Zandt[1,2], Minghong Ma[3], Daniel W. Wesson[1,2]

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Across all sensory systems, perception of sensory stimuli is modulated by a variety of factors aside from the stimuli themselves, including cognitive states like attention. Our lab recently demonstrated that the olfactory tubercle (OT) exhibits increased signal-to-noise in its representations of odors when they are selectively attended, but the circuit mechanisms underlying this are unclear. The medial prefrontal cortex (mPFC), which is crucial for attention and cognitive flexibility, projects directly to the OT, providing a candidate mechanism. We injected retrograde AAVs into the rat OT to confirm the presence of this pathway, and found a strong population of neurons in the prelimbic (PrL) and infralimbic (IL) regions of the mPFC. Additionally, we injected anterograde AAVs encoding synaptophysin-GFP or -mRuby into the PrL and IL within the same rat. This revealed that these projections most densely target the medial OT, and only sparsely target the piriform cortex. To investigate the functional role of this connection, we recorded local field potentials in the olfactory bulb (OB), OT, and mPFC simultaneously while rats engaged in an operant task that required them to flexibly switch their attention between competing tones and odors. We found that LFP power was modulated by attention in the OB in the beta and gamma ranges, and the mPFC in the theta and gamma ranges. We also found that coherence between the OB-mPFC and the mPFC-OT was higher when rats attempted to switch their attention from tones to odors. Ongoing work investigating the modulation of active odor sampling by attention may inform the influence of respiration on this network. Overall, these results begin to reveal an olfactory attention network and bring us closer to understanding the circuits that underlie odor-directed attention.

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FCOI Declarations: None

O160-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Individual Differences in Odor Naming and Odor Nameability

Sarah Cormiea, Pamela Li, Jason Fischer

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Odors have no fixed size, shape, or spatial location. Even for very familiar odors, people often struggle to identify them by name. Here, in a series of three tasks, we investigated how odor naming ability varied across individuals. We also investigated how odor stimuli themselves varied in nameability. We devised an odor naming task to test participants' ability to identify odors without any visual or context clues. This task involved smelling a set of 36 real-world odors (e.g., oranges, onions, coffee, baby powder, burnt matches, vanilla, grass) and trying to name them. Participants were allowed to make as many guesses as they wanted for each odor (they were asked, "Do you want to guess anything else?" after each guess). Participants were not given feedback about the accuracy of any of their guesses. The resulting data comprised a corpus of responses for each participant and for every odor in our set. To assess low-level olfactory performance, participants also completed an odor discrimination task in which they had to sniff two odor mixtures on each trial and rate them as the same or different. We computed their overall accuracy for odor discrimination ability as well as a d-prime score. Participants also completed the Kaufman Brief Intelligence Test (KBIT) to assess linguistic ability, non-verbal reasoning, and problem solving. Across two testing sessions, we found that some people were consistently better at identifying odors than others, even after controlling for odor discrimination and KBIT scores. Taken together, these results demonstrate that odor naming ability varies within a population and is not reducible to a collection of other cognitive abilities. And nameability is a unique and reliable perceptual property of odors themselves.

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FCOI Declarations: None

O161-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Olfactory Meta-Cognition in Anxiety and Depression: the Different Role of Common and Social Odors

Elisa Dal Bò[1], Claudio Gentili[1], Florian Ph.S Fischmeister[2,3], Cinzia Cecchetto[1]

*[1]University of Padua, Padua, *, Italy, [2]University of Graz, Graz, *, Austria, [3]Medical University of Vienna, Vienna, *, Austria*

Diminished olfactory functioning has been widely reported in depressive disorders, whereas evidence in anxiety disorders is still controversial. Along with olfactory functioning, olfactory meta-cognitive abilities (i.e., odor awareness, olfactory imagery and importance of odors) are essential in shaping olfaction. Surprisingly, very few studies examined these meta-cognitive abilities in relation to depressive, anxiety, and social anxiety symptoms, and none of them considered the awareness of social odors (i.e., body odors). This pre-registered study examined the relation between olfactory meta-cognitive abilities and depression, general anxiety, and social anxiety in 429 individuals. Self-report measures of depression, general anxiety, and social anxiety, along with self-report olfactory meta-cognitive scales, were collected using an online survey. Linear regression analyses revealed

that olfactory awareness and importance of odors were significantly directly predicted by anxiety but not by depressive scores. Olfactory imagery was predicted neither by anxiety nor by depressive symptoms. When looking specifically into social odors, higher depression and lower social anxiety predicted increased awareness. To summarize, the present findings did not confirm our hypotheses of reduced awareness for odors in depression, but add to the limited literature about anxiety disorders, corroborating the importance of olfactory function in anxiety. These data support the notion of a close relation between emotion and olfaction, while future studies are needed to disentangle the different role of common and social odors in depressive and anxiety symptoms as well as their importance in full-blown psychiatric conditions. The study is partially supported by the project *POTION* funding under Horizon 2020 FET programme.

Funding Acknowledments: The present study is part of the POTION project that has received funding from the European Commission Horizon 2020 research and innovation program under grant agreement No. 824153.

FCOI Declarations: None

O162-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Mapping the Connectivity and Microstructure of the Human Lateral Olfactory Tracts with Diffusion MRI

Shiloh L. Echevarria-Cooper[1,2], Guangyu Zhou[1], Christina Zelano[1], Franco Pestilli[4], Todd B. Parrish[5], Thorsten Kahnt[1,3]

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The olfactory tracts connect the olfactory bulb (OB) to primary olfactory areas in the brain, but little is known about these pathways in humans. Historically, susceptibility and motion artifacts in diffusion MRI (dMRI) images have prevented accurate characterizations of the human lateral olfactory tracts (LOTs) *in vivo*. Here we used an optimized dMRI sequence to reduce susceptibility artifacts, and individualized head stabilizers to prevent motion artifacts in order to characterize the connectivity and tissue microstructure of the LOTs in human subjects. Subjects (n=25, aged 19–33 years) underwent olfactory perceptual testing (Sniffin' Sticks), a 1.5mm resolution multi-shot EPI dMRI scan (90 directions, b=1000s/mm^2, and 12 B0 volumes), and T1- and T2-weighted anatomical scans. A constrained spherical deconvolution model was used to perform probabilistic tractography to identify the LOTs in individual subjects, with seeding regions in the OBs and at a midway point along the LOTs. LOTs were identified in all subjects, but most showed a small area of signal drop-out, resulting in two disjointed LOT segments. Natural cubic spline interpolation was used to connect the two LOT segments, and individual LOT masks were normalized to MNI space and averaged to create a probabilistic LOT atlas. We found that in all subjects, the LOTs connected the OB in at least one hemisphere with the anterior olfactory nucleus, the piriform cortex, and the olfactory tubercle; 76% of subjects also showed LOT connectivity with the amygdala. Fractional anisotropy (FA) and mean diffusivity (MD) were calculated along the length of the LOTs to create tissue microstructure profiles. MD profiles were negatively correlated with olfactory discrimination scores, suggesting a role for LOT integrity in odor discrimination.

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FCOI Declarations: None

O163-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Investigating State-dependent Regulation of Olfactory Processing by the Basal Forebrain

Elizabeth Hanson, Katie Brandel-Ankrapp, Cameron Smith, Paul Pfaffinger, Jacob Reimer, Benjamin Arenkiel

Baylor College of Medicine, Houston, TX, USA

Top-down circuit regulation allows flexible modulation of sensory processing in response to behavioral states like attention and arousal. Understanding the impact of state-dependent modulation on olfactory processing has been limited by the spatial scale and temporal resolution of *in vivo* imaging platforms. Leveraging high-speed, meso-scale two-photon imaging in mice, here we examined how spontaneous shifts in attention and arousal modulate spatiotemporal properties of odor responses across the olfactory bulb. Combining mesoscopic imaging of the olfactory bulb with temporally precise odor delivery and detailed behavioral state monitoring, we visualized olfactory bulb odor response dynamics across spontaneous changes in behavioral state. We also interrogated upstream neuronal populations in the basal forebrain thought to mediate top-down control of olfactory bulb activity. From the basal forebrain, cholinergic and GABAergic neurons project extensively to the olfactory bulb. Using fiber photometry in freely behaving mice, we found that basal forebrain GABAergic neurons

are acutely recruited during distinct phases of an olfactory-cued go/no-go discrimination task, including odor detection and the response to an odor-associated reward. Notably, we also found that chemogenetic inhibition of basal forebrain GABAergic neurons reduces sensitivity and reward-seeking behavior in the olfactory-cued go/no-go task. Ultimately, these studies aim to dissect state-dependent activation of basal forebrain circuits and their impact on olfactory processing with the goal of revealing circuit mechanisms and pathways involved in state-dependent regulation of both sensory and cognitive processing.

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FCOI Declarations: None

O164-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Olfactory bulb and primary olfactory cortex volumetry in Alzheimer's disease and Mild Cognitive Decline: a meta-analysis and systematic review

Benoît Jobin[1,2], Benjamin Boller[1,2], Johannes Frasnelli[1]

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Alzheimer's disease (AD) is associated with olfactory deficits. The cerebral atrophy of structures related to olfaction has been found to lead to olfactory deficits in Alzheimer's disease (AD). Interestingly, research has shown that conversion from mild cognitive impairment (MCI) to AD is better predicted with the addition of an olfactory identification measurement. Thus, the aim of the systematic review and meta-analysis was to verify whether the presence of a clinical diagnosis of AD or MCI is associated with a volumetric decrease in two key structures associated with olfaction: the olfactory bulb (OB) and the primary olfactory cortex (POC). We collected articles from PsycNet, PubMed, Ebsco, and ProQuest databases. To be eligible, studies had to compare OB or POC volumes between a clinical group (AD dementia or MCI) and a control group of cognitively typical participants aged 55 years and older. Six studies met the inclusion criteria for OB volumes comparison between clinical groups and control groups. The meta-analysis on OB revealed a large and heterogeneous effect size indicating smaller volumes in patients with AD [M=52.53, SD=6.89] compared to healthy older adults [M=59.51, SD=8.16] (k=5, g=-1.18, 95% CI [−2.45, 0.10]). Smaller OB volumes are also observed in patients with MCI [M=54.05, SD=6.66] compared to healthy controls [M=58.64, SD=9.21]. The systematic review on POC which included three studies revealed that smaller structures are observed in patients with both AD and MCI compared to controls. These findings suggest that neurodegeneration in the olfactory structures occurs in the early course of the disease from MCI to AD stages.

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FCOI Declarations: None

O165-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Adolescent Mice Differentially Engage with Flavored Nicotine-Containing Electronic Cigarette Juices

Natalie L Johnson[1], Theresa Patten[2], Amanda M Dossat[1], Mariella De Biasi[2,3], Minghong Ma[4], Daniel W Wesson[1]

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Adolescent use of nicotine-containing electronic cigarettes (e-cigarettes) has dramatically increased in recent years. While flavor additives have been banned from combustible cigarettes, their use is relatively unrestricted in e-cigarettes. Human and animal studies suggest that these flavorants are critical players in the acquisition and maintenance of e-cigarette use, especially in adolescents, although the exact mechanisms that underlie their effects on enhancing nicotine intake are currently unknown. Here we examined how adolescent mice of both sexes interact with e-cigarette juice odors by analyzing their respiration acquired in an unrestrained whole-body plethysmograph. We selected commercially available juices, including strawberry juice which is commonly 'vaped' by human e-cigarette users. We predicted that mice would sample mixed nicotine + flavorant juices more vigorously than juices containing only nicotine. While mice investigated all stimuli through sniffing and could readily discern between stimuli, they spent more time in high frequency, investigatory sniffing when presented with the odor of strawberry or nicotine + strawberry compared to nicotine alone. This outcome suggests that the strawberry odorant is appetitive, whether presented alone or together with nicotine. The vigorous sniffing in response to nicotine + strawberry seems independent of nicotine's effects as a primary reinforcer, since plasma cotinine levels were undetectable when measured 30 minutes after exposure. These results indicate that flavors are more than simply inert compounds in e-cigarette liquids and align with a developing theory that these additives may minimize the harsh sensory effects of nicotine. Further experiments are currently underway to elucidate the neural mechanisms underlying these effects.

Funding Acknowledgments: NIDCD T32 DC015994 NLJ NIDA R01 DA049545 MDB, MM, DWW NIDA R01 DA044205 MDB NIDCD R01DC014443 DWW NIDCD R01DC016519 DWW NIDA R01DA049449 DWW, MM
FCOI Declarations: None

O166-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

The Role of Posterior Insular Cortex in Taste-Visceroceptive Integration

A-Hyun Jung[1], Camille T. King[2], Ginger D. Blonde[3], Michael King[4], Camilla Griggs[5], Koji Hashimoto[6], Alan C. Spector[3], Lindsey A. Schier[5]

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Animals use viscerosensory feedback to guide ingestive decisions, but the brain mechanisms underlying its integration with other senses (e.g. taste) are poorly understood. Schier et al (2016) found that lesions in posterior insular cortex (pIC), which receives both taste and visceral input, disrupted conditioned taste avoidance in a 2-bottle test. Here, we used a serial taste reactivity (TR) paradigm to investigate if pIC plays a role in the rapid integration of visceral information with taste-guided behavior. Male rats were implanted with intraoral (IO) cannulae and received bilateral microinfusions of ibotenic acid (pICx) or PBS (Sham) in pIC. During the serial TR session, rats were IP-injected with 2 mEq/kg LiCl or NaCl and then received IO infusions of 0.3M sucrose (30s) every 5 min for 45 min. Oromotor responses elicited during each infusion were recorded and scored offline for TR. To assess if this sucrose-LiCl pairing produced a conditioned taste aversion or avoidance, all rats then underwent a TR test and 2-bottle choice test. LiCl-injected Sham rats decreased ingestive and increased aversive TR to sucrose across the pairing session. By contrast, the LiCl-injected pICx group failed to suppress their ingestive TR and exhibited a substantially delayed and attenuated shift to aversive TR. During retention tests, the LiCl-injected pICx group displayed TR patterns that were between those of NaCl- and LiCl-injected controls. The LiCl-injected pICx group also showed a significantly higher preference for sucrose than the Sham group in the 2-bottle test. That said, not all rats were impaired by the pICx lesion. Overall, the results show that pIC plays important roles in the adjustment of taste-guided behaviors in response to the immediate effects of LiCl and subsequent expression of a taste aversion.

Funding Acknowledgments: NIH, R01-DC009821, ACS. University of Southern California Institutional Funds, LAS.
FCOI Declarations: None

O167-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Choosing olfactory stimuli based on categories of objects can be a possible way for multimedia content

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Unlike our number of senses, multimedia had mainly focused on visual and auditory senses. As one of the attempts to extend senses used in multimedia, olfactory stimulation has been used in multimedia contents for enhancing the sense of multimedia's reality. As selecting odors for multimedia, matching odors with objects in scenes is mainly conducted. When odors were matched with objects in the senses, odors could be matched with categories of objects or specific objects. According to previous multimedia studies, matching odors with categories of objects could reduce cost and effort than matching odors with specific objects. However, it is still unclear that viewers' responses to videos with multiple odors (e.g., rose, lavender, lily) from a category (e.g., flower) can be similar. Therefore, we studied whether odors belonging to the same categories can induce similar behavioral and neuronal responses in videos. To understand the effects of odors belonging to similar categories, we conducted questionnaires and EEG experiments. Our result showed that odors in similar odor categories were higher congruent to video clips than odors in the different odor categories. In our EEG data, mainly delta and theta bands were clustered in both video clips when categories of odors were similar. Our studies suggested that matching odors with categories of objects in multimedia can be feasible.

Funding Acknowledgments: This work was supported by a grant to CM by the Convergent Technology R&D Program for Human Augmentation through the National Research Foundation of Korea (NRF), funded by the Ministry of Science and ICT (2019M3C1B8090845) and Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2020R1A6A1A03040516).
FCOI Declarations: None

O168-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

TRPM8 mediates decorrelation between responses to cool temperatures in trigeminal orosensory neurons but is not necessary for trigeminal cool responses

Jinrong Li, Christian H Lemon

University of Oklahoma, Norman, OK, USA

The cold and menthol sensitive ion channel transient receptor potential (TRP) melastatin 8 (TRPM8) is expressed by trigeminal afferent fibers innervating the oral cavity. These fibers project to the trigeminal subnucleus caudalis (Vc), which routes oral temperature information to higher brain centers for integrative and affective processing tied to flavor. The role of TRPM8 in the coding of cool temperatures by Vc cells is poorly characterized, with multiplicity of cold receptors a controversial topic. Here, we examined the role of TRPM8 in oral temperature coding by Vc neurons using extracellular recordings in TRPM8 deficient and wild-type mice. Under anesthesia, Vc neurons were tested for thalamic projections using antidromic stimulation methods and for responses to oral temperatures (8°, 14°, 22°, 28°, 35°, 42°, 46° and 57°C). Cooling to <35°C produced strong activity in Vc neurons in both TRPM8 deficient and wild-type mice. Using multivariate techniques, we found that Vc cool neurons in wild-type mice (n=43) compose multiple types sensitive to different ranges of cool temperatures. Across cells, adjacent cool temperatures evoked positively correlated ($p<0.05$) activity, suggesting the Vc population response tracked systematic changes in cooling sensation. In contrast, analysis of Vc cells from TRPM8 deficient mice (n=24) identified only a single type of cold neuron that displayed a monotonic increase in activity to cooling steps from 35° to 8°C. Across TRPM8 deficient cells, responses to all cool temperatures <35°C showed significant positive correlation indicative of confusion across the cooling range. Thus, TRPM8 input is needed to sharpen distinctions between neural codes for cool temperatures but is not necessary for trigeminal cooling activity.

Funding Acknowledments: NIDCD DC011579 CHL

FCOI Declarations: None

O169-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Odor stimuli modulate self-face perception within 220–330 ms: an event-related potential study

Sun Ae Moon[1], Kwangsu Kim[1,3], Jisub Bae[1,3], Youngsun Jin[2], Cheil Moon[1,3]

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Our face is the most powerful tool for socializing. It conveys a great deal of information about ourselves. For this reason, we regularly check our own reflections in the mirror in everyday life. Previous studies have revealed that context and sensory stimuli alter face perception and evaluation. In particular, odor and face crossmodal emotion integration has been reported. However, it is unclear how odor-evoked emotion would differentially alter self-face neural processing. This study investigated how the self-face perception modulated according to presented odor stimuli using the mean amplitude of event-related potentials (ERP) and post-survey ratings. Thirty participants showed differences in the mean ERP amplitudes in the left hemisphere's frontal region while seeing self-face when exposed to a pleasant odor (lavender) or an unpleasant odor (isovaleric acid). Additionally, females showed a more sensitive self-face perception and evaluation response than males to odors. This study could be used to develop neuro-cosmetics or enhance social well-being.

Funding Acknowledments: This research was supported by Basic Science Research Program funded through the National Research Foundation of Korea (NRF) by the Ministry of Education (2020R1A6A1A03040516) and the Convergent Technology R&D Program for Human Augmentation funded through the National Research Foundation of Korea (NRF) by the Ministry of Science and ICT (2019M3C1B8090845).

FCOI Declarations: None

O170-POSTER SESSION #2

TUESDAY, 9:00 AM - 10:00 AM

Evaluation of PROP Taster Status with Machine Learning.

Lala Chaimae Naciri, Melania Melis, Mariano Mastinu, Iole Tomassini Barbarossa

*University of Cagliari, Monserrato (CA), *, Italy*

Several physiological studies have focused on the use of the genetic ability to taste the bitter compound 6-n-propylthiouracil (PROP) to evaluate the individual variability of taste perception in humans. PROP sensitivity is associated with general taste perception, food preferences and health. Psychophysical and electrophysiological methods are used to evaluate PROP sensitivity and classified subjects as belonging to three PROP taster categories (super-taster, medium taster and non-taster).We used Supervised Learning (SL) classifiers (a machine learning (ML) approach) for automatic identification of eighty-four subjects as belonging to taster categories, by including features which have been

associated to PROP taster status, such as psychophysical taste ratings, taste sensitivity to taste qualities, papilla density, *TAS2R38* and *CA6* genotypes, age, gender, BMI and smoking status. Results showed that it is possible to automatically achieve objective PROP taster status identification with a high precision (97%). A strong correlation of PROP taster status with the PROP ratings, *TAS2R38* genotypes and fungiform papilla density were found. The features were classified in order of importance in facilitating the learning as follows: PROP paper disk (50 mM), PROP solution (0.32 mM), PROP solution (3.2 mM), PAV/PAV genotype (mostly to classify super-tasters), AVI/AVI genotype (mostly to classify non-tasters), fungiform papilla density (a high value pushes toward super-taster prediction). In conclusion, the proposed SL approach allows an automatic, immediate, scalable and high precision classification of PROP taster status of subjects. ML may represent a milestone for physiology studies on taste, with applications ranging from basic science and medicine to food tasting evaluations.
Funding Acknowledments: grants from the University of Cagliari: Fondi 5 per mille (Anno 2017)
FCOI Declarations: None

O171-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

The effect of the Weber ratio on the precision and accuracy of logistic models in Sniff Olfactometry measurements.

Jiayue Ni, Qi Tang, Dave Huang, Andrea Gomez, Zoe Alcott, Justin Ong, Alyssa Green, Hannah Kelson, Marcus Weeks, Leto Solla, Terry E Acree

Cornell University, Ithaca, NY, USA

During Sniff Olfactometry (SO) experiments (Rochelle 2017), human subjects were asked in a binary forced-choice protocol to identify 70ms puffs of odorant headspaces at different concentrations using a "staircase" of concentration differences. Using binary-logistic models to determine thresholds for the odorants yielded large variations in the 95% confidence interval (CI) for the measured thresholds across multiple experiments. We have attempted to address this inconsistency through an investigation and revisitation of sample presentation protocol for the SO. If the samples were presented with a "staircase" increasing or decreasing concentration, the logistic models both produced very large CIs and generally failed to yield a recognizable psychophysical function. However, when the order of presentation was randomized but with large interstimulus concentration differences, the models yielded very small CIs and more precise psychophysical functions. The failure of small interstimulus concentration differences—and the success of larger differences—to produce a reliable psychophysical function points to the likely presence of a "just noticeable difference" of concentration in human olfaction, below which the probability of detection is greatly reduced.

Funding Acknowledments: Procter & Gamble 90475 Analyzing Odor 1438952 -
FCOI Declarations: None

O172-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Human olfactory ecology appears to be helpful in the improvement of the sense of smell

Anna Oleszkiewicz[1,2], Lena Heyne[1], Mandy Cuevas[1], Antje Haehner[1], Thomas Hummel[1]

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Scientists already accumulated evidence for the role of odours in regulating human behaviour and this field of research rapidly develops, providing more and more exciting discoveries. In this context, our daily odorous environment has been surprisingly poorly explored. The aim of our study was to quantify olfactory perception and preliminarily identify factors affecting the frequency of odorous experiences. We were also interested in knowing whether human olfactory ecology provides enough stimulation to rehabilitate olfactory function in people with a compromised sense of smell. In this study, patients with olfactory deficits (n=62) and healthy controls (n=97) had their olfactory threshold and odour identification abilities measured before and after a two-week intervention comprising counting of conscious perception of odours naturally occurring in the environment. We observed positive effects of the intervention on olfactory performance suggesting that [1] the conscious focus on odours may change its perception, [2] social and physical environment can effectively stimulate the human olfactory system, presumably supporting the spontaneous recovery of the olfactory system.
Funding Acknowledments: AO was supported by the Ministry of Science and Higher Education (#626/STYP/12/2017) and the National Science Centre (OPUS grant #2020/37/B/HS6/00288).
FCOI Declarations: None

O173-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

GABA, Calretinin, otpa-Protein, and *Ihx5*-Driven GFP Expressions in Zebrafish Indicate Thalamic Eminence Origins within Extended Medial (Olfactory) Amgydala

Baylee A Porter[1], Liam O'Leary[2], Lydia Waner[2], Thomas Mueller (Ph.D.)[2]

[1]Department of Biochemistry & Molecular Biology, Urology SUNY Upstate Medical University Weiskotten Hall, Syracuse, NY, USA, [2]Division of Biology, Kansas State University, Manhattan, KS, USA

Zebrafish is an increasingly important model for Autism Spectrum Disorders whose etiology affects the function of smell and taste systems. Typically, autisms compromise the amygdala which forms an integral part of the olfactory system. Analyzing multiple molecular marker distributions in zebrafish identified the zebrafish amygdala ground plan and how it relates to mammals in terms of homology and structural similarities. The new framework posits deep evolutionary ancestries between zebrafish and mammalian medial extended (olfactory) amygdala. The objective of this study is to extend our knowledge regarding the zebrafish posterior medial amygdala (MeAp) mediating social behavior in response to olfactory cues. Based on its otpa positivity and is function in kin recognition, this intermediate nucleus ("Vi") was previously considered "the zebrafish subpallial medial amygdala." However, our expression analysis refutes this idea. To shed further light on the topological origin and possible function of this structure, we analyzed the distribution of glutamatergic, GABAergic, and calretinin-expressing neurons indicating that this nucleus represents the rostral thalamic eminence (EmTr) defined by the expression of otpa, *vGlut2a*- and *lhx5*-driven GFP. Moreover, we show that the tela choroidea is attached to this nucleus supporting our interpretation its topological place of origin. This finding has implications for the evolutionary interpretation of the lateral olfactory tract (lot), which appears not to be related to the accessory olfactory tract as previously suggested. Our findings will further improve our understanding of the olfactory system of zebrafish critical for its usefulness as a model for spectrum autism disorders.

Funding Acknowledgments: The research was supported by the Cognitive and Neurobiological Approaches to Plasticity (CNAP) Center of Biomedical Research Excellence (COBRE) of the National Institutes of Health under grant number P20GM113109. Moreover, the Human Frontier Science Program (HFSP) funded the research under the grant number RGP0016/2019.
FCOI Declarations: None

O174-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Smell Where You're Going, or Go Where You're Smelling: Olfactory Navigation in Humans

Clara U. Raithel[1,2], Alexander J. Miller[1], Russell A. Epstein[2], Thorsten Kahnt[3,4,5], Jay A. Gottfried[1,2,3]

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Empirical evidence suggests that olfaction plays an important role in navigation across a wide range of species. However, studies investigating olfactory navigation in humans are rare. We have used a combination of air-dilution olfactometry techniques and Virtual Reality (VR) software applications to explore whether humans can learn to navigate a two-dimensional landscape comprised of discrete odor cues, by learning about the spatial relationships among odorous objects and integrating this knowledge into a cognitive map. Our data show that, across the time course of the experiment, participants made fewer errors while searching for the target odor of a given trial. This effect was associated with a significant increase in the number of trials completed across successive time bins, and a significant increase in the number of trials completed per minute. These behavioral results suggest that participants can learn to navigate a complex odorous environment with great precision, reinforcing the notion of olfactory navigation in humans. We have also begun implementing neuroimaging and computational approaches to characterize the neural mechanisms that support odor-based navigation in the human brain, with preliminary data suggesting the presence of "grid-like" (6-fold symmetric) representations in both entorhinal and prefrontal cortices. In next steps, we plan to elucidate the interactions between olfactory and extra-olfactory domains (e.g., vision) to gain unique insights into goal-directed path-finding and spatial navigation at the neural and behavioral levels.

Funding Acknowledgments: NIDCD R01DC010014 JAG
FCOI Declarations: None

O175-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Interspecific Chemosensory Communication of Emotions: Reciprocal Recognition of Fear and Non-fear Body Odour Between Humans (*Homo sapiens*) and Horses (*Equus ferus caballus*)

Agnieszka Sabiniewicz[1,2], Piotr Sorokowski[2], Michał Białek[2], Karolina Tarnowska[2], Robert Świątek[2], Matthias Laska[3]

*[1]Smell and Taste Clinic TU Dresden, Dresden, *, Germany, [2]Institute of Psychology, University of Wrocław, Wrocław, *, Poland, [3]Department of Physics, Chemistry and Biology, Linköping University, Linköping, *, Sweden*

Mammalian body odour conveys cues about an individual's emotional state that can be recognised by conspecifics. So far, no studies have examined whether reciprocal recognition of emotions between humans and animals, based on body odour, occurs. Thus, the aim of the present study was to

address this question in two experiments. In the first experiment, body odour samples were collected from 16 two years old thoroughbred horses (*Equus ferus caballus*) in a fear and a non-fear situation, respectively. The horse odour samples were then assessed by 73 human (*Homo sapiens*) odour raters. In the second experiment, body odour samples were collected from 10 adult humans in a fear and a happiness condition, respectively. The human body odour samples collected in these two conditions, together with a control condition, were then presented to a total of 21 horses. The results of the first experiment showed that humans, as a group, were able to correctly assign whether horse odour samples were collected under a fear or a non-fear condition, respectively. The results of the second experiment, in turn, demonstrated that the horses displayed some differential behaviour in response to human fear and happiness odour. The horses lifted their heads significantly more frequently and for longer in the fear and the control condition compared to the happiness condition. Similarly, the horses tended to touch a familiar person that was present during the test more frequently and for longer in the fear condition compared to the happiness condition. Additionally, depending on odour condition, the horses differed in the time they spent keeping their ears back. To conclude, the present study provides first evidence for reciprocal purely olfactory recognition of emotions between humans and horses.

Funding Acknowledments: none
FCOI Declarations: None

O176-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Effects of auditory cues on gustatory perception and event-related potentials

Han-Seok Seo[1], Franziska Lohse[2], Thomas Hummel[2]

*[1]University of Arkansas, Fayetteville, AR, USA, [2]TU Dresden, Dresden, *, Germany*

Previous studies have shown cross-modal correspondences between auditory and gustatory cues. For example, lower (higher) pitch notes were found to be associated with bitter (sweet or sour) taste. While congruent sounds have been found to modulate perceived intensity or pleasantness of tasting or odorous substances, little is known about the effect of auditory cues on gustatory event-related potentials. This study, thus, aimed to determine whether congruent sounds could affect perceived intensity and pleasantness of tasting substances and gustatory event-related potentials (ERPs). Twenty-four right-handed volunteers received six combinations of auditory and gustatory cues. More specifically, two types (salty or sweet) of tasting substance were presented with three different (Christmas carol, sea waves, and no additional sound) sound clips. After receiving each combination stimulus, participants were asked to rate taste intensity and pleasantness on visual analogue scales. During the stimulus presentation using a computer-controlled gustometer, their gustatory ERPs were also recorded. After the experimental session, the participants were asked to rate both degree of congruency between the auditory and gustatory cues and pleasantness of auditory cues on nine-point scales. The results showed that Christmas carol and sea wave sounds were better matched to sweet and salty tastes, respectively. Congruency of auditory cues were found to affect pleasantness, not intensity of tasting substances. Congruent sounds were also found to modulate neural latency of P2 peak in the gustatory ERPs. In conclusion, our findings show that congruency of auditory cues affect pleasantness and neural processing of tasting substances.

Funding Acknowledments: University funds
FCOI Declarations: None

O177-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Odor Induced Beta and Gamma Oscillations in Human Piriform Cortex Facilitate Odor Identification

Qiaohan Yang, Guangyu Zhou, Gregory Lane, Christina Zelano

Department of Neurology, Northwestern University, Feinberg School of Medicine, Chicago, IL, USA

Neural oscillations are a ubiquitous property of olfactory system responses to odors across species. In rodents, responses in three key frequency bands, including theta (4-8Hz), beta (13-30Hz) and gamma (30Hz and above), have been identified, and each have distinct functional and temporal properties. However, far fewer studies have examined oscillations in the human olfactory system, and we still lack basic understanding of the functions and spectrotemporal characteristics of these rhythms in humans. Here, we utilized intracranial EEG methods to directly record local field potential oscillations in human piriform cortex while participants performed an odor identification task. We found distinct odor-induced oscillations in theta, beta, and gamma frequency bands, similar to rodent studies. Theta oscillations emerge and exist only during a short period after sniff onset; gamma oscillations dominate for a larger duration of inhalation, as well as during inhale-exhale transition; and beta oscillations extend through the entire breathing cycle, peaking during exhale. In addition, we found that beta and gamma oscillatory amplitude were better linked to identification accuracy than theta, while theta phase significantly drove higher frequency oscillations during inhale when odor was present, indicating a possible functional divergence of these rhythms. Our findings suggest a fundamental role of beta and gamma rhythms in the human olfactory system,

in addition to replicating evidence of human odor-induced theta rhythms. Our data further indicate that despite differences in anatomy and breathing rate, olfactory oscillations are conserved across species.

Funding Acknowledments: This study was financially supported by the National Institutes of Health Grants (NIDCD) R00-DC-012803, R01-DC-016364, and R01-DC-018539 to Christina Zelano.

FCOI Declarations: None

O178-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Daily Exposure to a Cranberry Polyphenol Oral Rinse Alters the Oral Microbiome in PROP Taster Status Classified Individuals

Neeta Y. Yousaf[1], Guojun Wu[2], Melania Melis[3], Mariano Mastinu[3], Cristina Contini[4], Tiziana Cabras[4], Iole Tomassini Barbarossa[3], Liping Zhao[2], Yan Y. Lam[2], Beverly J. Tepper[1]

*[1]Department of Food Science and Center for Sensory Sciences & Innovation, Rutgers University, New Brunswick, NJ, USA, [2]Department of Biochemistry & Microbiology, Center for Microbiome, Nutrition & Health, New Jersey Institute for Food, Nutrition & Health, Rutgers University, New Brunswick, NJ, USA, [3]Department of Biomedical Sciences, University of Cagliari, Monserrato, Cagliari, *, Italy, [4]Department of Life and Environmental Sciences, University of Cagliari, Monserrato, Cagliari, *, Italy*

Diet and salivary proteins are known to influence the composition of the oral microbiome and recent data suggest that TAS2R38 bitter taste genetics may also play a role. This study investigated the effects of daily exposure to cranberry polyphenols as an oral rinse on taste perception, salivary proteins, and oral microbiota. PROP supertasters (ST, n=10) and non-tasters (NT, n=10) used 30 mL of an oral rinse (0.75 g/L cranberry extract in spring water, 47% w/w polyphenols, CPE) twice daily for 11 days while consuming their habitual diets. Subjects tasted and evaluated cranberry beverages at the beginning and end of the intervention. Whole-mouth saliva was collected and tested for salivary proteins via HPLC-ESI-IT-MS and immunoblotting; the oral microbiome composition was determined using 16S rRNA gene V4 amplicon sequencing. We showed that the CPE rinse did not affect perception of the beverages but altered selected salivary proteins. Specifically, α-amylase and Mucin 5B levels were lower post-intervention (p=0.025). Global oral microbiome structure, in the context of weighted UniFrac distance, was significantly different between NTs and STs at baseline (p=0.012) but the groups did not differ at the end of the intervention (p=0.525). Using adjusted Principal Coordinates Analysis to account for inter-individual variations, we showed that the CPE rinse significantly modified the oral microbiota composition in NTs but not in STs (unweighted UniFrac distance; p=0.023 and p=0.096 respectively). These preliminary data show that a brief regimen of daily oral exposure to polyphenols (without consumption) can alter the oral microbiome. CPE may have differential effects on the oral microbiota of NTs and STs. Future studies will investigate the functional significance of these differences on oral health.

Funding Acknowledments: Funded by New Jersey Agricultural Experiment Station, HATCH Project 10180 (granted to BJT) and Rose Marie Pangborn Scholarship 2019 (SSSF, granted to NYY).

FCOI Declarations: None

O179-POSTER SESSION #4

THURSDAY, 9:00 AM - 11:00 AM

Sustained gamma oscillations (> 10 s) induced by a single odorized sniff in human piriform cortex.

Guangyu Zhou, Torben Noto, Stephan Schuele, Joshua Rosenow, Gregory Lane, Christina Zelano

Department of Neurology, Feinberg School of Medicine Northwestern University, Chicago, IL, USA

The functional role of high frequency oscillations in human piriform cortex has not been well established. In this study, we recorded local field potential (LFP) data from human piriform cortex in one patient who performed three different olfactory tasks over three separate runs. The three tasks required the participant to indicate: 1) whether or not they detected any odor (Detection task), 2) whether the odor was edible (Edibility task), or 3) the identity of the odor (Naming task). Odors and sniffs were identical across runs and tasks. Sniff-onset aligned spectrograms of piriform LFPs revealed distinct oscillatory responses across frequencies and tasks. During the detection task, we found alpha (range) and beta (range) oscillations that lasted approximately 3 s and gamma (~ 30 Hz) oscillations that lasted approximately 6 s. During the naming task, we found similar duration of alpha and beta oscillations, but gamma oscillations lasted up to 10 s. We also found gamma oscillations in orbitofrontal cortex that lasted up until the time of the response. In this poster, we will show and discuss our findings of sustained oscillations in piriform cortex and orbitofrontal cortex during different olfactory tasks.

Funding Acknowledments: This study was financially supported by the National Institutes of Health Grants (NIDCD) R00-DC-012803, R01-DC-016364, and R01-DC-018539 (to Christina Zelano).

FCOI Declarations: None

O180-ORAL ABSTRACTS: TASTE

THURSDAY, 12:30 PM - 2:15 PM

A comparison of methods for measuring sweet taste preference

May M Cheung[1], Sari Puputti[2], Paul M Wise[1]

*[1]Monell Chemical Senses Center, Philadelphia, PA, USA, [2]University of Turku, Turku, *, Finland*

Preference for sweet taste is an important topic in sensory nutrition. Most preferred level of sweetness can be derived from ratings of liking (rating method, or RM), or from forced-choice preference judgments (paired-comparison, or PC). For both methods, aqueous solutions of sucrose (AS) are the most common stimuli, but AS are unrealistic. We compared AS with a more realistic model beverage, namely vanilla milk (VM) for both RM and PC. Healthy adults (n = 20) rated liking for five concentrations of sucrose in both AS and VM. Participants also completed PC tracking. For 18 of 20 participants, functions of rated liking vs. concentration agreed reasonably well between AS and VM. For the remaining two participants, pleasantness increased with sucrose concentration in VM, but not in AS. Magnitude of liking for the highest rated concentration ranged from neutral to moderate across individuals, but did not differ significantly between AS and VM on average. According to a method (RM vs. PC) by stimulus (AS vs. VM) ANOVA, most preferred concentration was lower on average for PC than for RM ($p < 0.01$), and tended to be lower in VM than in AS ($p = 0.053$), but differences were modest. Further, most preferred concentrations were significantly correlated among all stimuli and all methods. Though there were differences among methods and stimuli, to a first approximation, all combinations of stimulus and method yielded similar information regarding individual differences. Future studies should include larger sample sizes and additional model stimuli, but current results suggest that for some purposes simple solutions (convenient and less prone to spoilage) and rating methods (easier to implement than PC) may provide comparable information on individual differences in most preferred level of sweetness.

Funding Acknowledments: Monell Institutional Funds
FCOI Declarations: None

O181-ORAL ABSTRACTS: TASTE

THURSDAY, 12:30 PM - 2:15 PM

"Just Noticeable Difference" in Sweetness Perception of Cola-Flavored Carbonated Beverage: Small Changes are Noticeable

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Sugar sweetened beverages and sodas represent a large proportion of energy intake from added sugars in the American diet, especially in adolescents. We aimed to determine the "Just Noticeable Difference" (JND) in sweetness for a cola-flavored carbonated beverage, starting at a concentration of 12% w/w sucrose. Subjects were recruited from Purdue University, West Lafayette, IN. Two testing sessions were conducted, and each participant's response was recorded using RedJade, a sensory software. Coded samples were presented as a series of five paired-comparison (2-alternative forced choice) tests, asking "which sample is sweeter?". Each pair contained the 12% w/w sucrose cola beverage and a dilution. The pairs were presented in ascending order of difference in sugar concentration, with samples counterbalanced within pairs. Subjects rinsed with spring water between pairs. In the first test, subjects (N=52) showed statistically significant ability to detect the change in sucrose concentration at 10.21% ($p=0.0039$), but not 11.07% ($p=0.17$). In the second test, subjects (N=41) could reliably identify the sweeter sample at 10.89% ($p=0.014$), but not 11.25% ($p=0.38$). The sensory tests indicated that subjects could detect a change in sweetness at approximately 11% sucrose. The data indicate that in a 12% w/w sucrose cola beverage, sucrose can be reduced by ~9.25% of the original concentration (12% to 10.89%) before becoming apparent to consumers. Thus, if greater reductions in sugar sweetness are desired, the difference in sweetness will likely be noticed. However, further work should consider whether sugar reductions of greater than 9.25% would be acceptable, even if such reductions are apparent.

Funding Acknowledments: This work is funded by an Indiana University Center for Diabetes and Metabolic Diseases Pilot and Feasibility grant, an initiative funded by NIH/NIDDK, and by a Purdue University Justice Grant from the Center for Families.
FCOI Declarations: None

O182-ORAL ABSTRACTS: TASTE

THURSDAY, 12:30 PM - 2:15 PM

Spatio-temporal dynamics of task-specific neuronal activation in primary gustatory cortex

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Neuronal responses fluctuate from one instance to another. The role of such neuronal response dynamics in human taste processing, however, is poorly understood, and was hence the focus of the present study. We hypothesized taste-evoked activity would dynamically change within the gustatory insula and vary between hemispheres as taste processing unfolds. Using time-resolved source reconstruction of scalp-recorded electrophysiological responses (EEG) during different tasks,

we observed the first sweep of task-dependent differences within 200 ms after taste delivery. Most of this initial activation occurred in areas with high granule cell density, in line with neuroimaging studies. These differences were apparent between hemispheres and insular subregions and changed dynamically over the 1,500 ms analysis window. In contrast to whole-brain responses, we found no differences in the onset of insular responses between tasks. This suggests that task-specific latency differences originate outside the gustatory insula, possibly in motor-related areas. Together, the results suggest that temporal dynamics should be considered an integral and informative parameter of gustatory coding, rather than being viewed as a nuisance for measurements, It is hence important to consider that taste perception unfolds in time: It requires more than merely an instantaneous gustatory 'snapshot'.

Funding Acknowledments: none

FCOI Declarations: None

O183-ORAL ABSTRACTS: TASTE

THURSDAY, 12:30 PM - 2:15 PM

The Role of Novelty and Familiarity on Taste Processing in Insular Cortex

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While multiple lines of research have investigated taste processing in the gustatory region of insular cortex, little is known regarding how novelty and familiarity affect taste responses. Prior research investigating how experience alters cortical taste processing overwhelmingly focuses on the effects of associative learning. To examine how novelty and familiarity affect basic taste coding on both a population and single-cell level, we combined microendoscope calcium imaging in awake, behaving animals with a non-associative learning paradigm. Mice were trained to drink water from sipper tubes in a Davis Rig lickometer. After several days of training, mice were given two trials of each basic taste per day for five days. Imaging data collected from the gustatory cortex during behavior demonstrate that on a population level, the number of active neurons significantly decreases between the first and fifth days of taste exposure. While the overall number of active neurons decreases, the proportion of taste responsive neurons remains relatively stable, with the decrease coming largely from non-taste responsive cells. We are investigating changes in animals receiving only water presentations across the five days to reveal if our effects are due to taste exposure or are related to novelty-induced cortical states. Regarding coding, the taste responsive population is primarily broadly-tuned, and population taste preferences remain stable across days. Current analyses are focused on further characterizing individual cell responses across days.

Funding Acknowledments: This work was funded by a National Institutes of Health Grant to JDB and MLF [NIDCD R01 DC016833].

FCOI Declarations: None

O184-ORAL ABSTRACTS: TASTE

THURSDAY, 12:30 PM - 2:15 PM

Persistent Molecular Reprogramming of Sweet Taste by Diet

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Diets high in sugar, salt, and fat alter taste perception and food preference, contributing to obesity and metabolic disorders, but the molecular mechanisms through which this occurs are unknown. Here we show that in response to a high sugar diet, persistent epigenetic reprogramming of the sensory neurons of *D. melanogaster* flies by the Polycomb Repressive Complex 2.1 (PRC2.1) reduces sweet sensation and promotes obesity. Using a combination of neurogenetic and targeted chromatin and gene expression tools we find that in animals fed high sugar, the binding of PRC2.1 to the chromatin of the sweet gustatory neurons is redistributed to repress a developmental transcriptional network that modulates the responsiveness of these cells to sweet stimuli, reducing sweet sensation. This redistribution in PRC2.1 binding and activity is dependent on a nutrient sensing pathway that links cellular metabolism to gene regulation. Importantly, half of these transcriptional changes persist despite returning the animals to a control diet, causing a permanent decrease in sweet taste. Our results uncover a new epigenetic mechanism that, in response to the dietary environment, regulates neural plasticity and feeding behavior to promote obesity.

Funding Acknowledments: This work was funded by NIH R00 DK-97141 and NIH 1DP2DK-113750, the Klingenstein-Simons Fellowship in the Neurosciences, the Rita Allen Foundation (to M.D.), and NIH R35 GM-128637 (to P.L.F).

FCOI Declarations: None

O185-ORAL ABSTRACTS: TASTE

THURSDAY, 12:30 PM - 2:15 PM

A porous medium model of filiform papillae structure and deformation to predict oral mechanosensitivity to viscous solutions

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The mechanisms of oral mechanosensation, an important aspect of sensory perception for food appreciation and swallowing, are not well understood. While filiform papillae have been speculated to contribute to food texture perception, no quantitative evidence has linked their structural characteristics to mechanosensation. Extending a previous study, we modeled the human tongue surface as a porous medium and simulated the complex, high viscous Newtonian fluid flow through the papillae structures in 59 human subjects. Papillary length, width, and density in each subject were characterized with optical profiling and subsequently modeled. An elastic curve equation was applied to predict filiform papillae deformation as a function of viscous shear stress. Our simulation showed the degree of predicted deformation significantly correlated to a previously presented dataset (Miles, *et al* 2020, AchemS) of measured viscosity Just-Noticeable-Difference (JND) thresholds ($r=0.50$, $p<0.001$), and was particularly affected by papillary length and density. Indeed, a pseudo-parameter that is papillary length times density, had an even stronger correlation to both deformation ($r=0.77$, $p<0.00001$) and JND threshold ($r=0.68$, $p<0.00001$). However, the diameter of the papillae, while also varying across subjects, had little impact on deformation or JND. Our model indicated this is likely due to a reciprocal interaction between papillae diameter and fluid shear stress. Papillae with larger diameters would result in higher viscous shear stress due to a narrower gap and stronger fluid-structure interaction, but a larger diameter papilla would also deform less easily. This study re-affirms the validity and novelty of modeling the human tongue surface as a porous medium to investigate oral stimulation and mechanosensory function.

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FCOI Declarations: None

O186-ORAL ABSTRACTS: TASTE

THURSDAY, 12:30 PM - 2:15 PM

A journey of searching taste bud progenitor cells under lingual epithelium

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Our recent findings revealed that Sox10-expressing tissue compartments under the lingual epithelium, i.e., connective tissue core of taste papillae and/or von Ebner's gland, host progenitor cells that differentiate to mainly type III taste cells during taste bud maturation and maintenance in postnatal mice. To identify which cell type(s) in the Sox10-expressing tissue compartments contribute to taste buds, we used inducible Cre drivers and reporter (tdT) to map the neural crest that gives rise to most connective tissue cells, connective stromal cells, or von Ebner's glands, a minor salivary gland connected to the bottom trenches of circumvallate and foliate papillae in posterior tongue. A single dose of tamoxifen treatment in Sox10-iCreER^{T2}/tdT at E8.0 specifically labeled neural crest cell lineages, while labeled cells were not found in taste buds. Vimentin is an intermediate filament expressed in a diverse population of cells in the connective tissue, including neural crest and non-neural crest-derived cells. Administration of multiple doses of tamoxifen in Vimentin-CreER/tdT mice marked connective tissue cells extensively, and similarly to Sox10-iCreER^{T2}/tdT with tamoxifen at E8.0, Vimentin-CreER/tdT labeled cells were not observed in taste buds. However, circumvallate taste bud cells were labeled concurrently with von Ebner's glands in Sox10-iCreER^{T2}/tdT mice receiving prolonged tamoxifen administrations. Of note, the absence of labeled cells in circumvallate taste buds and von Ebner's gland were consistent in Sox10-iCreER^{T2}/tdT mice for neural crest and Vimentin-CreER/tdT mice for stromal cell lineage mapping. Our data suggest a potential contribution of von Ebner's glands to taste buds, for which ongoing studies are being undertaken to collect direct evidence.

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FCOI Declarations: None

O192-THE CURE FOR OLFACTORY LOSS

FRIDAY, 9:00 AM - 11:00 AM

AChemS Clinical Symposium:The cure for olfactory loss

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The corona pandemic made it painfully clear to a broader public that there are limited options for the treatment of olfactory loss. Hence, the title of the symposium is provocative. Having said this, major advances in the understanding of olfactory loss have been made during the alst 20 years. Several options for treatment have been investigated, so that their possibilities and limitations are now clearer. The symposium will almost exclusively include presentations from medical doctors who see patients with olfactory loss on a daily basis. Speakers come from the USA, the UK and France, and all of them are widely recognized researchers. First, Katie Whitcroft form London will talk about corticosteroids which are the most frequently used drugs in the treatment of olfactory loss. Vijay Ramakrishnan from Aurora will deal with the nasal microbiome which may play a major role in olfactory loss. Andrew Lane from Baltimore will then talk about most recent advances in the understanding of the mechanisms of olfactory loss associated with inflammatory conditions - which are the cause of approximately 2/3 of all olfactory disorders, apart from aging. Finally, Moustafa Bensafi from Lyon will shed light on current developments in new therapeutic options including olfactory implants.

Funding Acknowledgments: none
FCOI Declarations: None

O193-THE CURE FOR OLFACTORY LOSS

FRIDAY, 9:00 AM - 11:00 AM

The Use of Steroids in Patients With Olfactory Disorders

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Corticosteroids are drugs that are often used in the treatment of a wide range of inflammatory and sensorineural conditions. Since such mechanisms may be involved in aquired causes of olfactory dysfunction, corticosteroids have been proposed as having the potential to improve olfactory function in patients suffering from olfactory loss. In this presentation, we will review the data about usefulness and the role of corticosteroids in the management of olfactory dysfunction.

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FCOI Declarations: None

O194-THE CURE FOR OLFACTORY LOSS

FRIDAY, 9:00 AM - 11:00 AM

Inflammation and olfactory function

Andrew Lane

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The anatomic location of the olfactory epithelium (OE) makes it vulnerable to damage from infectious and non-infectious agents. The remarkable capacity for OE regeneration allows the sense of smell to be maintained in this challenging environment. A critical component of injury and repair mechanisms at mucosal surfaces is activation of the immune system. Inflammation is essential to removing debris and protecting the host from microbial invasion until barrier integrity is restored. Bidirectional signaling between the neuroepithelium and immune cells regulates reparative inflammation and maintains homeostasis. Pathologically persistent olfactory inflammation, such as in the setting of chronic rhinosinusitis, is associated with loss of mature olfactory neurons and failure of normal regeneration. This dysfunctional state is mediated in part by basal cells, which participate in the immune response at the expense of their neuroepithelial progenitor function. Re-establishment of the non-neuronal epithelial envelope and resolution of inflammation is a prerequisite to complete regeneration of a functional olfactory neuronal organ. Strategies to reverse the loss of the sense of smell due to age or disease will likely need to factor in neuro-immune pathways and/or leverage reparative inflammation to fully activate olfactory regeneration.

Funding Acknowledgments: NIDCD R01DC016106
FCOI Declarations: None

O195-THE CURE FOR OLFACTORY LOSS

FRIDAY, 9:00 AM - 11:00 AM

The sinonasal microbiome and the sense of smell

Vijay R. Ramakrishnan

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Recent years have seen a remarkable amount of research into the role of the microbiome in regulating mucosal homeostasis and inflammation. The nasal cavity and paranasal sinuses are colonized by dense assemblages of bacteria and other microbes in health and disease states. Microbiota signatures are associated with sinonasal health and disease, tissue inflammation, and symptom measures. In this symposium we will discuss rationale and hypotheses for olfactory dysfunction resulting from dysregulated microbiota-epithelial crosstalk in respiratory and olfactory epithelia. We will discuss recent publications in this area, and present novel findings from an ongoing human study. Finally, we will discuss challenges and limitations that are important to overcome in the next phase of research.

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FCOI Declarations: None

O196-THE CURE FOR OLFACTORY LOSS

FRIDAY, 9:00 AM - 11:00 AM

Restoring olfaction: from current paradigms to olfactory implants

Moustafa Bensafi

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Olfactory deficit influences several aspects of quality of life (ex. relationship to food, social interactions). Surgical and pharmacological treatments, and olfactory training are possible therapies. However, when these treatments fail, artificial systems assisting individuals with olfactory loss in their daily life could be a promising therapeutic alternative. Artificial noses are increasingly used in industry for specific needs (ex. quality control) but they are not made available for people with olfactory loss. How they could be useful in patients with smell deficits is still an open question. The present conference will present data from the literature combined with experimental data showing the latest technological developments in artificial olfaction. We will discuss how these technologies can be applied to the field of olfactory deficits, and how patients perceive the usefulness of such prostheses or implants of the future.

Funding Acknowledgments: This work was granted by the Human Chemosensation IRP (CNRS)
FCOI Declarations: None

O202-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

The catnip/silver vine response in domestic cats: II, the uncovering of the biological significance of the behavioral response

Reiko Uenoyama[1], Tamako Miyazaki[1], Jane L. Hurst[2], Robert J. Beynon[2], Masaatsu Adachi[3], Shuji Kaneko[4], Toshio Nishikawa[3], Masao Miyazaki[1]

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When domestic cats and other felids sniff nepetalactone and nepetalactol emitted from catnip (*Nepeta cataria*) and from silver vine (*Actinidia polygama*), respectively, they rub their faces and heads against the plants and roll on the ground as a characteristic response. While this response is well known, its biological significance and underlying mechanism remain undetermined. This study aimed to elucidate the neurophysiological mechanism and functional significances of this feline response using nepetalactol as a stimulant. We hypothesized that the μ-opioid system regulating euphoric and rewarding effects in humans is activated during the silver vine response in cats. Nepetalactol increased plasma β-endorphin that is an endogenous opiate in cats, while pharmacological inhibition of μ-opioid receptor by naloxone suppressed the silver vine response in cats. These results demonstrated that the μ-opioid system is involved in the expression of the silver vine response in cats. We next focused on mosquito repellent activity of nepetalactone and further hypothesized that the silver vine response allows cats to transfer nepetalactol in the plant on their fur for chemical defense against mosquitoes. Nepetalactol and silver vine leaves had also mosquito repellency. Cats rubbed their faces and heads on the nepetalactol-paper even when the papers were placed cage walls or ceiling. In cats rubbed against the paper, nepetalactol was transferred to their faces and heads. In the test of the mosquito repellent property of cats, mosquitoes avoided the nepetalactol-treated cats or the cats that responded to silver vine leaves compared to control cats. These results revealed that the feline silver vine response protect them from mosquitoes, the major pests carrying viruses and parasitic insects.

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FCOI Declarations: None

O203-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

Neural and Molecular Mechanisms of Microbe-sensing in the Control of Animal Behavior

Ben Brissette, Niels Ringstad

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Animals use the chemical senses of taste and smell to represent the environment. How complex and distributed sensory representations of the world are integrated to form sensory percepts and instruct behavior remains poorly understood. The nematode *C. elegans*, with its well-defined genetics and compact, accessible nervous system, permits cell-specific manipulation and monitoring of neural activity to determine how sensory information is integrated and how neural activity generates behavior. Using a genetically encoded integrator of neural activity, CaMPARI, I found that exposure to *E. coli* and *E. faecalis* elicit different responses in interneurons of freely behaving *C. elegans*. These microbes have different effects on *C. elegans* biology and elicit different behavioral responses: *C. elegans* avoids *E. faecalis*, which is highly pathogenic, but is attracted to *E. coli*, which is nutritive. I discovered that AIB and AIZ interneurons, which receive convergent inputs from many chemosensory neurons, are strongly inhibited by exposure to *E. coli* but remain active in the presence of *E. faecalis*. I also observed this effect using microbe-conditioned media, indicating that differential activation of chemosensory neurons generates the observed difference in interneuron activity. Using the calcium indicator GCaMP, I mapped sensory responses to *E. coli* and *E. faecalis* and found that distinct populations of chemosensory neurons respond to chemical cues derived from these microbes. These data indicate that chemosensory representations of these microbes are complex and distributed, and they may be integrated in AIB and

AIZ interneurons. Our next goal is to manipulate activity in chemosensory neurons and monitor how interneuron activity changes to determine the computation used to integrate complex sensory information.
Funding Acknowledments: NIGMS GM122573 NR NINDS 2T32NS086750-06A1 BB
FCOI Declarations: None

O204-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

Active Olfactomotor Responses in Head-Fixed Mice

Isabelle Cullen, Jared Acosta-King, Matt Smear

University of Oregon, Eugene, OR, USA

Olfactomotor responses are respiratory, orofacial, and locomotive movements for sampling and reacting to odors (Rabell et al. 2017, Kurnikova, Deschênes, and Kleinfeld 2019, Findley et al. 2020, Johnson et al 2003, Wesson et al 2008, Jones and Urban 2018). Altered sensory sampling behaviors, such as eye movement, temperature insensitivity, and pain insensitivity, have been identified in individuals with Autism Spectrum Disorder (ASD). In addition, Rosenkrantz et al. (2015) showed that olfactomotor behavior is affected in children with ASD. These children did not modulate sniffing behavior to aversive odors despite correctly identifying odors as unpleasant, suggesting an altered unconscious motor response. To investigate the neural mechanisms underlying olfactomotor sampling, we investigated respiratory and orofacial responses to odor using wildtype mice. Wildtype mice are exposed to 2-phenylethanol (attractive odor), 2-methylbutyric acid (aversive odor), pinene (neutral odor), or clear air over the course of a behavioral session. We record respiration with an intranasal thermistor and track orofacial movements using DeepLabCut. Our preliminary results in wildtype mice suggest that mice alter their sniffing and nose movement in response to odor stimuli. This work will shed light on active olfaction and help us understand more about naturalistic olfactomotor behaviors.
Funding Acknowledments: Peter O'Day Fellowship, BRAINI
FCOI Declarations: None

O205-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

Automated Control of Odor Dynamics for Neurophysiology and Behavior

Luis Hernandez-Nunez[1,2,3], Aravinthan D.T. Samuel[1,2]

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Animals rely on their olfactory systems to avoid predators, forage for food, and identify mates. Olfactory systems decode the information in environmental odor cues based on chemical identity and on temporal dynamics. Studying the temporal neural processing of odor stimuli has been difficult because odorized airflows interact with surfaces and other air currents, making odor temporal control technically challenging. Here, we present a method for automated control of odor waveform amplitude, baseline (background), and frequency. We demonstrate the type of experiments and analyses this technique enables by studying how the temporal properties of olfactory stimuli are decoded in the early olfactory system and navigational behavior of larval *Drosophila*. Precise odor control and calcium measurements in the axon terminal of the Olfactory Receptor Neuron (ORN) Or42b revealed that, as in photoreceptor neurons, Or42b gain-suppression is accompanied by a speed-up of its neural response, a non-linear phenomenon called dynamic adaptation. We also found that Or42b sensitivity to changes in odor concentration decreases with odor background; however, sensitivity to odor contrast is invariant regardless of the odor background. Finally, using our technique in a behavioral arena, we uncovered correlations between the temporal dynamics of larval navigation motor programs and the neural response dynamics of certain types of early olfactory neurons. The method we present here is independent of the instruments used to measure neural activity or behavior, and thus, can potentially be used with other model organisms.
Funding Acknowledments: ADTS NSF 1555914
FCOI Declarations: None

O206-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

Application of Deep Learning on Foci of Neural Activity Makes It Possible to Identify Crucial Brain Areas for the Classification of Aversive and Hedonic Neural Odor Processing

Raphael Lermer[1], Alyssa Torske[2], Thilo Bauer[1], Jessica Freiherr[1,3]

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Aversive odors and scents have been proven to influence people, but how they are processed on the cortical level has not yet been fully explored. The influence of odors on purchase decisions leads to an economic interest and makes this research suitable for the trend of neuromarketing. In this study, a meta-analysis of neuroscientific studies in which

stimulus processing has been investigated was conducted. The focus lies on the localization of the affected brain regions and the implementation of an artificial neural network that can distinguish different brain imaging studies with respect to their research question. The neural network that was developed distinguished for the respective condition based on some statistically determined important coordinate points in the brain, whether a study involved odors or other sensory stimulation. In a second run, the neural network differentiated whether studies involved pleasant or unpleasant odors. For each publication, the foci were used as maxima of multidimensional distributions to reconstruct brain activity and feed the network. The classification achieved high precision. In addition, the network can use the backquery to output the points that are important for classification and thus identify the concerned brain regions. For olfactory processing, the amygdala and the piriform cortex were identified, and for aversive odors, the left frontal inferior gyrus, the insula and area OP4. The identification of regions for pleasant odors needed to be more precise, but parts of the amygdala and anterior cingulate cortex were considered as promising. This study might provide the basis for the classification of individual brain scans and enable resulting neuro marketing applications.

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FCOI Declarations: None

O207-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

Valence shifts in female behavioral responses to male pheromone during pregnancy

Caitlin H. Miller, Matthew F. Hillock , Jiawen Yang, Brandon Carlson-Clarke , Melissa R. Warden, Michael J. Sheehan

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How an animal selects the appropriate behavioral response to a stimulus given its current internal state remains a central question in the fields of behavioral ecology and neuroscience. In order to interrogate the mechanisms and circuitry involved in behavioral selection, it is essential to identify a behavior that exhibits a clear valence shift in response to a highly specific sensory stimulus. In the house mouse, we have discovered a novel and striking behavior with these characteristics: female mice exhibit a dramatic and consistent valence shift in response to the male sex pheromone *Darcin* across reproductive states. This protein pheromone is normally secreted in the territorial urine marks of male mice. It has been previously shown that sexually receptive females are attracted to and approach *Darcin*. In stark contrast, we have found that pregnant females exhibit both avoidance and escape behaviors to the same male pheromone. We further interrogate what other male urine components females attend to, and the role of identity information in mediating the valence of male urine marks across reproductive states. This paradigm provides a unique opportunity to examine the processes underlying behavioral selection and valence processing, while shedding light on the hugely understudied behavioral changes that occur during pregnancy.

Funding Acknowledgments: USDA Hatch NYC-191428
FCOI Declarations: None

O208-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

Changes in pair-wise correlations during running reshapes global network state in the main olfactory bulb

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Neural codes for sensory inputs have been hypothesized to reside in a broader space defined by ongoing patterns of spontaneous activity. To understand the structure of this spontaneous activity in the olfactory system, we performed high-density recordings of neural populations in the main olfactory bulb of awake mice. We observed changes in pairwise correlations of spontaneous activity between mitral and tufted (M/T) cells when animals were running which resulted in an increase in the entropy of the population. Surprisingly, pairwise maximum entropy models that described the population activity using only assumptions about the firing rates and correlations of neurons were better at predicting the global structure of activity when animals were stationary as compared to when they were running, implying that higher order (3rd, 4th order) interactions governed population activity during locomotion. Taken together, we found that locomotion alters the functional interactions that shape spontaneous population activity at the earliest stages of olfactory processing, 1 synapse away from the sensory receptors in the nasal epithelium. These data suggest that the coding space available for sensory representations responds adaptively to the animal's behavioral state.

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FCOI Declarations: None

O209-ORAL ABSTRACTS: OLFACTION II

FRIDAY, 12:00 PM - 1:45 PM

Dopamine D3 receptor expressing neurons in the olfactory tubercle bidirectionally mediate depression-like behaviors in mice induced by chronic restraint stress

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Clinical studies reveal strong correlation between olfactory dysfunction and depression, a neuropsychiatric disorder causing great social and economic burdens worldwide. However, the underlying neural circuits responsible for depression remain incompletely understood. The olfactory tubercle (OT), the most ventral part of the striatum, is situated at the interface of the olfactory system and brain reward regions. The OT is populated with multiple GABAergic neuronal subtypes: dopamine D1- and D2 receptor-expressing spiny projection neurons (D1- and D2-SPNs) and tightly packed dopamine D3 receptor-expressing neurons (D3 neurons) that are predominantly found in the islands of Calleja (IC). By integrating optogenetics, *ex vivo* electrophysiological recordings and behavioral assays, we investigated the role of these OT neurons in a chronic restraint stress (CRS)-induced mouse model of depression. We showed that CRS reliably induced anxiety- and depression-like behaviors and decreased OT D3 neuronal excitability. Cell-type-specific optogenetic activation of D3 neurons ameliorated anxiety-like behaviors and partially reversed depressive phenotypes in CRS-treated mice. In addition, activation of D3 neurons produced a rewarding effect revealed in conditioned place preference tests. Loss-of-function of D3 neurons induced severe depressive phenotypes characterized by lack of motivation. Moreover, OT D3 neurons directly inhibit neighboring spiny projection neurons which innervate ventral tegmental area neurons that directly project to the nucleus accumbens, a major reward center in the brain. Our study provides a novel role of OT D3 neurons in bidirectionally mediating depressive phenotypes, providing an attractive neural substrate for intervention and treatment of depression.

Funding Acknowledments: R01DC006213, R01DA049449, and R01DA049545.

FCOI Declarations: None

O210-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Chemical Adducts of Flavor Aldehydes Formed in E-Cigarette Liquids Are Cytotoxic and Inhibit Mitochondrial Function in Respiratory Epithelial Cells

Sairam V Jabba[1], Alexandra N Diaz[1], Hanno C Erythropel[2], Julie B Zimmerman[2], Sven E Jordt[1]

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Introduction: Flavor aldehydes in e-cigarettes, including vanillin, ethyl vanillin (vanilla), and benzaldehyde (berry/fruit), rapidly undergo chemical reactions with the e-liquid solvents, propylene glycol, and vegetable glycerol (PG/VG), to form chemical adducts named flavor aldehyde PG/VG acetals. The objective of this study was to compare the cytotoxic and metabolic toxic effects of acetals in respiratory epithelial cells.

Methods: Metabolic assays were carried out in bronchial (BEAS-2B) and alveolar (A549) epithelial cells. Potential cytotoxic effects were analyzed using the LIVE/DEAD cell assay in BEAS-2B cells and primary human nasal epithelial cells (HNEpC). Cytostatic effects were compared using Click-iT EDU cell proliferation assay in BEAS-2B cells.

Results: Compared with their parent aldehydes, PG acetals diminished key parameters of cellular energy metabolic functions, including basal respiration, adenosine triphosphate production, and spare respiratory capacity. Benzaldehyde PG acetal (1–10 mM) increased cell mortality in BEAS-2B and HNEpC, compared with benzaldehyde. Vanillin PG acetal was more cytotoxic than vanillin at the highest concentration tested while both diminished cellular proliferation in a concentration-dependent manner.

Conclusions: Reaction products formed in e-liquids between flavor aldehydes and solvent chemicals have differential toxicological properties from their parent flavor aldehydes and may contribute to the health effects of e-cigarette aerosol in the respiratory system of e-cigarette users. Manufacturers' disclosure of e-liquid ingredients at time of production is insufficient to inform a comprehensive risk assessment of e-cigarettes.

Funding Acknowledments: NIH grants R01ES029435, U54DA03615108

FCOI Declarations: Sven-Eric Jordt is consultant for the Research Institute for Fragrance Materials (RIFM).

O211-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Dissecting the Role of AP-2ε in Controlling the Genetic and Functional Identity of Vomeronasal Neurons

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The functional identity of neurons is established and maintained by the tightly regulated expression of transcription

factors (TFs) that control chromatin architecture and selective activation of genetic programs. The dysregulation and misexpression of these elements can lead to abnormalities in neuronal identity, circuitry formation, and subsequently altered behavioral patterns. To better understand the ability of TFs to change set genetic programs we used the mouse accessory olfactory system as a model. The vomeronasal organ (VNO) is an olfactory subsystem composed of two main populations, apical and basal vomeronasal sensory neurons (VSNs) which are responsible for the detection of pheromones. The proper generation, specification, and organization or these neurons are important for the social and sexual behaviors in many vertebrates. We have previously shown that Tfap2e (AP-2ε) is crucial for maintaining cellular identity and homeostasis in the VNO, however what role this TF plays in controlling the genetic basal VSN identity is still unknown. To examine this, we have generated a Cre-inducible AP-2ε mouse line, where the mTfap2e gene was cloned into the ROSA26 locus. Using this mouse line we were able to rescue the AP-2ε phenotype and assess the ability of this TF to reprogram apical VSNs to basal-like neurons. By combining in-vivo experiments and single-cell transcriptome analysis we were able to identify a range of direct or indirect genetic targets for AP-2ε. (NIDCD 1R01DC017149-01A1 PEF)

Funding Acknowledments: (NIDCD 1R01DC017149-01A1 PEF)

FCOI Declarations: None

O212-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Characterization of the function of E3 ubiquitin ligases Znrf3/Rnf43 in taste and lingual epithelial tissues

Chanyi Lu[1], Xiaoli Lin[1], Junpei Yamashita[1], Minliang Zhou[1], Ranhui Xi[1], Yali Zhang[1], Hong Wang[1], Robert F. Margolskee[1], Bon-Kyoung Koo[2], Hans Clevers[3], Ichiro Matsumoto[1], Peihua Jiang[1]

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Taste cells turn over continuously throughout life. The ability of adult taste stem/progenitor cells to give rise to new taste cells helps maintain taste tissue homeostasis. This process is regulated by neuronal input. We recently revealed that R-spondin substitutes for neuronal input for taste cell regeneration and proposed that gustatory neuron-expressed R-spondin-2 (Rspo2) may be the neuron-derived factor that regulates taste stem cell activity. R-spondin is the ligand for stem cell-expressed G protein-coupled receptors Lgr4/5/6 and E3 ubiquitin ligases Znrf3/Rnf43. The ternary interaction of R-spondin-Lgr4/5/6-Znrf3/Rnf43 is important for augmenting Wnt signaling. Here, we set out to determine the functional role of Znrf3/Rnf43 in regulating taste stem/progenitor cell activity using a loss of function approach by specifically deleting Znrf3/Rnf43 in Krt5-expressing epithelial cells. Similar to the function of Znrf3/Rnf43 in the intestinal epithelial tissue, Znrf3/Rnf43 negatively regulates taste tissue homeostasis. Genetic deletion of Znrf3/Rnf43 in Krt5-expressing epithelial cells led to taste cell hyperplasia, mirroring the effect of exogenous R-spondin. Furthermore, neuronal input becomes dispensable in these mice. Surprisingly, the lingual epithelial tissue degenerated in the Znrf3/Rnf43 double knockout mice. Administration of a Wnt signaling inhibitor (C59) blocked taste cell hyperplasia and lingual epithelial tissue degeneration in the Znrf3/Rnf43 double knockout mice, suggesting that the context-dependent effects of Znrf3/Rnf43 on taste and lingual epithelial tissues are mediated by Wnt signaling. In summary, we show Znrf3/Rnf43 plays important but different roles in regulating taste and lingual epithelial tissue homeostasis.

Funding Acknowledments: R01 DC018627, R01 DC013807

FCOI Declarations: None

O213-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Toward the restoration of damaged taste organs with a genetically encoded Hedgehog pathway agonist

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Stanford University School of Medicine, Stanford, CA, USA

Taste loss is a frequent side effect of cytotoxic cancer therapies. To facilitate recovery from taste loss, we are investigating the cellular origins of taste receptor cells as a basis for developing new agents to stimulate their regeneration. We performed single-cell analysis of all cells in the taste organ including *Gli1*+ labeled Hedgehog responsive cells and then conducted long-term lineage-tracing using genetic drivers to map the spatial and clonal distribution of stem/progenitor renewal units in taste organs. To better understand the role of the Hedgehog pathway in taste receptor maintenance and regeneration (Lu et al. PNAS, 2018), we developed a nanobody that can achieve Hedgehog pathway activation in both dorsal skin and lingual tissues by systemic AAV delivery, without the lipid modification required for activity of the native Hedgehog protein (Zhang et al. PNAS,

2020). We plan to use this nanobody platform to engineer agonists of the Hedgehog pathway with targeting specificity for unique cell types. These agents may facilitate the regenerative effects of Hedgehog pathway activation in damaged sensory organs while avoiding the causation of Hedgehog pathway-associated malignancies in other tissues.
Funding Acknowledments: 1R01DC016892-01
FCOI Declarations: None

O214-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Overview of Intestinal Bitter Taste Receptors: Gene Expression in Human, Pig and Mouse

Francisca P. Noya-Leal[1], Jocelijn Meijerink[2], Shanna Bastiaan-Net[1], Renger Witkamp[2], Jurriaan J. Mes[1], Nicole de Wit[1]

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Bitter taste receptors (TAS2Rs) are new targets for the pharmaceutical market as they were found to be players in several important metabolic and physiological processes outside the oral cavity. Lately, it has been studied how intestinal TAS2Rs recognize bitter compounds and elicit secretion of energy- and appetite- controlling hormone peptides, e.g. GLP-1 (Glucagon-like peptide-1). Although TAS2Rs have been reported to be expressed on intestinal enteroendocrine cells, such as I, K, L, and enterochromaffin cells, the expression of these receptors along the entire intestinal tract (i.e., Duodenum, Jejunum, Ileum, and Colon) is not yet fully elucidated. Studying their expression pattern could provide insight into the functioning of TAS2Rs in the intestine. Thus, we aimed to evaluate the gene expression profile of the TAS2Rs at different locations in the intestine across species: in human and relevant models, such as pig and mouse. By employing microarray analysis of biopsies and mucosal scrapings, we examined the gene expression levels of TAS2Rs in the three mammalian species along the intestinal tracts. We compared their expression pattern to other functional markers in the intestine. The evaluation of TAS2Rs gene expression shows that intestinal tissue contains a large number of bitter receptor family members in the three species: at the least, 24/29 in humans, 11/14 in pigs and 35/35 in mice. TAS2Rs throughout all intestinal sections show low expression levels compared to the enterocyte marker Villin 1 and the enteroendocrine marker Chromogranin A, and with comparable expression level to other taste receptors. We conclude that human, pig, and mouse TAS2R orthologs are, overall, equally distributed along intestinal sections. However, per species, TAS2Rs show orthology-independent profiles.
Funding Acknowledments: ANID 72170330 FNL
FCOI Declarations: None

O215-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Determining the relative lineage potentials of *Lgr5*$^{+}$ and *Sox2*$^{+}$ taste progenitor cells *in vitro*

Lauren A. Shechtman[1], Jennifer K. Scott[1], Dany Gaillard[1], Bryan J. Johnson[2], Peter J. Dempsey[3], Linda A. Barlow[1]

[1]Department of Cell & Developmental Biology, School of Medicine, and the Rocky Mountain Taste & Smell Center, University of Colorado Anschutz Medical Campus, Aurora, CO, USA, [2]Cell Biology, Stem Cells and Development graduate program, Aurora, CO, USA, [3]Section of Developmental Biology, Department of Pediatrics, University of Colorado Medical School, Aurora, CO, USA

The sense of taste is mediated by taste receptor cells (TRCs) that are continuously renewed from epithelial progenitor cells located outside taste buds. This process is regulated by Wnt/ß-catenin and Hedgehog signaling. In the mouse circumvallate papilla (CVP), progenitors express the Wnt target gene *Lgr5* which replenish epithelial cells inside and outside of taste buds (Yee et al, 2013 Stem Cells). *Lgr5*$^{EGFP+}$ cells isolated from the CVP of *Lgr5*^{EGFP} mice can be cultured into lingual organoids containing both taste and non-taste epithelial cell lineages (Ren et al, 2014 PNAS). Lineage tracing has revealed *Sox2*$^{+}$ cells can also give rise to both taste and non-taste epithelium *in vivo* (Ohmoto et al, 2017 Chem Senses). Interestingly, *Lgr5*^{EGFP} and SOX2 are partially co-expressed in the CVP progenitor population. Thus, we used organoid technology to test the relative stem potentials of *Sox2*$^{+}$ and *Lgr5*$^{+}$ cells. When we isolated *Sox2*$^{EGFP+}$ cells from the CVP of *Sox2*^{EGFP} mice and cultured them *in vitro*, we found *Sox2*-derived organoids were less TRC-competent than *Lgr5*-derived organoids and instead comprised mostly progenitor and non-taste epithelial cells. Since SOX2 is expressed at high levels by cells in and around CVP taste buds and at lower levels in non-taste epithelium, we next examined taste competencies of organoids cultured from *Sox2*^{EGFP} progenitor cells expressing different levels of EGFP. We found cells expressing the highest levels of *Sox2*^{EGFP} generate TRC-replete organoids while cells expressing lower levels of *Sox2*^{EGFP} do not; however, taste competency in all Sox2-derived organoids is still reduced compared to Lgr5-derived

organoids. Therefore, we are currently investigating the transcriptomes of *Lgr5*$^{+}$ and *Sox2*$^{+}$ progenitors to identify genetic regulators of taste and non-taste lineage production.
Funding Acknowledments: Supported by National Institutes of Health/National Institute for Deafness and Other Communication Disorders R01DC012383 & R01DC018489 to LAB, and R21DC016131 & R21DC016131-02S1 to DG.
FCOI Declarations: None

O216-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Structural Basis and Function of Kirrel3 Homophilic Adhesion in Vomeronasal Sensory Neuron Axonal Targeting.

Neelima Vaddadi[1,2,5], Jing Wang[6,7], Joseph Pak[6,7], Emilie Dumontier[1,5], Mitra Cowan[4,5], Engin Ozkan[6,7], Jean-Francois Cloutier[1,2,3,5]

[1]Montreal Neurological Institute, Montreal, QC, Canada, [2]Dept. Neurology and Neurosurgery, Montreal, QC, Canada, [3]Dept. Anatomy and Cell Biology, Montreal, QC, Canada, [4]Goodman Cancer Centre, Montreal, QC, Canada, [5]McGill University, Montreal, QC, Canada, [6]University of Chicago, Chicago, IL, USA, [7]Dept. Biochemistry and Molecular Biology, Chicago, IL, USA

The Kirrel3 receptor has been implicated in the regulation of multiple processes during the development of nervous system circuitry, including in the targeting and coalescence of olfactory and vomeronasal sensory neuron (VSN) axons within glomeruli and in the formation of synapses. The function of Kirrel3 in these processes has been proposed to rely on homophilic adhesion between Kirrel3 molecules, but the physiological importance of Kirrel3 homophilic interactions in circuit development remains to be established. To assess the requirement of homophilic adhesion in Kirrel3 function, we first visualized the molecular basis of the homophilic adhesion by solving the crystal structure of the mouse Kirrel3 homodimer complex. These analyses identified the first immunoglobulin domain as the mediator of Kirrel3 homophilic adhesion and identified specific residue substitutions within this region that abolish the interaction. To examine the importance of Kirrel3 homophilic adhesion in circuit formation *in vivo*, we used the CRISPR-Cas9 technology to edit the *Kirrel3* gene in mice to encode a Kirrel3 protein lacking homophilic adhesion capabilities (*Kirrel3-Q128A*). An analysis of axonal targeting in the accessory olfactory system of *Kirrel3Q128A* mice revealed alterations in the formation of the glomerular map, which phenocopy defects observed in *Kirrel3* null animals. Taken together, our results uncover the homophilic adhesion of Kirrel3 receptors as a key mechanism to regulate axonal targeting during development of the nervous system.
Funding Acknowledments: Canadian Institutes of Health Research and Natural Sciences and Engineering Research Council (to JFC) NIH R01NS097161 (to E.Ö.)
FCOI Declarations: None

O217-ORAL ABSTRACTS: MOLECULAR/ DEVELOPMENTAL APPROACHES IN CHEMOSENSATION

FRIDAY, 2:30 PM - 4:30 PM

Chromatin Based Reprogramming of *fru* and *dsx* in Courtship Circuits with Social Experience and Pheromone Signaling.

Pelin C Volkan[1,2], Bryson Deanhardt[2], Songhui Zhao[1], Chengcheng Du[1], Aishani Saha[1], Charles Soeder[3], Corbin Jones[3]

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How sensory experience alters gene regulation to modify innate or learned behaviors remains unknown. We use fly courtship as a model to study this question because social cues such as pheromones affect innate and experience-dependent courtship behaviors, which are governed by two genes, *fruitless* (*fru*) and *doublesex* (*dsx*), respectively. For example, monosexual grouping suppresses wild type male courtship behaviors but also increase in locomotion and courtship competition with age. Furthermore, socially isolated *fru* mutant males do not court, however if grouped, they use olfactory social cues to learn to court with flies around them. This learning also requires the gene *dsx*. We found that in the olfactory receptor neurons (ORNs) chromatin around *fru* gene is modified with social experience and pheromone signaling. Changes in *fru* chromatin alters *fru* splice patterns, which affects expression of downstream target genes with neuromodulatory functions, ultimately modifying neuronal sensitivity and courtship behaviors. Similar to the peripheral olfactory neurons, group housing and pheromone signaling modified active chromatin marks around *fru* and *dsx* in the central courtship circuits in the brain. Signaling from different pheromone receptors elicited differential effects on chromatin around both genes. Interestingly, we found that active chromatin marks around *dsx* increase in the brain when *fru* mutants are grouped. This suggests that social experience and ORN circuit activity can modify *dsx* regulation in the central circuits to induce courtship learning in *fru* mutants. Our results provide insights into the fundamental

mechanisms by which sensory experience drive behavioral modulation and learning, via chromatin-mediated changes in the expression of genes critical for neural circuit structure and function.

Funding Acknowledments: NINDS NS109401 P.C.V.

FCOI Declarations: None

O224-ISN - MORNING SESSION

SATURDAY, 8:30 AM - 10:15 AM

Why Do We Eat What We Eat?

Alexandra DiFeliceantonio[1,2]

[1]Fralin Biomedical Research Institute at VT, Roanoke, VA, USA, [2]Department of Human Nutrition Foods and Exercise, Virginia Tech, Blacksburg, VA, USA

Dietary factors contributed to nearly 50% of all cardiometabolic deaths in the US in 2012, making it one of the leading causes of preventable death in the US. We make choices with long lasting health outcomes many times a day just by choosing what to eat. Central nervous system computations govern and execute these food choices, but the gut communicates information about nutritional outcomes to the brain to update value and influence choice via brain reward systems. How does the brain integrate these signals to guide eating behavior? Specifically, how might the unique properties of foods our modern food environment versus our evolutionary one (ie. macronutrient composition, energy density, nutrient availability) alter or compromise these systems? What can we learn from studies of other potent stimuli, such as drugs of abuse, and their effects on brain reward systems? I will discuss past and ongoing studies aimed at answering these questions and probing the neurobiological and metabolic underpinnings of food choice and food reward.

Funding Acknowledments: AD is part of the iTHRIV Scholars Program which is supported in part by the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Numbers UL1TR003015 and KL2TR003016.

FCOI Declarations: None

O226-ISN - MORNING SESSION 2

SATURDAY, 10:45 AM - 12:45 PM

Decoding the Tomato Flavor Preferences of Consumers. Fixing the Broken Tomato

Harry Klee

University of Florida, Gainesville, FL, USA

Although the tomato is ubiquitous in cuisines and one of the highest value vegetable crops produced world-wide, consumers generally hold negative views on the flavor quality of commercial varieties. Breeders have made tremendous progress in breeding varieties for high yield and postharvest shelf life but have largely neglected flavor due to the many challenges associated with this trait. The challenges include complex genetics, expensive phenotyping and major environmental influences. We have taken a systematic approach to simplifying this complex trait, first defining the underlying chemistry of consumer preferences and, subsequently, the genetic control of the important metabolic pathways. Advances in genome sequencing technologies have permitted us to identify the genetic variations that influence the synthesis of flavor-associated chemicals in many hundreds of accessions of the domesticated tomato, *Solanum lycopersicum*, and its closest relatives. The extensive genetic resources have facilitated assembly of genetic markers that can be used to improve flavor of commercial cultivars, satisfying the desires of both producers and consumers. Recently, we have initiated reintroduction of superior alleles of flavor-associated genes into a modern commercial variety with mediocre taste. Early results indicate that we can significantly increase the contents of favorable volatiles and that individuals can distinguished the introgressed lines from the commercial parent. These results indicate that we can improve the flavor quality profile using directed genetic improvement. This analytical/genetic approach is now being applied to other fruit crops, including blueberry and strawberry.

Funding Acknowledments: National Science Foundation. IOS 1844237

FCOI Declarations: None

O233-ISN - AFTERNOON SESSION 2

SATURDAY, 3:00 PM - 5:30 PM

Flavor, Nutrition, and Obesity

Adam Drewnowski

Prof. Dr. Adam Drewnowski is the Director of the Center for Public Health Nutrition at the University of Washington in Seattle, Professor of Epidemiology at the School of Public Health and the Director of the Nutritional Sciences Program. He also directs the UW Center for Obesity Research. Dr. Drewnowski obtained his MA degree in biochemistry at Balliol College, Oxford, and PhD degree in psychology at The Rockefeller University in New York. He is the author of the Nutrient Rich Foods Index, which helps consumers to identify affordable healthy foods. The Seattle Obesity Study (S.O.S.), funded by the National Institutes of Health, combined health survey research with novel methods of spatial analysis to examine the multiple determinants of health and body weight. Dr. Drewnowski is the author of the Nutrient Rich Foods Index, an early nutrient profiling model, has more than 350 research publications, and advises governments, foundations and the private sector on affordable nutrient density and obesity-related issues.

FCOI Declarations: None