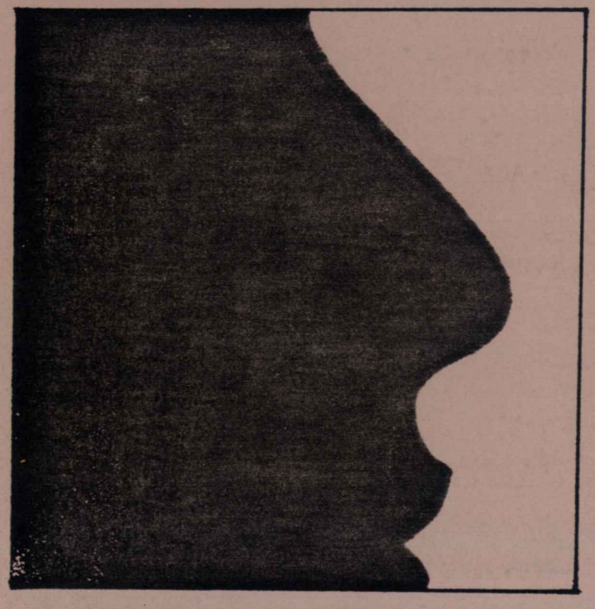
PROGRAM



The Second Annual Meeting of the Association for Chemoreception Sciences

MAY 4-8, 1980
SARASOTA, FLORIDA

ASSOCIATION FOR CHEMORECEPTION SCIENCES

PROGRAM

Sunday Evening, May 4

6:00 - 8:00 PM — Registration, Sarasota Hyatt House

Monday Morning, May 5

8:30 - 10:30 AM — Session I. Development and Plasticity in Chemoreception
Chair: D. G. Moulton (University of Pennsylvania)

P. E. Pedersen and E. M. Blass (The Johns Hopkins University) Dimethyl disulfide: A cue for nipple attachment in albino rats.

W. G. Hall (Dorothea Dix Hospital, Raleigh, NC) The development of taste in rats: Measurements of intake and behavioral responsiveness.

P. Cancalon (Florida State University) Effect of ZnSO4 on the catfish olfactory mucosa.

G. D. Burd and F. L. Margolis (Worcester Foundation for Experimental Biology and Roche Institute of Molecular Biology) Morphological effects of intranasal zinc sulfate irrigation on the mouse main and accessory olfactory systems.

P. P. C. Graziadei (Florida State University) Growth of olfactory sensory axons into the brain of adult bulbectomized mice.

P. A. Simmons, J. A. Rafols, and T. V. Getchell (Yale University and Wayne State University) Ultrastructural changes in the olfactory bipolar neurons following olfactory nerve section.

B. J. Baum, J. M. Weiffenbach, R. O. Wolf (National Institute of Aging and National Institute of Dental Research) Gustatory function and food enjoyment during aging.

10:30 - 11:00 AM — COFFEE BREAK

11:00 - 1:00 PM — Session II. Early Events in Chemoreception
Chair: I. J. Miller, Jr. (Bowman Gray School of Medicine)

G. L. Heck and J. A. DeSimone (Medical College of Virginia) Influences of stimulus transport on chemoreceptor stimulation.

T. H. Morton and R. B. Nachbar (Brown University) Rate-sensitive detection in olfaction: Variation of sensitivity with the human menstrual cycle.

L. D. Rhein and R. H. Cagan (Monell Chemical Senses Center and Veterans Administration Medical Center) Isolation, biochemical characterization and odorant binding of cilia.

R. G. Mair, R. C. Gesteland, H. Yancey, L. Meerschaert, and D. L. Blank (Northwestern University and Naval Research Lab) Physiological differentiation of olfactory receptor cilia types.

Monday Morning, May 5 (continued)

11:00 - 1:00 PM — Session II. Early Events in Chemoreception (continued)

R. B. Koch, H. Rossi, and S. Price (Mississippi State University and Medical College of Virginia) Effect of antibody against anisole binding protein on odorant perturbation of Na^+-K^+ ATPase activity.

D. M. Norris (University of Wisconsin) Molecular mechanism of quinone perception by insects.

L. M. Kennedy and B. P. Halpern (Worcester Foundation of Experimental Biology and Cornell University) The Ziziphins: Surface active sweetness-modifying saponins from Ziziphus jujuba.

J. G. Brand, J. A. Plutte and D. L. Bayley (Monell Chemical Senses Center) Interaction of salts with liposomes.

Monday Afternoon, May 5

2:00 - 5:00 PM — Workshop: Intracellular and Extracellular Recording Techniques

Intracellular Techniques
Chair: G. Shepherd (Yale University)

Participants:

G. Fain (University of California, Los Angeles)
T. Getchell (Wayne State University)
J. Nemitz (Medical College of Virginia)
M. Nowycky (Yale University)
J. Teeter (Monell Chemical Senses Center)

Extracellular Techniques
Chair: R. Gesteland (Northwestern University)

Participants:

R. Gesteland (Northwestern University)
T. Getchell (Wayne State University)
J. Kauer (Yale University)
R. O'Connell (Worcester Foundation)

Monday Evening, May 5

6:30 - 8:00 PM — Informal Discussion: National Science Foundation Support for Research in the Chemosenses (J. Brown, Biological, Behavioral and Social Sciences; T. Dolan, Sensory Physiology and Perception; and AChemS members)

Monday Evening, May 5 (continued)

8:00 - 10:30 PM

Session III. Poster Presentations

1. O. G. Brock (Florida State University) Prey trailing behavior of rattlesnakes (Crotalus adamanteus).
2. B. Bryant and J. Atema (Boston University Marine Program) Effects of diet change on body odor and aggressive behavior in catfish.
3. W. S. Cain and C. L. Murphy (John B. Pierce Foundation Laboratory and Yale University) Odor and irritation: Interaction between chemoreceptive modalities.
4. P. J. Canney and B. P. Halpern (Cornell University) Feeding deterrent effects in larvae of the southern armyworm, Spodoptera eridania (Lepidoptera: Noctuidae), elicited by leaves and leaf constituents from the jujube tree, Ziziphus jujuba (Rhamnaceae).
5. M. Cheal and J. Klestzick (McLean Hospital and Harvard Medical School) Gerbil investigatory responses to socially relevant odors.
6. L. Collins, D. Chiu and R. P. Erickson (Duke University) Tastes lose their identity in mixtures: A comment on the analysis/synthesis issue.
7. R. J. Contreras and P. W. Stetson (Yale University) Brain stem mechanisms in control of salt intake and blood pressure.
8. R. G. Davis (Veterans Administration Medical Center) Development of practical clinical assessment tests of odor perception based on odorant microencapsulation techniques.
9. S. M. Ferkovich (Behavior and Basic Biology Research Laboratory, AR/SEA, USDA) Hydrolysis of the sex attractant of the cabbage looper moth by antennal esterases.
10. D. F. Foster and J. C. Smith (Florida State University) Temporal parameters of the rapid oral mixing of glucose and saccharin solutions in the rat.
11. M. R. Garcia-Medina and W. S. Cain (John B. Pierce Foundation Laboratory and Yale University) Bilateral summation in the common chemical sense.
12. B. Gregg, M. Kittrell and D. Thiessen (University of Texas at Austin) Urine signaling in mongolian gerbils.
13. R. J. Hyde and R. P. Feller (Dental Service, VAMC) Taste and olfaction after tongue brushing.
14. L. S. Kaslove and B. M. Slotnick (The American University) Effects of eating on hedonic ratings of food odors.
15. E. M. W. Kittrell, D. D. Thiessen and B. R. Gregg (University of Texas) Harderolipids and sandbathing in the mongolian gerbils.
16. C. M. Kratz (Monell Chemical Senses Center) Citric acid and inhibition of growth.
17. L. E. Marks, B. Rifkin, L. M. Bartoshuk and J. C. Stevens (John B. Pierce Foundation Laboratory and Yale University) Individual differences in taste intensity of 6-n-propylthiouracil determined by magnitude matching.

Monday Evening, May 5 (continued)

8:00 - 10:30 PM

Session III. Poster Presentations (continued)

18. H. L. Meiselman and B. L. Bell (US Army Natick R & D Command) Effect of stimulus compound on range and procedural effects in taste psychophysics.
19. D. G. Mook (University of Virginia) Saccharin preference in fluid and food.
20. G. H. Nowlis and C. Pfaffmann (The Rockefeller University) The compound taste of saccharins.
21. R. M. Pangborn (University of California) Does dietary intake of salt, sweets, and fats influence sensory perception of NaCl, sucrose, and butterfat?
22. W. H. Pearson, S. E. Miller and B. L. Olla (Battelle Pacific Northwest Laboratory and National Marine Fisheries Service) Possible psychophysical power functions in marine organisms.
23. G. Preti, J. G. Kostelc, G. R. Huggins, H. J. Lawley, P. R. Zelson and J. McKitrick (Monell Chemical Senses Center and University of Pennsylvania) Idiopathic malodor production in humans.
24. M. E. Rashotte, J. C. Smith, T. A. Austin and C. H. Pollitz (Florida State University) 24-Hour free-feeding patterns in beagles.
25. D. R. Riskey (Monell Chemical Senses Center) Psychological vs. sensory adaptation following repeated exposure to a taste context.
26. M. J. Russell and T. Mendelson (University of California) Olfactory influences on mother-infant attachment in humans.
27. B. Sandick and A. V. Cardello (US Army Natick R & D Command) Taste profiles from single human circumvallate papillae: Comparisons with fungiform profiles.
28. A. B. Smith, III, J. R. Donnelly, J. G. Kostelc and G. Epple (Monell Chemical Senses Center) Analysis of marmoset scent marks by GC/MS.
29. R. D. Sweazey and D. V. Smith (University of Wyoming) Hamster food selection: Conditioned aversion to basic tastes.
30. A. S. Trant, J. Serin, H. O. Douglass and B. P. Halpern (Roswell Park Memorial Institute and Cornell University) Is taste related to anorexia in cancer patients?
31. J. L. Wellington and G. K. Beauchamp (Monell Chemical Senses Center) Stability of urine-based chemical communication in the guinea pig.

NOTE:

32. J. B. Ranney (NIH) Information on The Communicative Disorders Program, NINCDS.

Tuesday Morning, May 6

8:30 - 11:00 AM — Session IV. Invited Speaker Symposium on Microbial Chemoreception
Chair: M. Levandowsky (Haskins Laboratories of Pace University)

G. W. Ordal (University of Illinois) Sensory processes in bacteria.

J. Van Houten (University of Iowa) Chemoreception in Paramecium.

A. D. J. Robertson (Biological Research Corp. Laboratory) Chemoreception, aggregation and evolution.

E. Schiffman (National Institute of Dental Research) Receptor-mediated chemotaxis in phagocytes.

11:00 - 11:30 AM — COFFEE BREAK

11:30 - 1:00 PM — Session V. Endocrine Factors in Chemoreception
Chair: M. Meredith (Worcester Foundation for Experimental Biology)

B. J. Davis, G. E. Hoffman and F. Macrides (Worcester Foundation for Experimental Biology and University of Rochester Medical School) Somatostatin and LHRH perikarya and axons are present in the olfactory system in the hamster.

C. A. Cornwell-Jones (Princeton University) Intracerebral 6-hydroxydopamine reverses conspecific odor preferences of male albino rats.

J. Nyby (Lehigh University) Pituitary regulation of female chemosensory sex signals in mice (Mus musculus).

R. L. Doty (University of Pennsylvania) Endocrine, cardiovascular and psychological correlates of olfactory sensitivity changes during the human menstrual cycle.

J. G. Kostelc, G. Preti, P. R. Zelson, G. R. Huggins and J. Tonzetich (Monell Chemical Senses Center, University of Pennsylvania and University of British Columbia) Cyclical variations in salivary volatiles.

Tuesday Afternoon, May 6

2:00 - 5:00 PM — Workshop: Taste Testing in a Clinical Setting
Chair: F. A. Catalanotto (University of Connecticut Health Center)

J. Weiffenbach (National Institute of Dental Research)

L. M. Bartoshuk (John B. Pierce Foundation Laboratory and Yale University)

H. Moskowitz (Developmetrics)

Tuesday Evening, May 6

7:30 - 10:00 PM

Session VI. Poster Presentations

1. G. D. Adamek, R. C. Gesteland and C. Braker (Northwestern University and Taste and Smell Consulting Group) Field potentials evoked by antidromic stimulation of the olfactory nerve.
2. C. R. Almli, W. B. Forbes, C. A. Velozo and M. A. Henault (Worcester Foundation for Experimental Biology and Ohio University) Ontogeny of induced waves in rat olfactory bulb.
3. S. K. Barrett (University of Miami) A comparison of the basic morphology and histology of the tongues of several marine mammals.
4. R. P. Byrd, Jr. and J. Caprio (Louisiana State University) Relationship of olfactory receptor and bulbar responses to amino acids in the catfish.
5. P. J. Cunzeman and B. M. Slotnick (The American University) Olfaction after prolonged exposure to specific odors.
6. C. Derby and J. Atema (Boston University Marine Program) A neurophysiological analysis of chemoreceptors of walking legs of the American lobster (Homarus americanus).
7. R. Erickson, E. Covey and G. S. Doetsch (Duke University and Augusta Medical College) Neuron and stimulus typologies in the rat gustatory system.
8. M. Frank, P. van der Ven and A. Wang (The Rockefeller University) Sensitivities of the mouse chorda tympani to taste stimuli.
9. R. L. Gellman and R. G. Mair (Northwestern University) Postnatal development of rat olfactory bulb neurons.
10. J. F. Gent (John B. Pierce Foundation Laboratory) The time course of gustatory adaptation.
11. R. C. Gesteland, R. G. Mair, F. J. Weingartner and R. E. Susek (Northwestern University and Taste and Smell Consulting Group) Desorption olfactometry--an improved method for control, delivery and quantification of olfactory stimuli.
12. C. A. Greer, W. B. Stewart, J. S. Kauer, K. Mori and G. M. Shepherd (Yale University School of Medicine) Uptake patterns of 2-deoxyglucose associated with electrical stimulation of the olfactory nerve in rat and in vitro turtle olfactory bulb.
13. K. A. Hamilton (University of California) Aging effects on newly-described dactyl sensilla of the kelp crab, Pugettia producta (Randall): Light and electron microscopic observations.
14. G. Hellekant (University of Wisconsin) TOM-An advanced device for taste stimulation.
15. D. L. Hill, R. M. Bradley and C. M. Mistretta (University of Michigan) Development of monochloride salt taste responses in the rat's chorda tympani nerve: A single fiber analysis.
16. K. Holland (Monell Chemical Senses Center) Behavioral and conditioned cardiac reflex assays of the amino acid sensitivities of channel catfish.
17. D. E. Hornung, D. B. Kurtz, M. M. Mozell, J. Ewing and O. G. Brandt (SUNY Upstate Medical Center and St. Lawrence University) Air movement parameters through the bullfrog olfactory sac.
18. L. V. Hutchison and B. M. Wenzel (UCLA School of Medicine) Structure and function of the olfactory system in procellariiform birds.

7:30 - 10:00 PM

Session VI. Poster Presentations (continued)

19. R. Johnson and E. Covey (Duke University) A test of two candidate neural codes in gustation: A discrimination time study.
20. I. R. Lapidus and M. Levandowsky (Haskins Laboratories of Pace University) The mechanism of chemosensory accumulation by the ciliate protozoan Tetrahymena.
21. J. R. Mason and D. A. Stevens (Clark University) A behavioral assessment of detection thresholds for butyl acetate and butyl alcohol by tiger salamanders (Ambystoma tigrinum).
22. M. S. Mayer, R. W. Mankin and G. F. Lemire (USDA/SEA) Interactions among the processes comprising the EAG.
23. M. Meredith, D. M. Marques, F. L. Stern, R. J. O'Connell and B. J. Davis (Worcester Foundation for Experimental Biology) HRP used to trace olfactory and vomeronasal axons after lesions.
24. C. M. Mistretta and R. M. Bradley (University of Michigan) Developmental changes in salt taste responses may continue postnatally in lambs.
25. G. A. Monti Graziadei (Florida State University) The olfactory marker protein (OMP) in the neuroepithelium of adult mice after bulbectomy.
26. C. L. Murphy and A. V. Cardello (US Army Natick Laboratories) Anion and cation influences on the tastes of fifteen halide salts.
27. H. Sloan, L. B. Jones and B. Oakley (University of Michigan) Silastic nerve cuffs containing colchicine act upon the nerve trunk and not the tongue to eliminate taste buds.
28. H. M. Stedman, C. M. Mistretta and R. M. Bradley (University of Michigan) Comparison of chemosensitive responses from the chorda tympani, glossopharyngeal and superior laryngeal nerves in the lamb.
29. D. A. Stevens and H. T. Lawless (Clark University and US Army Natick R & D Command) Age-related changes in flavor perception.
30. M. H. Teicher, W. B. Stewart, J. S. Kauer and G. M. Shepherd (Yale University School of Medicine) Developmental studies of the olfactory bulb: 2-Deoxyglucose uptake patterns in suckling rat pups.
31. K. Tonosaki and D. Tucker (Florida State University) Responsiveness of the olfactory receptor cells in dog and box turtle to aliphatic n-fatty acids.
32. J. C. Walker, J. C. Smith and M. E. Rashotte (Florida State University) Behavioral and anatomical study of the reconstitution of the olfactory nerves in pigeons.
33. S. A. Witherly, R. A. Schemmel and M. D. Dauria (Michigan State University) Hedonic, intensity and salivary responses between elderly and college-age subjects to gustatory and olfactory food stimuli.
34. C. J. Wysocki, G. K. Beauchamp, J. L. Wellington, S. Erisman, M. L. Barth (Monell Chemical Senses Center) Access of low volatile stimuli to and clearance rates from the mammalian vomeronasal organ.

Wednesday Morning, May 7

8:30 - 9:45 AM — Session VII. Invertebrate Chemoreception
Chair: M. S. Mayer (USDA)

H. Thompson and B. W. Ache (C. V. Whitney Laboratory of the University of Florida) Taurine thresholds in lobster chemoreception.
J. L. Frazier (Mississippi State University) Characterization of house fly tarsal sugar receptors with sulfhydryl reagents and kinetic analysis.
D. Rittschof (UCLA School of Medicine) Enzymatic production of cues attracting hermit crabs to shell acquisition sites.
R. Chase (McGill University) Electrophysiological analysis of sensory function in the snail tentacle.
B. Jahan-Parwar (Worcester Foundation for Experimental Biology) Modification of sensory evoked behavioral and neural responses during different behavioral states in Aplysia.

9:45 - 10:15 AM — COFFEE BREAK

10:15 - 11:30 AM — Session VIII. Coding
Chair: M. E. Frank (Rockefeller University)

W. L. Silver (Florida State University) Comparison of olfactory nerve twig, mucosal neural, and EOG responses in the American eel, Anguilla rostrata.
J. C. Boudreau, J. Oravec, N. K. Hoang and T. White (University of Texas at Houston) Neurophysiology of the geniculate ganglion amino acid sensitive (sweet-bitter) system.
B. Rifkin and L. M. Bartoshuk (John B. Pierce Foundation Laboratory and Yale University) The bitter taste of potassium chloride, sodium benzoate, and potassium benzoate is related to the genetic ability to taste 6-n-propylthiouracil.
E. Covey and R. P. Erickson (Duke University) Temporal neural coding in gustation.
B. M. Slotnick (The American University) Olfactory discrimination behavior after thalamic and amygdala lesions in rats.

11:30 - 1:00 PM — BUSINESS MEETING: MEMBERSHIP OF THE ASSOCIATION.

Wednesday Evening, May 7

7:30 - 9:00 PM — GIVAUDAN LECTURE: 'Possible sensory synapses in the carotid body' by Carlos Eyzaguirre, M.D., D.Sc. (Hon.)

Dr. Carlos Eyzaguirre was born in Santiago, Chile and received his M.D. degree from The University of Chile. He has served on the faculty of the Catholic University of Chile, the Johns Hopkins University, and the University of Utah. Since 1965, he has been chairman of the Department of Physiology at the University of Utah. His various honors include the Cajal Medal from the University of Madrid and the Claude Bernard Medal from the Sorbonne. He is noted for his long-standing, major contributions to the study of neuromuscular function and the physiology of carotid body chemoreceptors.

Dr. M. M. Mozell will introduce the speaker.

Wednesday Evening, May 7 (continued)

9:00 PM SOCIAL GATHERING

Thursday Morning, May 8

8:30 - 11:30 AM Session IX. Invited Speaker Symposium on the Complementarity of of Laboratory and Field Studies of Chemical Communication.
Chair: D. Muller-Schwarze (SUNY Syracuse)

D. Muller-Schwarze (SUNY Syracuse) Choices and compromises in field and laboratory studies of mammalian pheromones.

F. H. Bronson (University of Texas) Priming pheromones: ecological considerations based on laboratory studies.

R. T. Carde (Michigan State University) Moth sex pheromones: Behavioral criteria for validation of structural assignments.

C. Gustavson (North Dakota State University) Apparent differences in laboratory and field prey lithium aversions.

11:30 AM CLOSING

EXECUTIVE COMMITTEE

Maxwell Mozell, Executive Chairperson

Program Committee — Charlotte Mistretta (Chairperson), Bernice Wenzel, William Cain, John Caprio

Membership Committee — Rose Marie Pangborn (Chairperson), Gary Beauchamp

Finance Committee — Thomas Getchell (Chairperson), Steven Price

The Association gratefully acknowledges generous financial support from the following companies:

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Notes

ABSTRACTS OF VOLUNTEER PAPERS AND POSTER PRESENTATIONS

FIELD POTENTIALS EVOKED BY ANTIDROMIC STIMULATION OF THE OLFACTORY NERVE - SINGLE UNIT STUDIES. Gloria D. Adamek, Robert C. Gesteland and Christopher Braker. Northwestern Univ., Evanston, IL 60201 and Taste and Smell Consulting Group, Inc.

Previous studies have shown that the field potential of olfactory receptor units recorded with extracellular electrodes in the olfactory epithelium is unexpectedly complex in shape. It is not clear whether this complexity is due to varying conduction velocities in different regions of the receptor neuron, non-homogenous extracellular resistivity, or summated activity of more than one synchronously active cell. There is some indication that action potentials evoked by odors have different waveforms from those occuring spontaneously. These possibilities can be sorted by comparing the waveforms of natural action potentials with those evoked by simulation of the olfactory nerve. Single-unit recordings of electrically evoked action potentials orthodromically invading the receptor epithelium show that waveform complexities are due both to the unusual conduction properties of the neurons and to synchronous activity of neighbors. When stimulating electrically at near threshold levels, the inherent properties of a single neuron are displayed. At higher levels, contributions of neighbors are seen. As the simulus intensity is further increased a true compound action potential is displayed, representing the summated activity of a very large number of receptor axons. Single unit discrimination with antidromic activation is dependent upon recording electrode tip size and impedance; larger tips and lower resistances summate over a larger portion of the total cell population. An ancillary benefit of the antidromic activation technique is that the search for single cells with a microelectrode is more efficient when the population is electrically stimulated during the search. It is the only way to find units which are quiescent in the absence of odorous stimulation. Finally, the activity of olfactory receptor neurons is strongly dependent upon recent firing history. At stimulus rates as low as one per second, spontaneous activity and response to odorous stimulation are changed for minutes following cessation of the antidromic stimulation.

This work was supported in part by NSF Grant No. BNS 78-17479 and NIH Grant No. 5-R01-NS14663.

ONTOGENY OF INDUCED WAVES IN RAT OLFACTORY BULB. C. Robert Almli, Wm. B. Forbes, Craig A. Velozo and Mark A. Henault. Worcester Foundation for Experimental Biology, Shrewsbury, MA and Ohio University, Athens, OH.

Electrical slow-wave activity of the main olfactory bulb (MOB) was recorded in rats 6 - 21 days of age. Since the chronically indwelling bipolar electrodes remained patent for several days following surgery, recordings could be made over a three-day interval in each preparation. Pups were suckled with their littermates between recording sessions and exhibited normal weight gain. Frequency content of the recorded signals was determined using the Fast Fourier transform. Multiple 8-sec. epochs were digitized at 256 Hz. yielding power spectral values with .125 Hz resolution over a frequency range of 0 - 128 Hz.

At 6 days of age, MOB electrical activity exhibited a major frequency component at about 12 Hz. having a bandwidth of about 6 Hz. At 11-12 days of age this component had increased to about 14-15 Hz. At 21 days of age, a relatively broad peak was exhibited centered at about 60 Hz. with a bandwidth of about 20 Hz. Examination of the untransformed time series confirmed that these frequency components correlated with respiration-related induced waves at all ages. These data indicate that the frequency of MOB induced waves increases dramatically between 12 and 21 days of age. The report of Hinds and Hinds (J. comp. Neurol., 169: 15-40, 1976) indicates that during that period there is an approximate doubling of the number of granule-to-mitral cell synapses in the external plexiform layer of the murine MOB suggesting that the present results may reflect a functional maturation of feedback inhibitory processes on MOB output neurons. Supported by NICHD grant HD 06364.

A COMPARISON OF THE BASIC MORPHOLOGY AND HISTOLOGY OF THE TONGUES OF SEVERAL MARINE MAMMALS. Sandra K. Barrett. Biology and Living Resources, R.S.M.A.S., University of Miami, 4600 Rickenbacker Cswy Miami, FL. 33149. Four different species of marine mammals were examined: one sirenian species - the West Indian manatee or sea cow, Trichechus manatus, and three cetacean species - the pilot whale, Globicephala melaena, the striped dolphin, Stenella coeruleoalba, and the pygmy sperm whale, Kogia breviceps. Specimens were obtained via the marine mammal salvage program operated by Dr. Daniel Odell of the University of Miami and the U.S. Fish and Wildlife Service in Gainesville, FL., in which beached dead animals are made available for examination. The gross structure of the tongues varied from an essentially smooth surface in the Kogia to an extremely grooved and folded surface in Globicephala, with intermediate complexity in Stenella and Trichechus. Only Trichechus had any papillae resembling traditionally described structures and these appeared to be fungiform, varying in size along the tongue. Histologically, all species have keratinized epithelium, but Trichechus shows extensive keratinization at the tip that thins further back on the tongue. All species also have extensive secretory glands, appearing far forward in the tongue and decreasing posteriorly in Kogia, and appearing in the middle of the tongue and continuing posteriorly in all the other species. No taste buds were found in Kogia or Globicephala (although fresher material should be examined), and secretory glands were almost exclusively mucus. In Stenella, as previously reported, and in Trichechus, taste buds were found, and in both cases these were located in the walls of grooves in the dorsal posterior tongue. Also, in both species, secretion was both serous and mucus, with separate and mixed glands. In Trichechus, mucus ducts were found closer to the surface of the tongue than the taste buds, raising the question of how the stimulating chemical can reach the taste receptor.

GUSTATORY FUNCTION AND FOOD ENJOYMENT DURING AGING. Bruce J. Baum*, James M. Weiffenbach, Robert O. Wolf. Nat. Inst. Aging*, Baltimore, MD and Nat. Inst. Dental Research, Bethesda, MD

Earlier studies have suggested that (1) taste acuity declines with age and that (2) this contributes to a diminished interest in food, and reduced food intake, in the elderly. Most studies have utilized either individuals with unspecified medical status or individuals who were institutionalized. The question then arises as to whether changes observed are due to primary deficiencies in the normal physiology of the gustatory apparatus occurring as part of "aging" or are secondary to pathology or pharmacologically induced changes in the individuals studied.

As part of the oral physiology component of the NIA's Baltimore Longitudinal Study of Aging, we evaluate gustatory function. The initial approach was simply to ask participants to provide a subjective assessment of (1) their taste perception and (2) their enjoyment of food. These responses were analyzed with respect to both the medical status of the subjects and the results of a comprehensive oral evaluation. Data were obtained from 162 participants (100 ♂, 62 ♀) in three age groups termed young (20-39 yrs), middle-aged (40-59 yrs) and older (60-89 yrs). All participants are community-dwelling and, for the present study, were defined as either healthy (undergoing no medical treatment, taking no prescribed medication, and "normal" by physical examination) or of questionable medical status (with systemic pathology, under medical treatment, taking prescribed medication).

Reports of diminished taste acuity increased with age in both health sub-groups. In healthy participants, this response was 5%, 11.6%, and 12.5% for young, middle-aged and older individuals, respectively. For subjects of questionable status in the middle-aged and older groups, the percentage reporting decreased taste acuity approached 30%. Similarly, when queried as to enjoyment of food compared to 10 years ago, almost all healthy subjects (96-100%) reported that satisfaction was the same or had increased. Among middle-aged and older participants of questionable status, 20 and 24%, respectively, reported decreased food enjoyment. Participants aged ≥50 years were also asked to compare food enjoyment presently with that at age 30. Among healthy individuals, only 3 of 50 (6%) reported a diminution in food enjoyment. However, in the questionable status group diminished food satisfaction was reported by 11 of 42 subjects (26%).

These results suggest that "real world" (*i.e.* self-perceived) deficits in gustatory function and food enjoyment are modest during aging but occur more frequently in individuals who are medically compromised. At present we are extending these studies by obtaining taste thresholds and data on the perception of superthreshold taste stimuli.

NEUROPHYSIOLOGY OF THE GENICULATE GANGLION AMINO ACID SENSITIVE (SWEET-BITTER) SYSTEM. James C. Boudreau, Joseph Oravec, Nga Kieu Phang and Thomas White, Sensory Sciences Center, University of Texas at Houston, TX 77025.

In the geniculate ganglion of the cat, dog and rat a common functional neural group of sensory neurons highly responsive to amino acids can be identified. These neurons are characterized by medium sized fibers and a high rate of spontaneous activity. The rate of discharge of these neurons can be either increased or decreased by the application of amino acids to the tongue. The amino acids L-tryptophan and L-isoleucine are inhibitory in all species, but the excitatory amino acids tend to differ somewhat: In the cat and dog L-proline and L-cysteine are maximally excitatory whereas in the rat L-lysine is maximally excitatory. Sugars are fair stimuli in the dog and rat but they are inactive in the cat. These neurons constitute the majority sampled in recording from the dog and cat geniculate ganglion, but are infrequently encountered in the rat. In behavioral experiments, cats accept solutions of excitatory amino acids and reject solutions of inhibitory amino acids. Those stimuli that excite the neurons tend to taste sweet for the human and those that inhibit taste bitter. We therefore postulate that the human sensations of sweet and bitter that arise from the front part of the tongue are subserved by a peripheral sensory system similar to that seen in the cat, dog and rat. This human sweet-bitter system has a base line of "spontaneous activity" and increases above baseline are perceived as sweet, decreases as bitter. A bitter-sweet sensation would result when part of the system is inhibited and part excited. This amino acid, "sweet-bitter" system has not been seen in recordings from the geniculate ganglion of the herbivorous goat, suggesting it is a taste system designed for the chemical analysis of animal tissues. Work supported in part by National Science Foundation Research Grants.

INTERACTION OF SALTS WITH LIPOSOMES. Joseph G. Brand, Janet A. Plutte and Douglas L. Bayley, Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA 19104.

The interaction of ions with the taste receptor cell plasma membrane is postulated to be the initial event in salt reception. the primary receptive site for salts is assumed to be the lipid bilayer matrix of the plasma membrane. The nature of the interaction of salts with this bilayer and the consequences of increasing ion concentration on bilayer organization are being studied using liposomes as models of the plasma membrane bilayer. The salt reception theory of DeSimone and Price [Biophys. J. 16, 869] assumes a major role for electrostatic screening of the charged lipid layer by positive ions in generating the receptor response. This theory predicts that salts should markedly affect surface properties of the lipid bilayer, but have little effect on the internal conformation of the bilayer. We have tested this hypothesis using fluorescent probes that sequester in different regions of a mixed phosphatidylserine-phosphatidylcholine liposome. Results show that ions affect the emission properties of 2-p-toluidinylnaphthalene-6-sulfonate [TNS], a probe that monitors the relative hydrophobicity near the surface of the lipid, but do not affect the expression of excimer fluorescence of pyrene or the emission polarization of 1-phenyl-6-phenylhexatriene [DPH], two probes that monitor the conformation of the bilayer interior. The alteration in TNS quantum yeild with salt addition is non-linear, apparently due to the achievement of a saturation. The extent of TNS alteration is dependent on the position of the positive ion in the lyotropic series.

PREY TRAILING BEHAVIOR OF RATTLESNAKES (CROTALUS ADAMANTEUS). O. Greg Brock. Florida State University Tallahassee, FL. 32306.

Observations of Eastern diamondback rattlesnakes in large field enclosures revealed that the principal method of prey acquisition is to coil in concealing vegetation and ambush, with an envenomating bite, prey (Sigmodon hispidus) passing within 10-20cm. Prey generally flee several meters ($\bar{X}$=15.77m±15.87m) before succumbing to envenomation. Rattlesnakes immediately recoil after the strike for from 2.5 to 39 min ($\bar{X}$=9.7 ±8.9 min) before beginning to search for and follow the chemical trails of their envenomated prey. The duration of this refractory period appears somewhat dependent (P=.058) upon the size of the prey envenomated (i.e., longer latencies for larger prey) but independent of temperature and prey survival time. Statistical analysis of spatial components of the snake trails in comparison to the prey trails show that (1) the initial segment of snake trails is more circuitous than subsequent segments, (2) movement patterns when off envenomated prey trails are more circuitous than when on these trails, and (3) greatest circuitousness in snake trails occurs when rattlesnakes lose envenomated prey trails (which occurs most frequently when prey trails turn sharply or double back) and when snakes relocated prey trails after losing them. An accelerated tongue flick rate accompanies trailing movements (cf., $\bar{X}$=1.21±0.396 flicks/s when trailing envenomated prey to $\bar{X}$=0.781±0.324 flicks /s when moving in the absence of envenomated prey). Trails of other nonenvenomated rats, of the same rat prior to envenomation, of rats smeared with C. adamanteus venom, and of reconstituted or freshly extracted C. adamanteus venom do not disrupt their trailing performance. Snakes located prey within 2 to 62 min after beginning to trail. Trailing times appear somewhat dependent (P=.093) upon how closely the snakes adhere to the prey trails. Analysis of video-taped envenomation and trailing sequences with juvenile C. adamanteus in a Y-maze complement and extend field enclosure observations.

EFFECTS OF DIET CHANGE ON BODY ODOR AND AGGRESSIVE BEHAVIOR IN CATFISH

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In addition to specifically synthesized pheromones, the presence of an animal may be detected chemically by less specific body odors. These odors could serve group or individual recognition. The importance of body odors in maintaining territories and dominance hierarchies was investigated by observing the effects of changing the body odor of one of a pair of male territorial brown bullheads, Ictalurus nebulosus.

Evidence from electrophysiological and conditioning experiments indicates that catfish can both smell and taste chemical compounds in low concentration and that they are sensitive to changes in the chemical composition of conspecific odor. Chemical analysis indicates that urinary amino acid profiles are relatively constant over periods of days and that they show qualitative and quantitative changes associated with manipulation of diet.

Pairs of fish were fed identically (trout chow) for at least 2 weeks during which time dominance hierarchies became established. To eliminate effects of the different food itself, the subdominant was removed for 36 hrs and fed beef liver in a separate tank. Three days before the diet change a control removal-reintroduction was done with the fish on the same diet. Control and experimental reintroductions were compared. Analysis is based primarily on both social and solitary behavior units of the dominant fish.

In 9 of 10 pairs, changes in dominance behavior and/or territorial patterns occurred following the manipulation of diet. The most common change (6 pairs) was an increase in the level of aggression exhibited by the dominant fish, as indicated by increases in the frequency of bites and decreases in aggressive displays. In one pair, the subdominant also lost territory. In pairs of fish which showed less defined patterns of dominance, the behavior of the resident after the diet change of his tank mate showed an increase in swimming frequency (1 pair) or decrease in behavioral interactions (2 pairs).

The observed changes, both behavioral and chemical, associated with a change in diet suggest that maintenance of territories and hierarchies is dependent on chemical recognition of familiar conspecifics. Diet manipulation seems to alter the chemical picture to which the dominant fish has habituated. The degree and time course of changes in the fish's behavior show that the disruption of recognition is temporary and that familiarity is regained within days.

MORPHOLOGICAL EFFECTS OF INTRANASAL ZINC SULFATE IRRIGATION ON THE MOUSE MAIN AND ACCESSORY OLFACTORY SYSTEMS. Gail D. Burd and Frank L. Margolis. Worcester Foundation for Experimental Biology, Shrewsbury, MA 01545 and Roche Institute of Molecular Biology, Nutley, NJ 07110.

The purpose of this study was to examine the morphological effects of intranasal zinc sulfate ($ZnSO_4$) irrigation on the olfactory (OE) and vomeronasal (VE) epithelia and the main (MOB) and accessory (AOB) olfactory bulbs. In addition, autoradiography was used to demonstrate the intranasal distribution and axonal transport of tritiated amino acids in these two primary afferent pathways. 0.17M $ZnSO_4$ or 0.9% saline was administered to the right nasal cavity of unanesthetisized mice. Tritiated amino acids were administered to control, saline- and $ZnSO_4$-treated mice. Saline- and $ZnSO_4$-treated mice were sacrificed after 1 to 600 days.

Intranasal irrigation with $ZnSO_4$ resulted in the destruction of the OE throughout the nasal cavity. Within 4 days, the turbinates, septum and dorsal fossa were lined with a new, non-sensory epithelium which consisted of a single layer of cuboidal or columnar-shaped cells. The number and types of cells forming this new epithelium changed over a period of several days to months. In some areas, the lamina propria was lined with respiratory epithelium. In most of the $ZnSO_4$-treated mice which survived more than 150 days, small areas of normal-appearing OE were observed. In contrast to the OE, the VE was rarely damaged by the $ZnSO_4$ irrigation. Intranasal irrigation with saline demonstrated that fluids administered to the nasal cavity caused some mechanical damage to the OE, but not to the VE, on the side of administration. Light and electron microscopic examination of the olfactory bulbs following $ZnSO_4$ administration demonstrated that the olfactory axons degenerated while the vomeronasal nerves were unaffected. Transneuronal changes were not observed in the second order neurons in the MOB or AOB.

Autoradiography demonstrated that: 1) fluids administered to the right nasal cavity usually labeled all of the right nasal cavity, but only partially labeled the left nasal cavity; 2) radioactive labeling of the OE was accompanied by labeled olfactory axons and terminals in the olfactory bulb; 3) intranasal administration of tritiated amino acids did not usually label the VE, but, in mice with labeled VE, the vomeronasal axons and terminals were also labeled in the AOB; and 4) $ZnSO_4$ did not destroy the VE because fluids, as administered to the nasal cavity in this study, did not enter the vomeronasal organ.

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RELATIONSHIP OF OLFACTORY RECEPTOR AND BULBAR RESPONSES TO AMINO ACIDS IN THE CATFISH. Ryland P.Byrd, Jr. and John Caprio. Department of Zoology and Physiology, Louisiana State University, Baton Rouge, La. 70803.

The olfactory bulb electroencephalogram (EEG) has been used as a method to imply receptor events (Hara, T.J., Comp. Biochem. Physiol. 56:559, 1977). However, experiments to correlate olfactory receptor and bulbar EEG activity in the same species of fish had not been performed. Reported here is the relationship between the receptor EOG and the bulbar EEG in the channel catfish, Ictalurus punctatus. The EOG in this species has been shown to be an indicator of olfactory neural activity in terms of phasic-tonic response characteristics, amino acid relative effectiveness and sensitivity (Caprio, J., J.Comp. Physiol. 123:357, 1978). The underwater EOG was recorded DC with calomel electrodes; a monopolar tungsten electrode positioned caudally in the olfactory bulb recorded the EEG activity (bandpass 1-300 Hz). Both the EOG and EEG exhibited an initial phasic response followed by a tonic level maintained throughout the stimulus duration. The relative magnitude of the tonic EEG activity (tonic level/phasic response), however, was significantly less than that for the EOG. Both EOG and integrated EEG responses increased exponentially with logarithmic increase in stimulus concentration from threshold to 10^{-3} or 10^{-2}M, described by the equation $R=k(10)^{n\log C}$, where R is the phasic response magnitude and k is the scale factor for the R coordinate. The data plotted on log-log coordinates result in a straight line with slope n. The slopes for the EOG series averaged 0.22 ± 0.04 (n=25), those for the EEG were 0.11 ± 0.04 (n=25). The EEG response-concentration curves were highly dependent upon the recording location in the olfactory bulb. Electrode placement other than in the caudal region of the bulb frequently resulted in responses that saturated at 10^{-5}-10^{-4}M stimulus concentration. Threshold was determined by extrapolation of the double-log plot of response versus stimulus concentration to control level. Thresholds for the more stimulatory amino acids were similar for either recording technique and averaged $10^{-9.0\pm 1.0}$M for the EOG and $10^{-8.6\pm 1.5}$M for the EEG. Amino acid relative effectiveness determined by either recording method also was not significantly different. The results indicate that in the catfish the olfactory bulb electroencephalogram is an indicator of olfactory receptor activity as evidenced by the similarities in EEG and EOG recordings.
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ODOR AND IRRITATION: INTERACTION BETWEEN CHEMORECEPTIVE MODALITIES. William S. Cain and Claire L. Murphy. John B. Pierce Foundation Laboratory and Yale University, New Haven, CT 06519.

Inhaled vapors may stimulate both olfactory receptor cells and endings of the trigeminal nerve. Because the trigeminal system commonly shares the chemosensory burden with olfaction, it is relevant to ask whether these anatomically distinct systems interact. Some obscure psychophysical observations argue for an inhibitory influence of trigeminal over olfactory activity. For instance, the 19th century philosopher Bain, noting that concentrated carbon dioxide (carbonic acid) evokes trigeminally-mediated pungency, remarked "if a current of carbonic acid accompanies an odour, the effect [odour] is arrested." We have taken up Bain's forgotten observation and used carbon dioxide, an odorless irritant at concentrations above 10%, to endow otherwise benign concentrations of the odorant amyl n-butyrate with varying degrees of pungency. Our experiments revealed a strong mutual interaction between pungency and odor, occurring without attenuation even when irritant enters one nostril and odor the other. The occurrence of such dichorhinic inhibition seems to establish the olfactory-trigeminal interaction beyond the stimuli used here. Measurements of reaction time to odorant and to irritant, and an assessment of how prior adaptation to irritant would diminish odor magnitude implied little involvement of trigeminally-mediated reflexes in the olfactory-trigeminal interaction. We therefore conclude that the interaction takes place primarily in the central nervous system.

EFFECT OF $ZnSO_4$ ON THE CATFISH OLFACTORY MUCOSA. Paul Cancalon, Dept. of Biological Science, Florida State University, Tallahassee, Florida 32306.

The effect of $ZnSO_4$ on the olfactory epithelium of the catfish (Ictalurus punctatus) was monitored by light microscopy, SEM and TEM. Following irrigation of the olfactory cavity with 0.12% $ZnSO_4$, drastic changes occur in the sensory area while the indifferent epithelium remains totally unaffected. After 7 h, the dendrites of the olfactory cells are filled with large vacuoles and most of the cilia and microvilli of the olfactory and sustentacular cells have disappeared. After 2 days very few olfactory receptor cells can be seen and they are almost impossible to find during the 3rd and 4th days. New olfactory neurons grow during the 5th day and they reach a number equivalent to that of a control mucosa during the 6th day. At this time, the sensory, but not the sustentacular, cilia and microvilli have grown back. After 7 days treated and control mucosa are indistinguishable. SEM study of the sensory area at day 6, when only sensory cells are visible, has shown that the two types of olfactory receptor cells characterized are not distributed at random, but that each occupies approximately one half of the sensory area. The effect of various salts was also investigated.
(Funded by NIH Grant NS 14912).

FEEDING DETERRENT EFFECTS IN LARVAE OF THE SOUTHERN ARMYWORM, SPODOPTERA ERIDANIA (LEPIDOPTERA:NOCTUIDAE), ELICITED BY LEAVES AND LEAF CONSTITUENTS FROM THE JUJUBE TREE, ZIZIPHUS JUJUBA (RHAMNACEAE). P.J. Cannoy and B.P. Halpern. Section of Neurobiology and Behavior of the Division of Biological Sciences and Department of Psychology, Cornell University, Ithaca, NY 14853 USA.

Feeding deterrence by intact Ziziphus jujuba leaves, Z. jujuba leaf powder (ZLP), or extracts (vid. Meiselman et al, Physiol. Behav. 17, 313-317, 1976; Kennedy and Halpern, Physiol. Behav. 24, 1980; Kennedy, Ph.D. Thesis, Harvard, 1979) was studied using freshly moulted 5th instar larvae of the broadly polyphagous Southern Armyworm, Spodoptera eridania, as the bioassay organism. The host plant, i.e., pre-bioassay food source for larvae was the kidney bean plant, Phaseolus vulgaris. In two-choice 24 hr preference tests, P. vulgaris leaves were preferred to Z. jujuba leaves, which were not fed upon. For no-choice feeding trials where only Z. jujuba leaves were available, no observable feeding occurred in the first 4 hr of exposure to leaves; sporadic, limited feeding occurred in the remaining 20 hr.

In two-choice preference tests using semi-defined diets containing lyophilized P. vulgaris leaf powder (PLP) or lyophilized ZLP as the leaf component, significant preference for the PLP-containing diet occurred ($p \leq 0.01$, Mann-Whitney rank sum test). This significant preference persisted in the dark, and also when olfactory cues were controlled by a layer of PLP, ZLP, or PLP/ZLP (1:1) containing diet which was plated just beneath a porous, suspended testing surface. Further preference tests compared the PLP-containing diet with a diet in which 22.6% (dry diet component w/w, i.e. 0.9% w/v) of the PLP diet was replaced by an aqueous-ethanol extract of ZLP. The extract-containing diet was rejected, thus eliminating diet texture and non-aqueous-ethanol soluble ZLP components as factors in the deterrent effect. A chloroform-ethanol fraction of the extract, replacing 9.1% of the dry diet components (0.36% w/v), resulted in rejection of the diet when compared to the PLP diet control. The ziziphins of this fraction are known to be selective taste modifiers for sucrose in humans and blowflies (vid. supra). Evaluation of deterrence as a possible function of taste modifier effects for S. eridania feeding is planned, since present data demonstrate feeding suppression, but do not indicate the mechanism.

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ELECTROPHYSIOLOGICAL ANALYSIS OF SENSORY FUNCTION IN THE SNAIL TENTACLE. Ronald Chase, Department of Biology, McGill University, 1205 Avenue Docteur Penfield, Montreal, Quebec, Canada, H3A 1B1.

The snail's tentacles obviously serve a sensory function. Recent behavioral studies have demonstrated a highly developed utilization of chemical cues apparently mediated by tentacular reception (Chase et al., Behav. Biol. 22, 1978; Chase & Boulanger, Behav. Biol. 23, 1978; Croll & Chase, J. comp. Physiol., in press). Physiological analysis, however, has been limited by the small diameter of afferent fibers ($<0.1\mu$). In the present study, extracellular recordings were obtained from a mixed population of neurons in the peripheral tentacular ganglion using suction electrodes. Tactile responses to air puffs were characterized by an extreme sensitivity and by a variable pattern which included sustained responses, on/off responses, and inhibitory responses.

The sensitivity to a standardized mixture of vegetable odors was studied in a series of experiments conducted under optimal conditions. Qualifications for inclusion in the series included: 1) Maintenance of a thin film of water on the epithelial surface, 2) Signal:noise ratio greater than 2:1, 3) Presence of a high sensitivity to tactile stimuli, and 4) Availability of paired controls for tactile responses. A total of 59 trials from 13 different preparations was evaluated. Responses contingent upon chemical stimulation were evident in only 7 of these trials, and in each case the margin of difference from the control response was not great.

The results emphasize the role of the tentacle in rheotactic orientation. The failure to record obvious chemosensory responses may be due to any of the following reasons: 1) Inappropriate experimental conditions, 2) False attribution of chemical sensitivity, or 3) The predominance of peripheral chemosensitive units which are less than the minimal size required for electrophysiological detection. The latter possibility will be tested in experiments utilizing recordings from the central nervous system.

GERBIL INVESTIGATORY RESPONSES TO SOCIALLY RELEVANT ODORS. MaryLou Cheal and Joyce Klestzick, Neuropsychology Laboratory, McLean Hospital and Harvard Medical School, Belmont, MA 02178.

The sense of smell plays a major role in gerbil social behavior. Female gerbils, as well as males, will readily investigate the odors of conspecifics in the stimulus-elicited investigation paradigm. The selective attention to the odor hole habituates over a series of one-minute trials if the odor is not associated with reward. That the decrement in responding is habituation and not receptor adaptation was supported by data from gerbils that were preexposed to the odor in a small holding tank prior to testing. These gerbils investigated the odor as long and as often as gerbils that were not preexposed. Also, habituation could be demonstrated 1, 7, 14, or 28 days after testing on two one-minute trials.

The odor typically used in this test was the odor emanating from soiled bedding taken from a cage of male conspecifics. Duration and frequency of investigation of this stimulus was very similar for male and female gerbils whether tested with the odor hidden under one of five holes or under one of two holes, a more sensitive test. Also there was no difference in investigation if the bedding came from their own home cage rather than from strange male gerbils. This was true when the odors were presented to independent groups in separate tests and when the odors were presented competitively to the same group of gerbils. This last experiment was conducted using just the two holes with odorants and also using five holes, three of which had no particular odor.

In tests conducted to learn what parts of the stimulus were responsible for investigation, there was no selective investigation of clean pine shavings or fecal boluses from male conspecifics. Also, only three of seven gerbils showed initial preference for food odors and only two of the gerbils habituated normally. All of the gerbils were on ad lib food prior to the tests, but the variability in the time since eating could account for the response variability. It was concluded that the gerbil's investigatory response was elicited by the chemical secretions from the animals. Phenylacetic acid was reported to be a constituent of gerbil ventral gland sebum. Odor-elicited investigation tests using the crystalline form and dilutions to physiological concentrations will be reported.

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TASTES LOSE THEIR IDENTITY IN MIXTURES: A COMMENT ON THE ANALYSIS/SYNTHESIS ISSUE. L. Collins, D. Chiu and R.P. Erickson. Duke University.

The "synthetic" view of taste psychophysics is that when two stimuli are mixed, they will fuse to form a third taste different from (and intermediate between) the original tastes; the "analytic" view is that they will not fuse, but will remain distinct, and thus no more than the 4 primary tastes can exist. As one test of this, we mixed representatives of the primary tastes with other stimuli to determine if they were still clearly identifiable.

The subjects were asked to identify which, of a pair of previously well-learned and easily discriminable stimuli (e.g. NaCl and HCl, called stimulus "A" and "B"), was contained in solutions with another stimulus. Significant numbers of errors (generally low, but sometimes over 50%) were made in the identification of the stimulus in the mixture. As examples, NaCl was mistakenly identified as HCl when mixed in QHCl or sucrose, and as QHCl when in HNO_3; HNO_3 identified as QHCl in NaCl or sucrose, as sucrose in NaCl or QHCl, and as NaCl in QHCl; sucrose as HNO_3 in NaCl or QHCl, and as NaCl in QHCl; and QHCl as HNO_3 in NaCl or sucrose.

Together, these data support the position that the taste quality of each test stimulus was changed in solution in the synthesis of a new taste intermediate between it and the stimulus in which it was mixed, the new taste being close enough to the other test stimulus to be mistaken for it a significant number of times.

BRAIN STEM MECHANISMS IN CONTROL OF SALT INTAKE AND BLOOD PRESSURE. Robert J. Contreras & Paul W. Stetson. Yale University, Dept. of Psychology, Box 11a Yale Station, New Haven, Ct 06520

Area Postrema (AP) and the nucleus of the solitary tract (NST) are two adjacent structures in the dorsal medulla. In rats, the AP is a midline structure at the caudal end of the 4th ventricle; it has been implicated as a chemoreceptor trigger zone for integration of emetic responses. The AP can be influenced chemically via the blood stream, due to the absence of a blood brain barrier in this region, and possibly via the cerebrospinal fluid. Ventrolateral to the AP is the NST, which receives incoming afferents from gustatory and visceral receptors. Thus, the AP and the NST, together, due to their location, composition and proximity to each other, may integrate information from a variety of sources. More recent reports suggest a role for the AP and NST in cardiovascular function. Damage to these structures produced a chronic labile hypertension, although the relative contribution of each structure to the syndrome is a subject of controversy. We have obtained the following data that may resolve this controversy.

18 experimental rats received lesions to the AP while 6 control rats received sham lesions. After the lesions, we gave the animals a two-bottle preference test between water and various molar concentrations of NaCl (.03, .1, .3, .5), glucose (.1, .3) or KCl (.1, .3) solutions. We found that AP lesioned rats exhibited a significant increase in intake of the NaCl solutions, but their intakes of glucose and KCl solutions were unchanged. These changes in intake were apparently not secondary to changes in output. Urinary sodium and potassium levels were the same for both groups of rats while on a control, sodium replete diet or on a sodium free diet. Preliminary histological observations of the brains revealed a correlation between the lesion and the salt intake behavior of the rat. Rats, with lesions restricted to the AP, showed an enhanced salt intake. When the AP was partially spared or when the lesion extended well into the NST, the rats did not, however, exhibit an increased salt intake.

We believe that these changes in intake are secondary to the hemodynamic effects of the lesions. From our data as well as data from other labs, we propose that hypertension results from damage to the NST, not to the AP. AP ablations result in hypotension and hypovolemia and the animals may try to compensate by drinking more saline. It would be counterproductive for a hypertensive, NST lesioned rat to increase its saline intake, inasmuch as excessive salt intake leads directly to hypertension in rats. Our data suggest that the AP and the NST may operate complementally to maintain sodium balance and normal blood pressure.

This research was supported by NIH, NHLBI Grant HL-24732.

INTRACEREBRAL 6-HYDROXYDOPAMINE REVERSES CONSPECIFIC ODOR PREFERENCES OF MALE ALBINO RATS. Catherine A. Cornwell-Jones, Department of Psychology, Princeton University, Princeton, NJ 08540

Odors produced by female rats attract male conspecifics, and castrating males reduces the preference. Castration also decreases concentrations of the neurotransmitter norepinephrine (NE) in olfactory-innervated brain regions (Cornwell-Jones & Marasco, Brain Research, 183, 1980). The present experiment determined whether reducing brain NE concentrations directly, without other effects of castration, would also reduce preference for conspecific odors in male rats.

Prior to surgery, odor preferences of sexually experienced male rats were tested in a two-choice situation in an apparatus which allowed animals to smell but not touch or taste differently scented wood shavings placed in two compartments below a screen floor. Unoperated males prefered the odor of pine shavings taken from the nest of a lactating female and her pups to the odor of fresh, unscented pine shavings.

The preference for nest odor remained after surgery in control males which had received bilateral intracerebral injection of saline-ascorbic vehicle into the vicinity of the ascending noradrenergic bundles. However, following bilateral injection of 8 µg of the neurotoxin 6-hydroxydopamine (6-OHDA), 4 out of 5 drug-treated animals each spent less than one-third of test time over nest odor, indicating preference reversal. 6-hydroxydopamine also reduced olfactory cortex norepinephrine levels by 87%, while dopamine levels were not significantly affected.

Pretreatment with intracerebral injection of 60 µg of amphetamine, a catecholamine uptake inhibitor and releaser, prevented 6-OHDA-induced preference reversal in 4 out of 5 animals, and limited olfactory cortex norepinephrine reduction to 50% of concentrations measured in amphetamine-pretreated vehicle-injected controls. The data implicate norepinephrine in the modulation of adult responses to conspecific odors.

TEMPORAL NEURAL CODING IN GUSTATION. E. Covey and R.P. Erickson. Duke University.

In addition to the spatial models of neural coding in gustation (labeled-line, across-fiber pattern), the complex temporal patterns seen in the neural responses to taste stimuli suggest the possibility of a temporal code. Two paradigms were used to test this possibility: a) to determine if the temporal patterns have evidence of characterizing the stimulus, and b) whether stimulation of the peripheral nerve with temporal patterns characteristic of stimuli which evoke unique behavioral responses, would themselves evoke these responses.

Comparison of the responses of single neurons of the rat NTS to a number of different stimuli has shown that different stimuli have different characteristic temporal patterns, and that these patterns contain sufficient information for identification of the stimulus (Covey & Erickson, A.C.S. '79). To determine whether these patterns are used by the animal, we electrically stimulated the chorda tympani nerve of decerebrate rats with different temporal patterns and looked for the presence of reflex behavioral (acceptance-rejection) responses as described by Grill & Norgren. Stimulation with patterns characteristic of NaCl or HCl elicited an acceptance response, while stimulation at steady frequencies elicited only a slight jaw snap or no response. Stimulation with the quinine pattern sometimes elicited a rejection response, or an acceptance response or jaw snap. Stimulation of the glossopharyngeal nerve is presently being used to further investigate these responses.

Thus, the reflex response depended on the proper temporal pattern, not simply on the fact that the nerve had been stimulated; in other words, the temporal patterns per se appear to constitute a neural code.

OLFACTION AFTER PROLONGED EXPOSURE TO SPECIFIC ODORS Patricia J. Cunzeman and Burton M. Slotnick, The American University, Washington, D. C.

Method: Rats were exposed from 5-65 days of age to either etnylacetoacetate (130 ppm), 4-methylvaleric acid (28 ppm), or clean air. Four animals from each group were sacrificed when removed from the odor exposure cages and four were trained on olfactory detection, absolute threshold, and intensity difference threshold tasks with both odors. Odor presentations were counterbalanced. A wind-tunnel operant chamber was used for discrimination training and odors were generated by an olfactometer. The olfactory bulbs of all rats were sectioned at 10 microns and stained with cresyl violet. Mitral cells were counted and measured at two frontal levels through one olfactory bulb of each rat. Separate statistical analyses were performed for each bulb quadrant.

Behavioral Results: Rats raised in the EAA odor performed as well as controls in all tests with EAA and 4-MVA. Rats raised in the 4-MVA odor had marked deficits in acquisition of the 4-MVA detection when tested first with 4-MVA, but not when detection training on 4-MVA was preceeded with training on the EAA odor. 4-MVA rats also performed more poorly than controls on the 4-MVA intensity difference threshold tests, but had no deficits on the 4-MVA absolute threshold tests or on any test with EAA.

Histological Results: No significant differences in the number or size of mitral cells were found for any bulb quadrant between animals sacrificed immediately upon removal from the odors and those trained or among the odor exposed and control animals.

Conclusions: The present study provides the first evidence that prolonged, specific odor exposure may lead to decreased sensitivity to the exposed odor. This deficit may be transitory because animals tested first on a novel odor showed no deficit in detection of the exposed odor. These results do not support the findings of Laing and Panhuber (J. Comp. Neur., 1978, 171, 345), that single odor exposure causes a deficit in detecting a novel odor rather than the exposure odor. The histological methods employed in the present study did not detect the odor-specific patterns of change in mitral cells reported by Doving and Pinching (Brain Res., 1973, 52; 115), Pinching and Doving (Brain Res., 1974, 82; 195), and Laing and Panhuber (1978).

SOMATOSTATIN AND LHRH PERIKARYA AND AXONS ARE PRESENT IN THE OLFACTORY SYSTEM IN THE HAMSTER. Barry J. Davis, Gloria E. Hoffman and Foteos Macrides. Worcester Foundation for Experimental Biology, Shrewsbury, MA 01545 and Dept. of Anatomy, Univ. of Rochester Med. Sch., Rochester, NY 14642

The locations of somatostain (SS; growth hormone-inhibiting factor) and luteinizing hormone-releasing hormone (LHRH) containing perikarya and axons were compared in the main olfactory bulb (MOB) and in rostral forebrain areas. SS and LHRH were visualized using Sternberger's unlabelled anti-body enzyme method. Well-defined SS immunoreactive perikarya were observed in all subdivisions of the anterior olfactory nucleus (AON), the entire piriform cortex (PC), and anterior hippocampus (HR). Our autoradiographic and HRP studies in the hamster have shown that the AON, PC and HR are connected reciprocally with the MOB. The number of SS perikarya was comparable to the number of HRP-positive neurons visualized in these olfactory cortices after HRP injections into the MOB. SS perikarya were both multipolar and fusiform in shape and were located primarily in Layer III. Multipolar SS perikarya also were observed in the granule cell layer (GL) of the MOB. Isolated SS immunoreactive axons were observed in the anterior commissure, throughout the olfactory peduncle and in the GL of the MOB. The locations of these axons correspond with the pathways used by axons from the AON, PC and HR enroute to the MOB.

In contrast to the SS perikarya, LHRH perikarya were more sparcely distributed. Fusiform LHRH perikarya were present in the ventromedial aspect of the olfactory peduncle and rostral hemisphere, and in the medial septal and vertical limb of the diagonal band. These areas are also known to project to the MOB. Axons arising from these LHRH perikarya coursed rostrally through the medial aspect of the olfactory peduncle and directly entered the GL of the caudal MOB. Axons also could be traced along the perimeter of the MOB and accessory olfactory bulb (AOB) within the superficial aspect of the glomerular layers. These axons entered the periglomerular region and external plexiform layers of the MOB and AOB.

Possible extra-hypothalamic roles of these neuropeptides in relation to olfactory function will be discussed.

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DEVELOPMENT OF PRACTICAL CLINICAL ASSESSMENT TESTS OF ODOR PERCEPTION BASED ON ODORANT MICROENCAPSULATION TECHNIQUES.

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A reasonable test of odor perception by clinical staff could contribute to medical care in numerous areas such as oncology, nephrology, psychiatry and gerontology. Thin coatings of microcapsules containig odorants applied to paper surfaces affords a "paper-and-pencil" test of odor perception which could be brief, inexpensive, self administered, and interpreted by staff without specialized training. Theoretically ideal models of such odor perception tests can be constructed, but optimum designs must rest on empirically established facts. This report will define the design criteria for such tests and describe findings of intermediate design studies.

The types of test techniques which could be used can be characterized as polar opposites: traditional psychophysics versus verbalized introspection. The present approaches used techniques which involve a synthesis from both extremes: graphic response ratings of odor pair similarity and odor pleasantness. Other techniques have been studied and excluded from further study (continuous recognition, forced choice recognition, identification, quality descriptions) or deferred for later study (absolute and differential thresholds).

The similarity judgments have been summarized by metric multidimensional scaling models such as INDSCAL and ALSCAL. The studies summarized here have focused on test reliability, test protocol parameters (instructions, presentation rate, pair order effect, and sequence effects) and on perception model adequacy (context sensitivity, replication reliability, and generality). The results show that highly reliable, brief tests of odor perception are feasible with the microencapsulated odorant. For small group data, perception studies of the highest possible reliability can be easily attained, which opens the way to a variety of clinical studies. The reliablity of current designs is not yet sufficiently high to guarantee a useful test for individual cases, however, results thus far encourage the expectation that this goal can be achieved.

A NEUROPHYSIOLOGICAL ANALYSIS OF CHEMORECEPTORS OF WALKING LEGS OF THE AMERICAN LOBSTER (HOMARUS AMERICANUS)

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Chemoreceptors of the two most distal segments of all four pairs of walking legs of lobsters were analyzed using extracellular recording techniques, in order to characterize the stimulus spectra, thresholds, and specificities of these primary receptor neurons. This information is used for comparison with similar data existing for antennular chemoreceptors.

A mussel (Mytilus edulis) extract was used to identify chemoreceptor cells. The responses to a variety of compounds in equimolar concentrations were compared to the mussel extract response. Of 48 compounds tested, the most stimulatory were several amino acids (L-glutamate, hydroxy-L-proline, L-aspartate, L-arginine, glycine, L-alanine), amines (betaine, taurine), ammonia, and the tripeptide glutathione. These compounds are also among the most abundant in the tissues and excretia of invertebrates upon which lobsters feed. Hemoglobin and odors from intact, live Mytilus are also effective stimuli; however, direct comparison with the above compounds is impossible since the molarities of these two stimuli are unknown.

The specificity of L-glutamate-sensitive cells was analyzed using single-cell recordings. These cells generally respond only to L-glutamate and not to any of the other 19 compounds tested, indicating that they are L-glutamate specialists.

Thresholds were determined for nine amino acids and amines using multi-cell recordings, and for L-glutamate using single-cell recordings. The multi-cell recordings demonstrate thresholds from $5x10^{-6}$M to $5x10^{-9}$M. Single-cell recordings show that the threshold for L-glutamate is near $5x10^{-8}$M.

Although there are behavioral and neuroanatomical distinctions between chemoreception in antennules (smell) and walking legs (taste), these results show that their peripheral receptor cells have many properties in common, including similar stimulus spectra, low thresholds, and stimulus specificity.

ENDOCRINE, CARDIOVASCULAR AND PSYCHOLOGICAL CORRELATES OF OLFACTORY SENSITIVITY CHANGES DURING THE HUMAN MENSTRUAL CYCLE

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Signal detection measures of olfactory sensitivity, as well as blood pressure, heart rate, body temperature, nasal airflow and respiration rate, were repeatedly established with 2 1/2 hr test sessions held bidaily across 17 menstrual cycles of women not taking oral contraceptives, 6 menstrual cycles of women taking oral contraceptives, and 6 equivalent time periods of 3 men. In addition, radioimmunoassay-determined plasma levels of LH, FSH, E_1, E_2, P and T, as well as responses to the Moos Menstrual Distress Questionnaire (MDQ) were established daily or bidaily throughout the study periods. Within the test sessions, significant and intercorrelated changes were found for d', heart rate, body temperature, respiration rate, nasal airflow and blood pressure in all three subject groups. Across the menstrual cycle phases, significant changes were noted in normally-cycling women for all of the hormones examined, as well as for body temperature, d', nasal airflow, and the MDQ Water Retention and Pain Scales. In the oral contraceptive group, significant changes were observed in d', LH, E_1, and body temperature, although only d' followed a cyclical pattern similar to that noted in normally-cycling women -- peaks in sensitivity during the second half of menses, midcycle, and midluteally. A number of the variables correlated with one another across the menstrual cycle phases in all three subject groups. Since similar fluctuations in d' were noted in both women taking and not taking oral contraceptives, factors other than circulating estrogens appear to be responsible for the major shifts in olfactory sensitivity during the menstrual cycle.

NEURON AND STIMULUS TYPOLOGIES IN THE RAT GUSTATORY SYSTEM

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Gustatory neurons may be grouped by various criteria, such as their "best stimuli", whether these neurons vary continuously in their stimulus sensitivity (and thus do not naturally form groups, as in audition), or whether they are composed of a few response classes (as color-coded visual neurons). The arguments for neuron classes have been made at the peripheral nerve level (Boudreau, Frank, Ogawa, Pfaffmann, Sato); however, a quantitative analysis ("cluster analysis") of the neural data at the NTS level in the rat (Woolston and Erickson) showed that the neurons did not form groups even though each responded better to one stimulus than the others. The present study applied this method to data at the peripheral nerve level. Responses were obtained to 12 stimuli in 21 chorda tympani neurons of the rat (sodium pentobarbital). Although these neurons could arbitrarily be placed in groups (for example, on the basis of whether their responses were greater to NaCl or HCl etc.), they did not form groups on the basis of consistent patterns of response across the stimuli used.

"Cluster analysis" of these data also bear on the issue of stimulus types; members of a type should evoke consistent patterns of response across neurons. At the NTS level, where a broad range of stimuli was used, no stimulus groupings were found (Woolston and Erickson). In the present study, 3 of the stimuli were Na salts and 2 were Li salts, known to be similar neurally and psychophysically; these formed a clear group. The other stimuli, QHCl, sucrose, $CaCl_2$, KCl, NH_4Cl, $MgCl_2$ and HCl, did not form groups. This makes the point that the finding of stimulus groupings depends on the stimuli used.

HYDROLYSIS OF THE SEX ATTRACTANT OF THE CABBAGE LOOPER MOTH BY ANTENNAL ESTERASES. Stephen M. Ferkovich. Insect Attractants, Behavior and Basic Biology Research Laboratory, AR/SEA, USDA, P. O. Box 14565, Gainesville, FL 32604.

Esterases were isolated from chemosensory sensilla on the antenna of Trichoplusia ni (Hübner). The disc gel electrophoretic patterns of these esterases from males and females were similar; however, more bands were observed in the antennae than in 8 other tissues examined. Most of the esterases detected in the 100,000 g supernatant of the antennal preparation could be dissociated from the 100,000 g membrane pellet. Esterases from both male and female antennae hydrolyzed the sex attractant, (Z)-7-dodecen-1-ol acetate, more rapidly than did the legs, fat body or Malpighian tubules. The enzymes primarily responsible for pheromone catabolism were less sensitive to paraoxon, eserine and p-(hydroxymercuri)benzoate than those hydrolyzing 1-naphthyl acetate. This suggested that a major portion of the observed pheromone-hydrolytic activity was due to acetylesterases. The significance of these findings is discussed in relation to the possibility of antennal esterases having a functional role in the olfactory process of males of T. ni.

Temporal Parameters of the Rapid Oral Mixing of Glucose and Saccharin Solutions in the Rat

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Individual licks and drinking patterns of six adult male rats were monitored during 24 hour, two-bottle preference tests in an attempt to describe the rapid oral mixing of fluids that occurs when rats are offered a glucose solution and a saccharin solution in separate bottles. Interlick interval histograms for within-solution and between-solution licks showed that the local licking rate and the amount of fluid consumed per lick were similar for glucose and saccharin, and that alternations from glucose to saccharin were generally shorter temporally than those from saccharin to glucose.

SENSITIVITIES OF THE MOUSE CHORDA TYMPANI TO TASTE STIMULI

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Many genetically pure strains of mice have been developed, several of which show differences in preference for solutions which are ingested and/or differences in physiological consequences of that ingestion. Although these differences may be mediated, in part, by the gustatory system, its role cannot be evaluated because its sensitivities are unknown in this species. Therefore, a chorda tympani nerve (which innervates taste receptors on the front of the tongue) of each of twelve mice (C57BL/6J or DBA/2J strain) was exposed using the mandibular approach, cut centrally, and lifted onto a recording electrode. The amplified activity of the whole nerve was integrated for 200 msec. bins and the result used as a measure of its response during periods of stimulation or rinse. Stimuli (concentration series of NaCl, HCl, ethanol, quinine-HCl, Na-saccharin and sucrose solutions) and distilled water rinses were introduced into a glass chamber encasing the anterior part of the tongue. All stimulus compounds but ethanol evoked increases in neural activity at concentrations which are known to be effective for other rodent species (e.g., the rat); application of ethanol was accompanied by a decrease in resting neural activity (as it is in the rat) that lasted throughout its administration and was followed by an increase in activity when replaced by the water rinse; this rinse-discharge was larger after stronger ethanol concentrations. When the size of responses to stronger concentrations of the stimuli are considered relative to the size of the response to 0.1 M NaCl, both quinine and sucrose are seen to be characteristically more effective stimuli for the mouse's anterior lingual taste receptors than they are known to be for the rat's.

CHARACTERIZATION OF HOUSE FLY TARSAL SUGAR RECEPTORS WITH SULFHYDRYL REAGENTS AND KINETIC ANALYSIS

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Dose-response curves for ED(+) glucose, β-D(-) fructose, sucrose, and D(+) galactose were determined by stimulating the tarsi of restrained flies and recording the labellar response on the scale proposed by Dethier (1976). Adaptation and disadaptation times were determined for each stimulus at selected concentrations. The frequency distribution of adaptation times for sucrose is not normally distributed but skewed toward the lower end. The time dependent blockage of labellar response was investigated for the sulfhydryl reagents para chloro mercuribenzoate (PCMB) and fluorescein mercuric acetate (FMA) applied to the tarsi either in the presence of the stimulating sugar, or without it. Kinetic analysis revealed that PCMB reacts extremely fast with its site of action, while FMA reacts more slowly. The response to 1 M fructose was inhibited to 48.6±4.7 percent of control response in less than 15 seconds, while the responses to 1 M glucose and sucrose were inhibited to 66.6±6.2 and 64.0±7.1 percent of their controls respectively. Labellar response to 0.1 M sucrose was inhibited to only 90% of its control level in 15 seconds. Recovery from adaptation to 1 M stimulus occurred in 5.6±.2 minutes, but the effects of the inhibitors persisted. Comparison electrophysiological studies are in progress.

BILATERAL SUMMATION IN THE COMMON CHEMICAL SENSE.

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Bilaterally applied stimuli often produce a unitary sensory impression. The perceived magnitude of the impression may exceed that produced by only one of the stimuli applied alone. Binaural loudness generally exceeds monaural loudness, and birhinic smelling generally exceeds monorhinic smelling. In both of these modalities, a vector sum of the unilateral stimulus magnitudes has been used to account for the degree of bilateral summation. Such a simple formula seems also to account for bilateral summation in the common chemical sense. We obtained this result in an experiment that employed a stimulus of carbon dioxide, an odorless irritant when inhaled in high concentrations. In the course of 75 sessions, 15 subjects inhaled various combinations of concentrations presented to the right and left nostrils. Psychophysical functions derived from stimulation of either nostril alone (pure air delivered to the other nostril) followed a positively accelerated course similar to that reported for integrated activity in the trigeminal nerve. When accompanied by stimulation of the contralateral nostril, perceived magnitude increased, but not in a manner strictly commensurate with either the concentration or perceived magnitude of the additional stimulus. The rule of combination approximated vector summation of the inhaled mass of the bilateral stimulus, with an angle (α) of 90° between the vectors. The degree of summation fell below that previously obtained for the odor intensity butyl alcohol (α = 60°). Nevertheless, the two chemosensory systems display evidence of a categorical similarity: rather strong, though imperfect, summation when stimulation is laterally balanced and weaker summation when stimulation is unbalanced.

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POSTNATAL DEVELOPMENT OF RAT OLFACTORY BULB NEURONS.

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Mammalian olfactory bulbs contain several distinct classes of interneurons, at least two of which (periglomerular and granule cells) make direct synaptic contacts onto mitral and tufted cells. The complexity of synaptic connections within mature olfactory bulbs makes it difficult to determine the effects of interneurons on the response properties of mitral and tufted cells. Autoradiographic studies of histogenesis in the bulb reveal that whereas the full complement of mitral and tufted cells are present at birth, most interneurons develope postnatally. Likewise, electronmicroscopic studies have suggested that synapses between receptor axons and second order neurons are more precocious than those formed by interneurons. This study describes the development of different types of interneurons. Material was obtained from two day postnatal (P2), P8, P15, P29 and adult rats and processed for cresyl and golgi staining. Examination of cresyl stained material shows that the mitral cell body layer occupies a relatively large proportion of the olfactory bulb in P2 rats. The relative volumes of the external plexiform layer, the internal plexiform layer, and the granule cell layer increase dramatically by P15. With golgi impregnation we see all cell types apparent in the adult bulb by P15. In accordance with the previously cited evidence, at P2 few cell types are present, the population consisting mainly of mature and immature mitral cells and a few superficial interneurons. These results suggest that the P2 rat is a promising preparation for electrophysiological studies of mitral and tufted cell responses in isolation of many interneuronal influences.

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THE TIME COURSE OF GUSTATORY ADAPTATION.

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The time course of gustatory adaptation was measured for compounds representing each of the four qualities. Stimuli were delivered on solution-soaked filter paper, and the subject estimated the magnitude of the taste intensity at regular intervals over the course of adaptation. The stability of stimulation using this method permitted the observation of complete adaptation and the quantification of the time course of adaptation. Adaptation was characterized by the function $f(t) = Ae^{-t/T}$, where A is the taste intensity at $t = 0$, and T is the time it takes for intensity to reach 1/e of its initial value. A was shown to depend on the concentration, area, and location of the stimulus. The time constant, T, was shown to be positively correlated with the perceived intensity of the adapting solution. The rate of adaptation was independent of the quality of the adapting solution. It has been suggested that compounds with unusually persistent taste sensations might also have unusually long adaptation times. It was found, however, that the persistence of a compound is independent of its rate of adaptation.

DESORPTION OLFACTOMETRY - AN IMPROVED METHOD FOR CONTROL, DELIVERY AND QUANTIFICATION OF OLFACTORY STIMULI. Robert C. Gesteland, Robert G. Mair, Frank J. Weingartner and Ronald E. Susek. Northwestern Univ., Evanston, IL 60201 and Taste and Smell Consulting Group, Inc.

Odor dilutions are commonly prepared by mixing odorous vapors and odorless gases in measured ratios or by making dilutions of the solid or liquid odorous chemical in a solvent. These methods are cumbersome, difficult to accomplish accurately due to surface adsorption effects in the vessels and slow diffusion times, and, in the liquid case, limited by lack of an odorless solvent with characterized molecular properties for non-polar solutes. Many of these problems can be eliminated by using a solid adsorbent as the dilution and release medium of the odorous substance. For simple adsorption processes such as the Langmuir type, first order kinetics apply. In the equilibrium state the concentration of the vapor in the headspace over the adsorbent is a monotonic function of the odor vapor pressure, the affinity between the odorous substance and the adsorbent, and the fraction of the total adsorbent surface occupied by the odor monolayer. A measured amount of the odorant is mixed with a known amount of the adsorbent and time is allowed for equilibrium distribution to occur. This mixture is placed in a closed vessel. The headspace in the vessel then contains a fixed molar concentration of the odorous vapor, this concentration depending only upon temperature. There are a wide variety of adsorbing materials available, ranging from active carbon which has strongest affinities for non-polar substances to silica gel which most strongly adsorbs polar substances. Many lower energy surfaces are also available. Not all interactions are as simple as the Langmuir process but all behave in a qualitatively similar fashion. Measurement of vapor concentrations is easily accomplished with a photoionization or flame ionization detector over several orders of magnitude of concentration. At concentrations below the measurement capabilities of these detectors, adsorption-desorption processes are nearly ideal so that concentrations can be extrapolated with fair confidence. Because of the large ratio of adsorbent surface area to mass, equilibrium concentration in the headspace is rapidly attained following removal of a sniff of the head space vapor. For the same reason adsorption effects on the vessel surface are minimal. We have completed designs of several simple and practical olfactometers using this principle.

GROWTH OF OLFACTORY SENSORY AXONS INTO THE BRAIN OF ADULT BULBECTOMIZED MICE. Pasquale P.C. Graziadei, Department of Biological Science, Florida State University, Tallahassee, Florida 32306.

Total bulbectomy in neonatal mice (age 3 to 9 days) induced fast degeneration of the olfactory sensory neurons in the olfactory neuroepithelium. The neuronal degeneration is followed by reconstitution of a new population of neurons which regrow their axons into the spared portions of the forebrain, where glomerular formations are observed. Since the olfactory sensory neurons are a continuously renewing population of cells (Graziadei and Monti Graziadei, 1979), it would be interesting to know if their axons penetrate a mature forebrain after bulbectomy. Mice 3 to 6 months old were bulbectomized and sacrificed from 40 to 180 days postoperative. The skull, previously decalcified, has been embedded in paraffin and serially sectioned. Alternative slides were stained with iron hematoxylin and Holme's methods. In the adult the forebrain does not lean forward towards the lamina cribrosa as observed in neonatal animals (Graziadei, Levine and Monti Graziadei, 1978, 1979). A space corresponding to the removed bulb is often rapidly invaded by scar tissue which effectively stops the regrowing axons from reaching the forebrain. In several instances, however, the olfactory sensory axons have been observed to reach the spared portions of the forebrain. The axons form glomeruli-like structures as observed in younger animals. A considerable rearrangement of the local neuronal populations is observed. The relationship of the sensory axons with the cortical neurons will be illustrated.

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UPTAKE PATTERNS OF 2-DEOXYGLUCOSE ASSOCIATED WITH ELECTRICAL STIMULATION OF THE OLFACTORY NERVE IN RAT AND IN VITRO TURTLE OLFACTORY BULB. C.A. Greer, W.B. Stewart, J.S. Kauer, K. Moriⁿ and G.M. Shepherd. Sections of Neuroanatomy, Neurosurgery and Gross Anatomy, Yale Univ. Sch. Med., New Haven, CT, 06510.

Odor stimulation elicits distinct patterns of 2-deoxyglucose (2DG) uptake in the glomerular layer of the rat olfactory bulb, as detected by the Sokoloff autoradiographic method. The results suggest that increasing odor concentration is correlated with increased activity in the axons of specific groups of receptor cells and that the axons project to groups of glomeruli in the olfactory bulb (Stewart, Kauer and Shepherd, J. Comp. Neurol., In Press). We have sought further information about the contribution of receptor axons to the patterns by examining 2DG uptake associated with selective electrical stimulation of the olfactory nerve. The nerves were exposed in rats and stimulated through a bipolar electrode while recording evoked potentials in the bulb. Stimulation of the nerve bundles in the dorsal recess of the nasal cavity produced evoked potentials limited to the lateral anterior aspect of the ipsilateral bulb. Autoradiography revealed an intense focus of 2DG uptake in that region. Low frequencies (1/4 sec.) and low intensities of stimulation yielded uptake patterns centered in the glomerular layer. Increasing frequency (up to 10/sec.) and higher intensities resulted in progressive extension of the 2DG focus into neighboring laminae of the bulb. Stimulation of other olfactory nerve bundles, or antidromic stimulation of the lateral olfactory tract, produced readily distinguishable patterns. The general characteristics of 2DG uptake found here are similar to those observed following odor stimulation, which supports the interpretation that odor induced 2DG uptake is primarily due to increased activity in olfactory axons.

Similar experiments have been carried out in the isolated turtle olfactory bulb. The Sokoloff method was adapted to the in vitro preparation by continuously infusing the bath with ^{14}C-2DG (50μC/100ml) during the 45 min. period of stimulation. This was followed by a 15 min. washout with turtle Ringer prior to freezing and standard preparation for autoradiography. Stimuli were submaximal in intensity and delivered at a rate of 1/2-5 sec. while recording evoked responses in the bulb. Stimulation of an entire nerve bundle, to either the dorsal or ventral aspect of the bulb, produced extensive 2DG uptake in the corresponding part of the bulb. Following these relatively intense volleys, the induced 2DG uptake could be seen throughout most of the bulbar layers. The results demonstrate that the Sokoloff method can be applied successfully to in vitro preparations of the CNS, and moreover that the results are qualitatively similar to those observed in vivo.

URINE SIGNALING IN MONGOLIAN GERBILS

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Urination in gerbils involves a behavioral sequence which spreads urine over the substrate. Intact males tend to urine mark more than females or castrate males. Preliminary open-field preference tests indicated that females spent more time near the intact male urine than castrate urine. Subsequently, females with controlled reproductive states (either ovariectomized or ovariectomized with sc estrogen injections) were tested for discrimination and preference using urine samples from intact males, castrate males, and protein-free filtrate from intact male urine. (The protein was precipitated using trichloroacetic acid.) Habituation of a rearing response to sequential presentations of the different urine stimuli was found to be a reliable and efficient method for determining the gerbils' ability to differentiate types of olfactory stimuli. The course of habituation during an odor presentation provides additional information which may relate to preferences found in choice situations such as open-field tests.

THE DEVELOPMENT OF TASTE IN RATS: MEASUREMENTS OF INTAKE AND BEHAVIORAL RESPONSIVENESS

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Oral infusion techniques were used to study the development of rat pups' willingness to consume various solutions and their behavioral reactivity to different tastes. One series of tests evaluated pups' response to sucrose (solutions: water, 5% and 10% sucrose) in pups 3, 6, 9, 12, and 15 days of age. A second series evaluated the response to quinine in pups of the same ages (solutions: water, .025% and .05% quinine hydrochloride). Pups were deprived for 24 hr and then tested in a 10-min infusion test (a brief infusion of the solution every 2 min) carried out in a 33°C incubator. Taste solutions were infused through fine cannulas implanted in the front of pups' mouths.

From 3 days of age, pups consumed increasingly greater volumes as the concentration of sucrose increased (increase significant after 6 days). This early positive responsivity to sucrose was confirmed by behavioral measures, which indicated marked and significant stimulation of mouthing and activity by sucrose from 3 days of age. In contrast, pups' response to quinine was slower to develop. The intake of quinine was not depressed relative to water until 9 days of age. At 9 days, mouthing was also significantly inhibited, however, aversion and rejection responses (e.g. chin scrape, paw-tread) were not apparent until 12 days of age.

AGING EFFECTS ON NEWLY-DESCRIBED DACTYL SENSILLA OF THE KELP CRAB, PUGETTIA PRODUCTA (RANDALL): LIGHT AND ELECTRON MICROSCOPIC OBSERVATIONS.

by Kathryn Ann Hamilton*

ABSTRACT: Dactylopodite surface structures of the kelp crab, Pugettia producta, were studied using light and scanning electron microscopy. The most numerous structures were flattened plate-like setae which were morphologically distinct from those described for other Crustacea. Comparison of setae from juvenile and mature animals showed that plate setae undergo morphological changes during the life of a crab. Plate setae of small juvenile crabs (carapace length < 1 cm) were not flat and they more closely resembled the rod setae of other crustacean dactyls. In addition, all types of kelp crab setae became worn and encrusted with filamentous bacteria during intermolt; often only the sockets of setae remained in mature crabs. Although the functional consequences of wearing and encrustation are unknown, it has been suggested that sensory capabilities of sensillae might be impaired. However, chemical and mechanical responses recorded electrophysiologically from afferent sensory nerves during stimulation of worn dactyls from mature crabs showed that functional receptors existed. Discovery of small surface structures (diameter < 3 cm) at higher magnifications suggested that setae extending from the dactyl surface might not be the only sites of reception, although either worn and encrusted setae might be functional or a few undamaged setae might provide adequate sensory information. Since P. producta is a majiid crab, it cannot molt after maturation, although it may live for more than a year afterwards. It is possible that the presence of plate setae and small cuticular structures, seen for the first time on kelp crab dactyls, represents an adaptation to life in a rugged environment for this crab whose life cycle resembles that of some insects by including a terminal state of anecdysis.

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INFLUENCES OF STIMULUS TRANSPORT ON CHEMORECEPTOR STIMULATION

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The principal component of the gustatory sensitivity to flow rate of a stimulus solution can be identified with the convective forces which govern the transport of stimulus to the receptor membrane. These forces are dependent on the rate of flow per unit area, i.e. the stimulus velocity. Stimulus transport via convection and diffusion is a function of both concentration and velocity gradients established by the hydrodynamic flow of the stimulating solution at the tongue surface. While the details of these functional relationships will vary with solution characteristics, and system geometries, strong insights into the mechanics of the stimulation process can be gained through consideration of a typical case. A stimulus jet perpendicular to a planar surface containing a taste pore produces a stimulus flow pattern where convection dominates except in a thin layer at the surface through which the stimulus must diffuse in order to reach the taste pore. The diffusion boundary layer thickness is determined by the solution viscosity, jet velocity and tastant diffusion constant. A dependance of the thickness on the inverse square root of the jet velocity is predicted. The magnitude of the diffusion boundary layer is significant at stimulus velocities of tens of centimeters per sec where predicted diffusion boundary layers are on the order of tens of microns. Diffusion through such distances would add tens of msecs. to observed latencies. Analysis of olfactory latencies indicates that they are due mainly to diffusion through the aqueous mucus layer. One of the additional consequences of a significant diffusion barrier to the stimulus is that the time course of concentration at the receptor membrane will depart markedly from a rectangular waveform and exhibit a significant latency. The spreading of the stimulus waveform over time can be expected to be reflected in neural waveforms. Preliminary analysis suggests that the early neural response can be well characterized as reflecting the concentration waveform at the receptor. If the characteristic rise time of the concentration waveform is of the same order of magnitude as the receptor adaptation time, the magnitude of the phasic response can be expected to be diminished.

TOM-AN ADVANCED DEVICE FOR TASTE STIMULATION.

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Investigators in vision, hearing and mechanoceptions have gradually refined their stimulation techniques while scientists in gustation seem to stick to methods from old days. It seems evident that in our attempts to acquire a more profound knowledge of the sense of taste accurate information on when, which and how long stimulus is applied, as well as control of temperature and flow rate and ability to stimulate with a large number of stimuli in any order is essential.

For many years we have devoted time to this problem and we have developed a system which controls up to 31 different taste stimuli. This is accomplished by magnetic valves. The valves control the outlet from flasks housed in a thermostat-regulated water-bath, whose water also surrounds the tubes from the flasks to nozzles, which empty on a trough just above the surface of the tongue. There is little mixing of stimulus, because the only part the solutions share is the trough, which generally is rinsed between stimulations. The trough minimizes mechanical artifacts to the extent that they cannot be observed. The valves are controlled in several ways. One is through pushbuttons. They can also be opened by applying a +5 V to a 31 pin connector or by a five-bit binary coded signal. There are two built-in programming devices. One offers any sequence of up to 10 different stimuli, the other one switches between two of any valves. Through the binary input the device can interact and be controlled by a computer. This device will be demonstrated more in detail.

DEVELOPMENT OF MONOCHLORIDE SALT TASTE RESPONSES IN THE RAT'S CHORDA TYMPANI NERVE: A SINGLE FIBER ANALYSIS.

D.L. Hill, R.M. Bradley, and C.M. Mistretta, Dept. Oral Biol., Sch. Dent., U. Michigan, Ann Arbor, MI 48109

Developmental changes occur in whole-nerve responses of the rat's chorda tympani nerve to stimulation of the tongue with some monochloride salts. The integrated NH_4Cl response in young rats is larger than responses to NaCl and LiCl; however, at adulthood, the responses to NaCl and LiCl are larger than those to NH_4Cl (Neurosci. Abst. 5, 127&128). These changes in the integrated response must reflect changes in single fiber response characteristics. For example, the number of fibers responding to each chemical may alter with age, or the response frequencies of fibers may change.

To investigate these possibilities, responses of 22 single fibers from young rats (14-20 days old) and 20 fibers from adult rats were recorded after application of 0.1M and 0.5M solutions of NH_4Cl, NaCl, LiCl, and KCl to the anterior tongue. Each fiber responded to all stimuli. When response frequencies from all fibers were averaged within each age group, the same relative responses to monochloride salts were found as in whole-nerve recordings. However, the majority of young fibers were clearly maximally responsive to NH_4Cl, whereas most adult fibers were maximally responsive to NaCl and LiCl.

	MOST EFFECTIVE STIMULUS	
	NH_4Cl	NaCl or LiCl
Young	N = 14	N = 5
Adult	N = 3	N = 12

Three young and three adult fibers were equally responsive to NH_4Cl, NaCl, and LiCl. One adult fiber was maximally responsive to KCl.

Although numbers of fibers responding maximally to each stimulus were clearly different between the two age groups, response frequencies did not seem to shift. The average response frequencies to each stimulus for fibers maximally responsive to NH_4Cl in both young and adult rats were nearly the same; this also occurred for fibers maximally responsive to NaCl and LiCl.

It can be concluded that the changing whole nerve response to monochloride salts is not due to shifting response frequencies of fibers but rather to a change in proportions of fibers responding maximally to specific chemicals. These changes presumably reflect altered sensitivities of taste receptor membranes that take place during development. (Supported by NIH Postdoc. Grant NS06423 to DLH, NSF Grant BNS 77-09920, and NIDR, NIH Res. Career Dev. Award DE 00066 to C.M.M.

BEHAVIORAL AND CONDITIONED CARDIAC REFLEX ASSAYS OF THE AMINO ACID SENSITIVITIES OF CHANNEL CATFISH. Kim Holland, Monell Chemical Senses Center.

The olfactory and cutaneous taste systems of channel catfish (Ictalurus punctatus) are highly sensitive to certain amino acids. Although both systems may respond to the same amino acid, electrophysiological data suggest that they may have different thresholds (Caprio, 1977, Nature. 266). Both electrophysiological (Caprio, 1978, J. Comp. Physiol. 123A) and biochemical (Krueger and Cagan, 1976, J.Biol.Chem. 251) studies have established hierarchies of sensitivity of the cutaneous taste system for amino acids which are in general, but by no means exact, agreement. Whole animal correlates to the biochemical and electrophysiological data have been obtained using conditioned feeding and conditioned cardiac reflex assays. The sensitivity hierarchy data obtained using these two techniques are in excellent agreement. Thresholds for both normal and anosmic (olfactory tract sectioned or nares plugged) animals were essentially identical ranging from 1×10^{-6}M for β-alanine to 1×10^{-9}M for L-cysteine. The greatest sensitivity was for L-cysteine = L-arginine > L-alanine = L-serine = glycine > β-alanine.

Anosmic animals acquired the conditioned feeding response as rapidly as intact fish. Similarly, anosmic fish displayed reflex bradycardia which was qualitatively similar to that shown by intact animals and which yielded identical threshold values. Various possible data analysis techniques for the cardiac assay are discussed.

AIR MOVEMENT PARAMETERS THROUGH THE BULLFROG OLFACTORY SAC. D.E. Hornung, D.B. Kurtz, M.M. Mozell, J. Ewing. SUNY, Upstate Med. Ctr., Syracuse, N.Y., 13210. O.G. Brandt. St. Lawrence University, Canton, N.Y., 13617.

The processing of olfactory information may be influenced by the parameters (flow rate, volume, and time) with which odorized air gains access to the olfactory mucosa. These parameters could not only have an influence on differential surption in its role as a putative odorant analyzer, but might also influence other analyzing processes based upon the selective sensitivity of receptors or their graphic distribution. Therefore, a miniature hot-wire anemometer which can be supported in front of the frog's external naris was developed to gain a quantitative description of the normal air flow through the olfactory sac. Individual "face" masks made from Kerr Elastic Impression material were used to mount the anemometer such that the normal opening and closing of the external naris was not affected. A body suit made of stretchable cloth held the mask and attached the anemometer snugly in place. The air flow records from the anemometer paralleled the mechanical events involved in the frog's rather complex respiratory behavior as described by Gans, et al., Science 163: 1223 (1969). They described two-phase buccal oscillations which move air into and out of the buccal cavity and three-phase ventillation cycles which move air into and out of the lungs. Our study of 8 animals (270-365 grams) showed a direct correlation of weight with peak flow rate and volume for all the ventilation cycle phases. Duration of the ventilation cycle phases as well as the duration, peak flow and volume of the buccal cycle phases were unaffected by body weight. The results calculated from the appropriate regression equations for a 300 gram frog are:

	Buccal		Ventilation Cycle		
			1st	2nd	
	In	Out	Out	Out	In
Peak flow rate (cc/min.)	119	108	238	175	224
Volume (cc)	.85	.78	.91	.45	1.22
Time (sec)	.62	.66	.41	.23	.61

(NIH Grant NS03904)

STRUCTURE AND FUNCTION OF THE OLFACTORY SYSTEM IN PROCELLARIIFORM BIRDS. Larry V. Hutchison and Bernice M. Wenzel, Dept. Physiol. and Brain Res. Inst., UCLA Sch. Med., Los Angeles, CA 90024

Using electrophysiological and anatomical techniques, we have outlined the major projections of the olfactory bulb to centers in the forebrain of the pigeon, both ipsilaterally and contralaterally. There are pauci-synaptic connections to a number of telencephalic sites. Polysynaptic olfactory input is diffuse, extending to sensory processing and relay areas and to structures involved with behavioral integration. Anatomically distinct areas show characteristic evoked potentials and evidence is accumulating for the topographic specificity of changes from baseline firing rates of individual cells, in terms of increases, decreases, and modifications of the temporal patterns of spikes, following electrical stimulation of the olfactory nerve. Response profiles can be extracted, using time series analyses by computer, defining particular aggregates of cells which show specific patterns of excitation, suppression, and modifications of temporal sequences of spontaneous activity related to parameters of stimulation. Recently, neurophysiological and anatomical work has begun on one of the procellariiform species we have attracted to odor stimuli at sea, viz., the Northern Fulmar (Fulmaris glacialis). Compared to the pigeon and most other birds, the fulmar and other procellariiforms possess substantially larger olfactory conchae, mucosal area, and olfactory bulbs. Our study indicates that the central olfactory connections in the fulmar also appear to be proportionately more extensive. Bipolar stimulation of olfactory nerve twigs with 8-15 V pulses (single or train), 0.5-1.0 ms duration, at 0.1-1.0 Hz resulted in characteristic evoked potentials and significant modifications of spontaneous unit activity (± 20% change in rate) in the olfactory bulb and in forebrain projection sites comparable to those recorded from analogous structures in the pigeon. In preliminary experiments, certain odor stimuli of unspecified concentrations combined with ambient air significantly modified pre-odor baseline rates of unit activity in the bulb. The same natural food odors used in field work (cod liver oil and krill homogenate) consistently inhibited bulbar unit activity, while ambient air and control solvent did not significantly modify baseline firing rates.
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TASTE AND OLFACTION AFTER TONGUE BRUSHING. R.J. Hyde and R.P. Feller. Dental Service, VAMC, Loma Linda, CA 92357

Previous studies have shown that dentifrices can induce taste disorder by decreasing threshold taste acuity. We obtained taste scaling responses and olfactory detection thresholds for pyridine from 12 young (28 ± 4 yrs) and 5 older (61 ± 8 years) male (9) and female (8) subjects (Ss), all in good oral health, immediately following operator-controlled tongue brushing. Several concentrations of sucrose, NaCl, citric acid and caffeine over the full scaling range, were tasted in 10 ml volumes. All were paired with equal volumes of distilled water for forced-choice discrimination together with scaling. All subjects participated in an orientation and two control trials, then after tongue brushing alone and again after tongue brushing with a major commercial dentifrice. Post-rinsing whole saliva Na and urea levels were determined. The older Ss, all "tasters" of PTC, rated bitterness of caffeine significantly lower than did younger Ss. Scaling responses for the other tastants were similar between age groups. The five highest (suprathreshold) concentrations for sucrose, NaCl and citric acid showed no differences for both controls or between the second control trial and oral treatments for all taste qualities studied. The significant effect on caffeine bitterness estimates between controls probably resulted from differences in order of taste quality presentation. Thus, tongue brushing and dentifrice effects on suprathreshold taste responses were no greater than order effects. Apart from NaCl, the older Ss did not discriminate the lowest (near threshold) concentrations from water blanks as well as the younger Ss. Salivary Na levels were similar. The bitter taste of urea, whose salivary levels were higher in the older group, might influence bitter taste acuity. Tongue brushing with and without dentifrice decreased threshold taste acuity mostly in the older Ss. Olfactory thresholds were similar between groups but showed improvement following tongue brushing only in the older Ss, none of whom were regular tongue brushers. In conclusion, the immediate effects of tongue brushing were slightly greater in the older Ss studied, and only for near-threshold concentrations of tastants.

MODIFICATION OF SENSORY EVOKED BEHAVIORAL AND NEURAL RESPONSES DURING DIFFERENT BEHAVIORAL STATES IN APLYSIA.

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Chemical cues from food (seaweed) arouse Aplysia and elicit locomotor and feeding behaviors (Am. Zool., 1972). Chemical cues from an egg-laying Aplysia and/or an egg mass also attract Aplysia and elicit aggregation, mating and/or egg-laying in this hermaphroditic organism (The Physiologist, 1976). In the presence of both food and sex attractants Aplysia displays a behavioral choice which appears to depend on its behavioral state. In the egg-laying state the food induced motor responses are suppressed. These responses are also suppressed in functional males if they are actively engaged in mating but not in their female partners. As a result, the food aroused mating females frequently end up carrying their male partners to the food site. These observations suggest a hierarchical organization of chemosensory evoked behaviors in Aplysia. A behavioral choice in the presence of different ethologically significant chemosensory stimuli suggests altered sensitivity to stimuli eliciting lower order behaviors during higher order behavioral states. Behavioral state-dependent response modification is not restricted to chemosensory responses. In a food aroused Aplysia, mechanosensory responses are also modified. Tactile stimulation of a tentacle elicits a withdrawal reflex in the unaroused state (96%, N=200) and a characteristic orienting reflex in the food aroused state (92%, N=200). Tactile response modification following food stimulation can also be obtained at the level of the 4th order neurons (4° Ns) along the activated neural pathways (Comp. Biochem. Physiol., 1980). Before stimulating with food chemicals, tactile stimulation of a tentacle produces a two component inhibitory response in the 4° Ns, but after food sensory stimulation which strongly activates the 4° Ns, an identical tactile stimulation results in an excitatory (spiking) response. Preliminary data suggest that interaction of an electrogenic pump (Comp. Biochem. Physiol., 1979) and the two component tactile synaptic input may be partially responsible for the motivational state-dependent modification of sensory integration in the 4° Ns. The firing of the 4° Ns in food aroused Aplysia may be significant because these cells appear to be motor neurons mediating foot movement (J. Neurophysiol., 1978). They also appear to make synaptic connections with many other neurons which also appear to have motor functions (Brain Res. Bull., 1979) and thus may be capable of coordinating the body movements required for orienting. These data suggest that behavioral and neural responses to a particular sensory stimulus obtained during one behavioral state can be altered during another behavioral state. Since a single sensory stimulation can rapidly alter the behavioral state of an organism, the interpretation of the neural responses to the commonly used random or repetitive sensory stimulations may be complicated unless the behavior or some other indication of the total organismic response to these stimuli is monitored. (Supported by grants: NS 12483, NS 14388 and BNS 77-24174)

A TEST OF TWO CANDIDATE NEURAL CODES IN GUSTATION
A DISCRIMINATION TIME STUDY

R. Johnson and E. Covey. Duke University

One aspect of the validation of a candidate neural code is the successful prediction of behavior from that code. This project is an attempt to predict discrimination performance with two types of candidate neural codes.

If the neural codes for two stimuli are very similar, then the animal should have more difficulty telling them apart than if they are very dissimilar. In human perception, this fact has been well established with regard to the discrimination of visual patterns; the more similar the patterns, the longer it takes to discriminate between them.

The candidate codes for gustatory stimulus quality were 1) temporal patterns, and 2) spatial (across-fiber) patterns recorded from the rat chorda tympani nerve and NTS. Assuming that the human neural coding mechanisms are similar to those in the rat, the similarities between patterns should predict the amount of time necessary for the human to decide which of two tastes had been delivered.

The relationship between reaction time for subjects to discriminate between two taste stimuli, and similarity of their temporal or spatial neural response patterns was investigated. Reaction time for discriminating between pairs of stimuli was found to increase with increasing similarity of temporal pattern and NTS across-fiber pattern, suggesting that both spatial and temporal aspects of the response are related to discrimination of taste quality. No such relationship was found between discrimination time and chorda tympani across-fiber pattern. Since the temporal pattern is virtually identical at the chorda tympani and NTS, but across-fiber patterns are somewhat different, it might be speculated that temporal patterns in the chorda tympani give rise to spatial patterns at the NTS.

These findings suggest a role for both spatial and temporal aspects of the gustatory neural code.

Effects of Eating on Hedonic Ratings of Food Odors.

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Sixty-four subjects judged the pleasantness and intensity of six non-food odors before and after eating lunch. Ratings were made using an adaptation of Cain's graphic rating procedure for magnitude estimation (Cain, 1978).

No significant differences in pre-treatment measures were found between experimental and control subjects; the hedonic values of food and non-food odors were equivalent prior to food ingestion. A repeated measures ANOVA revealed a significant 3-way interaction (type of odor, eating and pre- vs. post-eating judgment). Hedonic changes were in the expected direction; subjects who ate between judgments rated most food odors as less pleasant after eating than before. Anchovy, beef bouillon, parmesan cheese and peanut butter odors were rated less pleasant after eating whereas ratings of orange and chocolate did not change significantly.

These results are generally consistent with those reported by Duclaux et al (1973), but suggest that negative alliesthesia as a post-eating phenomenon may be limited to certain odors and does not occur in all normal weight humans. Within the limited sample of food odors used, the two sweetest odors were those for which hedonic judgments did not change after eating.

In future studies it would be of interest to explore different classes of food odors and to manipulate types of food ingested by subjects.

Cain, W. S. and F. Johnson, Jr. Lability of odor pleasantness: influence of mere exposure. Perception, 1978, 7, 459-465.

Duclaux, R., J. Feisthauer and M. Cabanac. Effets du repas sur l'agrément d'odeurs alimentaires et nonalimentaires chez l'homme. Physiology and Behavior, 1973, 10, 1029-1033.

THE ZIZIPHINS: SURFACE ACTIVE SWEETNESS-MODIFYING SAPONINS FROM Ziziphus Jujuba. L.M. Kennedy and B.P. Halpern. Worcester Fndn. Exptl. Biol., Shrewsbury, MA 01545 and Psych. & Biol., Cornell Univ., Ithaca, NY 14853.

Extracts of Z. Jujuba leaves suppress sweetness perception in humans (Meiselman et al., 1976) and behavioral and neural responses to sucrose in blowflies (Kennedy, 1979; Kennedy and Halpern, 1980). The water soluble portion of an aqueous ethanol extract was extracted with first hexane, then ether, and finally chloroform-ethanol. The active chloroform-ethanol fraction was separated into two components-- ZjE-A which had surface active properties, and ZjE-B which did not. Human psychophysical tests revealed significant sweetness-modifying activity in ZjE-A ($p < 0.01$), but not in ZjE-B ($p > 0.05$). The results indicated that the active component is either closely associated with, or is itself, an amphipathic molecule (hydrophilic at one end and hydrophobic at the other end) and supported the notion of a role for surface active properties in the taste-modifying action of Z. Jujuba.

ZjE-A, ZjE-B, and a partially purified sample of gymnemic acids (Bartoshuk et al., 1969) were analyzed by thin layer chromatography (TLC). Samples were developed in four different solvent systems and visualized by two techniques which are applicable for detection of saponins-- Liebermann-Burchard reagent and heat, or blood-gelatine. The TLC and other data suggested that the active principle in Z. Jujuba consists of a group of compounds (ziziphins), which are saponins, probably triterpene glycosides, as are the gymnemic acids. However, the ziziphins differed from the gymnemic acids in TLC mobility and in coloration by Liebermann-Burchard reagent. Therefore, while the ziziphins are similar to the gymnemic acids, they are not the same compounds as the gymnemic acids.

ZjE-A consisted of 60-80% ziziphins and, in terms of specific activity, was at least 70 times as potent as a crude aqueous extract of Z. Jujuba leaves. Thus ZjE-A is a potent preparation of the active principle in Z. Jujuba leaves which should be useful for future physiological and chemical studies.

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Bartoshuk et al., Olfaction and Taste III, 436, 1969.
Kennedy, Ph.D. Thesis, Harvard, 1979.
Kennedy and Halpern, Physiol. Behav., 24 (1), 1980.
Meiselman et al., Physiol. Behav., 17, 513, 1976.

HARDEPOLIPIDS AND SANDBATHING IN THE MONGOLIAN GERBIL

E.Melanie W.Kittrell, Del D.Thiessen & Barbara R. Gregg
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The Harderian gland is a large bilobular gland located in the orbit of the eye in most vertebrates. It is particularly prominent in rodents. Harderian gland secretions are primarily lipids and pigmented porphyrins and are secreted into the conjunctival sac inside the nictitating membrane. From the nasal corners of the conjunctival sacs, the secretion drains down the nose via single Harder-lachrymal ducts. In rodents, these ducts open at the tip of the nares and extrude Harderian material during facial grooming. This material is then spread with the paws throughout an animal's coat. In the gerbil, Harderolipids make a significant contribution to pelage condition and subsequently to thermoregulation.

Sandbathing has been proposed as a means for regulating pelage oil content in a variety of species. A social-communicatory function for sandbathing has also been established for kangaroo rats. In this paper, the role played by Harderolipids in affecting components of sandbathing behavior and choice of sandbathing sites will be discussed. Harderolipid influences on open-field behavior in the gerbil will also be presented.

EFFECT OF ANTIBODY AGAINST ANISOLE BINDING PROTEIN ON ODORANT PERTURBATION OF Na^+-K^+ ATPASE ACTIVITY. R. B. Koch and Hernan Rossi, Dept. of Biochem., Miss. State Univ., Miss. State, MS 39762 and Steven Price, Dept. of Physiology, Med. Coll. Virginia, Richmond, VA 23298.

Price [Chem. Senses and Flavor 3, 51 (1978)] reported the isolation of an anisole binding protein (ABP) from dog olfactory epithelium. Goldberg et al. [Ibid. 4, 207 (1979)] showed that antibodies to the ABP were potent inhibitors of the mouse EOG (less than 1 ng was sufficient to cause greater than 50% inhibition of responses due to exposure to odorants. Koch and Gilliland [Life Sci. 20, 1051 (1977)] showed that odorants caused differential perturbation of Na^+-K^+ ATPase activity from dog olfactory epithelium preparations. In recent studies using antibodies to ABP, we observed that odorant perturbation of Na^+-K^+ ATPase activity from cow olfactory tissue was strongly affected by ng quantities of antibody. Antibody protein (80-32 ng per ml reaction mixture) prevented odorant perturbation of Na^+-K^+ ATPase activity. Antibody effect on odorant perturbation showed concentration dependence and was active against a number of different odorous chemicals. Thus electrophysiological and biochemical responses showed sensitivity to the antibody from the anisole binding protein from dog olfactory tissue. It is proposed that Na^+-K^+ ATPase is at least one form of specific binding protein for odorants present in the plasma membrane of the terminal swellings of olfactory tissue bipolar cells. It is further proposed that Na^+-K^+ ATPase may act as a transducer for initiation of nerve signals caused by odorant-enzyme complex interaction. Technical assistance of Mildred Sellars is gratefully acknowledged. Partial support from ARO Contract # DAAG 29-80-C-0033 and NIH Grant # DE 04271.

CYCLICAL VARIATIONS IN SALIVARY VOLATILES. James G. Kostelc[1], George Preti[1,2], Philip R. Zelson[1,3], George R. Huggins[2] and Joseph Tonzetich[4]. [1]Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA., 19104; [2]Dept. of Obstetrics/Gynecology and [3]Dept. of Oral Medicine, Univ. of Pa.; [4]Dept. of Oral Biology, Univ. of British Columbia, Vancouver, B.C.

It has been speculated that volatile organic compounds produced by humans may communicate information concerning the reproductive status of a female. In addition, these volatiles have potential for diagnosis of pathologic states. The time of optimum fertility in the human female is of considerable importance and volatiles characteristic of this time could be a significant diagnostic tool. Studies in our laboratory have shown that volatiles endogenous to the oral cavity such as the volatile sulfur compounds (VSC), H_2S, CH_3SH and $(CH_3)_2S$ may serve as indicators of time in the reproductive cycle. Since putrefactive processes which yield VSC also produce other volatile compounds found in saliva, an array of volatiles may cycle as do the VSC. Currently, we have only examined salivary volatiles from males as they relate to periodontal degradation. The present study extends previous work with VSC to include all volatile organic compounds in females. Donor females gave basal morning saliva each day for 2 cycles each. Basal body temperature charting was used to obtain the approximate day of ovulation. Longitudinal sampling of 2 males was done across 30 day periods. GC/MS analysis of volatiles reveals qualitative differences between female and male subjects. In addition, quantitative changes (2-10 fold increases) are found in certain compounds at various times in female cycles (viz. di- and trimethylsulfide, dodecanol, indole and diphenylamine). The results, together with VSC data, suggest that an array of volatiles in the oral cavity cycle.

CITRIC ACID AND INHIBITION OF GROWTH. Constance M. Kratz. Monell Chemical Senses Center.

Sixty male weanling rats were fed diets containing 10, 20, or 50% protein for 16 days. One-half of the animals at each protein level received the unadulterated control diet ad libitum, while the remainder of the rats were fed 4 diets with aversive additives (4% NaCl, 2.5% sodium saccharin, 3% citric acid, 3% sucrose octaacetate). These diets were rotated on a daily basis to minimize sensory habituation. The animals were then rehabilitated on the control diet for 4-8 days. Food intake and body weights were measured daily. The addition of aversive agents to the diet had no effect on cumulative food intake, weight gain, or efficiency of food utilization at any level of protein intake. However, analysis of the effect of each additive individually revealed that weight gain and feed efficiency, but not food intake, were significantly lower on days when citric acid was added than on other days. In the 24 hour periods after citric acid feedings, the animals showed increased weight gain without hyperphagia, so that there was no cumulative weight deficit over the 16 day period. On the first day of the recovery period, all experimental groups showed increased weight gain, efficiency, and a trend towards hyperphagia, although this latter measure was significant only in the 10% protein group. The 10% protein group continued to show hyperphagia and increased weight gain for the duration of the recovery period.

In a second experiment, 56 male weanling rats were fed a control diet or one containing 1, 3, or 6% citric acid or sodium citrate for 20 days; after this, the 3 citric acid-fed groups underwent a 12 day recovery period of ad libitum feeding on the control diet. Chronic feeding of citric acid or sodium citrate had no effect on food intake, but cumulative weight gain and feed efficiency were depressed by consumption of 6% citric acid diet. Food intake was unchanged in all groups throughout the recovery period. Rate of weight gain was elevated in 3 and 6% citric acid groups during recovery; feed efficiency was initially higher than in controls, but this difference diminished as recovery progressed.

THE MECHANISM OF CHEMOSENSORY ACCUMULATION BY THE CILIATE PROTOZOAN TETRAHYMENA. I. R. Lapidus and M. Levandowsky, Haskins Laboratories of Pace University, New York, NY 10038.

The freshwater ciliate Tetrahymena accumulates in capillary tubes containing solutions of peptone or certain amino acids. The mechanism of accumulation is largely orthokinetic: the cells swim slower in the attractant, and thus in a steady-state more cells tend to be found in the attractant than in control capillaries.

These results relate to models of accumulation and dispersion. It is shown that there are logical difficulties in deriving the usual Keller-Segel (macroscopic) equation from a microscopic picture of the organism's swimming behavior. In particular, the diffusion term of the equation,

$$\nabla_x \mu(x) \nabla_x N(x),$$

where ∇ is the gradient operator, μ is a diffusion coefficient, and N is cell number-density, should be replaced by the term

$$\nabla_x^2 (\mu(x)\, N(x)),$$

which appears in the Kolmogorov forward equation of biased diffusion.

Abstract Withdrawn

PHYSIOLOGICAL DIFFERENTIATION OF OLFACTORY RECEPTOR CILIA TYPES. R. G. Mair, R. C. Gesteland, H. Yancey, L. Meerschaert, and D. L. Blank. Northwestern Univ., Evanston, Il 60201 and Naval Research Lab, Washington, D. C. 20375.

Olfactory cilia are generally thought to be immotile except when shortened by damage. Previous experiments in our laboratory have demonstrated that undamaged cilia do move and that this motility is affected by odorous stimulation and by the ionic composition of extracellular fluid. Recent observations of excised tissue in ringers suggest that three types of cilia may be distinguished on the basis of morphology and patterns of movement when viewed under differential interference contrast microscopy. Ciliary types are also distinguished by the effects of extracellular ions, odorous stimulation and extracellularly applied detergent on their motility. We have named the types streamers, strokers and wigglers. Streamers are relatively long (70-200 m) and immotile. They have remained immotile in all the experimental manipulations we have performed. Strokers are of medium length (40-150 m) and move in a slow whip-like fashion. Wigglers tend to be shorter (10-40 m) and move more rapidly. Both wigglers and strokers exhibit altered motility in response to odorous stimulation. In general, wigglers are more sensitive to weak stimulation and stop sooner following overstimulation than strokers. Wigglers are also generally more sensitive to changes in the ionic composition of extracellular fluid. Wigglers and strokers slow to a stop within 20 minutes (wigglers stopping faster) when placed in Ca++ free ringers containing 0.1% Triton-X (which presumably reduces membrane ionic diffusion barriers). Both types of cilia restart when 4mM ATP, 4mM MgCl2, and 3mM EGTA are added to the detergent solution. This suggests that wigglers and strokers are like the extensively studied cilia of Paramecium caudatum in requiring the presence of ATP and Mg++ for their contractile proceses to operate. Taken together, the present results suggest that wigglers and strokers have similar contractile processes but different membrane properties which make them differentially sensitive to chemical changes in extracellular fluid. The present data do not indicate whether the different cilia reflect stages of differentiation or the occurrence of different types of mature olfactory receptors.

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INDIVIDUAL DIFFERENCES IN TASTE INTENSITY OF 6-N-PROPYLTHIOURACIL DETERMINED BY MAGNITUDE MATCHING. Lawrence E. Marks, Bathesheva Rifkin, Linda M. Bartoshuk, and Joseph C. Stevens, John B. Pierce Foundation Laboratory and Yale University, New Haven, CT 06519.

Differences in sensitivity to various taste substances are typically assessed in terms of differences in absolute threshold. Threshold measurements alone, however, leave open the question of differences in sensitivity above threshold. The present study assessed individual differences in suprathreshold sensitivity to 6-n-propylthiouracil (PROP) and NaCl by J. C. Stevens and Marks's method of magnitude matching: Each of 15 subjects gave magnitude estimates of the perceived intensities of various concentrations of PROP and of NaCl, and of various SPLs of a 1000-Hz tone; taste and sound trials were alternated within a given session, and the subject was instructed to judge taste intensity and loudness of a single common scale of perceived magnitude. This made it possible to calculate the SPL of the 1000-Hz tone whose loudness equaled each taste intensity. When the results were expressed in terms of such loudness "matches," they readily distinguished tasters from non-tasters of PROP. At the highest PROP concentration (3.2×10^{-3} M), tasters and non-tasters differed by more than 35 dB in their loudness matches. Individual subjects also differed in their matches to NaCl, though much less than in their matches to PROP; suprathreshold sensitivity to NaCl, as defined by the loudness matches, was similar in PROP tasters and non-tasters.

A BEHAVIORAL ASSESSMENT OF DETECTION THRESHOLDS FOR BUTYL ACETATE AND BUTYL ALCOHOL BY TIGER SALAMANDERS (AMBYSTOMA TIGRINUM)

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Electrophysiological investigations have shown that the response thresholds for olfactory receptor units involve concentrations between 10^{-6}M and 10^{-8}M for butyl acetate and butyl alcohol. The present study assessed whether these findings are reflected in behavior. Using an intense light as an unconditioned stimulus, two groups of tiger salamanders (Ambystoma tigrinum) were trained to respond to odorant-air mixtures of butyl acetate (3.1×10^{-5}M) or butyl alcohol (1.1×10^{-5}M). Then they were given test trials on which various concentrations of their training odorants were presented using a temporal forced-choice method of ascending limits. Results showed that reliable responding to odorant-air presentations was maintained by concentrations of butyl acetate above 2.4×10^{-7}M and concentrations of butyl alcohol above 8.5×10^{-8}M. These results provide behavioral support for electrophysiological studies of olfactory detection thresholds in these animals.

INTERACTIONS AMONG THE PROCESSES COMPRISING THE EAG

M. S. Mayer, R. W. Mankin and G. F. Lemire

The utility of the electroantennogram (EAG) in quantitative analysis is limited by the complexity of the processes involved in its generation. To help elucidate the nature of these processes we have investigated the interactions among compound stimuli and the effects of selectively stimulating parts of the antenna. By stimulating the antenna of Trichoplusia ni (Hübner) with its sex pheromone we found interactions among the carrier air, room air, and the pheromone. The greatest sensitivity to pheromone was obtained when the negative-going potential evoked from cells responding to high relative humidity was balanced by the positive-going potential from cells responding to low relative humidity. The response to pheromone from selectively stimulated antennal sections could be distinguished from the control response only at high pheromone doses and the response tended to be proportional to the number of sensilla stimulated. When portions of the antenna were removed, the magnitude of the EAG tended to be larger when the recording electrode was near areas of high sensillar density. This implies that the EAG arises predominantly from the sensilla nearest the recording electrode.

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EFFECT OF STIMULUS COMPOUND ON RANGE AND PROCEDURAL EFFECTS IN TASTE PSYCHOPHYSICS. Herbert L. Meiselman and Barbara L. Bell. US Army Natick R & D Command, Natick, MA 01760. Stimulus range is known to affect the slope (exponent) of psychophysical functions; larger stimulus ranges generally yield flatter psychophysical functions. In taste, it is also known that stimulus presentation procedure affects such functions; sipping a tastant yields steeper functions than flowing. Preliminary data presented at 1979 AChemS showed a range effect for both sipped and flowed salt (NaCl) stimuli, but only found a presentation procedure effect for narrow range stimuli (but not for wide range).

A follow-up experiment using more subjects and two stimulus compounds (NaCl, sucrose) has been completed. As before, magnitude estimations were obtained from salt stimuli of either 100-500 mM or 10-5000 mM, and from sucrose stimuli of either 100-500 mM or 20-2000 mM. In addition, psychophysical functions were obtained with both sipped and flowed stimuli.

Results for NaCl continued to show a range effect; both wide range functions were flatter (slopes .72, .76) than both narrow range functions (slopes .97, 1.09). Both wide range functions were remarkably similar to those reported last year for the same stimuli (.72, .78), while the narrow range functions were somewhat lower (1.05, 1.41).

Results for sucrose were puzzling. The slopes for all functions were approximately the same (0.74, 0.82) irregardless of presentation procedure or stimulus range. Previous data had shown that presentation procedure is a clear phenomenon for salt but not as clear for sucrose; it appears that estimates of sucrose strength continue to be difficult to predict, possibly because of other variables.

HRP USED TO TRACE OLFACTORY AND VOMERONASAL AXONS AFTER LESIONS
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Horseradish peroxidase (HRP) infused into the nasal cavities of an anesthetised hamster (50µl;20%) is taken up by olfactory and vomeronasal receptor cells and transported to main and accessory olfactory bulbs (MOB,AOB). When processed for HRP 24 hrs later the bulbs show a dramatic dark border where the main olfactory glomeruli are filled with reaction product (RP). Vomeronasal glomeruli in the AOB show very light RP in untreated animals but dense RP in animals treated with 0.2mg epinephrine. Epinephrine induced fluctuations in systemic blood pressure may operate the vomeronasal (VN) pump and draw HRP into the VN organ (VNO). This finding is consistent with the hypothesis that the VN pump and hence the VN system is usually activated only in appropriate behavioral contexts. We have used the HRP method to assess the extent of damage produced by lesions of the receptor cells or axons of olfactory and VN systems. Using the methods of Winans and Powers (Br.Res.126:325), the VN nerves passing between the MOBs were cut or the animals were infused intranasally with ZnSO4 (ZS, 0.17M in saline) to destroy olfactory receptors. Animals received epinephrine and intranasal infusion of HRP at various postlesion survivals and were sacrificed 24 hrs later. Horizontal 30µ frozen serial sections through the MOB and AOB were mounted on slides and processed by the TMB method. In some animals the VNO or olfactory epithelium was also processed. Where VN nerves were cut, no RP could be detected in AOB glomeruli in any section. The AOB glomerular layer showed some shrinkage but glomeruli, outlined by neutral red stained nuclei, were visible in all animals up to 26 days after VN cuts. All VN cut animals also showed evidence of MOB damage, some of which would not have been obvious without the use of HRP. The dorsal half of the medial MOB wall was often completely deafferented caudal to the cut but cell loss and glomerular changes there were not obvious. In all ZS treated animals, some RP appeared in the MOB on at least one side, mainly in the lateral wall but in some animals also in the rostral pole and ventromedial region. All ZS treated animals showed RP in the glomeruli of the AOB. At 6-9 day survival after ZS, animals which showed no interest in food odors (24 hr food deprived) had less RP in the MOB than those which did show interest. The differences in RP density and distribution between the groups was not striking. Experiments continue.

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DEVELOPMENTAL CHANGES IN SALT TASTE RESPONSES MAY CONTINUE POSTNATALLY IN LAMBS. C.M. Mistretta and R.M. Bradley, Dept. Oral Biol., Sch. Dent., U. Michigan, Ann Arbor, 48109.

Neurophysiological taste responses from both the peripheral and central nervous system change during development in the sheep. Among the most striking changes are those that occur during stimulation of the anterior tongue with four monochloride salts, NH_4Cl, KCl, NaCl, and LiCl. Essentially, NaCl and LiCl become more effective stimuli relative to NH_4Cl and KCl as development progresses. Such studies of developing taste responses can be especially fruitful in understanding basic taste function because correlates of the changes can be sought with microscopic and physicochemical techniques. But to correctly interpret correlates, it is essential to know with some precision when major changes occur.

We are defining the time course of alterations in chorda tympani nerve responses to chemical stimulation of the anterior tongue by recording from multifiber preparations. All responses are expressed as ratios relative to the response elicited by NH_4Cl, the most effective stimulus at all ages. Preliminary data are presented in this table.

	NH_4	K	Na	Li
110 day fetus (10)	1.00	0.84	0.24	0.22
130 day fetus (7)	1.00	0.70	0.34	0.44
50 day lamb (6)	1.00	0.66	0.72	0.87
Adult (2)	1.00	0.72	0.78	0.76

Examination of the NaCl and LiCl columns in the table illustrates the increasing effectiveness of these stimuli, relative to NH_4Cl and KCl. Data in these columns also indicate that a major change in the NaCl and LiCl responses occurs between 130 days of gestation (term = 147 days) and about 2 months after birth. Although by 130 days of gestation taste bud morphology at the light microscopic level is essentially similar to that of the adult, functional development is clearly not complete. These neurophysiological changes suggest that taste receptor maturation continues during late gestation and possibly postnatally in the sheep.

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THE OLFACTORY MARKER PROTEIN (OMP) IN THE NEUROEPITHELIUM OF ADULT MICE AFTER BULBECTOMY. G.A. Monti Graziadei, Dept. of Biological Science, Florida State Univ. Tallahassee, Florida 32306.

In adult mice, after section of the fila olfactoria the OMP disappears from the neuroepithelium as a consequence of the degeneration of the mature neurons. Once the neuronal population is reconstituted (Monti Graziadei and Graziadei, 1979), the content of OMP returns to normal values (Harding et al., 1977). In a new series of experiments in adult mice (3-6 months old), total bulbectomy was unilaterally performed. The mice were sacrificed at different postoperative survival times from 20 to 90 days, and perfused with Bouin's fixative. The bulbs and turbinates were embedded in paraffin and histological sections obtained. Selected sections were stained with the unlabeled antibody method (Sternberger et al., 1970) and adjacent sections were used as controls or stained with iron hematoxylin. Regeneration of neurons in the neuroepithelium, and regrowth of their axons into the cranial cavity, occurred in approximately 20 days in every bulbectomized animal. Two different results were obtained. When the regrowing axons reached the spared portions of the forebrain, forming glomeruli-like structures, the olfactory sensory neurons perikarya and axons reacquired their content of OMP. When scar tissue developed, effectively stopping the olfactory axons from reaching the forebrain, the OMP was restricted to the neurons located close to the epithelial surface. The olfactory axons were seen to form large neuromas in the cranial cavity, in close proximity to the lamina cribrosa. Positivity to the immunoreaction was present in the neuromas, however, some portions were unstained. The absence of OMP from the neurons when the axons fail to reach the forebrain, indicates that profound changes occur, possibly related to the maturative process of the neurons.

Acknowledgements. The antibody to the OMP was kindly provided by Dr. F.L. Margolis, Roche Institute of Molecular Biology, Nutley, N.J.. This research was supported by NSF Grant BNS 77/16737 and NIH Grant NS 08943 to Dr. P.P.C. Graziadei.

SACCHARIN PREFERENCE IN FLUID AND FOOD

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Nearly all rats prefer saccharin-sweetened to plain water over a range of concentrations. When saccharin is added to liquid or solid food, only a minority of rats show such a preference at any concentration. In those that do, the preference is fragile and easily disrupted. Neither starvation nor treatment with insulin recruits a saccharin preference in rats not spontaneously displaying one.

Damage to the hypothalamus does recruit a strong and consistent preference for saccharin-sweetened food in previous non-preferrers. This finding is further evidence that the failure of preference is not a ceiling effect. But it raises problems of its own: The saccharin preference in hyperphagic rats does not reflect a greater discriminativeness of food selection. It is accompained by an elevation, rather than a reduction, in absolute and differential preference and aversion thresholds for sapid solutes in water. The rat saccharin preference conceals mysteries that neither the "palatability" hypothesis, nor the "cue-to-food" hypothesis, can adequately resolve.

RATE-SENSITIVE DETECTION IN OLFACTION: VARIATION OF SENSITIVITY WITH THE HUMAN MENSTRUAL CYCLE

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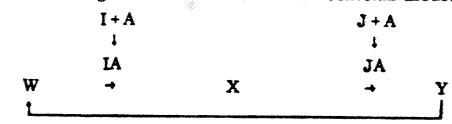
A mathematical model for human olfaction has been developed from the notion that the receptor responds to the slope of concentration with time, dC/dt, as well as to the concentration, C, of odorant. This model for a rate-sensitive detector is based on a kinetic scheme proposed by Koshland and MacNab[1] for bacterial chemotaxis. It generates appropriate psychophysical functions (including an incremental threshold resulting from adaptation) for "instantaneous" onset of stimulus. When the model is coupled with a more realistic presentation of stimulus, based on an analogy with gas chromatography (GLPC), it explains the variation in olfactory sensitivity that women exhibit during the menstrual cycle. The experimental result[2] that this variation is unique to only the most involatile odorants (e.g. Exaltolide, coumarin, cinnamyl butyrate) is predicted from the rate sensitivity of this model. The observed variation is entirely due to alterations in the access of odorant to the receptor and does not require any fluctuation in the sensitivity of the receptor itself.

The following version of the Koshland-MacNab model was used:[3]



A represents odorant molecules. I and J are regulatory enzymes that, when bound to A, catalyze the production and destruction, respectively, of an intermediate X. Output of the receptor is taken to be a monotone increasing function of the concentration of X. By the GLPC analogy, concentration of odorant at the receptor will vary with time as $\mathrm{erfc}(1/\sqrt{4Dt})$, where D is an effective diffusion coefficient. The effect of variations in D on the maximum values of X will be discussed.

References

1. MacNab, R.M. & Koshland, D.E., Proc. Nat. Acad. Sci. USA 1972, 69, 2509-2511.
2. Mair, R.G.; Bouffard, J.A.; Engen, T; & Morton, T.H., Sensory Processes 1978, 2, 90-98.
3. Hoshikawa, H. & Saito, N., J. Theor. Biol. 1978, 70, 1-15.

ANION AND CATION INFLUENCES ON THE TASTES OF FIFTEEN HALIDE SALTS.

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The fact that the effectiveness of a given salt in eliciting an impulse in taste neurons is largely determined by the size of the cation (Beidler, Handbook of Percept., VI, A, 1978) does not necessarily predict that the cation size will determine the magnitude of the perceived saltiness of that salt for man, although it may predict the total intensity of the salt. Total perceived intensity of the salt will reflect magnitude of saltiness, magnitude of any non-salty tastes and accompanying water tastes, all as affected by mixture suppression (Bartoshuk, Murphy and Cleveland. Physiol. & Behav., 1978, 21, 609-613). The common halide salts (e.g. LiCl, NaCl, KCl) can elicit varying magnitudes of sweet, sour, bitter and/or salty tastes depending on the salt concentration (Dzendolet and Meiselman. Percept. Psychophys., 1967, 2, 29-33; Cardello and Murphy. Chem. Senses Flav., 1977, 2, 327-339). Both concentration-dependency and magnitudes of the qualities of the less common halides are yet to be investigated. Hence, relative effects of anion and cation on the magnitudes of the qualities of these salts remain unclear. In the present study, the first experiment employed the method of magnitude estimation to examine the intensity of sweet, sour, bitter and salty at four concentrations of each of the following fifteen halide salts: LiCl, LiBr, LiI, NaCl, NaBr, NaI, KCl, KBr, KI, RbCl, RbBr, RbI, CsCl, CsBr and CsI. All fifteen salts tested showed concentration-dependent shifts in taste quality, eliciting non-salty as well as salty tastes. In a second experiment, a NaCl rinse was used to cross-adapt the saltiness of these salts in order to explore the non-salty qualities. Results of these experiments indicate that cation and anion each contribute to the perceived tastes of the halide salts. Both heavier cations and heavier anions generally produced the more bitter salts. Weight of the cation had no consistent effect on the perceived saltiness of the salt; however, lighter anions produced saltier salts. Removing the saltiness of the halides through cross-adaptation to NaCl increased perceived bitter magnitudes of the salts of the heaviest anion (I^-), but had minimal effect on bitterness viewed as a function of cationic weight.

MOLECULAR MECHANISM OF QUINONE PERCEPTION BY INSECTS

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Many quinones are major natural allomones or kairomones for many species including numerous insects. Knowledge of the mechanism of their perception thus is important. Evidence that reversible oxidative-reductive chemistry is involved in such chemical senses was presented previously (Norris, D.M. 1969. Ann. Entomol. Soc. Amer. 63:476-478; Norris, D.M. et al. 1970. Science 170:754; Rozental, J.M. and Norris, D.M. 1973. Nature 244:370-371). These and our other published findings also proved that perception involved reversible oxidation-reduction of sulfur atoms in proteinaceous macromolecules in dentritic membranes of chemosensory neurons. However, the exact mechanisms and involved chemical species have remained ill defined. Using fluorescence spectrophotometry, evidence of intermediates and products from 2-methyl-1,4-naphthoquinone (menadione) interactions with receptor preparations was obtained. Detailed analyses of the kinetics of involved reactions were conducted. Unless otherwise stated all reactions involving receptor were run at pH 6.0 in a deoxygenated 0.1 M PO_4, 0.9% NaCl buffer. Menadione concentrations, initially in 95% ethanol, were added to buffered preparations in a manner that yielded a final concentration of 10% ethanol in each preparation. Interaction of menadione with sulfhydryl-containing receptor involved first-order kinetics, and produced fluorescent emission with a maximum at 420nm. Excitation maxima appeared at 245 and 333nm. All appropriate controls failed to yield these characteristics. All data, including the excitation and emission spectra of the product of the studied interaction, support the product as being the reduced (i.e., hydroquinone) form of menadione. Experimental findings thus are compatible with the mechanism of menadione perception being a direct hydrogen transfer from receptor to messenger ligand. Detailed experimental data will be presented. (Research supported partially by N.S.F. grant #BNS74-00953).

THE COMPOUND TASTE OF SACCHARINS.

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If a compound taste stimulus has one weak and one strong component, the strong component may overshadow the weaker in aversive conditioning, resulting in a measurable aversion only to the stronger component. Pre-exposure to the stronger component prior to aversive conditioning with the compound stimulus renders that component less effective, and the weaker component more effective for conditioning (Nowlis and Frank, 1977). Sodium saccharin is reported at strong concentrations to have a bitter component to man, yet aversive conditioning with Na saccharin in hamsters establishes a sucrose aversion, not a quinine aversion. Furthermore, a given concentration of insoluble saccharin produces more activity in hamster whole chorda tympani than does Na saccharin, the latter solution being less acidic than the former. Conditioning with these two saccharin solutions following nine days exposure to sucrose produces the expected results:

1) both establish a quinine aversion;
2) only insoluble saccharin produces an HCl aversion.

PITUITARY REGULATION OF FEMALE CHEMOSENSORY SEX SIGNALS IN MICE (MUS MUSCULUS)

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Male mice emit ultrasonic vocalizations when highly aroused sexually. The male ultrasounds are often emitted in the presence of a female but are also emitted in the presence of female chemosensory cues (e.g. urine) in the absence of the female. Thus the vocalizations can serve as a robust, naturally-occurring, biologically-relevant assay for the presence of female-specific chemosensory cues.

Several lines of research indicate that pituitary rather than ovarian hormones are important in hormonally regulating the production of the female-specific ultrasound-eliciting cue. Female ovariectomy performed prepubertally or in adulthood, with or without accompanying adrenalectomy, had little or no effect upon elicitation of ultrasounds by female urine. Hypophysectomy, however, eliminated the ability of female urine to elicit ultrasounds. Exogenous administration of levels of testosterone and estrogen which are known to inhibit the production and release of pituitary gonadotropins also reduced the ultrasound-eliciting properties of female mouse urine. Finally, the ability of hypophysectomized females to produce urine which elicits ultrasounds was restored by exogenous administration of gonadotropins. This research was supported by NSF grant BNS77-15265.

DOES DIETARY INTAKE OF SALT, SWEETS, AND FATS INFLUENCE SENSORY PERCEPTION OF NaCl, SUCROSE, AND BUTTERFAT?*

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The folkloric contention, "You are what you eat," was seldom reflected in altered sensory responses to salt, sugar, and fat in beverages, as a function of dietary intake of the corresponding ingredients or food products.

NaCl. Neither perceived intensity nor degree of liking for NaCl in diet tomato juice differed among young adults classified according to low, medium, and high intake of salt. Threshold determinations with 57 subjects revealed no significant correlations between dietary salt intake and sensitivity to NaCl in distilled water or in diet tomato juice. Forced-choice, paired comparison tests showed more correct responses among low-salt users for water solutions, with a reversed relationship when the salt was tested in tomato juice, suggesting that results from model systems cannot be extrapolated to foods.

Sucrose. Perception of sweetness intensity in lemonade did not differ among 51 subjects classified according to low, intermediate, and high intake of dietary sugar. However, those with higher intakes gave the highest hedonic response to lemonade with 14% added sucrose, whereas those with lower intakes ascribed highest hedonic scores to lemonade with 8-10% added sucrose.

Butterfat. Grouping subjects by fat intake resulted in three patterns of response in a forced-choice, paired-preference test. The 16 low-intake subjects gave increasing preference for increasing amounts of butterfat (0.25, 0.75, 1.5, 3.0, and 5.0%) in skimmilk; the 27 intermediate-intake subjects preferred the second level with decreasing preference for increasing concentrations; the 27 high-intake subjects varied little from the 50% chance level for any concentration of butterfat.

Classification of 53 different subjects by frequency of intake of dairy products, resulted in similar responses to intensity of butterfat in skimmilk, and in degree of liking for lower levels of butterfat (0, 2, 3, and 4%). However, subjects who rarely consumed dairy products demonstrated greater dislike for the high-fat milks (8 and 16%) than did subjects with intermediate and high intakes. When subjects were grouped according to type of milk normally consumed (none, nonfat, lowfat, or whole), slightly different patterns of hedonic response to added butterfat (0, 2, 3, 4, 8, and 16%) in skimmilk were observed.

* With appreciation to graduate students, S. Pecore, K. Bos, and M. Giovanni.

POSSIBLE PSYCHOPHYSICAL POWER FUNCTIONS IN MARINE ORGANISMS

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To measure variation in the intensity of food searching with stimulus strength, hake, Urophycis chuss, were presented with a series of concentrations of a clam extract, and the amount of time spent swimming and moving the chemosensitive pelvic fins over the substrate was recorded. Power functions related the duration of both aspects of food searching to the extract concentration. If one assumes food searching duration is proportional to the magnitude of sensation, then this measure of intensity obeyed Stevens' psychophysical power law. If the assumption is true, then the simple power law relating magnitude of sensation and stimulus strength in humans may also describe the same relationship in another vertebrate.

DIMETHYL DISULFIDE: A CUE FOR NIPPLE ATTACHMENT IN ALBINO RATS.

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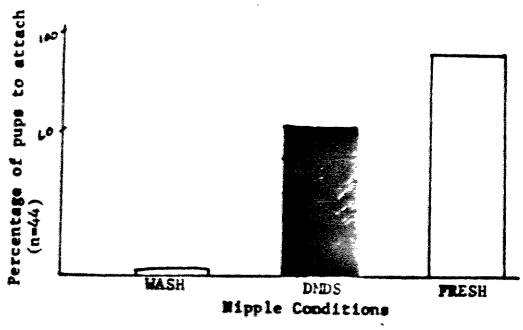
Albino rats depend heavily upon olfactory cues for location and attachment to the mother's nipples (Bruno, Blass & Teicher, 1979; Teicher & Blass, 1976, 1977). Chemical lavage procedures that clean the nipple of organic substances virtually eliminates nipple attachment in rat pups 0-28 days of age. Painting the washed nipple with amniotic fluid or saliva and salivary gland extract of littermates restores nipple attachment to prewash levels. Isotonic saline, mother's diet or urine, bovine milk, and corn oil do not elicit nipple attachment at any time. The narrow range of substances that elicit nipple attachment and the specificity of the behavioral response guided us to isolating and identifying the chemical properties of saliva that elicit nipple attachment.

The literature suggested to us that dimethyl disulfide (DMDS) might be the critical cue controlling nipple attachment on the following grounds: (1) DMDS has been found to be behaviorally active, (2) DMDS probably exists in rat saliva. Accordingly, DMDS was tested for its ability to elicit nipple attachment. Painting a synthetic sample of DMDS onto a washed nipple (to which pups do not attach) reinstates nipple attachment in rat pups 3-5 days of age.* Analysis by gas chromatography/mass spectrometry indicates that DMDS is a prominent component of saliva obtained from 3-5 day old rat pups. Thus, DMDS is sufficient to elicit nipple attachment in neonatal rats.



IDIOPATHIC MALODOR PRODUCTION IN HUMANS, George Preti[1,2], James G. Kostelc[1], George R. Huggins[2], Henry J. Lawley[1], Philip R. Zelson[1,3] and John McKitrick[4]. [1]Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA 19104; [2]Dept. Obstetrics/Gynecology and [3]Dept. of Oral Medicine, Univ. of Pennsylvania; [4]William Pepper Laboratory, Hospital of the Univ. of Penna.

The production of malodor from disease states has received some attention - particularly amongst pediatricians. Characteristic malodors often accompany the onset of certain diseases, particularly those involving lesions in amino acid metabolism or anaerobic infections. We have had several patients whose principal presenting complaint is an offensive odor originating in the oral cavity or genital region. In addition, these patients have often been examined by clinicians from several specialities who find them to be clinically normal. We present here two case studies: one patient presented with oral malodor (Sub. A) while the second presented with an objectionable urine odor from her vagina (Sub. B).

The profile of volatile compounds obtained from Sub. A's saliva contained a greater variety and concentration of volatile compounds than would be expected in the saliva of healthy patients Also, both the salivary headspace and mouth air from this patient contained relatively large amounts of volatile sulfur compounds, including dimethyldi- and trisulfide. The latter 2 compounds have not previously been seen in mouth air at detectable levels. The sulfur compounds discussed above could account for the reported malodor.

The separated organic constituents extracted from the vaginal fluids of Sub. B were subjected to organoleptic evaluation as they eluted from a gas chromatograph. GC/MS analysis of the single broad peak which contains the urine odor indicated the presence of benzoic acid and an aromatic hydroxy acid whose structure is being elucidated. There was no evidence for the presence of androgen steroid metabolites. The presence of a large amount of benzoic acid suggests a bacterial origin for the odorant being sought.

24-Hour Free-Feeding Patterns in Beagles

Eating and drinking by four adult male beagles, housed in outdoor conditions, were monitored by a photobeam arrangement mounted over the food and water bins. Photobeam breaks were recorded on a strip-chart recorder 23 hours a day with approximately 1 hour reserved for a maintenance intervention. Total daily intakes of dry food and water, and the animals' body weights, were recorded as well. Clusters of photobeam breaks were defined as eating periods, and two definitions of "meals" were employed to describe the patterns of eating. When the one-hour maintenance intervention occurred early in the morning, the number of "meals" peaked during the post-maintenance intervention period, at dusk, and at dawn. A change to mid-afternoon intervention shifted the dusk meal to a later time. Drinking tended to be prandial.

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ISOLATION, BIOCHEMICAL CHARACTERIZATION AND ODORANT BINDING OF CILIA

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The role of cilia in recognition of olfactory stimuli has been controversial. Previously published studies used electrophysiological techniques to assess their function and led to conflicting reports. The controversy over the role of the olfactory cilia has unfortunately not had the benefit of biochemical experiments.

Elucidation of the role of cilia in odor recognition and detailed examination of the specificity and mechanisms of odorant-cilia interactions appear difficult to achieve without obtaining a functionally active, isolated cilia preparation. We have isolated such a preparation from the olfactory rosettes of rainbow trout. Several biochemical markers were used to characterize the preparation and in addition, electron microscopy revealed the presence of cilia. The preparation was ascertained to be functionally active by its binding activity for ^{3}H-labeled odorant amino acids. L-Alanine, L-serine, L-threonine, L-lysine and D-alanine bind to the cilia preparation and the binding parameters correspond with those reported previously for Fraction P2 from the same species (1). These data demonstrate the functional activity of the isolated cilia.

The present approach now enables a more clear definition of the role of cilia in olfaction. Isolation from the olfactory epithelium of a cilia preparation with odorant binding activity provides biochemical support for the long-standing hypothesis that receptor sites for odorant molecules are an integral part of the cilia. We suggest that the receptor molecules, which are probably proteins, are localized in the membranes of the cilia.

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1. Cagan, R.H. and Zeiger, W.N., *Proc. Nat. Acad. Sci. U.S.A.* 75, 4679-4683 (1978).

THE BITTER TASTE OF POTASSIUM CHLORIDE, SODIUM BENZOATE, AND POTASSIUM BENZOATE IS RELATED TO THE GENETIC ABILITY TO TASTE 6-N-PROPYLTHIOURACIL.

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The bitter taste of three substances, potassium chloride, sodium benzoate, and potassium benzoate was found to be related to the genetic ability to taste the bitter substance 6-n-Propylthiouracil (PROP). Taste thresholds for the bitter substances PROP, phenylthiocarbamide or phenylthiourea (PTC), and other compounds containing the -N-C=S group show a bimodal distribution. Those least sensitive to PROP (nontasters) carry two recessive genes for taste blindness to PROP; the most sensitive (tasters) are either heterozygous or homozygous for the dominant gene.

Ten tasters and ten nontasters scaled the perceived intensities of the sweet, sour, salty, and bitter taste qualities of sodium chloride, potassium chloride, sodium benzoate, and potassium benzoate according to the method of magnitude estimation. Tasters found the bitterness of the latter three substances to be significantly greater than did the nontasters. This finding is important because potassium does not contain the -N-C=S group originally believed to be necessary for the bimodal bitter threshold distribution. Bartoshuk recently reported a similar finding: sodium saccharin (which also lacks the -N-C=S group) tastes significantly less bitter to nontasters than to tasters. The finding that the bitter taste of potassium chloride, sodium benzoate, and potassium benzoate is related to the genetic ability to taste PROP is of special importance because the source of the bitter taste is not the same for all three substances. The bitter taste of potassium chloride is attributed to the potassium cation, the bitter taste of sodium benzoate is attributed to the benzoate anion, and the bitter taste of potassium benzoate is attributed to the combined action of the cation and anion. The nature of this interaction is currently under investigation.

PSYCHOLOGICAL VS. SENSORY ADAPTATION FOLLOWING REPEATED EXPOSURE TO A TASTE CONTEXT

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Saltiness and pleasantness of soups were judged in four contexts defined by the relative frequency of stimuli high and low in NaCl concentration. Context affected judgments of saltiness such that a given stimulus was judged saltier when presented in a distribution including many low concentrations, less salty when higher concentrations were more frequent. Ratings of pleasantness were also effected by context; concentrations judged intermediate in saltiness tended to be rated maximally pleasant.

In a second experiment, rate and method of stimulus presentation were manipulated to assess the possible role of sensory adaptation in the observed contextual effects. Although reliable differences between methods of presentation were obtained, they were much too small to account for the observed effects of context.

A third experiment tested the duration of the observed contextual effects. The effects of two distributions of stimuli on perception of saltiness were tested immediately after exposure to the context, 1 hour after exposure, 4 hours after exposure, and 3 weeks after exposure. The effects of context were still apparent after 1 hour but had faded after 4 hours of delay. Results suggest an analogy between contextual effects as established in the laboratory and the effects of simple exposure to a food context (e.g., a specific diet) in everday experience.

ENZYMATIC PRODUCTION OF CUES ATTRACTING HERMIT CRABS TO SHELL ACQUISITION SITES. Dan Rittschof, Dept. of Physiology, UCLA School of Medicine, Los Angeles, CA 90024.

Hermit crabs require a gastropod shell of appropriate size for a variety of functions including survival. The availibility of shells limits hermit crab populations. Thus, the ability of hermit crabs to locate new undamaged shells is very important. The crabs cannot generally kill the original owner of the shell and thus must find empty shells or trade shells with other crabs. We report here a chemical mechanism by which hermit crabs are attracted to sites where gastropod predators are eating gastropod prey. The prey shell emptied in this manner is undamaged and suitable for occupancy by hermit crabs. The crabs come to the sites, interact with other crabs and wait for the prey gastropod shell to become availalbe. McLean (1974) hypothesized from behavioral observations that the attraction of the hermit crabs was chemically mediated. Our work confirms this hypothesis, suggests that the chemical cues are peptides, and predicts that the feeding predator releases a protease which produces the molecular attractants. We limited release at the test sites to molecules of less than 5,000 mW with dialysis membranes. The field experiments show that small molecules released from the flesh of the gastropod prey attract hermit crabs to the test sites. In addition, the hermit crab attractant molecules are specific as only snail flesh is attractive and the flesh of one snail species attracts one species of hermit crab while the flesh of a second snail species attracts a different hermit crab species. Tests without a predator but with gastropod flesh revealed that species such as blue brabs and fish (which are known to respond to amino acids) are attracted in minutes while hermit crabs are not attracted until several hours later. The addition of a specific endopeptidase, trypsin, which cleaves proteins only at lysine and arginine residues rendered the test sites attractive to hermit crabs on a time scale measured in minutes. The trypsin mediated response is similar to that observed at sites with a predator present. This suggests that the cue is produced from the prey snail flesh by a protease from the feeding predator. Preliminary molecular sizing by peptide gel analysis indicated that the cues are peptides containing less than 15 amino acid residues. Column chromatography of the active fraction suggested that the molecules are less than 6 amino acid residues in length. Amino acid sequencing of the peptides in this fraction is currently in progress. This work was funded by the curiosity of the author and his friends.

Olfactory Influences on Mother-Infant Attachment in Humans, Michael J. Russell & Terrie Mendelson. University of Calif., Brain Behavior Research Center, Sonoma State Hospital, Eldridge, Calif., 95431.

Previous research in this laboratory and others has shown that humans are able to recognize individuals by natural body odors. In this study we wished to determine if mothers are able to identify their infant by olfactory cues. Three tests were conducted on nine mothers and their vaginally delivered, normal, full term infants. The first test was conducted at two hours, the second at six hours, and the third at 48 hours post partum. In each test, the mother was asked to select her own infants' odor from that of strange infants in a three choice condition. In the first test the odor samples were vernix caseosa (birth covering) which had been collected on gauze pads just after delivery. In the second and third test the odor samples were the infants themselves placed in hospital bassinets. The mothers were blindfolded and the infants were quiet or sleeping. Our results indicate that mothers are not able to identify their infants odors at two hours, however, they can identify their infants odors at 48 hours. When asked which odors they preferred, the mothers chose their own infants most frequently.

These results suggest that mothers are able to identify their own infants. Further, they are able to do so with a frequency which is comparable to that which has previously been demonstrated for women identifying their own odor. We feel that mothers are learning to identify their infants in the first hours after birth.

TASTE PROFILES FROM SINGLE HUMAN CIRCUMVALLATE PAPILLAE: COMPARISONS WITH FUNGIFORM PROFILES. Barbara Sandick and Armand V. Cardello. US Army Natick R & D Command, Natick, MA 01760. In pilot experiments a technique was developed to chemically stimulate single circumvallate papillae in humans. Data obtained in these experiments from 12 papillae in 4 Ss revealed characteristic quality responding to suprathreshold concentrations of sucrose, quinine hydrochloride and citric acid in all Ss. However, stimulation with NaCl resulted in consistent sour and/or bitter quality responses in 3 out of 4 Ss. These data were similar to data obtained previously from stimulation of single fungiform papillae and from stimulation of restricted areas of the anterior tongue, in which the taste quality elicited by both NaCl and citric acid solutions was described equally often as sour or salty. Further tests to assess quality responding in single circumvallate papillae and to compare these responses to stimulation of comparable-sized areas in the fungiform region of the tongue havebeen completed.

Test solutions were 1.6 M sucrose, 5.0 M NaCl, .125 M citric acid and .0015 M quinine hydrochloride, and were chosen during pilot testing to ensure clear taste sensations. Solution droplets (.25ml) were presented in random order to single circumvallate papillae and to fungiform regions. Ss profiled the elicited sensations by apportioning magnitude estimates of intensity among the 4 basic taste qualities. Analysis of the response profiles for sucrose exhibited no differences between the two areas of stimulation. However, the circumvallate response profiles for quinine hydrochloride exhibited a significantly greater bitter component than the fungiform profiles. In addition, significant differences were observed in the profiles for both NaCl and citric acid. In both cases, significantly greater salty components were observed in the fungiform profiles and significantly greater sour components were observed in the circumvallate profiles. A comparison of the fungiform response profiles for NaCl and citric acid showed them to be identical, whereas the circumvallate profiles for these compounds were distinct.

These data are interpreted as showing significant differences in quality responding between circumvallate and fungiform papillae and suggest that circumvallate stimulation may play an important role in the discrimination and identification of the taste of electrolytes.

COMPARISON OF OLFACTORY NERVE TWIG, MUCOSAL NEURAL, AND EOG RESPONSES IN THE AMERICAN EEL, ANGUILLA ROSTRATA. Wayne L. Silver Department of Biological Science, Florida State University, Tallahassee, Florida, 32306. Present address: Department of Physiology, School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, 19104.

Although several electrophysiological recording techniques have been used to study the peripheral olfactory system of fishes, the relationships between the results obtained with these techniques have not been well examined. Three population response methods were compared in the present study in the American eel - neural responses recorded from the olfactory nerve and mucosa and the underwater electro-olfactogram (EOG).

Responses obtained with all three methods increased exponentially with logarithmic increase in stimulus concentration. This can be described by a straight line on a log-log plot. Thresholds were determined by intersecting the straight line with the control response value (the response to well water in which no stimulus was added). It was found that the eel's olfactory system is highly sensitive, with thresholds for L-glutamine averaging $10^{-9.6\pm1.9}$M (N=42) using nerve twig recordings, $10^{-7.8\pm1.2}$M (N=26) using EOG recordings, and $10^{-8.2\pm0.6}$M (N=13) using mucosal neural recordings. The nerve twig response increased more slowly with increasing concentration than the other two responses. In order to achieve a tenfold increase in nerve twig response magnitude it was necessary to increase the L-glutamine concentration by 10.3±2.7 log units, whereas a tenfold increase in EOG and mucosal neural response magnitude required increases in L-glutamine concentration of 5.3±1.2 and 6.5±1.5 log units, respectively.

The relative stimulatory effectiveness of 11 amino acids was also examined. There was little difference in the ordering of these compounds for the three peripheral recording methods.

The EOG and mucosal neural preparations can be obtained in most fishes, quickly and with a minimum of surgery. In using either of these methods, however, the possibility of a few log units loss in sensitivity must be taken into account. (Supported by NIH grant NS-08814)

ULTRASTRUCTURAL CHANGES IN THE OLFACTORY BIPOLAR NEURONS FOLLOWING OLFACTORY NERVE SECTION. P.A. Simmons, J.A. Rafols, and T.V. Getchell. Dept. Physiol., Yale Univ., New Haven, CT; and Morin Mem. Lab., Dept. Anat., Wayne State Univ., Detroit, MI

After sectioning the olfactory nerve the bipolar receptor neurons in the olfactory epithelium degenerate and are subsequently replaced by a new population of receptor neurons. In order to understand the changes occuring during this process we undertook an ultrastructural study of the olfactory epithelium of the salamander, Ambystoma tigrinum. After unilateral olfactory nerve section tissues were examined with the electron microscope following postoperative survival periods ranging from 12 hours to 90 days. Tissues from unoperated animals and the controlateral epithelia from each experimental animal served as controls. Normal mature receptor neurons have an elongated cell body containing a thin rim of cytoplasm and an ovoid nucleus with a characteristic "checkerboard" chromatin pattern. A single dendrite issues from the apical pole of the cell body and projects to the surface of the epithelium. From the apex of this dendrite numerous cilia project into the overlying mucus. A single, unmyelinated axon originates at the basal pole of the cell and traverses the basal region of the epithelium. Below the basement membrane these axons are enveloped in large numbers by Schwann cells, forming the olfactory nerve. After nerve section retrograde degeneration of the mature neurons is complete by day 10. Early in the degenerative phase the nucleus of the receptor neuron shows pronounced condensation of the chromatin, increased number of membrane infoldings, and dilatation of the space between the membranes of the nuclear envelope. At a later stage the cytoplasm of the cell increases in volume and its organelle systems break down, resulting in accumulation of various forms of cell inclusions. Accompanying degeneration of the neuronal population proliferation of cells in the basal region of the epithelium occurs. Apical processes containing centrioles are observed, suggesting that these cells are the precursors of the mature receptor neurons. At 29 days after nerve section profiles of dendrites and axons are distinguished throughout most of the epithelium, but the apices of the dendrites do not appear to reach the surface. Dendritic profiles containing microtubules, smooth endoplasmic reticulum, centrioles, and basal bodies are seen at or near the surface at 58 days. Cilia project from the dendrites reaching the surface. By day 88 neurons within the epithelium have resumed their normal ultrastructure. Correlation of the ultrastructural changes with previously reported neurophysiological studies indicates that neuronal activity of the epithelium is dependent upon the presence of fully differentiated olfactory receptor neurons.

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SILASTIC NERVE CUFFS CONTAINING COLCHICINE ACT UPON THE NERVE TRUNK AND NOT THE TONGUE TO ELIMINATE TASTE BUDS.

H. Sloan, L. B. Jones, and B. Oakley. Div. Biol. Sciences, Univ. Mich. Ann Arbor, MI 48109

To evaluate the effects of blocking axonal transport to the fungiform taste buds of the gerbil, Meriones unguiculatus, silastic cuffs containing 0 to 5.0% colchicine (w/v) were placed around the combined lingual-chorda tympani nerve. Electrophysiological recordings were made from the chorda tympani in the middle ear in response to taste solutions applied to the tongue 8hr to 15d after cuff implantation. Subsequently the tongues were histologically examined for the presence of taste buds. Normal taste responses and taste buds were obtained with control cuffs containing 0% colchicine. The absence of ipsilateral chorda tympani taste responses produced by a 1% colchicine cuff was correlated with ipsilateral degeneration of fungiform taste buds. In order to determine whether colchicine was acting at the level of the nerve trunk or the tongue, 1% colchicine curfs containing 0.79 μCi-7.86 μCi H^3-colchicine (specific activity 10.1 Ci/mmole) were placed around the combined lingual-chorda tympani nerve. Liquid scintillation counting of aliquots of the solubilized left and right halves of the anterior portion of the tongue revealed that colchicine levels were closely similar in the left and right halves of the tongue. Further, normal taste responses and fungiform taste buds were observed contralaterally to the cuff. We conclude that colchicine acted at the level of the nerve trunk and not in the tongue to eliminate ipsilateral chorda tympani taste responses and fungiform taste buds. Supported in part by NS-07072.

OLFACTORY DISCRIMINATION BEHAVIOR AFTER THALAMIC AND AMYGDALA LESIONS IN RATS. Burton M. Slotnick, The American University, Washington, D. C.

Method: Rats were initially trained on a visual discrimination task and then received sham lesions (n=7), lesions of the LOT at the level of the anterior amygdala (n=4), or of the mediodorsal thalamic nucleus (n=12). After surgery they were tested for retention of the visual task, trained to discriminate the odor of ethyl acetate from propyl acetate (.05% vapor saturation) and given reversal tests. Finally, animals were trained to detect the presence of a .005% concentration of amy acetate. A wind-tunnel operant chamber was used for discrimination training; odors were generated by an air-dilution olfactometer.

Histological Results: Amygdala lesions transected the LOT and destroyed surrounding portions of the piriform cortex and anterior amygdala. Discrete symmetrical lesions of the MD nucleus were obtained in 6 rats. The remaining 6 rats of the MD group had small asymmetrical lesions.

Behavioral Results: Animals with anterior amygdala lesions and those with asymmetrical MD lesions performed as well as controls on all tests. Animals with lesions destroying the greater part of MD had no deficits in visual discrimination retention, acquisition of the 2-odor problem, or the amyl acetate detection problem. However, they performed poorly on the odor reversal tests ($p<.005$).

Conclusions: Current anatomical and electrophysiological studies have demonstrated that, in addition to the piriform lobe, there are prominant olfactory projections to the amygdala, the hypothalamus, and the mediodorsal nucleus of the thalamus. Available evidence has implicated the hypothalamic projections in the control of neuroendocrine events, and the limbic projections as important in pheromonal communication. The present study provides the first evidence that the olfactory projections to the thalamus, but not to the limbic system, are important in complex learning involving olfactory cues.

ANALYSIS OF MARMOSET SCENT MARKS BY GC/MS. A.B. Smith, III, J. R. Donnelly, J. G. Kostelc, and G. Epple. Monell Chemical Senses Center, 3500 Market St., Philadelphia, Pa. 19104

Chemical communication via scent marking (with specialized scent glands) is involved in conveying a variety of behaviorally important messages (*e.g.* species, gender, individual identity, social rank) among such neotropical primates as *Leontopitheous rosalia* and *Callithrix jacchus*. To complement our recent study (*J. Chem. Ecol.* 3,45 [1977], 5, 543 [1979], *Tetrahedron Lett.* 983 [1976]) of the marmoset *Saguinus fuscicollis*, we have recently undertaken a comparative study of *C. jacchus* and *L. rosalia*, an endangered species. Scent marks were collected by allowing the monkeys to "mark" frosted glass plates or tubes. Solvent extraction (CH_3OH/CH_2Cl_2) followed by concentration and analysis by gas chromatography/mass spectrometry indicated the presence of the following mark components: in *L. rosalia*--C_5-C_9 alcohols, aldehydes, acids, C_{16} and C_{18} hydrocarbons and acids; in *C. jacchus*--C_{11} and C_{13} methyl ketones, C_{16} alcohol, C_{16} and C_{18} acid methyl esters, C_{20} and C_{22} terminal acetylenes. Further work is underway to identify the remaining components as well as to correlate the components to behavioral responses. Comparisons of the mark components of *L. rosalia* and *C. jacchus* to those of *Saguinus fuscicollis* will be discussed.

COMPARISON OF CHEMOSENSITIVE RESPONSES FROM THE CHORDA TYMPANI, GLOSSOPHARYNGEAL AND SUPERIOR LARYNGEAL NERVES IN THE LAMB. H.M. Stedman, C.M. Mistretta, and R.M. Bradley, Dept. Oral Biol., Sch. Dent., U. Michigan, Ann Arbor, MI 48109

In most electrophysiological investigations of chemosensitive responses, taste buds on the anterior tongue, supplied by the chorda tympani nerve, are studied. However, a large proportion of chemosensory input is via the glossopharyngeal and superior laryngeal nerves. We compared integrated chemosensitive responses from each of these three nerves while stimulating the anterior tongue, posterior tongue and epiglottis respectively, in lambs. For stimulation of the tongue, chemicals were dissolved in distilled water, which was also used as the rinse. For the epiglottis, 0.154 M NaCl was used as solvent and rinse, since water stimulated epiglottal chemoreceptors while 0.154 M NaCl did not.

The mean ratios of the adapted response to each stimulus relative to the 0.5 M KCl response are:

	NERVE		
Stimulus	VII	IX	X
0.5 M KCl	1.00	1.00	1.00
0.5 M NH_4Cl	1.59	2.61	[1.23]*
0.5 M NaCl	1.05	0.34	0.11
0.5 M LiCl	1.37	1.07	0.04
0.1 M citric acid	1.37	0.31	1.13
0.01 N HCl	0.45	1.83	0.63
1 M sucrose	0.18	0.49	0.00
0.02 M QuHCl	0.03	0.29	0.15
distilled water	0.00	0.00	0.64

(* 0.5 M NH_4Cl elicits a short duration, high frequency response in the superior laryngeal nerve, which rapidly adapts to the unstimulated level of activity. Therefore, since a steady state response is not obtained, this ratio is derived from single fiber studies).

NH_4Cl and KCl are very effective stimuli for taste buds supplied by all three nerves. Relative to the response to KCl, NaCl and LiCl decrease in effectiveness as the chemosensitive area becomes more caudal. Sucrose, QuHCl and HCl are more effective on the posterior tongue than on the anterior tongue or epiglottis; conversely, citric acid is relatively least effective on the posterior tongue. Distilled water is only an effective stimulus on the epiglottis, producing a response comparable with that for HCl. It can be concluded that chemosensitive responses are different for each of the areas studied. The dissimilarities may relate to the various functional roles of taste buds in these locations.

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AGE-RELATED CHANGES IN FLAVOR PERCEPTION. David A. Stevens and Harry T. Lawless. Clark University and U.S. Army Natick R & D Command, Natick, MA 01760. Three groups of subjects, aged 18 to 25 years (Young), 36 to 45 years (Middle) and 56 to 65 years (Old) judged the similarity of pairs of pureed fruits and vegetables and rated these foods on 10 attribute scales. The similarity judgements were analyzed by multidimensional scaling, and the attribute ratings were subjected to analyses of variance. In general, the Young subjects rated all foods as having a more bitter flavor than did the Old subjects. For three rating scales, like-dislike, sharp-flat, and fruity-vegetable like, there were age by food interactions. Young subjects liked corn to a greater degree than did the Middle or Old groups. The Young groups judged cantaloupe, green pepper, lima bean, onion, and pea to have sharper flavors than did the Old group. And the Old subjects gave cantaloupe, carrot, green pepper, and turnip ratings nearer to the neutral point of the fruit-vegetable scale than did the Young subjects. The multidimensional scaling showed similar three-dimensional solutions for the three age groups. However, the sharp and bitter foods, green pepper and onion, showed an orderly displacement with age along a dimension which might be considered intensity. Together, these results suggest that flavor perception in late Middle age is affected by a decrease in sensitivity to bitter substances, to a factor related to sharpness, and to odors.

HAMSTER FOOD SELECTION: CONDITIONED AVERSION TO BASIC TASTES. Robert D. Sweazey and David V. Smith. Dept. Psychol., Univ. Wyoming, Laramie, WY 82071.

Hamsters were placed for six days in a semi-natural environment, consisting of a sand-filled chamber maintained on a 12-hr light/dark cycle, from which a series of plastic tunnels projected "underground" and were kept in constant red light. Water was available ad lib in the sand-filled chamber and 5 gm each of 10 foods were placed in this area at the beginning of the six-day period. The hamster was introduced into the tunnel system and its behavior, nest location and food distribution were noted daily. All foods were hoarded within a couple of hours after the animal was placed in the tunnel, and were consistently stored near the nesting site, typically at the lowest points in the tunnel system. At the end of the session, the animal was removed and the location and amount remaining of each food was measured. In the saline-injected control animals there was remarkable consistency in the order of preference among these foods. Raw peanuts were consistently the most favored, followed by shelled sunflower seeds, rye, wheat, oats, soybeans, rice, barley, corn and Great Northern beans. Eighty percent of the peanuts were consumed, but only sixteen percent of the Great Northern beans.

If the animal was injected with 30 mg/kg apomorphine on the day prior to its introduction to the test chamber, consumption of all foods was reduced by 60-100 percent and normal hoarding behavior was disrupted. This widespread neophobia occurred only if the poison-induced illness was not paired with a distinctive gustatory cue. Additional animals were given apomorphine paired with either sucrose, NaCl or HCl. Rather than a general neophobia, these animals demonstrated consistent and unique patterns of food consumption, depending upon which taste quality was paired with the illness. For example, after sucrose aversion the most preferred foods (e.g., peanuts and sunflower seeds) were less avidly consumed, with concomitant increases in the consumption of some other foods. The consumption pattern following NaCl aversion involved a greater reduction for some of the same foods (e.g., rye and wheat) and the additional reduction of others (e.g., soybeans and Great Northern beans). Following HCl aversion, on the other hand, there was no generalization of the aversion to peanuts and an even greater reduction in the consumption of sunflower seeds. Thus, the gustatory (and possibly olfactory) cues provided by these basic taste stimuli have a very direct influence on food consumption. If the animal can associate the poison-induced illness with distinct oral cues, then its behavior toward novel food substances comes under oral control.

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DEVELOPMENTAL STUDIES OF THE OLFACTORY BULB: 2-DEOXYGLUCOSE UPTAKE PATTERNS IN SUCKLING RAT PUPS. Martin H. Teicher[a], William B. Stewart, John S. Kauer, and Gordon M. Shepherd. Sections of Neurosurgery, Neuroanatomy, and Gross Anatomy, Yale University Sch. of Med., New Haven, Ct. 06510.

Recent studies have provided behavioral evidence that olfaction is the dominant sensory modality for nipple localization by suckling rat pups (Teicher and Blass, Science 193:422, 1976). These studies have implied that the nipples are coated with a lipid-soluble substance that may act as a pheromone to attract the pups. As part of a study of the functional development of the olfactory system, we have extended the 2-deoxyglucose (2DG) method of Sokoloff to neonatal animals in order to detect sites of uptake in the olfactory bulb correlated with suckling behavior.

Rat pups 5-15 days of age have been used. Following intracardiac injection of ^{14}C-2DG (20 μC/100 g) the pups were placed on their anesthetized mother, in direct contact with a nipple. Attachment occurred within a few minutes, and suckling continued for 45 minutes. Preparation of the olfactory bulbs for autoradiography was by standard methods.

In 12 of 13 animals there was a focus of 2DG uptake in the dorsal part of the main olfactory bulb, at a position just medial to the accessory olfactory bulb. Correlation with the histological sections indicated that in most cases the focus was localized in or near a small group of glomeruli. Scattered foci were also present in medial and lateral parts of the bulb. In control experiments, pups exposed to room air or pure air showed activity in the above regions, but the overall patterns were not as heavily concentrated in the dorsomedial position. Exposure of pups to amyl acetate gave patterns similar though not identical to patterns found in adult rats exposed to this odor (Stewart, Kauer and Shepherd, J. Comp. Neur., in press). Increased 2DG uptake was also observed in the lateral preoptic area of most rat pups in all experimental conditions. Experiments are in progress to further define the specific sites correlated with pheromone-induced activity in newborn pups.

COMMUNICATION AND THERMOREGULATION BY HARDERIAN PIGMENTS AND LIPIDS. Thiessen, Del; Pendergrass, Merri; Gregg, Barbara; & Kittrell, E. Melanie W. Department of Psychology, University of Texas at Austin, Austin, Texas 78712.

Mongolian gerbils, Meriones unguiculatus, spread Harderian pigments and lipids on heat exchange areas of the body and on the hair during grooming. The material is sequestered in the conjunctival sac and is released down the Harder-lacrimal canal to the nares of the nose following muscular activity of the eye orbit. The Harderian material attracts conspecifics immediately following a groom and can stimulate grooming in conspecifics. The material is spread widely on the hair and insulates the animal from cold stress. In addition, Harderian substances on the hair regulate the reflectant quality of the pelage and hence affects thermoregulation under solar radient conditions. The gerbils apply the material by grooming and perhaps remove it by sandbathing in order to control body temperature. They may also regulate the material on the hair in order to better match their substrate.

TAURINE THRESHOLDS IN LOBSTER CHEMORECEPTION.
Hilary Thompson and Barry W. Ache.
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Precise measurement of receptor thresholds is important in understanding the role a sense organ plays in the biology and the sensory information processing of an organism. Two considerations have led us to reevaluate crustacean chemoreceptor thresholds. First previously published electrophysiological thresholds are high due to adaptation imposed by the use of high stimulus intensities and the order effects of stimulus sequence. Secondly the crustacea rival or exceed bony fish in the acuity of their behavioral amine detection (Pearson, W.H. and B.L. Olla, Biol. Bull.153:346,1977). Convergence of primary receptor axons on secondary olfactory cells is ca 30:1 in crustaceans (Sandeman, D.C. and S.E. Luff, Z. Zellforsch 142:37, 1973), 1000:1 in fish (Doving, K.B. and G. Gemne, J. Neurophysiol.28:139, 1965). Primary receptor cells of crustaceans may thus be more sensitive than those of fish if convergence accounts for the olfactory acuity of fish.

Using an experimental design geared to minimizing adaptation we show that the single units of the taurine sensitive chemoreceptor population of the spiny lobster (Panulirus argus) respond consistently at $5X10^{-12}$M, the lowest concentration used in this study. This suggests that the receptor threshold may be somewhat lower. For the total spike count (10 sec post stimulus, background count subtracted) the slope of the receptor population dose response plot on log-log coordinates (0.18±0.08,N=31) requires extrapolation over ten orders of magnitude to reach threshold at $5X10^{-23}$M taurine. This value is mitigated against both by its extreme nature and by the width of the regression line's confidence limits at ten decade steps from the data points. Mean response to control seawater did not provide a means of limiting the dose response plot, as it did not intersect the dose response curve. (Mean response to control=-0.459)

Comparison of our data on lateral and medial antennal filament receptors showed that there is no significant difference in sensitivity between the two populations suggesting that threshold differences are not the basis for the differential effect of lateral vs medial filament ablation on orientation. Stimulus error compared with receptor population response variability showed that a degree of variability was inherent in the receptor responses. The role of this response variability in lobster distance chemoreception may be to prevent receptors from losing temporal resolution by "falling in step" during the phasic stimulation that arises during flicking (Schmitt, B.C. and B.W. Ache, Science 205:204, 1979).

RESPONSIVENESS OF THE OLFACTORY RECEPTOR CELLS IN DOG AND BOX TURTLE TO ALIPHATIC n-FATTY ACIDS.

Keiichi TONOSAKI and Don TUCKER,
Department of Biological Science, Florida State University, Tallahassee, Florida, 32306.

Electrophysiological studies of olfactory receptor cells in the dog and box turtle have shown that a response is generated in an olfactory nerve twig when odorous air (aliphatic n-fatty acids C_3 to C_{10}) is applied to the mucosa. The dog's and the box turtle's response magnitude increases with increasing odor concentration. The relative response magnitude plotted against the carbon chain length of aliphatic n-acetates (C_2 to C_9) show similar curves for dog and box turtle (reported at the previous AChemS). However, the aliphatic n-fatty acids show slightly different curves. The dog's response magnitude is decreased with an increase in carbon chain length, but the box turtle's response magnitude increased up to C_7 and then decreased with an increase in carbon chain length.

IS TASTE RELATED TO ANOREXIA IN CANCER PATIENTS? A.S. Trant, J. Serin, H.O. Douglass, B.P. Halpern. Dept. of Surgical Oncology, Roswell Park Memorial Institute, Buffalo, New York and Nutrition and Psychology, Cornell University, Ithaca, New York.

The varied reports of abnormal thresholds in cancer patients (pts) gives rise to a controversy surrounding studies of appetite loss in neoplastic disease. Since no clearly definitive study exists, the objective of this project was to explore and reduce the sources of variation present in the literature and to determine whether taste is related to anorexia in cancer pts. Perception of the intensity and pleasantness of suprathreshold concentrations (conc) of NaCl, sucrose, citric acid and urea in common beverages was measured with an analogue scaling procedure in 62 pts at Roswell Park Memorial Institute with primary tumors in upper gastrointestinal or thoracic areas, 35 of whom were receiving chemotherapy. All pts were preliminarily grouped anorectic (anor) or nonanorectic (nonanor) based on their subjective self-rating of appetite. Those pts rating themselves as having a reduced appetite for food were classified as anor, unless the reduction in appetite was due to complications of the disease process (e.g., chemotherapy, surgery, tumor growth, etc.) in which case the pts were classified as nonanor. Adequate distinction between these 2 groups was confirmed by significant differences ($p < .05$) among the following parameters:

Group	Anor	Nonanor	Group	Anor	Nonanor
Number	26	36	Number	26	36
- Appetite[1] rating	2.00	4.06	-% Weight loss (1 month)	6.77	2.00
- Activity[1] rating	3.19	4.06	-% Ideal body weight	89.12	100.42
- Hunger[2] rating	14.77	29.36	- Adjusted cal[3] oric intake	101.68	160.75
- Mood rating[2]	27.08	14.28	- Serum albumin[4]	31.58	37.11

[1]5 point scale, [2]mm, [3]24 hour recall, [4]g/l

Analysis of variance of taste scores for subjects matched by age, sex, race, tumor site, and therapy demonstrated no significant differences in intensity or hedonic functions between anor and nonanor groups ($p > .05$). Slopes and y-intercepts of the intensity functions of anor pts did not differ from those of nonanor pts. And the conc of NaCl, citric acid and urea given the highest hedonic score by each pt did not differ between groups. However, the most preferred conc of sucrose of nonanor (mean=.68M) was significantly higher than that of anor (mean=.49M). Thus, taste perception in the suprathreshold conc range is not altered in anorexia, contrary to the conclusions of prior investigations which imply a relation between taste threshold and appetite loss. Only the pleasantness of sucrose differs between the 2 groups of cancer pts, anorectics preferring slightly lower sweetness levels.

STABILITY OF URINE-BASED CHEMICAL COMMUNICATION IN THE GUINEA PIG. Judith L. Wellington and Gary K. Beauchamp. Monell Chemical Senses Center, 3500 Market St., Philadelphia, Pa 19104

When presented with samples of male or female conspecific urine, male guinea pigs spend a considerable time investigating the urine. In a series of two-choice tests males discriminated among samples of urine indicating that a complex array of information is transmitted including genus, species, individual identity and recent dietary history. In particular, adult male guinea pigs spend much more time investigating (headbobbing, licking, sniffing) at female compared to male conspecific urine and more time investigating conspecific urine than heterospecific urine or a water control.

Chemical studies have indicated that the information on species and sexual identity is transmitted in part through compounds of high molecular weight (approx. 800 g/mole). It might then be anticipated that this information might not dissipate rapidly. The present study was undertaken to determine the stability of the chemical signals which transmit sex information.

In one study, samples of female urine were aged at room temperature for 20 days. The urine was either dried on glass plates (100 µl each) or held in vials during the 20 days. Sexually mature male guinea pigs were then given a series of choice tests comparing the urine (either dried or wet) with water. Regardless of whether the urine was aged on the plates or in vials it retained considerable attractiveness (mean investigating time for urine 38.7-52.4 sec; mean investigating time for water 5.3-9.2 sec).

To determine whether information differentiating male from female urine was also stable and to extend the time parameters, an additional study was conducted. Pooled samples of male and female guinea pig urine were aged at room temperature for between 20 days and 40 days. The same males were given choices between male and female urine aged 20 and 40 days. Even in urine aged 40 days, information on sex was still discernible to the subjects; aged female urine was preferred to aged male urine.

These studies, in conjunction with chemical work, indicate that the active components of guinea pig urine are highly stable under laboratory conditions. While natural conditions (e.g. rain, sunlight) would limit the stability of signals in the field, these studies do demonstrate that urine-based information could remain in the environment for a considerable period. Furthermore, they suggest that the active component(s) are not highly volatile nor are they rapidly eliminated by microbial activity.

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Behavioral and Anatomical Study of the Reconstitution of the Olfactory Nerves in Pigeons

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A psychophysical procedure was developed in which the pigeon was required to make different responses in the presence of clean air and various concentrations of amyl acetate in air. The pigeon was physically restrained and was unable to remove its head from the stimulus air stream. Absolute thresholds were determined and bilateral olfactory nerve sections were performed. The time course of the reconstitution process was then found by observing the decreases in thresholds across successive postoperative days down to postoperative levels. The olfactory bulbs were thenexamined, by use of a silver degeneration stain, to compare the degree of innervation in normal pigeons and those with newly reconstituted olfactory nerves.

HEDONIC,INTENSITY AND SALIVARY RESPONSES BETWEEN ELDERLY AND COLLEGE-AGE SUBJECTS TO GUSTATORY AND OLFACTORY FOOD STIMULI

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Comparison of sensory responses to gustation (saltiness and sweetness, both hedonic and intensity) and olfaction (intensity, odor recognition) was studied in 25 healthly elderly subjects (mean age: 83.0; SD: 5.0) and college students (mean age: 24.0; SD: 7.2). In addition, whole-mouth salivary flow rates were measured in response to sniffing and tasting lemon wedges and lemonade. Utilizing a 17-point, category structured scale, the taste hedonics and intensity responses to 6.0, 8.0, 10.0, 14.0, and 18.0% w/v sucrose in lemonade and 0, 1.0, 2.5, 4.5, and 7.0% NaCl in unsalted tomato juice were studied. Hedonic responses peaked for both groups at the 1.0% w/v NaCl level in tomato juice and the 14.0% w/v sucrose in lemonade. The positively sloped intensity responses to saltiness and sweetness were similar, although the elderly demonstrated a narrower range of response than the college students. In the olfactory studies, subjects compared odor recognition of ten food odorants, including the intensity of the first 7 using an unstructured 100mm line scale. Correct identification of the ten food odors averaged 86% and 33.5% for the college and elderly, respectively. Compared to the elderly, college students rated the seven odorants as being significantly more intense (mean: 61.4 vs. 42, $t = 4.49$, $p < .01$). In the final study, 2-minute salivary flow rates were measured under various conditions. Resting levels of salivary flow were similar for both groups. However, unlike the college students, salivary flow in the elderly did not increase due to sniffing lemons and increased only moderately in response to tasting lemonade. This research was partially supported by a NIH Training Grant No. GMO 1818, and the L. J. Minor Corp.

ACCESS OF LOW VOLATILE STIMULI TO AND CLEARANCE RATES FROM THE MAMMALIAN VOMERONASAL ORGAN. Charles J. Wysocki, Gary K. Beauchamp, Judith L. Wellington, Susan Erisman, Margaret L. Barth. Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA 19104

Mice, rats, guinea pigs, pine voles and meadow voles were tested in one of three behavioral situations: investigation of a social stimulus (urine); drinking of a novel solution (saccharin); or self grooming stimulated by the application of a foreign substance (carboxymethylcellulose [CMC]). In all situations the stimulus (urine, saccharin, CMC) was mixed with a fluorescent dye, rhodamine B, prior to its presentation or application. The animal was allowed to contact the stimulus ad libitum for a predetermined amount of time. Immediately thereafter the animal was killed and the vomeronasal organ was removed, sectioned and surveyed with epifluorescence microscopy for the presence of rhodamine specific fluorescence.

The results were clear cut. The "nonvolatile" fluorescent dye was observed in the vomeronasal organs subsequent to the investigation of urine, the consumption of a novel substance and self grooming.

We also explored the clearance of substances from the vomeronasal organ. Male mice were killed at one of a variety of survival times after a brief presentation of rhodamine-dyed female urine. The vomeronasal organs were surveyed for the presence of the fluorescent dye. Although the dye is strongly lipophilic, these studies indicated that it was rapidly cleared from the organ.

Thus, low volatile substances encountered in urine, novel solutions, or a cellulose-based gum have access to the vomeronasal organ. That this access occurs in a variety of contexts suggests that this receptor organ could be involved in the regulation of social behavior, ingestion, and in "self-smelling", a much broader array of behaviors than has generally been presumed. Specific experiments designed to test these hypotheses are required. Furthermore, although stimulus access to a chemoreceptor is necessary for stimulation to occur, it is not sufficient. At present, we do not know the properties of molecules which may activate the vomeronasal organ.

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