Oral Neuroscience 2021

Saturday, February 5th, 2022

Program & Abstract

Challenge to Intractable Oral Diseases

大阪大学 OSAKA UNIVERSITY

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Access

This meeting will be held on-line by “zoom”. All the attendees must install “zoom” before attending the meeting. The meeting ID and access URL are announced by e-mail of acceptance for your registration.

Presentation information

Please prepare slides for your presentation by using a presentation software (e.g. powerpoint, keynote, etc) and use the function, “Share Screen” (「画面の共有」) at your presentation.

Presentation time

- ✓ The time allowed for the slide presentation of plenary lectures is 55 minutes including for discussion.
- ✓ The time allowed for the slide presentation of mini review is 30 minutes including for discussion.
- ✓ The time allowed for the slide presentation of short talk is 15 minutes including for discussion.

Oral Neuroscience 2021

Online (Zoom)

09:00-09:05　Opening Remarks　Atsushi Yoshida

Session 1	Chair	Susumu Tanaka

09:05-10:00

[plenary lecture 1] Rhythm generation

Hidehiko Koizumi

(National Institute of Neurological Disorders and Stroke, National Institutes of Health)

Coffee break (10 min)

Session 2	Chair	Atsushi Yoshida

10:10-11:05

[plenary lecture 2] Morphological foundation for craniofacial sensory processing and oral motor function in the brain stem

Yong Chul Bae

(Dept. of Anat. and Neurobiol., School of Dentistry, Kyungpook Natl. Univ.)

Coffee break (10 min)

Session 3	Chair	Yusuke Yokota

11:15-1145

[mini review 1] Structure and Function of Somatosensory Innervations.

Satomi Ebara

([1]Dept. Anat. Meiji Univ. Integrative Med. Kyoto, [2]Dept. Oral Anat & Neurobiol, Grad Sch. Dentistry, Osaka Univ.)

11:45-12:00

[short talk 1] Cerebral cortical projections from the oval paracentral nucleus in the intralaminar thalamic nuclei in the rat.

Yumi Tsutsumi

(Dept. of Oral Anatomy and Neurobiology, Osaka Univ. Grad. Sch. Dent.)

12:00-12:15

[short talk 2] Early impairment of Mes V neuron comparing other types of sensory neurons in ALS model mouse

Soju Seki

(The First Department of Oral and Maxillofacial Surgery, Osaka University Graduate School of Dentistry)

Lunch (12:15-13:15)

Session 4	Chair	Chizuko Inui

13:15-13:30

[short talk 3] Effects of age and sex difference on the taste disorder caused by dietary zinc deficiency.

Akiyo Kawano

([1]Oral Anatomy & Developmental Biology, Osaka University Graduate School of Dentistry, [2]Oral Health Sciences, Otemae College)

13:30-13:45

[short talk 4] Behavioral analysis of long-trace conditioned taste aversion in rats

Keisuke Shinohara

(Behavioral Physiology, Human Sciences, Osaka Univ.)

13:45-14:00

[short talk 5] Prolonged decline in motivation level after sucrose reward devaluation in free-feeding rats: lick microstructure analysis of consummatory successive negative contrast

Jilada Chongmankhong

(Division of Behavioral Physiology, Graduate School of Human Sciences, Osaka University)

Coffee break (10 min)

Session 5	Chair	Hiroki Toyoda

14:10-14:40

[mini review 2] Dopaminergic nervous system and orofacial neuropathic pain

Hiroharu Maegawa

(Department of Dental Anesthesiology, Osaka University Graduate School of Dentistry)

14:40-14:55

[short talk 6] Longitudinal changes of mastication after weaning in the rats

Masaharu Yamada

([1]Department of Oral Physiology, [2]Department of Dental Anesthesiology, Graduate School of Dentistry, Osaka University)

14:55-15:10

[short talk 7] Biological Clock and Regulation of Dentinogenesis in Mouse Molars

Ryutaro Ono

([1]Department of Physiology and Systems Bioscience, Kyoto Prefectural University of Medicine, [2]Department of Dental Medicine, Kyoto Prefectural University of Medicine)

15:10- Closing Remarks

Abstract

Rhythm generation

Hidehiko Koizumi
National Institute of Neurological Disorders and Stroke,
National Institutes of Health

Rhythmical behaviors such as breathing, chewing and walking are critical for life in mammals. The cellular and circuit mechanisms generating these rhythms have been investigated for decades. We have studied respiratory rhythm generation and motor pattern formation operating in the rodent brainstem using multiple state-of-the-art and newly-developed experimental techniques as well as computational simulation approaches. I will discuss the recent advances of our understanding of neuronal/glial and circuit biophysical mechanisms generating the respiratory and masticatory rhythm and modulating the amplitude of these rhythmic activities in the brainstem.

Key Words: Breathing, Mastication, CPG

Morphological foundation for craniofacial sensory processing and oral motor function in the brain stem

Yong Chul Bae
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Elucidation of synaptic connectivity of axon terminals arising from specific neuron, involved neurotransmitters and receptor in specific neural circuit may help understand how the neural information conveyed via the specific neuron is processed and transmitted at the target brain area. In this presentation, I would like to talk about our findings on the 1) central connectivities of the various types of A-beta mechanosensitive trigeminal afferents in the trigeminal sensory nuclei (TSN) and 2) plasticity of the synaptic structures associated with peptidergic and non-peptidergic C afferent terminals in the inflammatory pain condition, which may help understand how specific craniofacial sensory information is processed at the 1st relay nucleus of the brain stem in normal and pathologic pain condition: We found that synaptic connectivities of the trigeminal sensory afferents differ among fiber types and among their projection nuclei, suggesting that craniofacial sensory information is processed in a distinctive manner depending on the fiber types and their projecting TSN. 2) We also found that substance P+, CGRP+ and isolectin B4 (IB4)+ axon terminals show change in their morphology and connectivities in the inflammatory pain condition compared to normal condition. 3) I also would like to talk about our findings of the inhibitory and excitatory synapses on the somata of the Vmes neuron: Vmes neurons show distinctive distribution pattern of GABA+, glycine+ and glutamate+ axon terminals on their somata and express extrasynaptic, homomeric glycine receptors, which is different from trigeminal motor neurons showing subsynaptic, heteromeric glycine receptor.

Key Words: C nociceptive afferent, trigeminal mesencephalic neuron, synaptic connectivity

Structure and Function of Somatosensory Innervations.

Satomi Ebara[1, 2], Aya Takenaka[2], Ren Nishimoto[2], Taiga Muramoto[1], Atsushi Yoshida[2], Takahiro Furuta[2]

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One of the most exciting subjects for us in 2021 may well be that TRP (trip) channel research won the Nobel Prize. TRP channels were well known as “Receptors for Temperature”. In addition, TRP channels also sense and react to chemical stimuli such as menthol and capsaicin. However, for our purposes it is just a part of what is commonly called somatosensory research that includes tactile sense. We will present an overview of structure and function of somatosensory innervation and we will show details of tactile sensation. Somatosensory receptors are formed at the peripheral tips of primary sensory neurons. All mechanoreceptors are discriminated by their morphology. Except for trigeminal mesencephalic nucleus, most cell bodies are distributed in trigeminal ganglia for the head and facial areas, and dorsal root ganglia for the body and limbs. The neurons are pseudo-unipolar whose peripheral branches form sensory receptors, central branches terminate in the brain or spinal cord. Recently, we detected single neurons by using intra-cellular, or intra axonal recording and labeling methods. Those results showed that those single neurons of mechanoreceptors innervate individual single kinds of receptors. Receptor units may be counted at the terminal point / hemi-node where myelinated axon lose their myelin sheath and initial action potentials are evoked. Fine caliber afferents, perhaps A-delta type, originated from a small cell body in the trigeminal ganglion. These are innervating palisade endings widely spread in the facial skin of the rat. On the other hand, Merkel endings and lanceolate endings in the whiskers are restricted to tiny receptive fields. Many kinds of mechanoreceptors and free nerve endings are distributed within overlapping. Think in terms of playing a symphony played by individual primary sensory neurons in the somatosensory system.

Key Words: primary sensory neuron, mechanoreceptor, intra cellular recording and labeling

Cerebral cortical projections from the oval paracentral nucleus in the intralaminar thalamic nuclei in the rat.

Yumi Tsutsumi[1], Yuka Mizuno[1, 2], Fumihiko Sato[1], Misaki Inoue[1], Yayoi Morita[1, 3], Takahiro Furuta[1], Ayaka Oka[2], Masayuki Moritani[4], Yong Chul Bae[5], Yoshihisa Tachibana[6], Atsushi Yoshida[1]
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The oval paracentral nucleus (OPC) is isolated from the paracentral nucleus (PC) in the rat intralaminar thalamic nuclei. We have demonstrated that proprioceptive sensation arising from rat jaw-closing muscle spindles is conveyed to the OPC. To reveal the OPC-cortex projections, we performed three experiments in rats. (1) We injected an anterograde neural tracer biotinylated dextranamine (BDA) into the OPC which was identified by recording field potentials responded to the electrical stimulation of masseter nerve and the extension of masseter muscle. BDA-labeled axons and terminals were observed in the primary (S1) and secondary (S2) somatosensory cortices and the granular insular cortex (GI). The cortical distribution of BDA-label was widespread and contiguous among the three cortical areas (S1, S2 and GI), but not separated. (2) To reveal the PC-cortex projection, we injected BDA into the caudal PC. Labeled axons and terminals were observed in the medial and lateral agranular cortices. These findings clearly showed that the cortical projection pattern was different between the PC and OPC efferents. (3) Finally, we injected a retrograde neural tracer Fluorogold into the S1, S2 and GI where the BDA-labeled terminals from the OPC were observed in (1). Among the intralaminar and sensory thalamic nuclei, only the OPC sent strong projections to all of the three cortical areas. In conclusion, the cortical projection features were different between the OPC and the other intralaminar and sensory thalamic nuclei. The proprioceptive sensation conveyed through the OPC-cortex pathway may be involved in sensory discrimination and integration. (COI : No)

Key Words: OPC, Muscle sensation, Cerebral cortex

Early impairment of Mes V neuron comparing other types of sensory neurons in ALS model mouse

Soju Seki, Yoshihiro Kitaoka, So Kawata, Susumu Tanaka
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Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease in which motor neurons degenerate, resulting in muscle atrophy, paralysis, and fatality. Studies using mouse models of ALS indicate a protracted period of disease development with progressive motor neuron pathology, evident as early as embryonic and postnatal stages. Key missing information includes concomitant alterations in the sensorimotor circuit essential for normal development and function of the neuromuscular system. Leveraging unique brainstem circuitry, we show in vitro evidence for reflex circuit-specific postnatal abnormalities and irregularities in the jaw proprioceptive sensory neuron (Mes V neuron) in the well-studied SOD1G93A mouse. These include impaired and arrhythmic action potential burst discharge. However, the mechanoreceptive and nociceptive trigeminal ganglion neuron (TG neuron) was resistant to excitability and rhythmic changes in age-matched SOD1G93A mice. Another type of sensory neuron, which the visual sensory retinal ganglion neuron (RG neuron) was also resistant to excitability changes. These results demonstrate a novel reflex circuit-specific proprioceptive sensory abnormality in ALS.

Key Words: ALS, Mes V neuron, TG neuron

Effects of age and sex difference on the taste disorder caused by dietary zinc deficiency.

Akiyo Kawano[1, 2], Chizuko Inui-Yamamoto[1], Naoya Saeki[1, 3], Makoto Abe[1], Takashi Maeda[1], Satoshi Wakisaka[1, 4]

[1]Oral Anatomy & Developmental Biology, Osaka University Graduate School of Dentistry, Osaka, Japan, [2]Oral Health Sciences, Otemae College, Hyogo, Japan, [3]Special Care Dentistry, Osaka University Dental Hospital, Osaka, Japan, and [4]Kansai Women's College, Osaka, Japan.

Zinc is one of the essential minerals for humans and animals, and low zinc conditions cause various abnormalities such as growth retardation, anorexia, epilation, skin parakeratosis, impaired immune responses and hypogeusia (decreased taste acuity). Zinc deficiency is thought the most common cause of taste disorder. It is known that the zinc deficiency in young and adult life can have specific and distinct effects (Keller et al., 2001). Clinically, a male-to-female rate of patients complain of taste disorders is about 2:3 (Japanese Society of Stomato-pharyngology, 2003). In the present study, thus, we examined the age-dependent influence of taste disorder caused by dietary zinc deficiency in both male and female rats.

Male and female Sprague–Dawley rats at the age of 3 weeks (young; male and female), 11 weeks (young-adult; male and female), 22 weeks (adult; male) and 35 weeks (old; female) were fed with low-zinc diet or normal diets for 4 weeks. The behavioral analysis of taste disorder was conducted by 2-bottle preference test and brief access test. In male animals, changes in taste preference demonstrated by 2-bottle preference test were recognized in salt (NaCl), sour (HCl) and bitter (quinine) in young-group, while young adult-group showed the change in preference to salt only. However, there was no difference in the preference rates for these solutions in adult-group. In female group, changes in taste preference demonstrated by 2-bottle preference test were recognized in salt and bitter in both young and young adult group. Even in the old group, the preference rate for these solutions has tended to increase.

The present results indicate that taste disorder caused by dietary zinc deficiency is more severe in younger animals in both male and female animals, and the effect of dietary zinc deficiency on taste disorder is apparent in female animals even at older ages.

Key Words: Dietary zinc deficiency, Taste disorder, 2-bottle preference test

Behavioral analysis of long-trace conditioned taste aversion in rats

Keisuke Shinohara, Yasunobu Yasoshima
Behavioral Physiology, Human Sciences, Osaka Univ.

Conditioned taste aversion (CTA) is considered a Pavlovian conditioning in which the tastant (conditioned stimulus, CS) is associated with a gastrointestinal malaise (unconditioned stimulus, US), but has the unusual property of tolerating a lengthy interval between the CS and US presentations. For example, rats can acquire a CTA even when the CS-US interval lasts several hours (long-trace paradigm), although the expression of conditioned responses is weaker than the short-trace paradigm of CTA. However, the qualitative differences in the expression of conditioned responses between these paradigms of CTA are not well understood. Here, we compared the ingestive behaviors of rats that acquired CTA in the short- or long-trace paradigm. For conditioning, a CS (25 mM saccharin solution) was presented for 20 minutes in the chamber to measure the approaching and licking spout of the bottle. Rats received a US (intraperitoneal injection of 0.15 M LiCl, 2% body weight) 30 (short-trace group) or 180 (long-trace group) minutes after presentation of CS. The other rats did a weaker US (0.5% body weight) 30 minutes after presentation of CS (weak-US group). In the test trial, the CS intake of all groups decreased from that of the conditioning trial, but those of the long-trace and weak-US groups were significantly higher than those of the short-trace group. These differences were characterized by the size of the licking burst. However, there was a difference between the long-trace and weak-US groups in the approach behaviors (duration of approaching the vicinity of the spout). The short-trace and long-trace groups showed a significantly decrease in approach behaviors in the test trial compared to the conditioning trial, while the weak-US group did not. These results indicate qualitative differences in the ingestive behaviors of rats under CTA expression between the short- and long-trace paradigms.

Key Words: Conditioned taste aversion, Trace conditioning, Rat

Prolonged decline in motivation level after sucrose reward devaluation in free-feeding rats: lick microstructure analysis of consummatory successive negative contrast

Jilada Chongmankhong, Keisuke Shinohara, Yasunobu Yasoshima

Division of Behavioral Physiology, Graduate School of Human Sciences, Osaka University

Taste reward value can be modulated by prior taste experience. Rats that have been repeatedly receiving 32% sucrose solution but are suddenly exposed to 4% sucrose show a lower intake of 4% sugar than animals that are always exposed to the 4% sugar. This phenomenon is known as consummatory successive negative contrast (cSNC) effect. Grigson et al. (1993) found that although both free-feeding and food-deprived rats showed suppression of the 4% sugar intake when exposed to reward downshift (32% to 4%), free-feeding rats exhibit a longer-lasting cSNC effect, while food-deprived rats show rapid recovery of sucrose intake within a few sessions. However, it remains unexamined how long the cSNC effect can be maintained in free-feeding animals. To address the issue, we examined consummatory licking behavior in free-feeding and food-deprived rats during longer postshift periods (13 trials). In addition, we assessed behavioral factors that were related to the cSNC effect through lick microstructure analysis. Both free-feeding and food-deprived animals showed suppression in the number of licks, compared to animals without the downshift experience. In free-feeding rats, the suppression of licks was associated with a decline in the number of licking bursts, which is suggested to be an index of motivation level. This decrement of the number of bursts suggests a declined motivation to drink the 4% sugar after the downshift in free-feeding animals. On the contrary, deprived rats showed a decrease in burst size, which reflects animals' evaluation of taste palatability. Consistently with Grigson et al. (1993), prolonged cSNC was maintained in free-feeding rats, but not in food-deprived rats. The present results suggest that the duration of cSNC depends on food deprivation state (i.e., deprived vs. non-deprived) and that motivational and palatability-related components of consummatory behavior can be differentially altered by prior taste experience, food deprivation state, and their interaction.

Key Words: Consummatory Successive Negative Contrast, Deprivation State, Lick microstructure analysis

Dopaminergic nervous system and orofacial neuropathic pain

Hiroharu Maegawa, Hitoshi Niwa
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The dopaminergic nervous system is said to be involved in the processing of pain. However, their relationship has not been fully investigated, especially in neuropathic pain. Dopamine receptors are divided into D1 class receptors and D2 class receptors. Stimulation of D1 receptors activates neurons, and stimulation of D2 receptors suppresses neurons. Dopamine receptors are also present trigeminal spinal subnucleus caudalis and spinal dorsal horn. We produced chronic constriction injury of infraorbital nerve (ION-CCI) rats as orofacial neuropathic pain model. Intraperitoneal administration of D2 receptor agonist suppressed mechanical hypersensitivity in ION-CCI rats. Next, we focused in the A11 nucleus which is involved in dopaminergic pain suppression mechanism. Microinjection of D2 receptor agonist and GABAA receptor agonist into the A11 nucleus suppressed mechanical hypersensitivity in ION-CCI rats. Next, we destroyed dopamine neurons in the A11 nucleus by 6-hydroxydopamine (6-OHDA) microinjection. Mechanical hypersensitivity was exacerbated in ION-CCI rats following 6-OHDA administration. These results suggest that D2 receptor agonist suppress orofacial neuropathic pain and the A11 nucleus is involved in modulation of orofacial neuropathic pain. One of the mechanisms by which dopamine receptors modulate pain is that D2 receptors have inhibitory effects on primary afferent neurons and secondary neurons. Another possible mechanism is that GABAergic inhibitory intermediate neurons have inhibitory effects on secondary neurons. GABA-containing neurons in the A11 nucleus may have such function. D1 and D2 receptor antagonist were reported to suppress neuropathic pain. D1D2 receptor complex is reported to suppress neurons when it is antagonized. D1 receptors, D2 receptors, and D1D2 complex likely to be in a mixed state.

Key Words: Dopamine receptor, neuropathic pain, A11 nucleus

Longitudinal changes of mastication after weaning in the rats

Masaharu Yamada[1, 2], Ayano Katagiri[1], Yuji Masuda[3], Hiroki Toyoda[1], Hitoshi Niwa[2], Takafumi Kato[1]

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[Introduction] Mastication is a rhythmic jaw movement that crushes food to form a suitable size for swallowing. Ingestive behavior changes from suckling to mastication during the weaning period, and then the masticatory function is matured as growing. However, the changes of masticatory dynamics after weaning have not been clarified in animals. This study attempted to establish a method for investigating developmental changes of masticatory function longitudinally in rats.

[Method] Rat pups received surgery to place electrodes for electromyogram (EMG) in the masseter and temporal muscles on the postnatal day 10 (P10). From P21 to P49, EMG and video recording for pellet chewing and pasta biting were performed in the plexus cage. Small-sized pellets and pasta sticks were given to the rats after fasting. The time for finishing a pellet (80 mg) and a pasta stick (80 mg) were measured. For pellet chewing and pasta biting, masticatory rhythms were assessed by fast Fourier transform analysis, and the lags and correlations between the two muscle activities were calculated by cross-correlation analysis.

[Result] EMG recording was successfully made from P21 to P49. During this period, the time for finishing a pellet decreased by 80%, while the pasta stick decreased by 98%. The reduction was considerable from P21 to P24 for both pellet (40%) and pasta stick (86%). Masticatory rhythm showed a larger increase for pasta biting (38%) than that of pellet chewing (13%). For pellet chewing, the correlation coefficient between two muscle activities increased from P21 to P24, and lag between them decreased by 25% from P21 to P24 significantly, and after P24, correlation and lag were stable. On the other hand, for pasta biting, correlation decreased from P21 to P49 moderately, and the lag did not change from P21 to P49.

[Conclusion] The results demonstrate longitudinal recordings of masticatory muscle EMG activities in growing rats after weaning and show the unique developmental changes in masticatory motor dynamics.

Key Words: EMG, Mastication, Development

Biological Clock and Regulation of Dentinogenesis in Mouse Molars

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Background: The circadian clock controls many behavioral and physiological processes with a periodicity of approximate 24-hour, enhancing the survival of organisms by enabling them to adapt to changing environmental conditions. Rhythmic incremental growth lines commonly occur in dental hard tissues of vertebrates, and dentin formation in rodent incisor reportedly showed a circadian pattern. Rodent incisors continue to grow throughout the animal's life; however, similar to human teeth, rodent molars stop growing after crown formation. This similarity suggests that the mouse molar is an excellent model to investigate the molecular mechanisms underlying growth of human teeth. However, not much is known about it.

Methods: We analyzed the incremental growth lines in mouse molar dentin and determined the periodicity of rhythmic dentinogenesis using tetracycline as the growth marker.

Results: The incremental growth lines in mouse molar dentin were generated at approximate 8-hour intervals in wild-type mice housed under 12:12 hour light-dark conditions. Moreover, the 8-hour rhythmic increments persisted in the Bmal1-/- mice housed in constant darkness, where BMAL1 is an essential component for circadian transcription. These results demonstrated the dentinogesis in mouse molar underlie the 8-hour ultradian rhythm (recurrent cycle much shorter than 24-hour) and are regulated independently from the circadian clock.

Conclusion: Our findings provide a new insight into tooth growth. Further studies are warranted to understand the biological mechanisms controlling rhythmic tooth growth and its functional significance.

Key Words: Biological Clock, Incremental Growth Lines, Ultradian Rhythms