1. Influence on autonomic nervous response of different cutaneous stimulation with expiratory

Kazuhiko Yamashita¹, Akira Okada¹, Kuniko Yamashita¹, Hitoshi Watanabe² (Osaka City Univ., Osaka City Univ.)

One of the physiological basis of acupuncture is the somatosensory input on the autonomic nervous system function. Furthermore physical therapy is done a clinical application on activating and inhibiting by such as brushing to skin. The purpose of this study is evaluating the effect of autonomic response to “acupuncture”, “tube”, “brushing”. It measures the electrocardiogram, blood pressure, body flexibility on 20 healthy men (18-21 years old). Acupuncture is the stimuli to cutaneous tissue. Tube is done tapping at the top of the tube to skin. Brushing is done about 5800/minutes by the motor to skin. Autonomic nervous system is assessed by heart rate variability. The high-frequency component (HF: 0.15-0.5 Hz) reflects vagal activity, while the low-frequency component (LF: 0.04-0.15 Hz) reflects both vagal activity and cardiac sympathetic activity. HF was used as an index of parasympathetic activity, and LF/HF was an index of sympathetic activity. The first experimental procedure is as follows, 1) resting supine 5 minutes, 2) deep breathing 5 times, 3) rest supine 3 minutes, 4) standing 3 minutes, 5) deep breath 5 times. It observes the suppression state of parasympathetic function. The second experiment procedure is as follows, 1) twice the body flexibility, 2) blood pressure, 3) resting sitting position 3 minutes, 4) each stimulus of acupuncture, tube, brushing, 5) blood pressure measurement after 3 minutes, 6) twice the body flexibility measurement. Parasympathetic nervous function after each stimulus has significantly increased.

Keywords : parasympathetic nervous function, expiratory, skin stimulation

2. Changes in the F-wave and somatosensory evoked potential in upper limbs during handgrip exercise


[Objective] The purpose of this study was to investigate changes in F-wave and somatosensory evoked potential (SEP) at the other side of muscular contraction during unilateral isometric handgrip exercise. [Method] 9 healthy males volunteered to participate in this study. Subjects performed isometric handgrip exercise at 0% (control), 10%, 20% and 30% of maximal voluntary contraction (MVC) for 1 min on right hand. F-waves were evoked in the left adductor pollicis brevis (APB) motoneurons by supramaximal electrical stimulation (duration: 0.2ms, frequency: 2Hz) applied to the median nerve at the wrist, and measured the number of F-waves which occurred with 120 consecutive stimuli for APB (F-wave frequency). SEPs in response to left median nerve stimulation from the right C4 (2 cm posterior to C4 of the International 10-20 system) were recorded by stimulating left median nerve at the wrist while maintaining contraction. SEPs were averaged in each conditions and the peak-to-peak amplitude of the N20 component was analyzed. [Results & Discussion] F-wave frequency was significantly higher at hand gripping (P<0.05) and depended on the contraction intensity. There was no significant difference in amplitude of N20 component. Results of this study was suggested that unilateral handgrip exercise facilitate the excitability of spinal α-motoneuron in the contralaterally muscles, but sensory input to primary somatosensory area was not influenced.

Keywords : F-wave, SEP, unilateral muscle contraction

3. Effects of warm-up activities on motor nerve conduction velocity depending on regular exercise habits

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[AIM] In this study, the effects of WU in the presence or absence of regular exercise on successive changes in motor nerve conduction velocity (MCV) were investigated to elucidate the scientific basis of its effectiveness. [METHODS] They were divided based on whether they exercised regularly into a non-exercise (NE) and exercise (E) group. Neuropack X1, an electromyogram/evoked potential measurement. Parasympathetic nervous function after each stimulus has significantly increased.

Keywords : Warm-up, Motor Nerve Conduction Velocity, Exercise habits

4. Effects of iron deficiency on depressive behavior and hippocampal neurogenesis in rats

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[Aims] Several studies have indicated that iron deficiency (ID) involved in the symptoms of psychiatric disorders such as depression. Recently, it has been reported that depression can be involved in the reduction in hippocampal neurogenesis, dysregulation of the hypothalamus-pituitary-adrenal (HPA) axis and decreased levels of brain serotonin. However, it is not known whether ID involved in these neuropathology of depression. The aim of this study was to determine the effects of ID on depressive behavior, hippocampal neurogenesis and neuronal activities in rats. [Methods] Male Wistar rats were assigned to either a control (Con) or an ID group. Con rats fed a control diet (Fe 35mg/kg) and ID rats fed an iron deficient diet (Fe 5mg/kg) for 4 weeks. Forced swimming test (FST) was applied on the last two days of the feeding period. The neurogenesis in the dorsal and ventral dentate gyrus (dDG, vDG) in the hippocampus and the neuronal activities in the dorsal raphe nucleus (DRN) that is a major source of serotonin neurons and the hypothalamic paraventricular nucleus (PVN) that mediates activation of HPA axis were measured using immunohistochemistry for Brdu, double-cortin (DCC), and FoxB. [Results] We found that ID increased depressive behavior. In addition, ID decreased DCC expression in the dDG, but not VDG (p=0.07), whereas the number of BrdU positive cells was not affected by ID. Neuronal activities in the DRN and PVN were not affected by ID. [Conclusions] These results suggest that ID increase depressive behavior via decreasing hippocampal neurogenesis.

Keywords : iron deficiency, depression, hippocampal neurogenesis
5. Mild exercise improves spatial memory dysfunction in type 2 diabetic rats

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[Aims] Type 2 diabetes (T2D) induces hippocampal-based memory dysfunction as one of complications. Although we recently revealed that moderate exercise improves memory dysfunction in T2D rats, an exercise regimen appropriate for the complication remains unclear. Since we have already found that lactate-threshold-based mild exercise enhances memory function in normal subjects, it is tempting to hypothesize that this exercise would improve memory dysfunction in T2D subjects. [Methods] Twenty-six-weeks-old Otsuka-Long-Evans-Tokushima-Fatty (OLETF; T2D animal model) rats and their genetic control Long-Evans-Tokushima (LETO) rats were randomly divided into sedentary and exercise groups. The exercise groups of both breeds were made to run on a treadmill at mild for 4 weeks (OLETF: 7.0 m/min, LETO: 10.0 m/min, 30 min/day, 5 days/week). Memory function in rats was evaluated using the Morris water maze test. [Results] OLETF rats showed a significant spatial memory dysfunction compared to their genetic control. Four weeks of mild exercise improved memory dysfunction without affecting any other clinical symptoms in OLETF rats. [Conclusion] The current study shows that even mild exercise, as well as moderate exercise, improves T2D-induced memory dysfunction without any changes in clinical symptoms. Our findings suggest that T2D hippocampus has a higher sensitivity to exercise than do peripheral tissues.

Keywords: type 2 diabetes mellitus, hippocampus, mild exercise

6. Acute moderate intensity exercise facilitates spatial memory consolidation via new proteins synthesis

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[Background] Although an acute bout of exercise boosts memory consolidation and thus improves long-term memory, the precise mechanisms are still disputed. Previous studies have shown that memory consolidation requires neuronal activity-dependent protein synthesis in hippocampal CA1 region, and that an acute moderate intensity exercise (AME) enhances its neuronal activity. These findings provide a hypothesis that AME could boost memory consolidation via protein synthesis. [Aims] This study attempts to establish a rat model enhancing memory consolidation by AME (Exp.1), and tests the hypothesis using a protein synthesis inhibitor, anisomycin (ANI), in the rat model (Exp.2). [Methods] All experiments used male Sprague Dawley rats (10 weeks of old), and object location test consisting of a training session and a test session with a 24-h delay. For the assessment of the memory consolidation, a discrimination ratio (DR) of the novel-location object to the familiar-location object was calculated in the test session. Exp.1: We examined whether 20 min of AME (20 m/min in treadmill) immediately after training session increase the DRs. Exp.2: We investigated the effects of ANI or placebo treatments into hippocampal CA1 before AME on DRs. [Results] Exp.1: AME significantly increased the DRs. Exp.2: The AME-induced increment of DRs were unchanged by placebo treatment, but abolished by ANI treatment. [Conclusions] Results indicate AME-induced memory consolidation mediate the action of protein synthesis in hippocampal CA1.

Keywords: acute moderate intensity exercise, memory consolidation, hippocampal CA1

7. Recovery of locomotor function impaired by the deficit of sensory feedback through the increase of the number of muscle synergies based on neuromusculoskeletal model

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[Aims] Postural control with sensory feedback plays an important role for stable locomotion. Absence of proprioceptive sensory feedback degrades locomotion. Also, the number of muscle synergies decrease due to merging of synergies at post-stroke. After rehabilitation, muscle synergies separate and the number increases. Defects of postural control will induce unstable gaits and tripping. However, the addition of muscle synergies may recover the motor function. We investigated their contributions to quadruped locomotion using a neuromusculoskeletal model of rats. [Methods] We developed a neuromusculoskeletal model of the fore- and hindlimbs of rats based on empirical anatomical data. We performed forward dynamics simulation. We reduced the contribution of the postural control, and then added one spatiotemporal pattern of muscle synergy. [Results] When we reduced the contribution of the postural control, shoulder and hip heights became lower and at last the model fell down. By adding the muscle synergies, the height recovered. [Conclusions] Our results suggest that adaptive modulation of muscle synergy structure compensates for the deficit in the posture control in locomotion.

Keywords: muscle synergy, posture control, locomotion

8. Does short sleep duration impair cognitive function during and after exercise?

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[Aims] Acute moderate exercise can improve cognitive function. In contrast, short sleep duration impairs cognitive function because of disturbed vital homeostasis. Hence, short sleep duration may affect cognitive function during and after exercise. The purpose of this study was to determine the effect of short sleep duration on cognitive function during and after exercise. [Methods] Eight subjects completed moderate exercise (50% peak VO2) for 30-min under either normal sleep duration (7 ours) or short sleep duration (3 ours). They performed cognitive tasks at rest, 5 min and 23 min after the start of exercise, and 15 after the exercise. Cognitive tasks were a spatial delayed-response task and a Go/NoGo task, which required working memory and executive function. Cognitive tasks were evaluated accuracy rate and reaction time (RT). [Results] At rest, RT on the Go/NoGo task was not different between normal and short sleep duration. In contrast, compared with rest, RT improved during exercise and after exercise in both conditions (p < 0.01). However, after exercise, the degree of improvement in RT was tented to lower short sleep duration than normal sleep duration (p = 0.077). Neither short sleep duration nor exercise after the accuracy on the cognitive tasks. [Conclusions] Acute moderate exercise improves cognitive function even under short sleep duration. However, short sleep duration may attenuate the improvement in cognitive function after exercise.

Keywords: short sleep duration, cognitive function, acute exercise
9. Determination of minimum locomotion speed activating hippocampal neurons with a c-Fos study: potential benefit of very light exercise

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It is expected that very light exercises such as Yoga and Tai chi would have clinical impacts on cognitive decline and depression, since those body works are easy and popular even for vulnerable peoples. Currently, it should be the case from our current findings that mild exercise and its training activates hippocampal neurons and enhances hippocampal neurogenesis and spatial memory, respectively. It is, however, still arguing whether such the very light exercise may have impacts on hippocampal neuronal activation and plasticity. We thus aimed at examining whether very light exercise would activate hippocampal neurons in rats. Adult male Wistar rats were subjected to a 30-min running test below 37%VO2 max, a very light intensity based on the ACSM criteria and histochemical spatio-temporal analyses for c-Fos expression in the hippocampal formation (dentate gyrus, DG; CA1 and CA3). As the results, an acute bout of very light running caused c-Fos accumulation within neurons in the DG and CA1, but not in CA3, suggesting a possible impact of very light exercise on hippocampal neuronal activation. This may provide evidence as a benefit of very light exercise according to the ACSM criteria.

Keywords: Very light exercise, Hippocampal neuron, Fos protein

10. Motor-evoked potentials and cortical silent period in lower limb after handgrip contraction

Ryouta Matsuura1, Takahiro Yunoki2, Mitsuhiro Ueno1

[Aims] The aim of the present study was to determine the effects of unilateral sustained handgrip contraction on the motor-evoked potentials (MEPs) and cortical silent period (CSP) elicited by transcranial magnetic stimulation (TMS) in the lower limb muscles ipsilateral and contralateral to the exercised hand. [Methods] Over 2 days, six healthy subjects performed a 120-sec handgrip contraction at a 30% maximal voluntary contraction (MVC) with their right hand. TMS was applied over the motor cortex to elicit MEPs and CSP in either the right or left tibialis anterior (TA) on different days at time points before, immediately after, 10 min, 20 min, and 30 min after the handgrip contraction. The MEPs were elicited when the TA was at rest and active (at 5% of the maximal electromyographic [EMG] activity) and the CSP was elicited when the TA was active (at 30% of the maximal EMG activity). [Results] For both the rest and active MEPs, there was no significant difference between those in the right and left TA. Regarding the CSP, the duration in the left TA was significantly shorter after the handgrip contraction, while the duration in the right TA did not significantly change after the handgrip contraction. [Conclusion] A unilateral sustained submaximal handgrip contraction affected the intracortical inhibition of the lower limb muscles ipsilateral and contralateral to the exercised hand differentially.

Keywords: Non-local muscle fatigue, Laterality, Transcranial magnetic stimulation

11. A single bout of intense exercise reduces aversive memory formation in mice


Purpose: It is well known that regular exercise rescues age- or stress-induced impairment of cognition with enhancement of brain-derived neurotrophic factor (BDNF) and hippocampal neurogenesis. On the other hand, previous study showed that a single bout of intense exercise improved working memory in mice. It remain to be elucidated, however, whether a single bout of exercise improve or impair long-term memory. Therefore, purpose of this study was to investigate effect of a single exercise on formation of long-term memory, aversive or non-aversive memory. Method: Male C57BL/6J mice were used to investigate the effects of a single exercise on aversive and non-aversive memory formation using two kinds of behavior test, fear condition test (FCT) and location recognition test (LRT), respectively. Exercise protocols used in this study were treadmill running at various intensity, i.e. mild, moderate, and intense (voltitional exhaustion). Mice were subjected to exercise at various time points, i.e. 30 min before, either 30 or 60 min after behavioral test. Result: In FCT, intense exercise, which is subjected at any time points, impaired aversive memory formation whereas low and mild exercise did not. On the other hand, non-aversive memory formation was not affected by any intensity of exercise at any time points. Conclusion: These findings showed that intense exercise might disturb formation of aversive memory but not non-aversive memory in mice, suggesting that intense exercise might be useful to prevent trauma associated with stress.

Keywords: Intense exercise, Memory formation, Aversive memory

12. Effects of regular treadmill running on sensitivity of hypothalamic paraventricular neurons, hippocampal neurogenesis, and depressive behavior in rats

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Accumulating evidence indicates that physical exercise can reduce and prevent the incidence of stress-related psychiatric disorders, such as depression. Physical exercise produces its anti-depressant effect by mediating activation of the hypothalamic paraventricular nucleus (PVN), and enhancing the hippocampal neurogenesis. However, few general concepts regarding the optimal physical exercise regimens that produce the anti-depressant properties have been developed. In the present study, we examined how 4-week treadmill running at different intensities (0, 15, 25 m/min, 60 min/day, 5 times/week) alter the sensitivity of PVN neurons to a 30-min acute treadmill running at different intensities (i.e., 0, 15, 25 m/ min) and the hippocampal neurogenesis in male Wistar rats, using immunohistochemistry for c-Fos and double-cortin (DCX). In addition, we performed forced swim test after the training as a measure of depressive behavior. We found that an acute treadmill running speed-dependently increased c-Fos expression in the PVN, and the training significantly inhibited those increased neuronal activities in the PVN during acute running, even though the intensity of training is low. The training also enhanced DCX expression in the hippocampal dentate gyrus, and decreased depressive behavior, regardless of the training intensity. These results suggest that regular exercise, even though the intensity is low, can improve depressive behavior through suppressing sensitivity of PVN neurons and enhancing hippocampal neurogenesis.

Keywords: training, depression, immunohistochemistry
13. Effects of amygdala lesion on cardiovascular responses in rats

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[Aims] Mental and physical stresses are caused by social relations and vigorous exercise, and strongly affect our behaviors. Although it is important to choose proper actions and control autonomic regulation to overcome these stresses by adapting to the situation, underlying neuronal mechanisms are still unclear. In this study, we tried to demonstrate how the amygdala, one of negative emotion center, involves in cardiovascular regulation. [Methods] First, we examined whether bilateral lesions of the amygdala in rats (n=5) affect the cardiovascular responses using telemetry system. Second, we examined cardiovascular responses induced by electrical stimulation of the unilateral amygdala in urethane-anesthetized rats (n=10). [Results] Bilateral electrolytic lesions of the central nucleus of the amygdala evoked consistent arterial pressure increases over the light/dark cycle under non-stressful environment. Electrical microstimulation of the central nucleus of the amygdala induced a gradual increase in arterial pressure and heart rate, whereas stimulation of adjacent nuclei evoked a phasic arterial pressure decrease, but no effects in heart rate. [Conclusions] These results suggest that the amygdala is crucial for regulating the basal level of cardiovascular parameters, and may also contribute to autonomic regulations during behavior under stress.

Keywords: amygdala, arterial pressure, rat

14. Astaxanthin supplement synergistically potentiates mild exercise effects on spatial memory and hippocampal neurogenesis in mice

Jangsoo Yook1, Hideaki Soya1 (Exercise Biochem & Neuroendocrinology Lab, Tsukuba Univ, Japan)

[Aims] Although exercise and natural supplements have beneficial effects in enhancing spatial memory and adult hippocampal neurogenesis (AHN), combining both have been shown synergistic effects only for learning and memory. However, their neuronal substrate remains uncovered. We currently reported that mild exercise (ME) has sufficient effects for enhancing memory and AHN, and that astaxanthin (ASX), a marine-derived carotenoid, has the same effects with ME. Here, we investigated whether ASX potentiates ME beneficial effects of enhancing memory by increasing AHN with potential molecules. [Methods] Adult male C57BL6J mice were received ASX (0.5%) with or without mild treadmill exercise (below ventilatory threshold, 7 m/min) for 4 weeks. To evaluate memory, the water maze was performed. To label AHN, mice were intra-peritoneally injected with BrdU before the intervention. Moreover, DNA microarray and IPA analysis were performed to reveal potential molecular factors. [Results] Both ME and ASX led to differential enhancements in learning and memory, which were greater by their combination. ME and ASX individually increased proliferation cells and newborn mature neurons, and their combination resulted in a greater increase of AHN compared to ME or ASX alone. Moreover, an omics approach showed the ME/ASX combination specific upregulation of genes (Cxcr4, Igf1r etc.). [Conclusions] ASX diet synergistically potentiates the ME effects on spatial memory and AHN with some newly identified molecules.

Keywords: Mild exercise, Astaxanthin, Hippocampus

15. Acceleration of Go/No-go decisional processing by mastication differs depending on the colors of visual trigger

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Aims: Much research has reported the benefits of the voluntary rhythmic mastication, such as increased levels of alertness and base metabolism, and expansion of working memory. This research used a Go/No-go visuomotor task to conduct detailed verification of whether masticatory movement resulted in shortened reaction time and the effect of differences in stimulant color on that result.

Methods: The study sampled 17 healthy adults. The test subjects underwent either a Go (green)/No-go (red) task in which they dorsiflexed their wrist only when the indicator showed a green light and remained still when it showed a red light, or a Go (red)/No-go (green) task in which they reacted to a red light only and did not react to a green light. We measured the reaction time using a surface electromyogram derived from the wrist extensor group. The test was conducted on different days and in random order and reaction times were compared before and after 5 minutes of masticatory movement from chewing gum. Results: The reaction time in the Go/No-go visuomotor task shortened after masticatory movement with gum only in the Go (green)/No-go (red) task. Conclusions: It is widely accepted that as visual triggers for initiating movement, the color triggered is afforded the meaning Go, and red the meaning No-go. We speculated that the reason behind a reduction in reaction time with masticatory movement not being observed in the Go (red)/No-go (green) task was due to the phenomenon of mutual interference (Stroop effect) between the visual trigger color and this affordance.

Keywords: reaction time, mastication, go/no-go task

16. The relationship between motor imagery and motor performance

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[Aims] Although previous studies focused on the relationship between brain activations and the motor imagery capability, whether brain activities during motor imagery may relate to actual motor performances are poorly investigated. Therefore, we examined the relation between brain activities during motor imagery and various motor performances. [Methods] The participants completed the experiments, including brain activity and four motor performance tests in the present study. At first, the participants were assessed brain activated area and mass, i.e., oxygenated-hemoglobin (oxy-Hb), during motor imagery of the four motor performances (darts, walking on the balance beam, picking up beans with chopsticks, and single-foot standing with eyes closed) using functional near-infrared spectroscopy (LABNIRS). After that, we also measured their motor performances corresponding motor imaging tasks. [Results] Oxy-Hb in prefrontal area was significantly increased during motor imagery of darts, but decreased during that of single-foot standing with eyes closed in high achiever. [Conclusions] These findings indicate that brain activities during motor imagery of various performances might be different by achievements of actual performance and the targets of imagery.

Keywords: motor imagery, fNIRS, Oxygenated-hemoglobin
17. Effect of moderate-to-vigorous exercise training on dorsal hippocampal volume of developing rats

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[Aims] It has been demonstrated that higher aerobic fitness levels are associated with greater hippocampal volumes in pre-pubertal children and adolescents. Endurance training at moderate-to-vigorous intensity, above the lactate threshold (LT), seems to be necessary to improve aerobic fitness of children and adolescents. The aim of this study is to determine the effect of moderate-to-vigorous exercise training on the volume of the dorsal hippocampus in developing rats. [Methods] Four-week-old (pre-pubertal) and 6-week-old (early-adolescent) male Wistar rats were divided into two groups: the control group (4wCont [n=6] and 6wCont [n=6]) and the exercise group (4wEx [n=6] and 6wEx [n=6]). Rats in 4wEx and 6wEx were subjected to 4 weeks of treadmill running training at a speed of 25 m/min (estimated to be above LT), 30 min daily, 5 days per week. Coronal brain sections of all rats were serially cut through a dorsal part of the hippocampus (+2.76 to -4.20 mm from the bregma). The volumes of the hippocampus and dentate gyrus (DG), a specific region involved in neurogenesis in the hippocampus, were estimated by means of the Cavalieri method using Nissl staining sections. 

[Result] Compared to 6wCont, 6wEx had significantly larger hippocampal and DG volumes. There were no significant differences in hippocampal and DG volumes between 4wCont and 4wEx. 

[Conclusions] These results suggest that moderate-to-vigorous exercise training increases dorsal hippocampal volume in developing rats and that this has positive effect depending on the developmental stage. 

Keywords: exercise training, hippocampal volume, developing rats

18. The changes of neural activity depend on leaning in single-lever press task

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[Aims] Our behavior shifts from goal-directed behavior to habitual behavior by training repeatedly. Recently, it has been reported that the adaptive shift of neural network in the brain may occur during the learning process. However neural mechanisms underlying this process are unclear. The purpose of this study was to examine how dose the neural network adaptively change throughout the learning using positron emission tomography (PET). [Methods] In this experiment, Long Evans rats and single lever press task were used. To measure regional brain activity in the entire rat brain, we used a small-animal neuroimaging method with 2-[18F]fluoro-2-deoxy-D-glucose (FDG). The freely rat received intravenous injection of FDG just before the starting of the behavioral task. And then, after 55 min from FDG injection, a PET scan was performed for 30 min under anesthesia. All PET scans were performed 4 times during training. The acquired data were reconstructed and were used for quantification and statistical analysis. [Results] Using FDG-PET methods, we found that the neural activity of prefrontal cortex, striatum and thalamus increased in the goal directed behavior. [Conclusion] It is possible that the neural network might be change according with the progression of learning in single-lever press task. 

Keywords: Habitual behavior, Goal directed behavior, FDG-PET

19. Hippocampal glycogen supercompensation followed by glycogen loading with exhaustive exercise

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[Aims] Hippocampal glycogen (Gly) localized in astrocytes, would play a crucial role in memory function. Muscle glycogen loading (GL) is a conditioning for endurance athletes that can be induced by exercise and high-carbohydrate diet. We recently found that GL increases hippocampal glycogen levels as well as in muscle. Although exhaustive exercise (Exh) and moderate exercise (Mod) is crucial for increasing hippocampal glycogen levels, it is unclear that these exercise are essential for the hippocampal GL. [Methods] Eleven weeks old male Wistar rats were randomly divided into four different conditions of exercise groups with commercial diet [GL group (day1, Exh at 20m/min, until exhaustion; day 2-4, Mod at 20m/min, 20min/day; day 5-7, sedentary); Exh group (only Exh in day1); Mod group (only Mod in day2-4); Sed (only sedentary in all days)]. Rats were sacrificed by microwave irradiation (10kW, 1.2sec) on day 7 to accurately detect brain Gly levels. [Results] Gly levels in muscle and liver were unchanged in all experimental groups. Hippocampal glycogen levels increased in GL and Exh group, even though hypothalamic and cortical glycogen levels did not increase with any types of exercise. [Conclusions] Our findings suggest that Exh is an essential factor for the hippocampal GL. Exh-induced energy demand in the hippocampus would be crucial for maximizing hippocampal glycogen levels. The current findings might contribute to establish the novel conditioning method enhancing hippocampal function. 

Keywords: Glycogen-loading, Exhaustive exercise, Hippocampus

20. Role of orexin in leptin sensitivity of hypothalamus after exercise

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[Aims] Transient endurance exercise enhances leptin sensitivity, but this mechanism is still unclear. We examined the mechanism of hypothalamic leptin sensitivity after treadmill running focusing on orexin which regulates muscle tension, metabolism and awakening changes. [Methods] We subjected the 45 min treadmill running (15m/min) for male C57BL/6j mice, and mice were received intraperitoneally (ip) injection of leptin (2mg/kg) after exercise. After 45 min of injection, we measured phosphorylation of STAT3 using immunohistochemistry and western blotting. In addition, we examined the expression of c-Fos in orexin neurons. [Results] Treadmill running increased c-Fos expression at orexin neuron. In addition, leptin injection after treadmill running enhanced hypothalamic STAT3 phosphorylation, but intracerebroventricular (icv) injection of orexin receptor blocker before treadmill running canceled enhancement STAT3 phosphorylation. Icv injection of orexin enhanced ip injection of leptin-induced STAT3 phosphorylation. [Conclusions] Orexin neuron activation involved in enhancement of leptin sensitivity after exercise. 

Keywords: orexin, leptin, hypothalamus
21. Effects of static muscle stretching on spinal reflex excitability in non-stretched muscles

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[Aims] It is well known that muscle stretching causes the suppression of spinal-reflex excitability in stretched muscles. However, there is no evidence on the effects of muscle stretching on spinal-reflex excitability in non-stretched muscles. Therefore, the aim of this study was to investigate the effect of muscle stretching on spinal-reflex excitability in non-stretched muscles. [Methods] Ten healthy males participated in this study. Spinal reflexes evoked by transcutaneous spinal cord stimulation were recorded in bilateral leg muscles before, during, 0 min and 5 min after stretching the right triceps surae muscles with three different intensities. [Results] The amplitude of spinal reflexes in both stretched and non-stretched muscles in the right leg was significantly smaller during stretching than before stretching (P<0.05). Furthermore, the amplitude of spinal reflexes in right leg muscles decreased significantly as the intensity of the muscle stretching increased (P<0.05). In contrast, the amplitude of spinal reflexes in left leg muscles did not decrease owing to muscle stretching.

[Conclusions] Our results clearly indicate that static muscle stretching has general inhibitory effects on spinal reflexes in ipsilateral leg muscles.

Keywords: spinal reflex, static muscle stretching, transcutaneous spinal cord stimulation

22. Would chronic mild-intensity exercise attenuate fear memory?

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[Aims] Recently, many people are suffering from mental diseases, such as PTSD. Drug is used against these disorders by erasing fear memory through the induction of hippocampal BDNF. Any drugs, however, always has some risks and side effects, and thus researchers need to know more natural and effective treatment against these disorders. The habitual mild-intensity exercise is expected to help in this direction, as suggested by previous research. However, it is unknown whether 2 weeks of mild-intensity exercise has potential effects for erasing the fear memory through the enhancement of BDNF signaling in the hippocampus. [Methods] Normal Wistar rats were subjected to mild-intensity exercise for 2 weeks. Experiments were composed of two: exercise after fear memory consolidation (Exp1) and exercise before fear memory consolidation (Exp2). The experiments were followed by fear extinction tests using fear conditioning chamber. BDNF mRNA levels were examined in the hippocampus of rats in both groups. [Results] The results revealed that a 2 weeks of mild exercise significantly decreased freezing behavior during the fear extinction test compared to control groups, both in Exp1 and in Exp2. But BDNF mRNA expressions in the hippocampus were unchanged between exercise groups and control groups. [Conclusion] Our results suggest that a 2 weeks habitual mild-intensity exercise may attenuate fear memory recall. The exact neuronal substrate is, however, still arguing and thus here is further experiments expected in the future.

Keywords: hippocampus, mild exercise, BDNF

23. Evaluation of behavioral characteristics of hypothyroid model rats

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[Aims] It is well known that the hypothyroid cause a number of symptoms for the mental as well as physical complaints. However, few studies are available to clear the mechanisms on brain functions, which regulate mental health and psychological disorders. In the present study, we investigated the effects of hypothyroid on brain functions and behaviors using rat models in order to resolve the essential role of thyroid hormone in regulating our mental health. [Methods] Male wistar rats were daily injected thyroid inhibitor, Methimazole, into the subcutaneous. Following 4 weeks, the rats performed several behavioral tests to investigate their mental conditions, such as the open field test, elevated plus maze, and Y-maze. The levels of brain monoamines, which is crucial in regulating our mental health. [Results] The thyroid hormone levels in Metimazole injected rats were significantly lower than saline controls. The body weight and blood glucose levels were significantly increased in the hypothyroid rats. There was no significant difference between the hypothyroid and control rats on results of the behavioral tests. On the other hand, the hypothyroid changed the levels of brain serotonin and dopamine in the several brain regions. [Conclusions] In the present study, we could conduct hypothyroid-like condition in endocrinial levels, but not find some behavioral characteristics related to mental health in these models. However, it is possible that another kinds of behavioral tests lead to different results because brain monoamine levels were disturbed in our hypothyroid models.

Keywords: hypothyroid, behavioral tests, monoamine

24. Acute stretching improves cognitive function and mood states in physically inactive people

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[Aims] It is well known that acute stretching enhances flexibility. However, little is known about how acute stretching influences cognitive function and mood states. Given that physical demands of acute stretching is very low, acute stretching may be beneficial to cognitive function and mood state in physical inactive people. The purpose of the present study was to test this specific hypothesis. [Methods] Nineteen sedentary young participants (22.3 ± 0.8 yr.) performed cognitive tasks and mood states questionnaire before and after stretching or resting period for the same duration (Control condition). The cognitive tasks included the Trail making test (TMT) and memory task. [Results] Performance of the TMT improved after the stretching (P = 0.001), while it did not change after the resting period. Stretching did not affect performance of memory test. After the stretching, Pleasamness and positive engagement improved (P = 0.031, P = 0.031, respectively). In contrast, anxiety and negative affect was not affected after the stretching. These results indicate that improvements in cognitive flexibility were accompanied by improvements in mood states. [Conclusions] Acute stretching seems to improve cognitive function in physically inactive individuals, and the improvements may be derived from improved mood states.

Keywords: mental health, cognitive function, inactive people
25. **A relationship between motor development and sensory disturbance in children**

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Purpose: Some reports have indicated that motor developmental disabilities show lack of skill and stiffness. A problem with sensory input has been regarded as a factor for such awkwardness of gross motions. To make an effective motor instruction program for children with developmental disorder, a relationship between sensory input and motor development in children must be clarified. The present study was designed to comprehend a relationship between motor development and sensory disturbance in children. Methods: The subjects were 164 kindergarten students, who were recognized to be healthy. Their parents or guardians were asked for the following concerning their children’s conditions by questionnaire: 1) A tendency toward sensory disturbance in the past and at present and 2) motor development [motor coordination and motor imagery] at present. Results: The following conditions were observed as for sensory disturbance: 36.5% children showed reluctance to play in a sandbox; 31.0% rejected to join hands with someone else; 26.5% disliked for their hands to become dirty; and 20.0% did not complain of any pain when they fell. The present conditions as for motor development were as follows: 36.5% were unable to do skipping (a rhythmical combination of two skills: the step and the hop) as motor coordination; 7.3% were unable to imitate simple movements; and 3.7% showed stiff movements of their arms and legs. The analysis of a relationship between the thus-observed sensory disturbance and immature motor development revealed significant correlation. **Keywords** : Developmental disorder, sensory, motor coordination

26. **The Influences of simultaneous bilateral muscle contractions on the control of handgrip force based on the subjective scale**

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[Aims] Bilateral deficit is known well, but little is known about that control of submaximal contractions based on the subjective scale with both hands. The purpose of this study was to examine the influences of simultaneous bilateral muscle contractions on the control of handgrip force based on the subjective scale. [Methods] Sixteen healthy men completed two sessions. During the sessions, participants performed one handgrip each at 100%, 75%, 50%, and 25% of their perceived maximal effort. During the first session, three conditions were performed; (1) grips were performed with right hand (right condition), (2) with left hand (left condition), (3) with both hands at same level strength (both condition). During the second session, grips were performed at different level strength with both hands each (both different condition). [Results] Participants could grade at the four levels of strength in all conditions. In the both different condition, grips at 25% of perceived max were increased when 50%, 75% and 100% of perceived max was performed with opposite hand. The influences of another grip on the opposite grip were greater at 25% of perceived max. The change of oxyhemoglobin at the prefrontal area was increased during both condition / both different condition compared to the right / left condition. [Conclusions] These results suggested that the mechanisms to plan the force level and brain activity in the both different condition might be different from that in the right / left condition. **Keywords** : grading, bilateral muscle contractions, grip force

27. **The Acute Effects of Dynamic Stretches on the Ground Contact Time of a Rebound Drop Jump**

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Objective: Since dynamic stretching (DS) was developed it has been known to have many clinical benefits. However, the acute effects of DSs on muscles activities and the relationship to the central nervous system have not been fully investigated. The purpose of this study was to examine the effects of using the DSs on ground contact times and the regulation of agonist-antagonist muscle activation during a drop jump (DJ). Methods: Thirty healthy young women participated in two DS sessions and a control session (SS: Static stretching). The DS session consisted of contract-relax-agonist-antagonist-contract (CRAC) and ballistic type (BT) stretches for the bilateral calf muscles 2 minutes, respectively. The SS session lasted 2 minutes and tibialis anterior (TA) and gastrocnemius (GM); Static stretches were performed alternately for each leg by a physical therapist. After each session, the subjects performed DJ from a height (0.25 m) twice. The vertical ground reaction force and the ground contact time together with an electromyogram of the left MG and TA muscles were measured simultaneously during DJ. Switching silent period (SSP) was calculated the time distance between the activities of GM and TA muscles. Results: The ground contact times both for CRAC and BT in DSs were significantly shorter than that in control. In two sessions, there were significant differences in the muscle activity times of GM and TA. SSP in CRAC was significantly shorter than that in control. These results suggest that CRAC facilitated a rapid, smooth movement through the switching between agonist-antagonist muscle activation. **Keywords** : silent period, dynamic stretching, rebound drop jump

28. **Neuromuscular activation and force tracking accuracy of quadriceps femoris during isometric knee sine-wave force task**

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[Aims] In previous studies, the sustained constant force level task has been used for investigation force steadiness or clarification of neuromuscular activation strategies to force modulation by the nervous system. However, it is unclear how the neuromuscular system modulates non-constant force exertion, such as a sine-wave task. The purpose of this study was to clarify neuromuscular activation and force accuracy of quadriceps femoris (QF) during isometric sine-wave force exertion. [Methods] Thirty healthy men and women (23 ± 4 years) performed force tracking task to match a given sine-wave force signal based on each subjects’ maximal voluntary contraction (MVC) on a computer monitor during isometric knee extension. Frequency of the sine-wave was 0.25 Hz and lasted for 30-sec with two different contraction levels, i.e. 4-8% (Lo) and 30-50% (Hi) of MVC. During the tasks, surface electromyogram (EMG) was recorded from four individual muscles in QF. The root mean squares (RMS) of EMG signals of each muscle were calculated and normalized by the RMS during the MVC. We investigated relative error of actual generated force against target force as force accuracy. [Results] The relative force fluctuation in whole sine-wave during Lo task was significantly greater than those of Hi task. For Lo task, RMS of three vasti muscles within 1 cycle of sine-wave were very similar, but not for rectus femoris. [Conclusions] The force accuracy in lower force level was worse than higher force level. It suggests that the contribution pattern for force accuracy was different between vasti muscles and rectus femoris. **Keywords** : force accuracy, force tracking, quadriceps femoris