

ES16**A FEAR-ACQUISITION SYSTEM IN AMPHIBIANS***S.O.G. Lindemann* and G. Roth**Brain Research Institut, University of Bremen, 28334 Bremen, Germany*

Amphibians possess most limbic centers found in mammals including the hippocampal formation (medial pallium), amygdala, septum, ventral striatum, hypothalamus, nucleus accumbens, ventral tegmental area and reticular nuclei such as the nuclei raphes and the locus coeruleus (Northcutt, 1981; Marin et al, 1996). We found evidence that - as in mammals - in amphibians limbic centers play an important role in the acquisition of fear. To investigate the function of the limbic system regarding the acquisition of fear, we developed a one-trial aversive learning task in the fire-bellied toad, *Bombina orientalis* using honey bees (*Apis m.sicula*) as negative conditioning stimulus. For identification of the brain areas involved in this task, the distribution of Egr-1, a transcription factor encoded by the immediate early gene (IEG) *egr-1*, was investigated using immunohistochemistry. Egr-1 (also known as *krox 24*, *zif/268*, *ZENK*) as well as *c-fos* are supposed to play an important role in the consolidation of memory traces (Grimm et al., 1996; Jin et al., 1997). We found that the expression of Egr-1 in the medial amygdala, the bed nucleus of the stria terminalis and the preoptic area of the experimental group was significantly higher compared to controls fed with palatable food.

Posture and Movement**PM1****VESTIBULAR CONTRIBUTION TO UPDATING THE RETINOTOPIC MAP***J. Ventre-Dominey¹* and I. Israël²**¹INSERM, Vision et Motricité, Bron - ²CNRS, LPPA, Collège de France, Paris, France*

Our purpose was to investigate in human the updating mechanism of retinotopic map based on vestibular information. The novelty of our study was to compare the ocular position accuracy to a memorized visual target 1) when the vestibular input was taken into account to update the retinal error or 2) when the vestibular input was ignored in order to maintain constant the retinal error. We studied horizontal saccades to visual memorized targets in 7 healthy subjects. The subject was seated in a rotating chair in the dark and horizontal and vertical eye movements were recorded by DC current electro-oculography. The paradigm was composed of 3 different conditions as follows: First, the subject had to maintain the gaze onto a head-fixed visual fixation point (for 7.5 sec) while a visual target was flashed for 1 sec at 10 degrees on the horizontal axis. After the extinction of the fixation point the subject had to perform ocular saccades onto the memorized visual target location 1) either in the current stationary body condition (Visual Condition: ViC) or 2) after a chair velocity step rotation with head-fixed visual point fixation. In

this last condition, after the chair was stopped and the fixation point was switched off, the subject had to saccade either to the spatial (Spatiotopic Vestibular Condition: SVeC) or to the retinotopic (Retinotopic Vestibular Condition: RVeC) location of the previously illuminated target. In each condition, after the ocular saccade has been made, a visual target was presented in the exact location to compensate for the possible error in eye position (corrective saccade). The 3 different experimental conditions ViC, SVeC, RVeC were presented in different sequential orders. The chair was rotated at different randomized angles of 10, 20 and 30 deg. We calculated the gain and the absolute error of the ocular position before the corrective saccades. Our preliminary main data demonstrate that 1) the final ocular position was similarly accurate (gain and error) in each condition (gain: ViC= 1.01, sd= 0.11; SVeC=1.06, sd= 0.12; RVeC= 1.02, sd= 0.16), and 2) the intra-individual accuracy (error) variability of the final position was significantly increased in the SVeC condition (ANOVA: $F(2,15)= 4.5$; $p= 0.029$). These data are discussed in terms of the vestibular contribution to updating the retinotopic map which supports visuo-spatial constancy during coordinated eye-head movements.

PM2

VISUAL SUBCEPTUAL AND PERCEPTUAL INFLUENCES ON MOTOR ACTIONS

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Recent data indicate dissociations between visual perception and motor performance. In particular, Goodale and colleagues have described that visual illusions have little or no effect on motor actions to illusory stimuli., suggesting that motor actions can operate independently of stimulus attributes and relevance. By contrast, accurate motor actions commonly depend upon correct identification of stimulus location. We investigated interactions between the perceptual and motor action systems by manipulating the perceptability and the location of visual stimuli preceding a go-cue. Ten healthy, young-adults performed movements in response to a go-cue appearing to the left or right of a fixation stimulus. A “priming” stimulus appeared before the go-cue and remained on a video monitor until go-cue onset. We manipulated the stimulus onset asynchrony (SOA, 11-1500 msec) between priming and go-cue onsets, contrast between the priming stimulus and background (delta = 5%, 10%, 28%) and spatial compatibility (compatible or incompatible) between priming and go-cue stimuli. Reaction time (RT) and spatial errors were measured. In a perceptual task, participants judged the location of the priming stimulus, with the percentage of trials judged correctly defining a hit rate. At short SOAs (11-39 msec) spatial incompatibility between the priming and go-cue stimuli yield higher RT than compatible stimuli, though the effect reversed at longer SOAs. The high contrast priming stimulus produced the most marked RT effect, but even the faintest priming stimulus produced a RT effect. Error rates paralleled the RT effects, indicating that the priming stimulus had a direct effect on motor actions. Hit rates in the perceptual task fell below 60-80% at short SOAs (11-39 msec) with near perfect performance at longer SOAs.

Comparing hit rate to the RT difference between spatially incompatible and compatible stimuli suggested a two stage process. At hit rates from 25 to 70%, the RT difference increased and thereafter declined to reverse as stimulus perceptability increased to near certainty. These data suggest that antecedent visual stimuli, even those not available to the perceptual system, can influence motor actions. We found that a semantically irrelevant stimulus could delay or facilitate movement onset, even when preceding a go-cue by 11 msec. Thus, stimuli with low perceptability, or subceptual stimuli, can exert effects on motor actions by modifying onset times and spatial accuracy. As stimuli become more perceptable, their effect on movement can change. In the current work, the transition between subceptual to perceptual conditions appears to occur between 39 and 100 msec, indicating that early in the visual-to-motor transformation subceptual processes can exert important influences on early planning mechanisms.

PM3

THE INFLUENCE OF COLOR ON THE CONTROL OF ARM MOVEMENTS

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In the present kinematic study subjects reached and grasped either a red (experiment 1) or a green (experiment 2) object, which could have two sizes and could be located either to the right or to the left of the subject's midline. Target could be presented either alone or with a distractor placed along subject's midline. Both red and green distractors were presented during both the two experiments. A control experiment (experiment 3) was carried out in which subjects matched the size of the red and the green target-objects with their thumb and index finger. The results of the present study can be summarised as follows: 1) target color influenced grasp, but not reach. Hand shaping was larger for grasping the red than the green target. Data collected during the matching task confirmed a trend to overestimate the red target and to underestimate the green one. 2) distractor color differentially affected the reach and the grasp component. Reach was slowed down by the presence of the distractors. This effect was greater for the red than for the green distractor, independently of target color. During grasp hand shaping was affected by incongruence between target and distractor colors. Hand shaping decreased during grasping the red target in presence of green distractor, and, conversely, it increased during grasping the green target in presence of red distractor. The results of the present study suggest that color is an object property involved in the control of reaching-grasping. The different effect of color on reach and grasp supports the notion that intrinsic object properties affect grasp more than reach. Finally, we propose that these results can be the counter-part of recent single neuron recording data on MT area of monkey showing that color is an object property analysed also in the dorsal visual stream.

PM4**SOURCE LOCALISATION OF MOVEMENT-RELATED POTENTIALS USING A REALISTIC HEAD SHAPE MODEL**

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Recent PET and fMRI studies have emphasised a strong overlap in activation of cortical and subcortical areas during execution and mental simulation of movements. In agreement with these data, studies relying on high time-resolution techniques, such as MEG or EEG provided evidence for primary motor cortex contribution to mental representation of motor acts. The present study was designed to compare the estimated locations, orientations, and strengths of current sources in the brain from measurements of evoked potentials during execution and mental simulation of simple finger movements. ERPs were calculated using the Scan 4.0 software. Different components in the movement-related potentials were identified by principal component analysis (PCA). MRI was conducted on a commercial 1.5 T scanner (Gyrosan ACS II Philips). MRI data were used to model the shape features of the volume-conductor. This method is implemented in the Curry 3.0 software and it localises electrical event generators using a volume conductor model constituted of realistically shaped compartments of isotropic and homogeneous conductivity. Electrode positions were digitised for subsequent integration with MRI data. Multimodal source localisation of functional data will be presented. Results are discussed in support to the notion that mental simulation of a movement requires utilisation of stored action representations, which obey to the same constraints as real movements.

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PM5**CORRELATIONS BETWEEN ANTAGONIST MOTOR RESPONSES AND KINESTHETIC ILLUSIONS INDUCED BY TENDON VIBRATION**

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In humans, tendon vibration evokes illusory sensations of movement that are usually associated with a tonic response in muscles antagonistic to those vibrated (Antagonist Vibratory Response, AVR). This study aimed at investigating the neurophysiological mechanisms underlying this motor response. For that purpose, we analysed the relationships between the parameters of the tendon vibration (anatomical site, frequency) and those of the illusory movement (direction, velocity), as well as the temporal, spatial, and quantitative characteristics of the corresponding AVRs (surface EMG, motor unit types, firing rates, activation latencies). One or two wrist muscle groups were vibrated, either separately or simultaneously,

at various frequencies. The kinesthetic illusions were quantified through contralateral hand tracking movements. Electromyographic activity was recorded with surface and intramuscular microelectrodes. Vibration of the wrist flexor muscles induced both a kinesthetic illusion of wrist extension and a motor response in the *Extensor carpi radialis* muscles (ECR). Combined vibration of the extensor and flexor muscles at the same frequency evoked neither kinesthetic illusion nor motor activity, while vibrating them at different frequencies induced both a kinesthetic illusion and a motor response in the muscle vibrated at the lowest frequency. The ECR surface EMG amplitude as well as their motor unit activation latency and discharge frequency were clearly correlated to the parameters of the illusory movement. Indeed, the faster the illusory movement, the greater the surface EMG and the sooner and the more intense the activation of the motor units. Combined vibration of the wrist flexor and adductor muscles induced a kinesthetic illusion that was intermediate between extension and abduction of the wrist. During kinesthetic illusions of wrist extension, motor responses were strongest in the ECR, whereas during kinesthetic illusions of wrist abduction, motor responses were strongest in the *Abductor pollicis longus* muscle. During kinesthetic illusions in the intermediate direction, the motor response was unequally distributed among both muscles, thus respecting their biomechanical properties. A vectorial modelling showed that the vectors representing the intermediate kinesthetic illusions corresponded to the summation of the vectors representing the illusory sensations in the two orthogonal directions. In addition, the motor responses could also be modelled as vectors. However, the vectors representing the motor responses to co-vibration corresponded to the averaging of the vectors representing the motor responses in the two separate directions. That the AVR is observed only when a kinesthetic illusion is evoked, together with the strong correlation between the parameters of the illusory movements and those of the AVRs suggest that this vibration-induced motor response may result from a perceptual-to-motor transformation of proprioceptive information.

PM6

MUSCLE SPINDLE FEEDBACK DURING "DRAWING-LIKE" MOVEMENTS

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It was proposed to study the proprioceptive sensory coding of movement trajectories during the performance of 2-D "drawing-like" movements imposed on the tip of the foot. For this purpose, the activity of the muscle spindle afferents from the Extensor digitorum longus, Tibialis anterior, Extensor hallucis longus and Peroneus lateralis muscles was recorded from the lateral peroneal nerve using the microneurographic technique. The drawing movements describing geometrical shapes such as squares, triangles, ellipses and circles were imposed at a constant velocity in both the clockwise and anti clockwise directions. A total number of 44 muscle spindle afferents were tested, 36 of which were identified as primary and 8 as secondary afferents. Whatever the shape of the imposed foot trajectory, the

primary endings from one muscle never discharged throughout the whole trajectory (on average, they discharged for only 49.2% of the length of the trajectory); whereas all the secondary endings discharged for most part of the drawing trajectories (average: 84.8%). All the afferents responded to passive ankle movements, and the relationship between the discharge rate and the direction could be described with a cosine-shaped tuning function. The peak of this function corresponded to the preferred sensory direction of the receptor-bearing muscles. The whole path of a given geometrical drawing movement was found to be coded in turn by each of the Ia afferents originating from each of the muscles successively stretched. The activity of each particular afferent was denoted by a “cell vector” pointing in this afferent’s preferred sensory direction at various points along each imposed trajectory. The response of an afferent population within one muscle was denoted by a vector corresponding to the sum of all the individual cell vectors. Each of these population vectors corresponding to one muscle gave the instantaneous feedback contribution by that muscle to the coding of the trajectory parameters. Lastly, a multi-population sum vector was calculated, corresponding to the sum of all the muscle vectors. A circular statistical analysis showed that the orientation of the sum vectors was significantly correlated with the theoretical vectors corresponding to the tangential directions of the drawing movements indicating that each muscle makes an instantaneous, oriented and weighted contribution to the proprioceptive coding of the movement direction during any movement trajectory. These findings suggest that trajectory information is already encoded at the peripheral level on the basis of the integrated inputs provided by sets of receptors belonging to all the muscles acting on a given joint.

PM7

MUSCLE SPINDLE FEEDBACK DURING SPATIALLY ORIENTED MOVEMENTS

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The proprioception coding of multi-directional ankle joint movements was investigated, focusing in particular on the question as to how accurately the direction of a movement is encoded when all the proprioceptive information from all the muscles involved in the actual movement is taken into account. During ankle movements imposed on human subjects, the activity of 30 muscle spindle afferents originating in the Extensor digitorum longus, Tibialis anterior, Extensor hallucis longus and Peroneus lateralis muscles was recorded from the lateral peroneal nerve using the microneurographic technique. In the first part of the study, it was proposed to investigate whether muscle spindle afferents have a preferred direction, as previously found to occur in the case of cortical cells; and if so, to analyse the neural coding of the movement trajectories using a “neuronal population vector model”. This model is based on the idea that neuronal coding can be analysed in terms of a series of vectors, each based on specific movement parameters. In the present case, each vector gives the mean contribution of a population of muscle spindle afferents within one directionally tuned muscle. A given population vector

points in the “preferred sensory direction” of the muscle to which it corresponds, and its length is the mean frequency of all the afferents within that muscle. Our working hypothesis was that the sum of these weighted population vectors (the sum vector) points in the same direction as the ongoing movement. The results show that each muscle spindle afferent, and likewise each muscle, has a specific preferred sensory direction, as well as a preferred sensory vector within which it is capable of sending sensory information to the CNS. In addition, the results show that neuronal population vector model accurately describes the multi-population proprioceptive coding of spatially oriented 2-D limb movements, even at the peripheral sensory level, based on the sum vectors calculated from all the muscles involved in the movement. In an accompanying poster, the coding of more complex 2-D movements such as those involved in drawing rectilinear and curvilinear geometrical shapes was investigated.

PM8

INFLUENCE OF COMBINED TACTILE AND PROPRIOCEPTIVE INFORMATION IN HUMAN POSTURAL CONTROL

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Three experiments were performed to investigate the relative contribution and the interactions of the plantar cutaneous and muscle proprioceptive messages in controlling human erect posture. Indeed, every whole-body sway probably results in a co-activation of both the cutaneous and muscular mechanoreceptors by modifying the pressure distribution under the plantar soles and by lengthening various muscles in particular at the ankle level. To evaluate the specific role of proprioceptive messages arising from various muscles, mechanical vibrations were applied to different muscles tendons at either one (ankle or neck) or two (ankle plus neck) body levels.

Results showed that: 1) the direction of the vibration-induced whole-body tilts varied according to the muscles stimulated; and it was opposite when neck or ankle muscles on the same side of the body were stimulated; 2) co-vibrating two muscles always resulted in body sways, whose direction and amplitude were a combination of those obtained by stimulating the same muscles separately. We propose that proprioceptive information from ankle and neck muscles may be used for two postural tasks: balance control and body orientation. We also suggest that co-processing of the various muscle proprioceptive messages followed a vector addition mode.

The contribution of the tactile feedback from the main supporting zones of the feet to postural control was assessed by creating an artificial « contrast » between the pressure levels of the forefoot and rear foot zones of standing subjects through static and dynamic vibration patterns.

Results showed that: 1) stimulating only one plantar zone also induced oriented body tilts; their direction was always opposite to the vibrated zone where a pressure increase was simulated; 2) co-vibrating two plantar zones resulted in additive postural responses; 3) co-stimulating the four anterior and posterior zones of both soles at the same frequency induced no clearly oriented body tilts but only increased

slightly the natural body sways. We conclude that the changes in the relative pressure simulated by differently vibrating the supporting zones of the soles gave rise to regulative postural adjustments able to cancel the virtual disequilibrium. In addition, the various cutaneous messages might be co-processed following the same additive rules as the multi-proprioceptive ones. Lastly, the interactions between the two sensory modalities in postural regulation were investigated using the same vibratory methods. Co-stimulating ankle muscles and plantar foot zones at different frequencies resulted in additive postural effects, whose direction and amplitude varied according to the frequency difference. Taken together, results suggest that the integration of intra- as well as inter-modal sensory messages seems obey a common vector addition laws for regulative postural purposes.

PM9

EVENT-RELATED LATERALIZED COMPONENTS OF THE EEG WITH DIRECTION INFORMATION FOR THE PREPARATION OF SACCADES AND FINGER MOVEMENTS

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Contra-ipsilateral ERP differences were investigated in the S1-S2 interval of a partial cueing paradigm to examine preparation for saccades and finger movements. A PCA on these differences was performed to get an objective overview about the different lateralised components. A visual S1 indicated either the direction (left vs. right) and/or the effector (saccade or finger movement) for the response required after S2 (visual/auditory). S2 only gave the information not given by S1. An occipital component (220 ms after S1) was found that may reflect an effector-independent direction code. A later component (320 ms after S1) was more specific for finger movements and larger when S2 was visual. A latter effector-independent frontal component (480 ms after S1) was possibly related to the planning of a lateral movement. Two other components were specific for the preparation of a finger movement (LRP before S2, and a parietal component 300 ms before S2). In conclusion, no saccade-specific component was found in the S1-S2 interval. PCA appears to be a suitable method for delineating these lateralized components.

PM10

DOES MOTION TRANSPARENCY AFFECT THE COHERENCE OF EEG SIGNALS?

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Several electrophysiological studies indicate that the processing of motion direction in complex patterns involves at least two stages. Area V1 constitutes the first stage, at which local motion measurements are

made. The second stage integrates the local motion signals to allow the percept of a coherent optical flow. This stage is assumed to be located in area MT. Both stages can be examined by using dynamic random dot kinematograms (RDKs) in which the characteristics of pixel displacement are varied. If pixels are displaced independently in different directions, a global uncorrelated motion perception results. Optical flow patterns can be evoked by moving all elements in the same direction. If subsets of the pattern elements are moving correlated but into different directions, a transparency effect occurs: Two surfaces are seen as moving above each other. Current computational models and neurophysiological studies indicate that in the case of motion transparency the two directions are signaled by two different subsets of MT neurons. Since each surface is perceived as a coherent whole, the output of single neurons in each of the subsets have to be spatially integrated, which possibly requires the temporal synchronization of neuronal responses. Since EEG coherence is a measure for the synchronization of EEG signals, we studied the effect of transparent motion on EEG coherence. Following global uncorrelated motion of the pixels, coherent (optical flow) or incoherent (transparency) direction perception was elicited. In the transparent condition, subsets formed by 50% of the pixels were moved into different directions.

The first experiment consisted of two transparent and one coherent condition. In the transparent conditions, we chose an angle of 90° or 180° between the subset directions. We found a change in EEG coherence for one of the transparent conditions (angle 90°) in comparison with the coherent condition: EEG coherence in the frequency range from 41Hz to 45Hz was lower in the transparent than in the coherent condition. The results were confirmed in a second experiment, in which two transparent and two coherent conditions were applied. In both transparent conditions the two pixel subsets moved with an angle of 90°. We found the same reduction in EEG coherence in the transparent conditions. The EEG coherence reduction might be explained as follows: For coherent motion, neuronal activity in only one cell assembly must be synchronized. In the transparent condition, at least two neuronal assemblies - firing independently and out of phase - are needed to encode the two transparent surfaces. This should reduce the EEG coherence because of the macroscopical EEG recording.

PM11

COHERENCE IN SPIKE TRAINS FROM MACAQUE PARIETAL CORTEX DURING A MEMORY SACCADE TASK

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Recordings were made at 20 sites in parietal cortex in two hemispheres from two animals using single tetrodes while the animals were performing a memory saccade task. Continuous voltage traces were sorted into spike trains from 2-6 cells per recording for a total of 207 cell pairs. Spike trains were then binned to 1 ms and coherences measured in a 256 ms sliding window for each pair of simultaneously

recorded cells. Coherence, was computed in the frequency domain as the cross spectrum between two Fourier-transformed spike trains divided by the square root of the product of the spectrum of each, and finally transformed to the time domain, for examination. Coherences were generally noisy, and thus the population means were calculated for each animal, aligning per-pair trial conditions according to the preferred target as determined by product of the firing rates. The means were quantitatively comparable between the two animals. Coherence in the means exhibited a peak near zero-delay, approximately 10 ms wide, which was modulated through the experimental task. Coherence was tuned over targets, being largest for the preferred target during the memory period. Coherence was high and broad during pre-cue fixation, abruptly sharpening in response to the target flash, and then sustained only for preferred target trials, broadening slightly through the memory period. As the animal saccaded to the remembered target location during preferred target trials, coherence initially decreased, until the visual response from target reillumination appeared at which point there was a transient, narrow, increase before coherence collapsed. Trials with non-preferred targets showed similar but lessened modulation in the post-fixation period.

PM12

SENSORY-MOTOR INTEGRATION IS THE BASIS OF CORRECT BEHAVIOR

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There is not any doubt that organization and neuron interaction principles are the same in various fields of the brain. The CNS complexity is associated with functional possibilities of animals on the scale of evolutionary ranks. Though the signal processing is very similar in different ranges there is no common idea about the neuron integration mechanisms. The spike flow transformation properties are ignored by many models and local neuron theories. By investigating the motor control system we also have studied the principles of impulse flow shaping on muscle contraction control electronic network model. It was found that the same impulse flow passing over two or more neurons rearranges to different pulse trains on each neuron output. The burst patterns and interspike intervals are the functions of synaptic organization and neuron size. We concluded that direct transmission of the same time pulse code from one central neuron to another is not possible. The adequate control can occur in closed loops only. In closed circuits the impulse burst patterns are homeostated by its element properties and impulse flows bear informative and energetic meaning. Impulse flows carry out nondestructive reading of information and define the pathways of its spreading into organized network. We consider parallel pathways to motoneurons as homeostatic mechanism transforming unstable locomotory apparatus into controlled one for brain higher levels. Due to the afferent and efferent tracts have significant time delays of the pulse transmission there are strong grounds for believing that anticipatory or predicted mechanisms must exist in the CNS. For this goal we proposed the network structure. Depth of a network excitation is determined by the maximal order of input signal derivative and is changed automatically as the signal changes.

Analysis of cerebellum and visual system, and the connections of pyramidal neurons with red nucleus neurons and the specific thalamic nuclei allows to say about existing of the predicting networks in the sensory organization and brain cortex. The neuron structures of the organisms shape automatically a future state of the environment. The vision system stabilizes our posture without selective attention. Yet in Parkinson's diseases during supporting isometric efforts we saw the decreasing in arm tremor amplitude when the monitor signs are switched off. In our study of isometric efforts in parkinson disease patients the cross-correlation functions show time delay decreasing between right and left hand activity at constant isometric effort supporting tasks as drug therapeutic action or in long time medicamentous treatment course. The findings confirm our idea that desynchronized and anticipatory mechanism distortions in ring and long-loop circuits are responsible.

PM13

V6 COMPLEX PROBABLY SUPPORTS VERY SPECIFIC COMPONENTS OF PREHENSION BEHAVIOR: A LESION STUDY IN MONKEYS

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In order to study the involvement of areas V6 and V6a in reaching and grasping, we caused restricted bilateral lesions in the anterior bank of the parietal-occipital sulcus of two adult *Cercopithecus aetiops*, trained for visuomotor tasks. In the first monkey (V6M1), both hemispheres were lesioned on the same day, while a two-month interval between the two lesions was given to the second monkey (V6M2). The patterns of misreaching, immediately detectable in both monkeys, differed from one another. V6M1 predominantly under- or overestimated the pieces of food disposed in a semicircle in front of it, while V6M2 tended to wring its wrist while grasping. Both monkeys displayed defective wrist orientation when required to pick up pieces of food from a narrow slit presented at different orientations, but this disorder was far more prominent in V6M2. A post-mortem histological analysis revealed that the V6 complex was only partially removed in V6M1, while in V6M2 the removal of the V6 complex was more complete. We suggest that the V6 complex plays a pivotal role in wrist orientation, and that the differences in prehension behavior between the two monkeys might be explained by the different degree of damage to the surrounding areas. The role of the V6 complex in visuomotor behavior is discussed within a hypothetical six-component model of reaching/grasping.

PM14**ARM-REACHING ACTIVITY IN AREA V6A (BRODMANN'S AREA 19) OF THE MACAQUE***P. Fattori^{1*}, M. Gamberini¹, D.F. Kutz² and C. Galletti¹**¹Dip. di Fisiologia Umana e Generale, Univ. di Bologna, 40127 Bologna, Italy and ²Dept. of Zoology and Neurobiology, Ruhr-University Bochum, D-44780 Bochum, Germany*

Area V6A is a cortical visual area located in the dorsal part of the anterior bank of the parieto-occipital sulcus, in the medial aspect of Brodmann's area 19. It has been reported to contain cells activated by somatomotor activity (Galletti et al. 1997, Eur. J. Neurosci. 9: 410-413). The aim of this work was to characterize the arm-movement related activity of V6A cells while the animal performed arm movements in darkness. Extracellular recordings were carried out in three awake monkeys (*Macaca fascicularis*). Two animals performed a fixation task and one a 3-D reaching task, in all cases with the head restrained. In the fixation task, the animal pushed and pulled a lever out of its field of view; in the reaching task, it performed arm reaching movements towards different directions in the peripersonal space. Both tasks were carried out in darkness. Eye position was recorded with an infrared oculometer. Electromyographic (EMG) activity was recorded with surface electrodes from 14 muscles of the arms, shoulders, neck and trunk. Two hundreds and two cells were recorded from area V6A. More than half of them (110/202) were affected by somatomotor activity. Almost all of these cells (104/110) were affected by the movement of the upper limbs. In the great majority of them (82/110), the activity was driven by movements of the contralateral arm. A minority of neurons were modulated by bilateral arm movements (8/110) or by movements of the ipsilateral arm (14/110). Arm movement-related neural discharge started before the onset of arm movement, often before the earliest EMG activity. Twenty-eight cells were tested with the 3-D reaching task. In almost all of them (27/28) the modulation of cell's activity changed according to the direction of arm movement. Different V6A neurons encoded different directions of movement and the preferred reaching direction changed from cell to cell. These data suggest that V6A cells were able to encode not only the motor event, but also its direction in the 3-D space. As all movements were performed in darkness, this arm-movement coding must occur on the basis of non-retinal inputs (like somatosensory inputs and/or copies of the motor commands). Since in area V6A both visual and non-visual neurons co-exist, we suggest that V6A is part of a cortical network involved in visuo-motor comparisons during arm-reaching movements.

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PM15**IN REACHING, HEMISPHERIC ASYMMETRY AND INTERHEMISPHERIC TRANSFER DEPEND ON THE SPATIAL COMPONENT OF THE MOVEMENT***J.L. Velay*, V. Daffaure, N. Raphael, and S. Benoit-Dubrocard**Lab. Neurobiologie Intégrative et Adaptative, UMR CNRS 6562, Université de Provence**52 Faculté de St Jérôme, Marseille, France*

Reaching towards visual targets requires forming a spatial relationship between points located in physical space and the limb extremity. Building this relationship involves spatial coordinates transformations. These operations have usually been investigated from the purely intrahemispheric point of view. Both hemispheres may participate, however, in the sensorimotor transformations, depending on which hand is being used and on the position of the target in the subject's visual field. The purpose of this study was to compare the intrahemispheric processes and the interhemispheric transfer occurring during the programming of 3 visuomotor responses with increasingly demanding spatial requirements. In all 3 tasks, the subjects had to respond to the same lateral visual spots located to the right or left of a central fixation point (FP). All 3 motor responses involved the shoulder and elbow. In the first task, which consisted of simply removing the arm from the starting platform when a target appeared, there were no spatial requirements. In the second task, which was a reaching movement towards the central FP, the movement parametrization was thought to be partly prepared in advance, regardless of the side on which the target spot appeared. The third task was a classical reaching response towards the eccentric target: the whole programming had to occur during the reaction time (RT). Both hands were tested under all 3 conditions. Forty subjects participated: 20 were right-handed (Rhr) and 20 left-handed (Lhr). The RTs increased with the spatial complexity of the response. In the classical reaching task, the RTs of the Rhrs were shorter when they used their left hand, which indicates that the programming was faster in the Rhrs'right hemisphere. No such hand-related difference was observed in the Lhrs. No such hemispheric asymmetry was observed in the other 2 tasks, in either the Rhrs or Lhrs. In the classical reaching task, the responses were faster when the target appeared in the visual field ipsilateral to the pointing hand (intrahemispheric condition) than when it appeared on the other side (interhemispheric condition). This timing difference was taken to reflect the interhemispheric transfer. No significant differences of this kind were observed in the 2 simpler tasks. Both hemispheric asymmetry and interhemispheric transfer seemed to depend on the spatial requirements of the movement. In the reaching task, although the joints involved were proximal, the command might be initiated in the hemisphere contralateral to the hand used, probably because the spatial parametrization of the movement has to be carried out in this hemisphere. Consequently, some information is transferred when the ipsilateral hemisphere receives the visual inputs. When no spatial parametrization is required, the command might be sent from either hemisphere and in this case, no transfer would be necessary.

PM16**TONIC PROPRIOCEPTIVE INFLUENCES ON CENTRALLY GENERATED LOCOMOTOR RHYTHM IN HUMANS***Y.P. Ivanenko*, R. Grasso, and F. Lacquaniti**Human Physiology Section of the Scientific Institute Santa Lucia, via Ardeatina 306, 00179 Rome, Italy*

The role of muscle proprioception in the control of equilibrium and of centrally generated locomotor rhythm can be studied by applying mechanical vibration to specific muscles which is known to activate muscle spindle afferents. Here we studied the effect of tonic proprioceptive input evoked by vibration of different muscle groups (Achilles tendons, m. tibialis anterior, quadriceps, hamstring muscles, dorsal neck muscles) in 7 normal subjects walking on the treadmill in a dark room. The velocity of the treadmill could be controlled by the feedback from the subject's position in such a way that forward displacement from the central position increased the treadmill velocity while backward displacement decreased it. Lower limb and trunk movements were recorded (4 camera 100 Hz ELITE). The effect of muscle vibration on locomotion differed significantly from that on normal static posture and consisted in the change of intersegment coordination and of walking velocity. Vibration of distal, shank muscles evoked little or no effect on the walking velocity. Vibration of hamstring and neck muscles produced a step-like increase of walking speed during forward locomotion and a decrease of speed during backward locomotion, while vibration of quadriceps muscles increased the walking speed during backward locomotion. The velocity increment (by 0.1-0.6 m/s) did not depend on the initial "background" walking speed (0.5-2 m/s) and increased with increasing vibration frequency. If applied during stepping in place, neck and hamstring muscle vibration elicited forward stepping at a constant speed. The effect of vibration on walking speed could be compensated by simultaneously applying horizontal force (about 20 N) to the upper trunk. The results 1) indicate that tonic inputs from peripheral afferents can modulate the locomotor rhythm generation, and 2) might reflect the relative role of different muscles for sensing and controlling walking speed.

*Supported by the Italian Ministry of Health.***PM17****THE JENDRASSIK MANOEUVRE CREATES CONDITIONS FOR INITIATION OF INVOLUNTARY STEPPING MOVEMENTS***Y.S. Levik, V.S. Gurfinkel, O.V. Kazennikov, and V.A. Selionov**Institute for Information Transmission Problems of RAS, Moscow, Russia*

We investigated the influence of Jendrassik manoeuvre on generation of locomotor movements in humans in horizontal position with legs suspended a horizontal plane. The hypothesis was checked that the increase of a level of tonic readiness could be a necessary precondition for activation of stepping mechanisms. Under normal conditions after 1-2 passive steps, imposed by the experimenter the

movements of the mobilised leg quickly stopped - it made only 1-2 cycles, the involvement of the second leg did not occur. However, if the same passive motion cycles were applied to one leg during performing of Jendrassik manoeuvre, this leg not only continued to carry out self-sustaining cyclic movements, but with a short delay, the second leg became involved in movements, and from the very beginning the reciprocal phase relations between movements of two legs were established. Thus, we showed the significant facilitatory influence of Jendrassik manoeuvre on stepping movements initiated by passive movements of one leg. The same influence could be seen on locomotion evoked by weak leg muscle vibration. The results of experiments allow to assume that a necessary condition of activation of spinal mechanisms of stepping generation is the increase of an activation level of tonogenic structures of CNS, participating in realisation of the locomotor program.

PM18

VECTION AND DIRECTION OF GRAVITY MODULATE TORSIONAL OPTIKOKINESIS

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A full-field visual stimulus rotating around the naso-occipital axis induces torsional optokinetic nystagmus (tOKN) with the slow phases in direction of the stimulus rotation. In addition, the perception of objective motion of the stimulus is intermittently interrupted by periods of illusory self-motion sensation, or circularvection (CV), in a direction opposite to stimulus motion. The explanation of vection is that visual motion signals summate with vestibular input to secondary vestibular neurones so that under circumstances of prolonged visual motion the net vestibular output signals self motion. When the axis of rotation is not aligned with the gravity vector, the perception of CV is also accompanied by a simultaneous paradoxical perception of whole-body tilt in the same direction as the perceived self-rotation. In the upright position there is a marked conflict between the visuo-vestibular signals that engender roll-tilt vection and somatosensory and otolith inputs that are veridical. This study investigates the influence of orientation to the gravity vector and the perception of CV on the characteristics of tOKN at a range of optokinetic stimulus velocities (30-60 deg/s). Observers were sitting upright or lying supine whilst observing the optokinetic stimulus and indicated their state of motion perception (object motion vs. CV). Monocular eye movement recordings were obtained for 3 minutes per session by three-dimensional infrared videoculography. Torsional nystagmus slow phase velocity gain and average torsional eye position were computed offline for both states of motion perception and experimental conditions. In absence of visuo-vestibular-somatosensory conflict there was a significant overall enhancement of tOKN gain at all perceptual states and stimulation velocities. In addition, at all stimulus velocities and body positions tOKN gain was significantly higher when observers reported perceiving CV rather than object motion. Average torsional eye position shifted significantly in the direction of the saccadic nystagmus component when conflict was absent and when observers perceived illusory self-

motion. The enhanced efficiency of torsional optokinetic eye movements under changed otolithic and somatosensory stimulation as well as during the visually induced perception of self-motion may be a manifestation of disinhibition of a restraining input exerted by the vestibular system onto oculomotor optokinetic and pursuit mechanisms, presumably on a level as early as the vestibular nuclei in the brainstem.

PM19

FUSIMOTOR SET IN HUMAN RELAXED MUSCLES

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The question as to whether or not there exists a fusimotor tone in relaxed healthy subjects is still a matter of debate. The authors of many studies have established that no significant changes in the spindle discharge can be detected as long as the receptor bearing muscle is not contracted. On the other hand, there exist several data supporting the idea that relaxed human muscles undergo a selective fusimotor drive depending on the attentive state of the subject and increasing during reinforcement maneuvers. The aim of the present study was to analyze the effects of reinforcement maneuvers, such as mental computation and the Jendrassik maneuver, on relaxed subjects' muscle spindle sensitivity to passively imposed sinusoidal stretching (1.5j, 2 Hz). The unitary activity of 26 muscle spindle afferents (23 Ia, 3 II) originating from ankle muscles was recorded using the microneurographic method. Particular care was paid to the subjects' state of physical and mental relaxation, which was assumed to be a pre-requisite for any effect of the gamma system to be detectable in the muscle spindle recordings. The results showed that the activity of 60% of the Ia afferents was modified during mental computation. The changes took the form of either an increase in the number of spikes (mean 24% among 11 Ia fibers) or a shortening in the latency of the response to sinusoidal stretching (mean 13 ms among 3 Ia fibers), or both. It was sometimes accompanied by an enhanced variability in the instantaneous discharge frequency, which in the most extreme cases yielded a response which was almost decorrelated from the stimulus. The increase in the muscle spindle primary endings sensitivity to stretch movements might begin as soon as the instructions were given to the subject and be enhanced during mental computation. Furthermore the increased effect might either stop after the subject gave the right result and was asked to go back to being as mentally relaxed as possible or continue for several minutes. The affected Ia units were found to undergo similar changes during the performance of a Jendrassik maneuver. The 3 secondary endings tested did not exhibit any change in their sensitivity to stretch during both maneuvers. It was concluded that human muscles at rest may be submitted to a fusimotor set. Tasks leading to modifications in the state of vigilance and arousal, such as performing mental computations, can be said to provide an efficient means of revealing this fusimotor output. The results of the present study rehabilitate the role of the fusimotor system in arousal and expectancy and contribute to narrowing the gap between the available human and behaving animal data.

PM20**AUTONOMIC RESPONSE TO REAL VERSUS ILLUSORY MOTION (VECTION)**

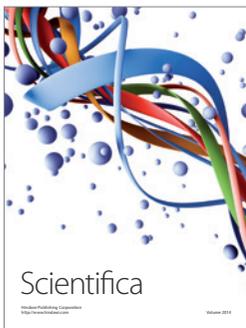
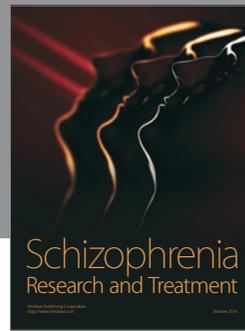
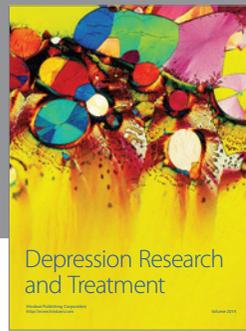
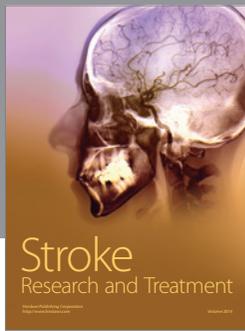
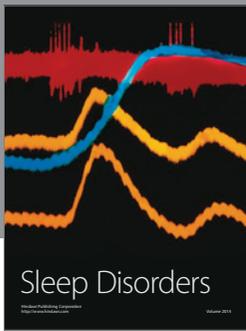
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Vection is an illusory self-motion induced by a moving visual field, familiar as the 'railway carriage' illusion of self-motion provoked by a passing train. Vection is attributed to a summation of visual motion signals with vestibular signals in vestibular nuclei type I neurones which give an output the brain may interpret as self-motion, though their input be only of visual motion. Movements and spatial reorientations demand changes in autoregulation. In this respect recent studies have shown that the vestibular system (the only senses specialised for signalling spatial orientation) has direct projections to centres controlling cardiac and respiratory regulation (1). Since the vestibular system easily engenders vection the question arises whether this illusory reorientation provokes inappropriate autonomic responses. Hence we compared autonomic responses to real spatial reorientation with those made to similar vection. Responses were obtained from 10 male subjects exposed to rapid roll tilts from upright of 20° and 30° in a flight simulator and compared with those evoked during the illusion of roll-tilt vection provoked by a torsionally rotating visual field in the form of a striped cone mounted in front of the subjects' face which rotated about their longitudinal axis. Comparisons were made of 10s data epochs pre- and post stimulus or vection onset. In response to vection arterial BP rose consistently in 6 subjects and, in all of these, a pressor response to real tilt was also observed. The remaining 4 subjects consistently had decreased BP in response to vection and their BP was little affected by real tilt. Six months later two subjects with opposite BP responses to vection were retested with the same results suggesting that the response characteristic is temporally stable. Subjects who raised their BP with vection and tilt may be dominated by tendency to arousal whereas those lowering BP may reveal the more appropriate response to tilt from upright which is to lower BP. Individual results did not correlate with responses to questionnaires on headache, ear and eye diseases and optical correction; susceptibility to motion sickness; susceptibility to startle, shock, blushing and fainting; introversion-extraversion; physical activity, attitude to physical risk and funfairs; use of social and prescribed drugs; medical history. The autonomic response to illusory spatial reorientation may be idiosyncratic depending upon relative visual-vestibular versus somatosensory dominance in autoregulation.

¹Yates (1992) *Brain Res. Rev.* 17:51.



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