

NeuroWatch

CALCIUM: THE DIRECTOR OF OUR MEMORY PROCESSES

R.J. Cormier, A.C. Greenwood, J.A. Connor. Bidirectional synaptic plasticity correlated with the magnitude of dendritic calcium transients above a threshold. *J Neurophysiol* 85, 399–406, (2001).

The role of calcium ions (Ca^{2+}) in the induction of different forms of synaptic plasticity has been a matter of study for more than a decade. As a mechanism for the induction of Long-term Potentiation (LTP) or Long-term Depression (LTD), it was hypothesized that an input-associated rise in intracellular Ca^{2+} in the postsynaptic neuron beyond a critical threshold would induce LTP, whereas lower levels would be required to induce LTD. In turn, different Ca^{2+} -activated enzymes would then convert the initial trigger into sustained modifications of synaptic plasticity: a moderate increase would lead to activation of phosphatases, while higher levels of intracellular Ca^{2+} would preferentially stimulate kinases. Compelling evidence demonstrates the requirement of Ca^{2+} transients in synaptic plasticity in a variety of brain regions (Lisman *et al.*, 1989; Llano *et al.*, 1991; Petrozzino *et al.*, 1995; Yuste and Denk, 1995; Tsumoto and Yasuda, 1996; Artola *et al.*, 1996; Neveu and Zucker, 1996). The debate in the recent past remained quiescent, and the present work by Cormier and colleagues sheds new light on this controversial issue. By means of combined intracellular sharp microelectrode recordings and microfluorometric measurements from single CA1 hippocampal neurons, the authors investigated quantitatively the changes in intracellular Ca^{2+} levels induced by glutamate pulses delivered iontophoretically. Electrophysiological test stimulation before and after iontophoresis showed that the direction of long-lasting synaptic changes was linked to glutamate-induced Ca^{2+} elevations above a critical threshold. LTP of synaptic transmission was observed with Ca^{2+} levels above 500 nM,

whereas lower concentrations (180–500 nM) lead to LTD. These data further support the view that Ca^{2+} plays a key role in synaptic plasticity and provide a quantitative evaluation of the amount of Ca^{2+} required to the switch between LTP and LTD.

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MAGNETIC PULSE FINDS NEW MOTOR PLACE

Matthew F. S. Rushworth, Amanda Ellison, and Vincent Walsh. Complementary localization and lateralization of orienting and motor attention. *Nature Neuroscience* 4(6), 656–661 (2001).

Evidently from this recently published study, Rushworth *et al.* significantly enhance the potential of repetitive transcranial magnetic stimulation (rTMS) as a viable technique for distinguishing functionally-specific brain regions in humans. With the aid of an infra-red tracking device, it was possible to anatomically localise the TMS coil and co-register its position with high-resolution MRI structural images of the subject's head.

Using this technology, the paper examines whether orienting attention and motor attention, two processes intimately related functionally, are actually anatomically discrete. Previous studies have shown the ability to disengage covert attention was compromised in patients with parietal lesions in the area of the angular gyrus. However, evidence also sug-

gests that covert orienting attention is dissociable from the subsequent preparation of an oculomotor response, and moreover that the mechanism for motor attention may indeed lie in a right parietal region more anterior to the angular gyrus.

During the systematic application of rTMS to transiently disrupt cortical functioning at sites in the left and right parietal cortices, reaction times (RTs) responses were recorded whilst subjects performed either an orienting attention task or a motor attention task. The RTs taken during rTMS trials were later compared to RT data collected during control experiments when no rTMS was involved. The results of the study reveal that not only are the modality-specific cortical processes involved in orienting attention and motor attention anatomically localised in the angular gyrus and supramarginal gyrus respectively, but also that the two attentional processes are indeed lateralised in humans; covert orienting being attributable to the region of the right angular gyrus and covert motor attention localised in the region of the left supramarginal gyrus.

In addition to presenting revealing evidence for the existence of a distinct anterior parietal mechanism for motor attention, Rushworth *et al.* have shown rTMS to be an important addition to the techniques available to cognitive neuroscientists, and one that can, when used imaginatively, consolidate and/or challenge the previous findings of lesion-deficit and animal models of cortical functioning.

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VARIABLE MOVEMENTS, VARIABLE THEORIES

Van den Dobbelaert J J, Brenner E, Smeets J B J. Endpoints of arm movements to visual targets. *Exp Brain Res* 138, 279–287 (2001).

A longstanding question in motor control is whether planning of goal-directed arm movements uses position coding or vector coding. The position-coding hypothesis argues that only the position of the target has to be specified, knowledge about the initial hand position is not required. In contrast, vector coding assumes that a movement is planned in terms of the required displacement, that is, the vector pointing from the initial hand position to the target position.

Early studies supported the position-coding hypothesis. More recent studies, however, have favoured vector coding, but the issue remains unresolved. The authors devised a novel,

elegant method to distinguish between the two theories, based on analysing movement variability. Subjects made a sequence of movements between visual targets (without visual feedback), in such a way that the endpoint of one movement was the starting position of the next. Assuming that the variability originates during planning, vector coding would predict that the endpoint variance is the sum of the variances in the displacements and in the starting positions. Position coding, on the contrary, predicts that the displacement variance is the sum of the variances in the starting and end positions. Therefore, comparing endpoint and displacement variance dis-

tinguishes between the two hypotheses.

The results show that displacements are more variable than end positions. A more sophisticated analysis, taking account of drifts in spatial perception, produces the same result. This study therefore finds clear support for position coding in movement planning, which is surprising in the light of other recent studies.

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