DELETIONS OF ENG ACTIVITY DURING FICTIVE LOCOMOTION AND SCRATCH SHOW MAINTAINED CYCLE PERIOD TIMING DESPITE FAILURES OF RHYTHMIC MOTONEURON EXCITATION AND INHIBITION.

SPINAL CORD RESEARCH CENTRE

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Deletions are spontaneously occurring periods of reduced or absent activity during otherwise rhythmic nerve activity

Deletions during the turtle scratch reflex

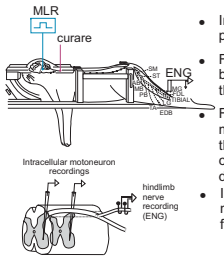
The study of deletions during rhythmic behaviours introduced by Stein and colleagues (Robertson and Stein, 1988) has led to an understanding of the organization of the pattern generator for this behaviour (Stein, 2004).

Deletions during cat locomotion

Deletions have been reported in the spinal cat walking on a treadmill (Grillner and Zangger 1979) as well as during fictive locomotion (Jordan 1991, Burke *et al.* 2001)

In this study we present an analysis of the nerve and intracellular motoneuron activities during deletions in fictive locomotion and scratch

METHODS



- Immobilized, decerebrate cat preparation
- Fictive locomotion induced by electrical stimulation of the brainstem.
- Fictive scratch induced by mechanical stimulation of the ear after application of curare to the ipsilateral dorsal root at C1.
- Intracellular recordings of motoneuron pairs during fictive rhythmic behaviours.

REFERENCES

Robertson GA, Stein PS. Synaptic control of hindlimb motoneurones during three forms of the fictive scratch reflex in the turtle. *J Physiol*. 1988 Oct;404:101-28.

Stein PS. Neuronal control of turtle hindlimb motor rhythms. *J Comp Physiol A Neuroethol Sens Neural Behav Physiol.* 2004 Sep 25 [Epub]

Grillner S, Zangger P. On the central generation of locomotion in the low spinal cat. *Exp Brain Res.* 1979 Jan 15;34(2):241-61.

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ABBREVIATIONS

CPG- central pattern generator
EDL - extensor digitorum longus
ENG- electroneurogram
GS - gastrocnemius
LG - lateral gastrocnemius
MG - medial gastrocnemius
MLR- mesencephalic locomotor region
PbSt- posterior biceps & semitendinosus
Plant- plantaris
PerL - peroneus longus
Quad- quadriceps
Sart- sartorius
SmAB- semimembranosus + anterior biceps
TA- tibialis anterior

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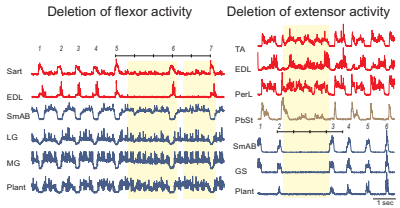
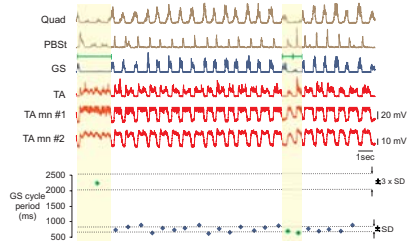
1. RECIPROCAL DELETIONS

- Deletions can occur in either flexor or extensor nerve activity
- Deletions occur at synergists across the hindlimb
- Reciprocity of activity between antagonists is maintained during deletions

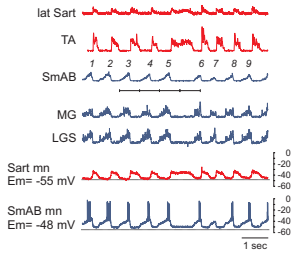
Deletions can occur during otherwise unperturbed fictive locomotion



Timing can be maintained despite clear changes in the locomotor drive potential

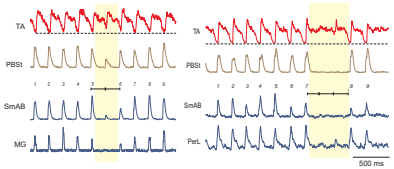


Reciprocity of motoneuron excitation can be maintained despite alterations in timing

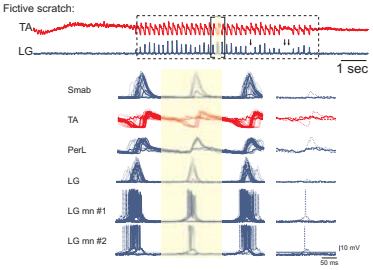


Only deletions of extensor activity were oberved during fictive scratch

- Deletions also occurred in synergists across the hindlimb
- Reciprocity of activity between antagonists is maintained during deletions in fictive scratch



The scratch drive potential can be reduced or completely absent during deletions



CONCLUSIONS

Like the study of deletions in the turtle, our study of deletions during fictive locomotion and scratch in the cat reveals organizational features of the networks responsible for generating these behaviours.

The similarity of deletions occurring during fictive locomotion and fictive scratch provides evidence for shared elements between the CPGs responsible for these two behaviours.

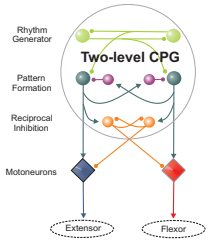
The switching of PerL activity from flexor-like during fictive locomotion to extensor-like during fictive scratch suggests a flexible organization of the pattern formation networks.

What have we learned about the locomotor CPG from deletions?

1.The simultaneous failures in proximal and distal motoneuron pools suggest a tightly coupled common excitatory drive during both fictive locomotion and scratch.

2.The ability to maintain the pre-existing rhythm following deletions suggests a separate “clock” function in the CPG.

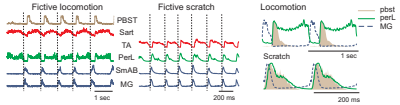
3.The concommittant failure to depolarize agonists and hyperpolarize antagonists stresses the tight reciprocal coupling within the CPG.



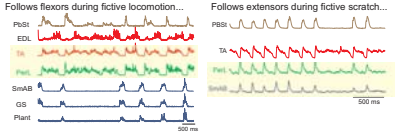
These physiological observations are the foundation of a new model of the central pattern generator

(See poster #883.3 Rybak et al SFN 2004)

PerL activity switches from flexion during locomotion to extension during scratch



The behaviour of PerL during deletions corresponds to its activity



2. NON-RECIPROCAL DELETIONS