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IN THE EUROPEAN CAPITAL OF CULTURE
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A spiking model of the basal ganglia demonstrates several complementary movement-cancellation mechanisms

Introduction

The recent pause-then-cancel model[1] proposes that cells of the subthalamic nucleus pause and arkypallidal cells of the external globus pallidus cancel action execution.

We investigated[2]…
How exactly do the arkypallidal cells contribute to action cancellation, and what could be the role of cortex-projecting cells of the external globus pallidus[3]?

Why do especially the arkypallidal cells get active during both action cancellation and execution[4]?

Conclusions

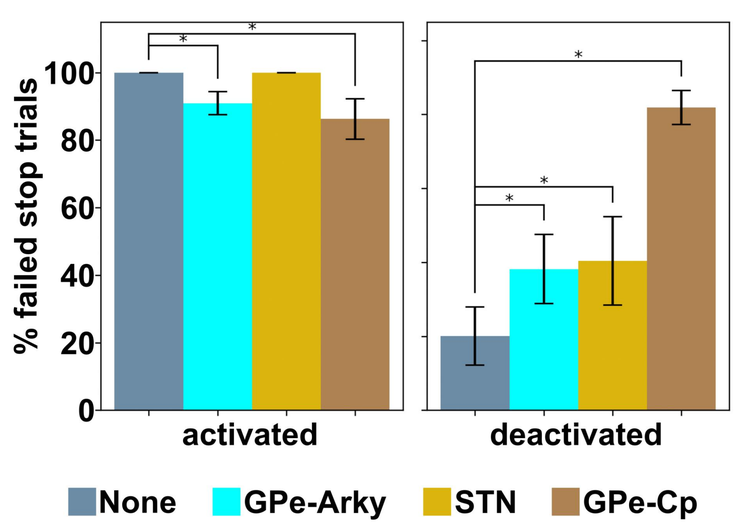
Cortex-projecting cells of the external globus pallidus might inhibit go-related cortical processes.

Go-related inhibitory striatal and stop-related excitatory cortical inputs may explain biphasic responses of cells of the external globus pallidus, both at action cancellation and execution.

Arkypallidal cells of the external globus pallidus appear to inhibit primarily striatal cells of the indirect pathway to free the external globus pallidus from inhibitory input from striatal cells.

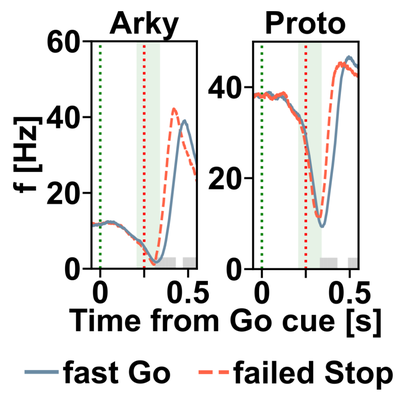
Results

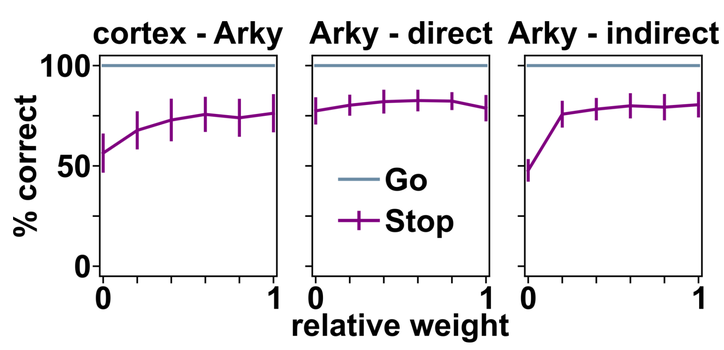
extra sheet: more results



The stop-cue-related responses of subthalamic, arkypallidal, and cortex-projecting cells of the external globus pallidus must complement each other to enable successful stopping behavior.

Cells of the external globus pallidus show biphasic responses during both stopping and action execution as in previous exp. studies.





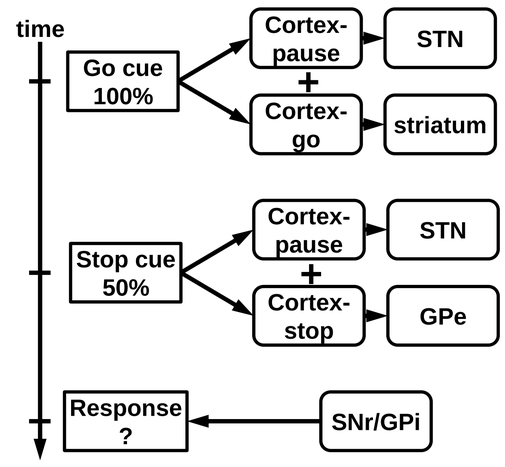
Surprisingly, the arkypallidal cells contribute to stopping by inhibiting the striatal cells of the indirect pathway but not those of the direct pathway.

Methods

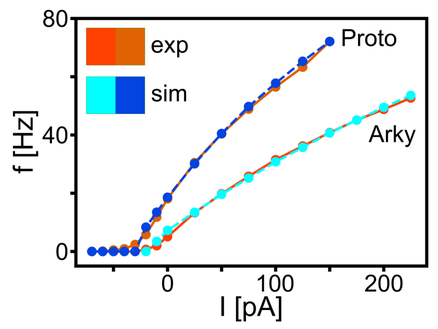
extra sheet: full model

A computational model of a cortico - basal ganglia - thalamic circuit consisting of spiking point neurons and implemented in the neurosimulator ANNarchy[5] was used.

A classical stop-signal-task based on Mallet et al. (2016)[6] was simulated:



We divided the globus pallidus into prototypical, arkypallidal, and cortex-projecting neurons. Gpe-Neurons were fitted to data:



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Acknowledgements

This research received funding from the program "CRCNS collaboration on computational neuroscience" BMBF 01GQ1707 and the SPP 2041 "Computational Connectomics" DFG HA2630/11-2.

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