

# 34<sup>th</sup> Annual Computational Neuroscience Meeting

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## P138: Quantifying harmony between direct and indirect pathways in a spiking neural network of the basal ganglia; healthy and Parkinsonian states

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☒ Passi Perduti

P138 Quantifying harmony between direct and indirect pathways in a spiking neural network of the basal ganglia; healthy and Parkinsonian states

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The basal ganglia (BG) show a variety of functions for motor and cognition. There are two competitive pathways in the BG; direct pathway (DP) which facilitates movement and indirect pathway (IP) which suppresses movement. It is well known that diverse functions of the BG may be made through “balance” between DP and IP. But, to the best of our knowledge, so far no quantitative analysis for such balance was done. In this paper, as a first time, we introduce the competition degree  $C_d$  between DP and IP. Then, by employing  $C_d$ , we quantify their competitive harmony (i.e., competition and cooperative interplay), which could lead to improving our understanding of the traditional “balance” so clearly and quantitatively. We first consider the case of normal dopamine (DA) level of  $\phi^* = 0.3$ . In the case of phasic cortical input (10 Hz), a healthy state with  $C_d^* = 2.82$  (i.e., DP is 2.82 times stronger than IP) appears. In this case, normal movement occurs via harmony between DP and IP. Next, we consider the case of decreased DA level,  $\phi = \phi^* (= 0.3) \times DA (1 > x_{DA} > 0)$ . With decreasing  $x_{DA}$  from 1, the competition degree  $C_d$  between DP and IP decreases monotonically from  $C_d^*$ , which results in appearance of a pathological Parkinsonian state with reduced  $C_d$ . In this Parkinsonian state, strength of IP is much increased than that in the case of normal healthy state, leading to disharmony between DP and IP. Due to such break-up of harmony between DP and IP, impaired movement occurs. Finally, we also study treatment of the pathological Parkinsonian state via recovery of harmony between DP and IP.

### Acknowledgements

### References

[1] Kim, S.-Y., & Lim, W. (2024). Quantifying harmony between direct and indirect pathways in the basal ganglia; healthy and Parkinsonian states. *Cognitive Neurodynamics*, 18, 2809-2829. <https://doi.org/10.1007/s11571-024-10119-8>