

Background

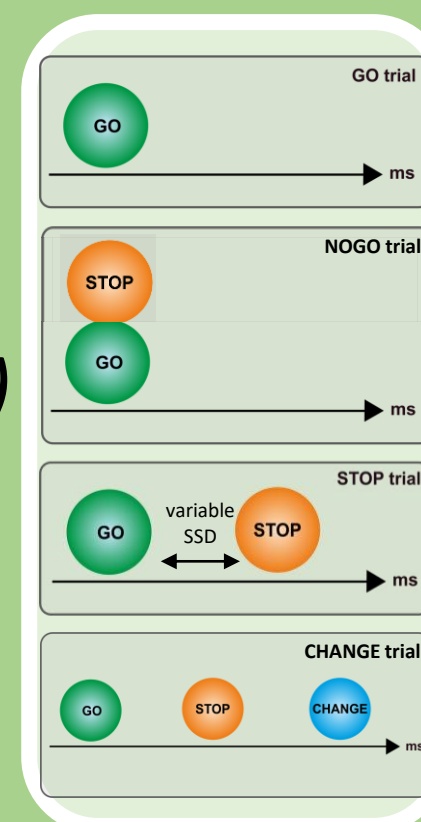
The ability to flexibly interact with the environment is fundamental for everyday life situations.

→ *Need to stop & change* initiated responses

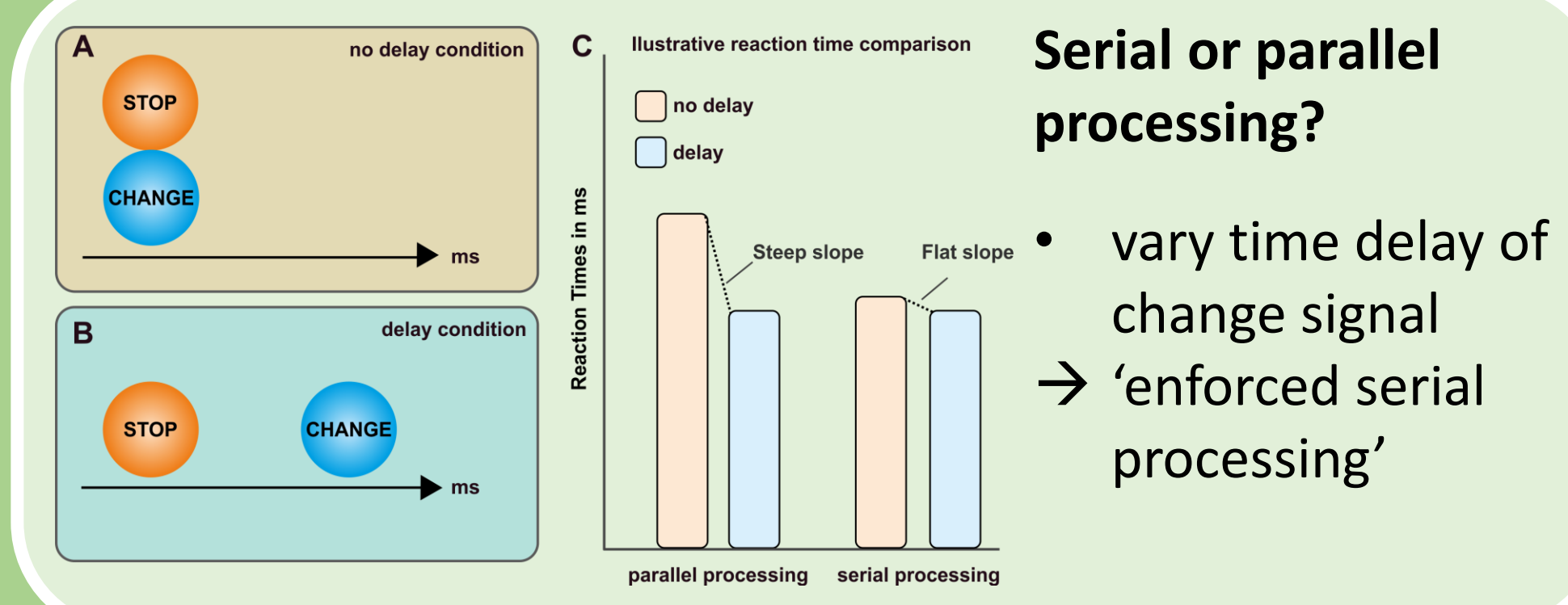
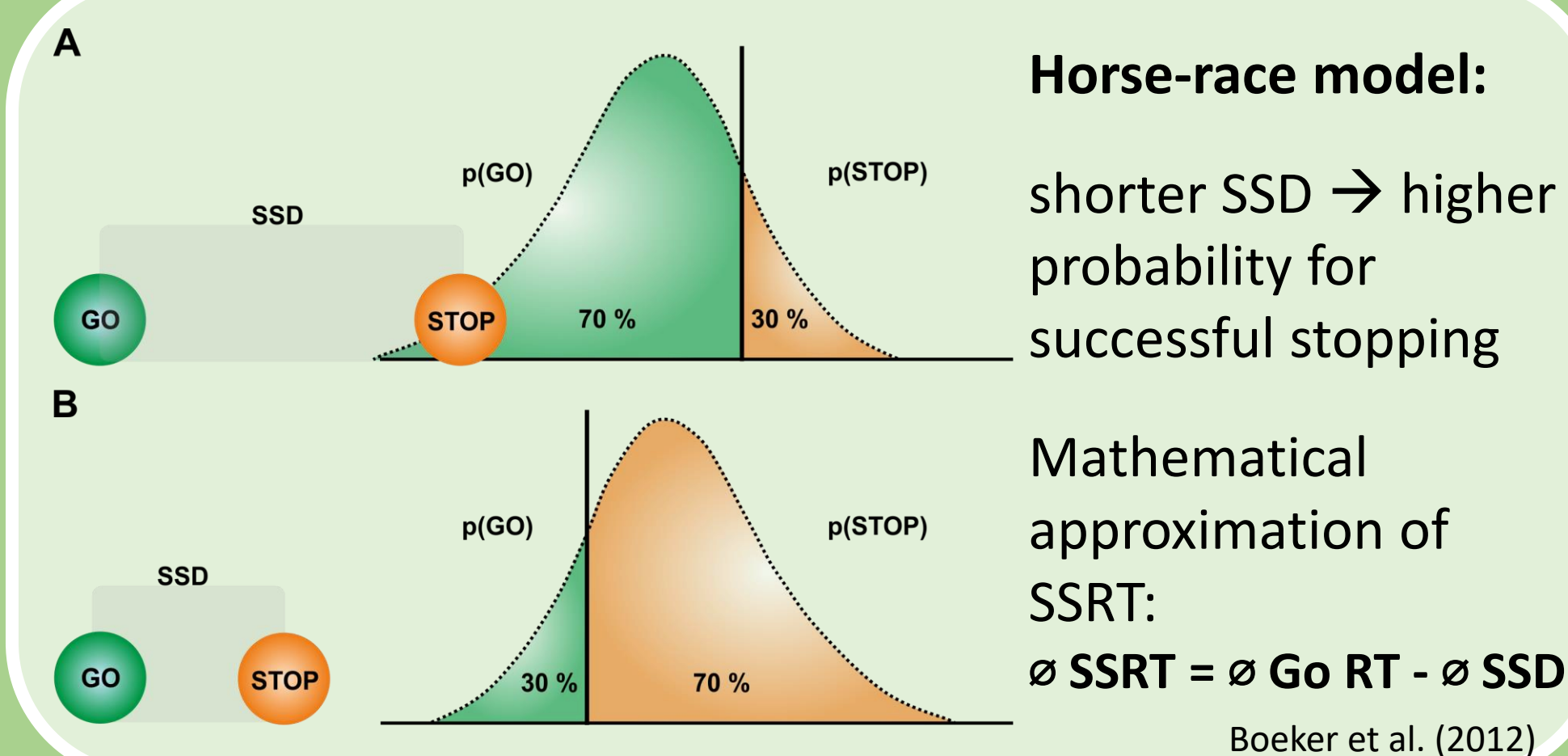
(Boecker et al., 2012)

Three paradigms to study response inhibition & response realignment:

- **Go/NoGo-Paradigm (GNG)**
 - › Need to inhibit initiated response
- **Stop-Signal Paradigm (SSP)**
 - › GNG + variable stop signal delay (SSD)
 - › Stop signal reaction time (SSRT)
- **Stop-Change Paradigm (SCP)**
 - › SSP + change stimulus
 - response realignment



How can we measure inhibition?



Background

Different stopping mechanisms?

Aron & Verbruggen (2008)

- Global vs selective stopping process
 - Selective process is more adequate for most everyday life situations.
- *Hyperdirect pathway* → (fast) global stopping
- *Indirect pathway* → (slow) selective stopping
- Different activation pattern in GNG/SSP

Swick et al. (2011)

Objectives

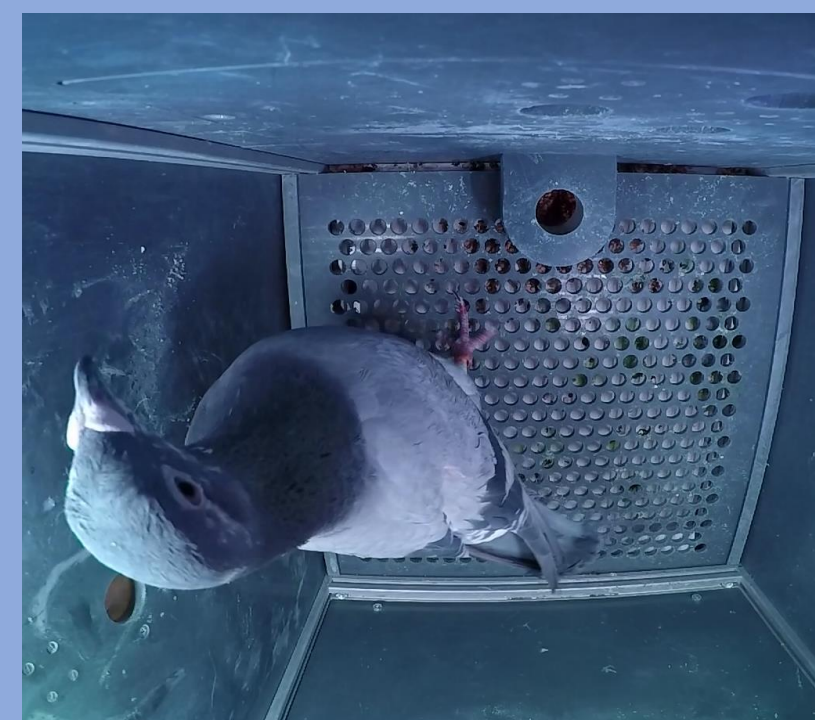
1. **Measure** SSRT from video footage & compare with mathematical approximation (horse-race model)
2. **Compare** behavioral properties of delay/no delay conditions (parallel vs. serial processing) in SCP using unsupervised behavioral clustering method.
3. **Identify** behavioral differences of the inhibition processes in GNG, SSP & SCP

Data Acquisition

Subjects: n=5 pigeons (*Columba livia*)

Setup:

- Skinner box equipped with various pecking keys and a feeder, suitable for the respective paradigms.



Procedure:

- › The pigeons successively participate in GNG, SSP and SCP.
- › Pecking responses are counted and stored for later analysis

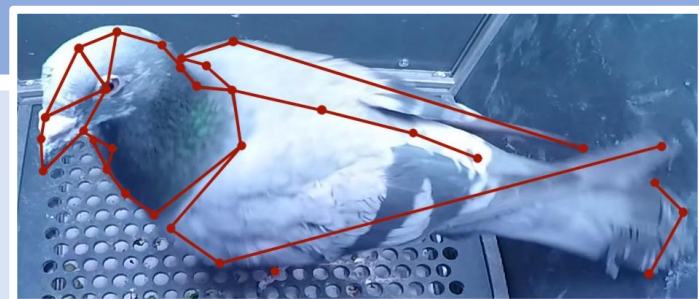
Video Data:

- Sessions are filmed with two GoPro Hero5 action cameras that are attached to the front side of the skinnerbox

Data Analysis

1. Tracking (DeepLabCut):

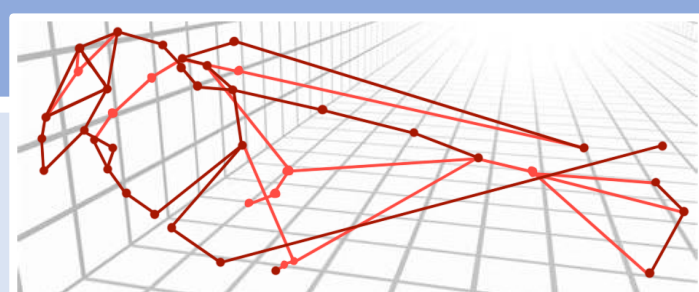
- Open-source python toolbox
- Noninvasive tracking of animal behavior from video data (supervised machine learning)
- measure the SSRT based on behavioral tracking



Nath et al. (2019)

2. Triangulation (Anipose):

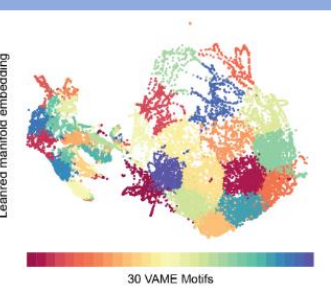
- Open-source python toolkit
- 3D pose estimation from different cameras based on DeepLabCut output



Karashchuk et al. (2021)

3. Clustering (VAME):

- Unsupervised deep learning framework
- Identify discrete behavioral motifs during inhibition phase
- Compare behavioral characteristics of different stopping processes



Luxem et al. (2022)

References

- Aron, A.R. & Verbruggen, F. (2008). Stop the Presses: Dissociating a Selective From a Global Mechanism for Stopping. *Psychological Science*, 19(11), 1146-1153. <https://doi.org/10.1111/2Fj.1467-9280.2008.02216.x>
- Boecker, M., Gauggel, S., & Drueke, B. (2012). Stop or stop-change – Does it make any difference for the inhibition process? *International Journal of Psychophysiology*, 87(3), 234-243. <https://doi.org/10.1016/j.ijpsycho.2012.09.009>
- Karashchuk, P., Rupp, K.L., Dickinson, E.S., Walling-Bell, S., Sanders, E., Azim, E., Brunton, B.W., & Tuthill, J.C. (2021). Anipose: A toolkit for robust markerless 3D pose estimation. *Cell Reports*, 36(13), 109730. <https://doi.org/10.1016/j.celrep.2021.109730>
- Luxem, K., Mocellin, P., Fuhrmann, F., Kürsch, J., Remy, S., & Bauer, P. (2022). Identifying Behavioral Structure from Deep Variational Embeddings of Animal Motion. *BioRxiv*. [Preprint.] January 14, 2022 [accessed 2022 January 25]. <https://doi.org/10.1101/2020.05.14.095430>
- Nath, T., Mathis, A., Chen, A. C., Patel, A., Bethge, M., & Mathis, M. W. (2019). Using DeepLabCut for 3D markerless pose estimation across species and behaviors. *Nature Protocols*, 14(7), 2152-2176. <https://doi.org/10.1038/s41596-019-0176-0>
- Swick, D., Ashley, V., & Turken, U. (2011). Are the neural correlates of stopping and not going identical? Quantitative meta-analysis of two response inhibition tasks. *NeuroImage*, 56(3), 1655-1665. <https://doi.org/10.1016/j.neuroimage.2011.02.070>