Applied Neuroscience (Exercise 1: Motor Learning)

Mishuk Mitra - 221621

1. Savings

Savings is a fundamental property of memory. It refers to the ability of prior learning to accelerate relearning even after behavioral manifestations of the prior learning have been washed out.

There are three main components of the savings experiment.

First, a novel response to a stimulus is gradually learned over the course of many trials.

Next, this stimulus-response is unlearned or extinguished so that the stimulus no longer evokes the learned response.

Finally, the initially learned stimulus- response is relearned under the original learning conditions. If savings is present, relearning will proceed more quickly than initial learning.



**Figure.1** adaptation vs. trials for both models

*1st phase-* A recent response to a stimulus and gradually learned over the trials.

*2nd phase-* Stimulus-response washed-out that the stimulus would no longer remind the learned response.

*3rd phase-* Relearning the initially learned stimulus- response but proceed more quickly than initial learning because of savings.

Here second model exhibiting a bit faster relearning than the single state model. There are 2 different states in multi-state learning as slow and fast state. Slow state started decrease slowly and not completely washed-out where fast state increases faster. when relearning phase starts Which biased the relearning more easier and faster. The single-state model fails to show savings (faster relearning), but multi-rate models show savings.

Here n0 is selected as trial value where the relearning phase begins. Different n0 have been chosen to justify savings presenting in the graph because of the different returning dynamics to the baseline due to disturbance.

2. Spontaneous Recovery

Spontaneous recovery is associated with the learning process that was first named and described by [Ivan Pavlov](https://en.wikipedia.org/wiki/Ivan_Pavlov) in his studies of [classical (Pavlovian) conditioning](https://en.wikipedia.org/wiki/Classical_conditioning). In that context, it refers to the re-emergence of a previously [extinguished](https://en.wikipedia.org/wiki/Extinction_(psychology)) conditioned response after a delay.

Error-clamp is basically blocks or eliminates error in the motor output. It is used for observing spontaneous recovery effect. So, to make error is absence we should make error equation to equal zero: e(n) = f(n) – x(n). That refers to, f(n) = x(n).



**Figure.1** Spontaneous recovery for both models

The single-state model does not predict changes in motor output from baseline in the error-clamp block, whereas the multi-state model predicts a transient rebound of motor output in the error-clamp block. This rebound is in the direction of the motor output displayed in the initial learning block, resulting in spontaneous recovery.

Spontaneous recovery is associated with the learning process that was first named and described by [Ivan Pavlov](https://en.wikipedia.org/wiki/Ivan_Pavlov) in his studies of [classical conditioning](https://en.wikipedia.org/wiki/Classical_conditioning). From his experiments he found that spontaneous recovery was the reappearance of a Conditioned Response (CR) that had been extinguished after a delay. In other words, it no longer occurred. Specifically, Pavlov found that spontaneous recovery can occur after a period of not being exposed to the Conditioned Stimulus (CS). This period is called spontaneous because the response seems to reappear unexpectedly.

The single-state model cannot not predict changes in motor output from baseline in the error-clamp block because adaptaion goes to zero, whereas the multi-state model predicts a transient rebound of motor output in the error-clamp block. This rebound is in the direction of the motor output because slow rate starts adapt slowly and in the erorr clamp block somethings remain that’s why it can recover.

****

**Figure.1** Jump-up behaviour for both models

These graphs show the relationships of the experimental error-clamp / relearning. The multi-state model predicts that performance at the start of the relearning block is already better than baseline. This jump-up in performance is caused by adaptation rebound in the error-clamp phase. This finding is predicted by the multi-rate model, but is not predicted by the single- state or gain-specific models.

References

1. [1]  Maurice A Smith, Ali Ghazizadeh, and Reza Shadmehr. Interacting adaptive processes with different timescales underlie short-term motor learning. PLoS biology, 4(6):e179, 2006. https://doi.org/10.1371/journal.pbio.0040179.
2. [2]  Yoshiko Kojima, Yoshiki Iwamoto, and Kaoru Yoshida. Memory of learning facilitates saccadic adaptation in the monkey. Journal of Neuroscience, 24(34):7531–7539, 2004. http://www.jneurosci.org/content/24/34/7531.long.