

## Application of a Temporal Model of Behavior to Activity of Delay Neurons in the Medial Prefrontal Cortex and Motor Cortex in a Reaction-Time Task

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A mathematical model of timing provides good fits to many standard behavioral timing tasks [1]. The question was whether or not this model would also fit the activity of delay-modulated neurons in the medial prefrontal cortex and motor cortex [3].

Rats were trained to hold down a lever for 1000 ms at which time an auditory trigger stimulus occurred (delay period). The release of the lever within 600 ms of the trigger stimulus produced water reinforcement (Fig. 1). Approximately 1/3 of the neurons showed a delayed response pattern: on most trials the spike rate abruptly increased after a delay period. With variability in the time of transition, the mean spike rate increased gradually through the interval, as shown in the bottom panels of Figure 2. Two examples are shown in Figure 2 for one session of two neurons.

A mathematical model that was previously used for timing behavior [1, 2] was used to fit the neural spike rate. It consisted of a pattern memory and a strength memory, which, together, were used to generate behavioral responses and spike activity. A closed form solution of this model [2] was used to obtain the parameter estimates.

The conclusion is that the same mathematical models used for the analysis of behavior, such as lever pressing and head entry into a food cup, can be applied to the analysis of spike activity of delay neurons in the medial prefrontal cortex and the motor cortex of rats. This may facilitate the analysis of the relationship between the neuronal and behavior activity.

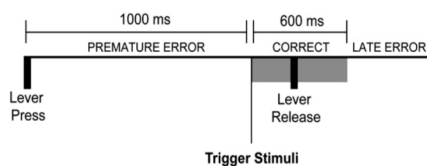


Figure 1. A trial of the reaction time task. From [3].

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### References

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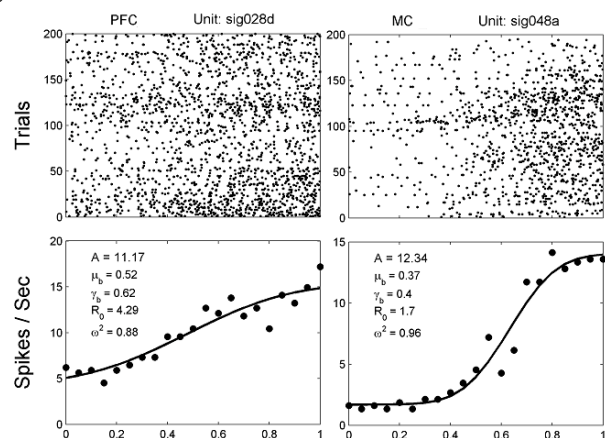


Figure 2. *Top panels*: Rasterplots of times of spikes. *Bottom panels*: Spike gradient (solid circles) and model fit (lines), and estimates of parameters of the model and goodness-of-fit. *Left panels*: A medial prefrontal cortex unit (PFC). *Right panels*: A motor cortex unit (MC).