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What you show is what you get: sampling biases in determining biological sensory function

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Introduction

Classical studies of biological sensory systems use the following main technique: sensory stimuli are drawn from a pre-determined distribution P(stim) and presented to the animal; the ensemble associated with sensory response is collected and used to characterize the conditional distribution P(stim|resp) (or parameters thereof) as a model of sensory system function. However, most of the standard statistical tool used in neuroscience to estimate P(stim|resp) are valid under a very fundamental condition – that the samples used to estimate P(stim|resp) are drawn *from the same distribution*. This is obviously not the case in most studies of sensory system, where the samples are drawn explicitly from a *different* distribution, P(stim) (the sampling distribution), selected by the scientist. We demonstrate here that in this case the observed conditional distribution is P*(stim|resp) = P(stim|resp) *P(stim) and expectations estimated with this dataset are parameters of P*, not P. To characterize the actual functional properties of the system, one needs to use estimators developed within unequal probability sampling theory [1]. We apply one of these estimators, the Horvitz-Thompson estimator of the mean $m_{HT} = \Sigma_i x_i/P(x_i)$, to observations $\{x_i\}$ from the cricket cercal sensory system and illustrate the ensuing changes in apparent functionality (Figure 1).

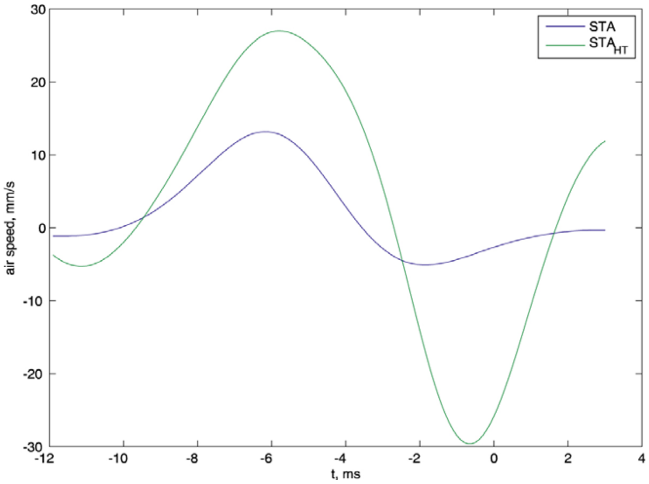

Figure 1
The spike-triggered average (STA) of air current stimulis sampled from a band-limited GWN distribution (5–500 Hz) is shown in blue. The corresponding Horvitz-Thompson estimate of the STA is plotted in green.

References

1. Thomson SK: *Sampling* 2nd edition. *New York: Wiley Interscience*; 2002.