1 Hardware

Acoustic stimuli are typically generated digitally and converted to an analog waveform using digital to analog converters (DACs) in the data acquisition system (e.g., internal sound card or National Instruments card). Thus, the resolution of the DAC is important for handling stimulus waveforms that contain both low and high intensity tones. As described by Kester (2005), the theoretical dynamic range (i.e., signal-to-noise) ratio for converters is $6.02N + 1.76dB$ where N is the number of bits. This equation is commonly simplified to $6N$. Regardless of which form of the equation is used, the calculation represents dynamic range under ideal conditions. The effective dynamic range is likely lower due to additional losses (e.g., wiring and interference from nearby electrical devices).

The 12-bit DAC used by Mitchell et al. (1996) has a theoretical maximum dynamic range of 74 dB. Although a standard ABR experiment may require only 70 dB of dynamic range for a given frequency, the calibration required by some closed-field speakers used in animal studies can vary by up to 20 dB across the frequency range of interest due to resonances shaped by the acoustic cavity (Hancock et al., 2015), requiring DACs that support dynamic ranges of at least 90 dB. Further, the effective dynamic range of the DAC is lower than the theoretical dynamic range. For example, modern 24-bit DACs have a theoretical dynamic range of 146 dB, but ambient noise limits it to approximately 120 dB in practice (Fujimori et al., 2000). Fortunately, 120 dB of dynamic range is sufficient for implementing the interleaved stimulus design across a large range of levels and frequencies. Therefore, equipment with 24-bit DACs is highly recommended when implementing the interleaved stimulus design.

2 Software

The software used in this study, psiexperiment, is available under the BSD three-clause license on Github and is free for anyone to download and modify. It currently is designed to work with both National Instruments hardware and Tucker-Davis hardware. The software has been tested on the PXI system configuration recommended by Eaton-Peabody Laboratories (Hancock et al., 2015) and the Tucker-Davis System3 RZ6. Instructions for installing the software and configuring it to run the various stimulus protocols are posted on the website. Although other hardware platforms are not supported as of publication time, the modular nature of psiexperiment will simplify the process of getting the software to run on other hardware platforms (e.g., high-quality 24-bit sound cards).

Documentation

`https://psiexperiment.readthedocs.io`

Source code repository

`https://github.com/psiexperiment/psiexperiment`

Digital Object Identifier

10.5281/zenodo.1405143

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