

A & B Buffer Experiment

Introduction

The clinician's capacity to determine a present or absent auditory brainstem response (ABR) is most confidently acquired from replication of the ABR tracing. Traditional means of replication (i.e., Sequential Replication) involve recording a single ABR tracing, often until a pre-determined number of sweeps have been averaged, and then recording a secondary tracing. In contrast, Vivosonic's A & B buffers (i.e., Concurrent Replication) allow the clinician to obtain two independent tracings in real time in order to observe a repeating ABR in real time.

Display the A & B buffers by selecting the A,B button at the top of the Test screen in Integrity software. Note that the main waveform (A+B) contains all averaged sweeps, while A and B each contain 50% of the total sweeps.

Research Question

Does the method of Concurrent Replication using Vivosonic's A and B buffers provide a reliable, faster means of demonstrating replication of an ABR result than the traditional Sequential Replication method? Is this Concurrent Replication approach a more efficient method for doing ABR testing?

Subjects

- Two (2) subjects (x2 ears) per clinician
- Selection of subjects is at the discretion of the clinic/clinician. Subjects may include oneself and/or colleagues.

Tester

- Testing clinician should meet the following criteria
 - Has training and experience running threshold ABR
 - Has training with Integrity software
 - Has training using both the traditional sequential and Vivosonic's concurrent (A & B buffer) methods of replication

Equipment

- Integrity software and VivoLink
- Charged VivoLink battery pack and backup
- Two-channel Amplitrode or VivoAmp
- Insert earphone transducers and ear tips
- Ambu single-use electrodes
- Prep material
- Printed **Record sheet**

Conditions

A record will contain a series of waveforms corresponding to a set of experimental conditions. For each Protocol, ABRs will be collected using both Sequential and Concurrent replication. Each replication type will be on individual Records. Therefore, each row in the table corresponds to a record:

Stimulus Type	Record #	Replication Type	Intensity (dB nHL)	# of Waveforms per Intensity	# of Ears	Total # of Waveforms in Record
Click	1	Sequential	80	2+	2	4+
	2	Concurrent	80	1	2	2
TB High Frequency (2 or 4 kHz)	3	Sequential	60, 30	2+	2	8+
	4	Concurrent	60, 30	1	2	4
TB Low Frequency (500 Hz or 1 kHz)	5	Sequential	60, 40	2+	2	8+
	6	Concurrent	60, 40	1	2	4

Table 1: Test conditions and Test order

- Stimulus Type: For each subject, the clinician should run clicks, high-frequency tone bursts, and low-frequency tone bursts. The clinician may select which high and low frequency tone bursts to run.
 - Click
 - High frequency tone-bursts: Select between 2000 or 4000 Hz
 - Low frequency tone-bursts: Select between 500 or 1000 Hz
- The following Protocols will be used in the experiment.
 - Click: **ABR air-conducted click 27.5**
 - Intensity of 80 dB nHL
 - Tone-burst (TB) High Frequency: **ABR air-conducted 2000 Hz tone-burst 37.7** or **ABR air-conducted 4000 Hz tone-burst 37.7**
 - Intensity of 60 dB nHL and 30 dB nHL
 - Tone-burst (TB) Low Frequency: **ABR air-conducted 500 Hz tone-burst 37.7** or **ABR air-conducted 1000 Hz tone-burst 37.7**
 - Intensity of 60 dB nHL and 40 dB nHL
- Replication type (i.e. method of repeatability)
 - Sequential repeatability
 - Will have at least 2 waveforms (i.e. at least 1 repeat)
 - Concurrent repeatability (A and B buffers)
 - Will have 1 waveforms (i.e. no repeat)
- Both ears will be tested within a record.
- Test order: Follow the test order in **Table 1** above. The order is also outlined in the **Record Sheet**.
 - Clicks are performed first, followed by high-frequency tone bursts and low-frequency tone bursts.
 - Sequential replication is performed before concurrent replication for each stimulus type.
 - For tone-burst protocols, 60 dB nHL is always performed directly before the low intensity.
 - The order of test ear can be varied, as per clinic's testing protocol.
- Video
 - A video of testing both Sequential and Concurrent replication with the Click Protocol (**ABR air-conducted click 27.5**) will be made, as described in the Procedure section below.
 - Before testing this protocol, start the video. Stop the video before moving on to the next protocol.

Experiment Planning

Subject Recruitment

- Each clinician should recruit two subjects (e.g., colleagues, etc.).
- Subjects should expect to devote one hour for ABR testing.

Equipment Planning

- There will be a video recording via screen capture software. This video will be used to provide evidence that the methods were correctly followed. Ensure CamStudio is downloaded to the Desktop and test its functionality.
- A folder on the Desktop should be created for data to be stored.
 - Confirm or create a folder on the Desktop labeled “A & B Buffer Study”

Test Room Planning

- Testing should be completed in a devoted room that remains consistent throughout the procedure.
- Testing does not need to be completed in a sound-treated room; however, acoustic noise in the test room should be controlled and minimized.
 - Any deviations in environment will be noted on the **Record Sheet**.
- Test room should be equipped with a table and chair for the Tester to run Integrity and a comfortable chair for the subject.

Preparing for Testing

Prepare Record Sheet

- Print a **Record Sheet**
- Fill in subject information.
- Observe the information to be compiled during recording. Observe that the protocol and replication type is pre-filled for each Record. Before beginning the test, fill in the starting ear and intensity. Note deviations during testing in the comments. When testing is complete, record the N and Neq for that waveform.

Prepare Equipment

- Ensure ABR supplies and equipment are available and ready for use, including charged battery packs.
- Turn on Integrity laptop
 - Load CamStudio software and test that is operational to screen record testing as noted in the procedure.
 - Load Integrity
- Integrity:
 - On the System screen ensure the selection for “Show number of Stim” is chosen
 - Confirm VivoLink is Bluetooth paired to Integrity software
 - Enter Patient Information.

Procedure

ABR Subject Preparation

- Note information on **Record sheet** regarding any cursory tests performed.
- To prep subject for ABR session, clean and scrub skin for the following montage:
 - High-forehead: Non-inverting
 - Low-forehead: Ground
 - Left and right mastoid/ Left and right earlobe: Inverting 1 (left) and Inverting2 (right).
- Apply single-use Ambu electrodes on prepped locations by peeling off the plastic backing and pressing along the perimeter of the electrode. The sticky-back of the electrode will adhere to the skin. Note that pressing in the middle is not advised as it may displace the conductive gel in the center.
- Attach Amplitrode, as appropriate.
- Insert earphone tips to appropriate depth into ear canal bilaterally.
- Have subject relax into a comfortable position.

Running the ABR

- Highlight the row corresponding to the subject.
- Select the Test tab and load the ABR test screen.
- From the Protocol drop-down, select the first protocol (**ABR air-conducted click 27.5**).
- Select starting ear to be Left or Right.
- Enter starting intensity.
 - 80 dB nHL for click
 - 60 dB nHL for tone bursts
- Check impedance
 - Impedance should be $<5 \text{ k}\Omega$ across all channels and maintained at $<5 \text{ k}\Omega$ across test conditions
 - Mark that the impedance check meets these criteria on the **Record Sheet**.
- One video will be recorded for each subject of the ABR recording for the first protocol (**ABR air-conducted click 27.5**) for both Sequential and Concurrent replication types. Start the video before beginning the first test, and stop the video before changing the Protocol to tone-bursts.
- Run the ABR test as per described in *Sequential Repeatability Test* and *Concurrent Repeatability Test* (see below), as appropriate.
- While recording waveforms, document each waveform as it is collected on the **Record Sheet**. This should correspond to the waveform numbers listed on the screen.
- Note any inconsistencies, environmental deviations, patient state, and Bluetooth status in the comment column. Note the N and Neq after stopping the recording for the Ipsilateral channel (Ch 1 for left, Ch 2 for right).
- The Record is complete once all appropriate intensities and both ears have been collected for the replication type.
- Press **Save**.
- Under Comment 1, note the Replication type.
- Press **Clear All** before starting the next Record. Waveforms should be cleared prior to beginning a new replication type.
- Once all six (6) Records have been completed, unhook the subject from the Amplitrode and take off Ambu electrodes.

Sequential Replication Test

1. Make sure that there are no traces on the ABR screen before starting the test.
2. **For the first protocol (ABR air-conducted click 27.5), click the Record button in CamStudio.**
3. When patient is resting and quiet with inserts in both ears click **Start** to begin the ABR.
4. Observe the waveform until comfortable with identification of a wave V prior to replication.
5. Waveform should meet the following criteria
 - a. Minimum of 400 noise-adjusted sweeps (Neq).
 - b. Noise is sufficiently low based on visual inspection
 - c. Either:
 - Wave V can be identified based on visual inspection.
 - Wave V cannot be identified at the approximate latency at which wave V should be present at the test intensity for a normal hearing individual. Noise is visually low.
6. Do **not** use statistical measures for interpretation of waveforms.
7. Mark wave V if identified.
8. **Replicate.** Repeat step 5. **note: more than a single replication may be necessary if response cannot be determined present or absent.*
9. Mark wave V on replication, if identified.
10. When satisfied with results, click **Stop**.
11. If stimulus type is a toneburst, decrease intensity to appropriate low intensity, and repeat steps 3 - 11.
12. Repeat steps 3 - 12 for the other ear.

Concurrent Replication Test (using A and B buffers)

1. Make sure that there are no traces on the ABR screen before starting the test.
2. When patient is resting and quiet with inserts in both ears click **Start** to begin the ABR.
3. Observe the waveform and A and B buffers until comfortable with identification of a replicable wave V.
4. Waveform should meet the following criteria
 - a. At least 800 noise-adjusted sweeps (Neq) recorded
 - b. Noise is sufficiently low based on visual inspection
 - c. Either:
 - Wave V can be identified based on visual inspection.
 - Wave V cannot be identified at the approximate latency at which wave V should be present at the test intensity for a normal hearing individual. Noise is visually low.
5. Do **not** use statistical measures for interpretation of waveforms.
6. Mark wave V if identified.
7. When satisfied with results, click **Stop**.
8. If stimulus type is a toneburst, decrease intensity to low intensity as appropriate, and repeat steps 3 - 9.
9. Repeat steps 3 - 12 for the other ear.
10. **For the first protocol (ABR air-conducted click 27.5), stop video recording.**

Analyses of Replication Techniques

- Finalize record sheet for each waveform collected, including ABR details regarding:
 1. Intensity and Test ear, where appropriate.
 2. Deviations in test environment, patient state, Bluetooth status, etc.
 3. N and Neq
- Calculate test time and fill in final column of **Record Sheet**
 1. Compare the total test time for each condition using the number of stimuli (N) and the stimulus rate (e.g., 27.5 stimuli per second for clicks and 37.7 stimuli per section for tone bursts).
 - a. $N/27.5$ = Number of seconds for each waveform (clicks)
 - b. $N/37.7$ = Number of seconds for each waveform (tone bursts)
 2. Rule out extraneous noise
 - a. Compare the N-Neq difference across conditions to rule out extraneous noise as a contributing factor. Also consider any comments made.
- ABR Statistics
 1. Turn on SS/SE. Set to appropriate latency to include wave V while maintaining 12 ms between SS and SE. The correlation coefficient (CC) is displayed in the table. Observe CC across conditions.
 2. Residual noise (RN), also displayed is a tool to determine the level of noise. Observe RN across conditions.

Post-Test Data Reporting

- Prepare ABR reports
 - Each row in Database corresponds to one (1) Record.
 - Highlight each Record for that subject and click Print.
 - Drop-down to select Comprehensive Report. Click OK.
 - Highlight VivosonicPDF in order to generate a PDF. Click Print.
 - Navigate into folder labeled “A & B Buffer Study”
 - Save the PDF with the subject initials and Record # (e.g., DR_Record1.pdf)
- Prepare Data Spreadsheet.
 - Highlight each Record.
 - Click Save to Spreadsheet.
 - Navigate into folder labeled “A & B Buffer Study”
 - Save the .txt file with the subject initials and date (e.g, DR_5Feb2016.txt)
- Scan finalized Record Sheet.