June 26, 2015

Dear Suzuki-san,

We want to thank you for the generous opportunity you provided for us to evaluate the Astem hb13 portable NIRS device over an extended period. We are impressed with the device and would like to provide some feedback and details of the testing that we performed over the last several months. Our interest in the device is multiple-fold including using it for evaluation of language, motor performance, cognitive function tasks and clinical evaluation. Over the course of our evaluation we were able to complete two pilot data collections that we would like to share here as well as some of the details of our experience. A brief outline and some example data is provided below:

Study 1. Stroop Task: Classic cognitive task.

We are interested in the neural responses associated with conflict. The classic Stroop task is a cognitive tool designed to introduce conflict in a decision making task and has been well studied using other methods including EEG and fMRI. We wanted to test the hb13 device for determining differences between congruent and incongruent stimuli in an experimental paradigm with known results. To do this, we employed a Stroop task using the hb13 and observed expected hemodynamic responses for congruent and incongruent trials. The data is shown below in Figure 1.

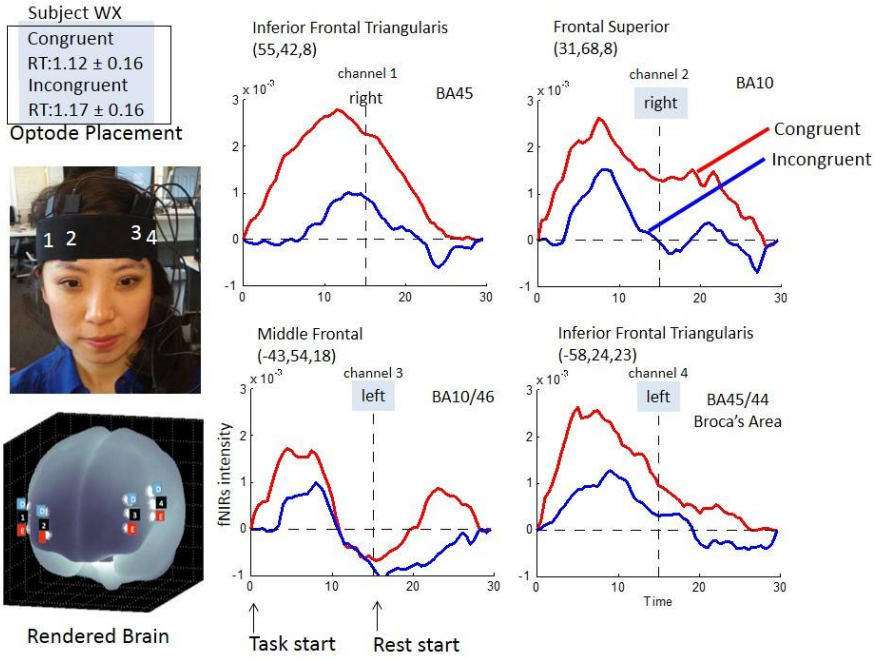

Figure 1. Setup of NIRS optodes and results for a single subject.

Hirsch, J. et al, 2014, Yale University.

We placed the optodes as lateral as possible bilaterally on subjects. Optode placement was calibrated using a Polhemus 3D digitizer and MNI coordinates are provided for each data trace. The data in the traces represent a block where subjects responded to incongruent or congruent stimuli for 15 seconds and rested for 15 seconds. The dashed vertical line shows the transition between task and rest. The

results show that the hb13 is capable of recording responses consistent with known hemodynamic responses and discriminates differences in amplitude in responses to congruent and incongruent stimuli.

Study 2. Language Task: Dialog between two individuals.

We are also interested in studying real-world language tasks using NIRS. Our goal was to study the responses in Broca's area concurrently in a pair of subjects while interacting in a dialogue. Subjects were provided stimuli in 30 second blocks which displayed a picture that was the focus of the discussion. Every 30 seconds the picture changed and the alternate subject would respond to the previous comments from their partner and continue a new statement regarding the new picture. The duration of the task was 6 minutes total. The setup and placement of the optodes is shown in Figure 2. The insert shows the data from two subjects participating in this task. MNI coordinates (as determined using the Polhemus 3D digitizer) are provided for reference. Event triggered results indicate an alternating pattern of activity in Broca's area between subject 1 and 2.

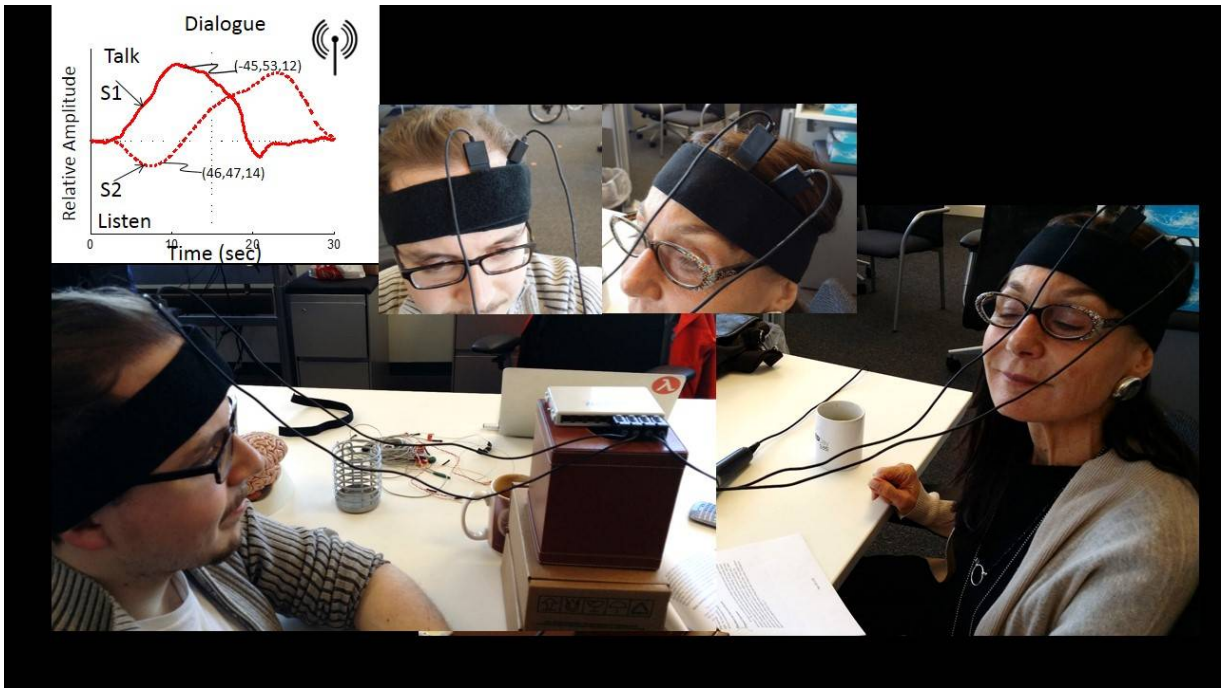

Figure 2. Interactive language task.

Hirsch, J. et al, 2014, Yale University.

Benefits

The hb13 is a small and wireless NIRS device which provides a truly portable functional brain imaging tool that can be used in many real world tasks. The integration of motion data and surface blood flow information is in line with the current thinking regarding signal processing of NIRS data. Simple placement of optodes on subjects allows for data collection to be performed without lengthy training of students and researchers. Further, while the price is still high, it is an order of magnitude cheaper than other NIRS devices on the market.

Drawbacks

In our testing we found a few items that could be changed or improved. First, while the Bluetooth communication is a benefit in making the unit portable, we found some issues with respect to the Bluetooth stack on various computers. There is a lot of inconsistency in the drivers provided and it made it difficult to relay the data. It might be nice to have a wired option as well to accommodate for this. Additionally, we were not 100% sure in the software what the purpose of dragging the optodes to the model's face is? It seems that this can be eliminated, but became a bit problematic on very high resolution displays. We found that when running the software at 1200p or above, this dragging did not work and required us to change the resolution of the monitor to run the software. Finally, while the pass-through COM communication was working well, we would have also liked to see the ability of the software to accept a trigger input from an external device natively. Occasionally, we found data was dropped over Bluetooth pass-through and we had to resynchronize the files manually.

Questions and possible suggestions

We occasionally found some responses in subjects that showed reversal of activity from what we expected. For example, in a 30 second block design where the first 15 seconds were stimulus and the last 15 seconds were rest, the data seemed to drift. At the beginning of the 6 minute trial the responses were following a hemodynamic response in the first 15 second block, but by the end of the trial, the responses were coming in the last 15 seconds. This was random, but always was coming when we lost our triggering system, so we had no way to accommodate for this variability. A trigger input to the device would accommodate for this. We are also wondering if the surface optodes would provide more optimized data if they were slightly further apart. We did not have a chance to evaluate surface data in detail and perform controlled studies, but we are wondering what the targeted depth of penetration of these recordings is? We performed 3D digitizing of the optodes using NIRS-SPM with good results, but would have liked to have some indication on the back of the rubber holders for the LED and detectors where the locations were to be even more accurate for this. It may not be necessary given the 3cm channel area, but it does make the procedure a bit simpler.

Overall and closing thoughts

We are pleased with the responses from the hb13 NIRS device in the two paradigms we present to you here. The ability of the hb13 to record hemodynamic activity appears to be robust and we are interested in further use of the hb13 in paradigms that involve subjects that cannot come in to the lab and for clinical evaluation for both psychiatric and motor dysfunction. We are interested in the ability of the hb13 to discriminate cortical from surface responses but did not have an opportunity to explore this capability in detail. The simplicity of placement of optodes is a real benefit of the device and allows for a very fast setup. The wireless nature of communication is both a convenience and a drawback (see below). The battery life was good as well as the build quality. The operation was simple and the software provided worked as expected. We did not use the analysis tools provided as we built our own. We also found the accelerometer data useful for single subject data, but obviously was not applicable in the dialog task.

We are interested in further use of the hb13 in our research especially to compare and validate the results to our new 140 channel Shimadzu LABNIRS. We would like to be able to initially test paradigms using the large machine to determine activity and specificity of regions of interest. After that, studies can be carried out in the field or at remote locations that the LABNIRS would be impractical.

In the future, we are interested in purchasing one or more of the hb13 units, however this is contingent on acquiring funding. Because of this, we would like to ask if it would be possible to negotiate a discount (perhaps at cost) on an hb13 unit for further comparison to data collected on the LABNIRS in the future. It would be our goal to publish this data and would be of great benefit to us in our current and future studies. We are happy to discuss the use of the hb13 further with you and are happy to provide other insights or comments on the use of the system. Please feel free to contact us directly or via Yumie-san. Again, we greatly appreciate your generous offer of letting us evaluate the unit and we are very impressed with its capabilities.

Best regards and thank you again,

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