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Aphasia Assessment on Android: recording voice, eye-gaze and touch for the BAT

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Research Questions

A) Is it possible to get natural data when using a touch tablet to test for language and/or communication deficits?

B) How is the data collected using a tablet different from data collected using paper materials?

C) Is the data collected automatically analyzable using existing Open Source audio and eye gaze libraries?

Background

Evaluating a speaker's language use in an assessment setting is a difficult task which requires speaker and listener to truly participate in a conversation yet allow for quantitative analysis of the speaker's production of the same words under varying conditions in minimally different utterances. The project follows up on Achim and Marquis (2011) by bringing the BAT (Bilingual Aphasia Test) to a "virtual paper" environment which is potentially just as natural and intuitive for patients to use (it looks like paper), and for clinicians to administer as the Paper BAT. Unlike a computer application, the Touch BAT was designed to simulate the flexibility of the Paper BAT, with the added benefit of allowing for a diversity of data collection integrated directly into the test. To get a better picture of the patient's linguistic profile the Touch BAT app records and analyzes the patient's voice, eye movements and touch location. Analyzing the touch, video and audio during the test reduces the data entry which must be done post assessment, and also permits review of the information later during treatment.

Methodology

Participants

- 17 students from Université de Montréal (16 female, 1 male) (ages 19 – 25).
- Highly proficient bilinguals (13 weaker in English, 4 no apparent difference between English and French and were tested in both languages).

Lab Procedure (40-55 minutes total)

Participants were instructed that they were going to be a control group for a touch tablet test for Aphasia, in their weaker language. The participants were presented with a welcome screen showing their progress in the course of the assessment (*fig. A*).

- Auditory Stimuli were read by the experimenter.
- Visual Stimuli were displayed on the tablet screen.
- All instructions were given exactly as indicated in the BAT with the following exceptions:
  - Sections History of Bilingualism and English Background were skipped and instead questions were asked in the Spontaneous Speech Section, and
  - The Spontaneous Speech and Writing sections were reduced (in the interests of time) from the original 5 minutes to 1 minute.
- Audio, video and touch data were collected for the entire experiment, but were analyzed for the sections indicated below:

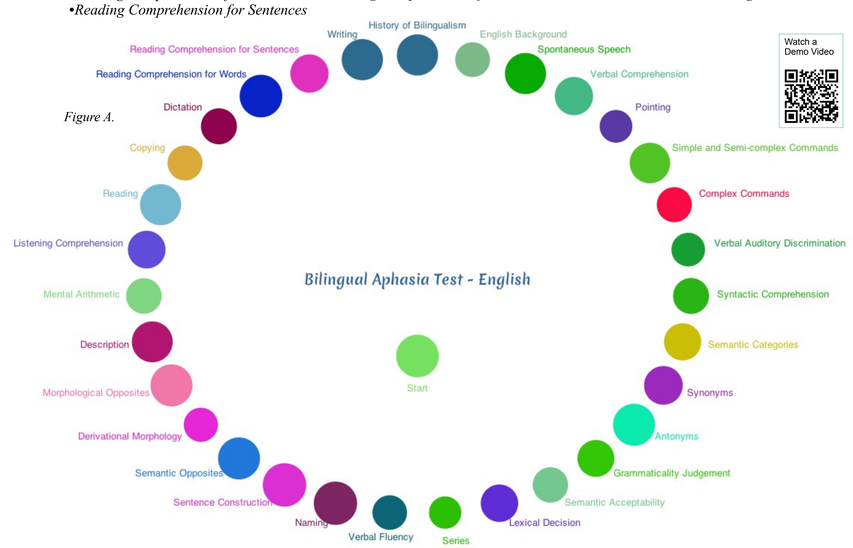
Eye Gaze:
- *Verbal Auditory Discrimination*
- *Syntactic Comprehension*
- *Description*
- *Reading Comprehension for Words*
- *Reading Comprehension for Sentences*

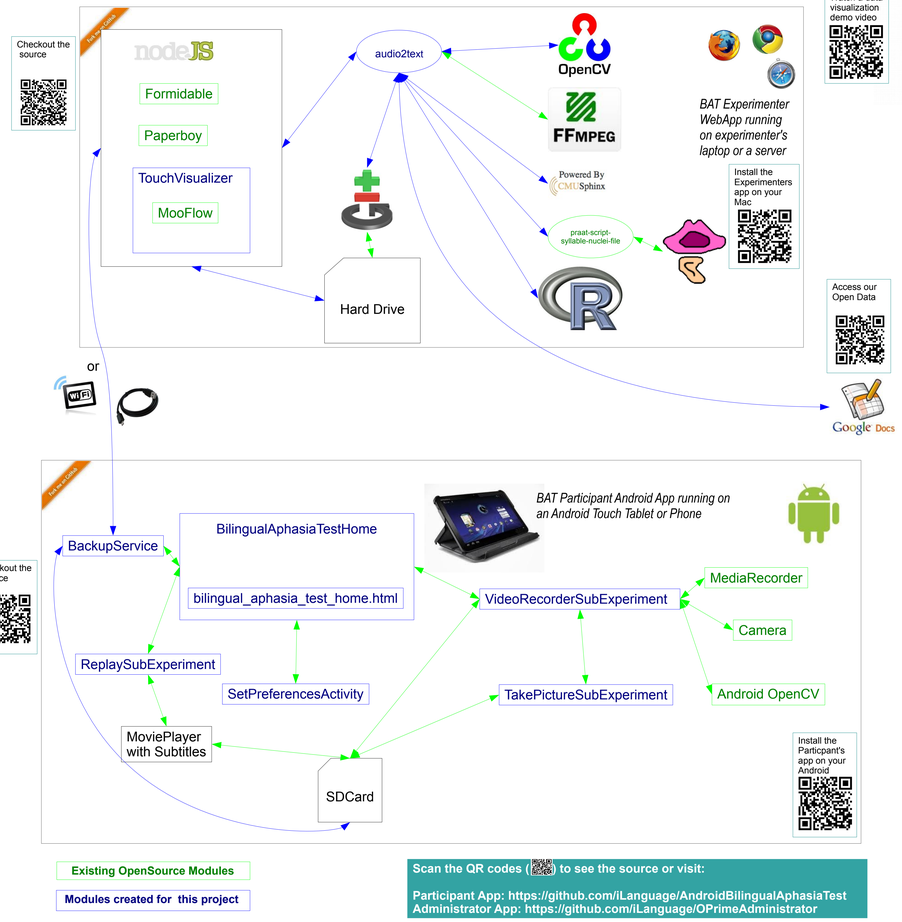
Touch:
- *Verbal Auditory Discrimination*
- *Syntactic Comprehension*
- *Reading Comprehension for Words*
- *Reading Comprehension for Sentences*

Audio:
- *Spontaneous Speech*
- *Series*
- *Description*

Handwriting:
- *Copying*
- *Dictation for Words*
- *Dictation for Sentences*
- *Writing*

Figure A.





Practical reasons for choosing which Touch Tablet Operating System

While we originally planned the application for iPad2, after some investigation we ultimately chose Google's Android OS for theoretical reasons. More importantly, practical reasons became apparent while we were building and testing the software. From a home-user's perspective the iPad2 and Androids are similar, but from the software developer's perspective the Operating Systems are very different.

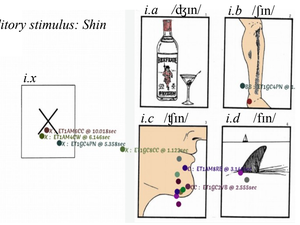
Android	iPad2
Variety of sizes and designs (none as nice as the iPad2).	Very well thought out hardware design.
Full access to your files. Can browse the file system on the tablet. Drag and drop files to backup results to a computer. Androids also have an external SDcard slot for more space and easier file transfer.	All files need to go through iTunes' library to sync to and from the device.
Designed as a full Computer Operating System like Linux (true multitasking, can schedule and run background processes to analyze and backup data).	Designed as a Phone Operating System (only task-switching, tasks can't run at the same time, so you can't backup or analyze data in the background).
Most apps are free.	Few free apps.
One time developer fee 25$.	Developer fees 50$ per year.
Accepts software written in Java, C, C++ (this means existing OpenSource libraries can run on the Android itself, the device doesn't need an internet connection, or to send files to a server).	Accepts software written in Apple's Objective C (this means to analyze the data you need an internet connection, and you need to send it to a server which can run the Open Source libraries).
Software can even be installed by simply emailing the file (easy to share research software, no need to make it publicly available).	Software must go through an Apple approval process before it can be installed. Device must be jailbreaked to install unauthorized software.
Flexible and practical choice for developing research software. Architecture is very easy to understand for new programmers and requires less coding to have a full functioning app.	Perfectly designed for home users but presents too many obstacles when developing research software.

Our main goal was to pave the path so that researchers can creatively re-purpose existing advanced OpenSource components in their labs or data collection procedures.

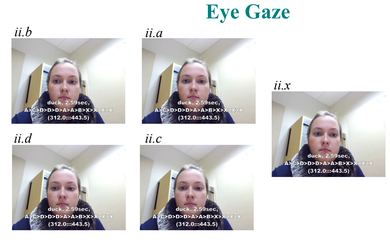
Results

Touch

i.) Auditory stimulus: Shin



Eye Gaze

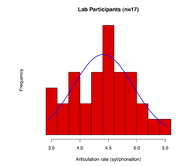


Audio – Articulation Rate

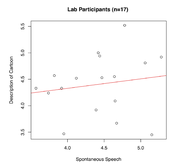
Our sample was highly varied (*iii. & iv.*) and lacked the power to do statistical analyses. However, by virtue of the Android Market we have access to over 10,000,000 and growing participants world wide.

We can collect norms for Bilinguals in a living room context in a way that was never possible before. Using a free and OpenSource tool also allows for the collection of a larger sample which allows for more statistical power in the inherently variable and complex production of natural language/communication data.

iii) Articulation rates range from 3.5-5.5 syllables per second

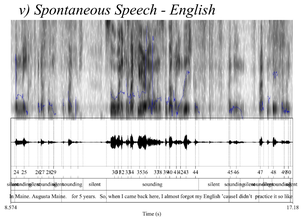


iv) A great deal of unsystematic variation Spontaneous Speech vs Description of a Cartoon



Audio – Prosody (pitch, phrasing, syllable timing)

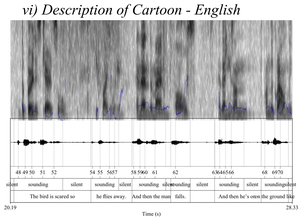
v) Spontaneous Speech - English



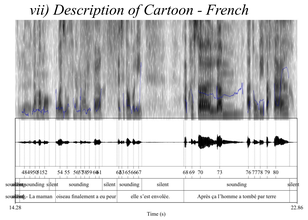
As shown in (*v., vi. & vii.*) we found natural phrasing, intonation contours and pausing in 16 out of 17 participants.

Because the stimuli were presented on a tablet, the participants wore no microphone and saw no video camera. They thought the tablet was there just to present images.

vi) Description of Cartoon - English



vii) Description of Cartoon - French

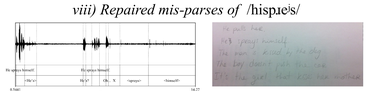


Handwriting

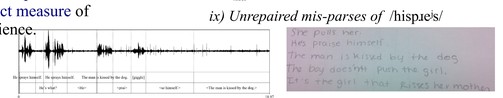
Snapshots of handwriting showed interesting parsing errors (*viii. & ix.*). Most of which were corrected by the participants, but the erasing marks remained.

In addition, the acoustic signal of the pencil writing on paper provided an indirect measure of syntactic parsing and writing experience.

viii) Repaired mis-parses of /hispɹeɪs/



ix) Unrepaired mis-parses of /hispɹeɪs/



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