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Web-Enabled Subjective Test (WEST) Research Tools Manual

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EXECUTIVE SUMMARY

The Web-Enabled Subjective Test (WEST) software offers a solution to the problem of gathering subjective testing data from multiple locations and multiple portable or computing devices.

Web standards, video compression standards, and inexpensive, low-power, high-performance processors have enabled mobile devices (such as smartphones, tablets, and other personal entertainment devices) to run full-fledged web browsers. These web browsers are able to play back inline media and collect opinions from experiment subjects.

This capability allows researchers to deliver media to any number of different types of devices as long as a few characteristics about the devices are known ahead of time. Small adjustments to a given codebase are required to deliver a consistent experience among devices, but the amount of work represented by these adjustments is minor compared to the alternative: writing and compiling a native application for each device.

The WEST software package includes turnkey server-side and client-side code that allows researchers to conduct a study with minimal investment in infrastructure. Once installed and configured properly, the software can deliver stimuli to and collect data from a number of popular devices.

WEB-ENABLED SUBJECTIVE TEST (WEST) RESEARCH TOOLS MANUAL

Andrew A. Catellier,¹ Luke Connors²

The Web-Enabled Subjective Test software allows researchers to conduct subjective tests on multiple devices with aggregated data collection and reporting. The system leverages modern web technologies and infrastructure to deliver test stimuli to typical mobile devices and personal computers. Devices with a modern web browser may be tested wherever a network connection is available. If resources allow, many subjects may participate in the test at one time. This unique capability allows for diverse and interesting subjective test plans. This manual describes how to install the WEST software on an Ubuntu Linux-based system.

Key words: subjective testing; mobile; multimedia quality; infrastructure

1 INTRODUCTION

The challenge of measuring delivered multimedia quality has rapidly become more complex in recent years. A multitude of delivery mechanisms combined with rapidly proliferating varieties of user terminals have greatly compounded the possible number of test cases. Performing multimedia quality tests on mobile devices presents a unique challenge due to platform lockdown (some platforms require central approval before applications can be distributed) in some cases and potentially large development costs in others. Due to the success of the H.264 video compression standard, the inclusion of dedicated silicon codecs in mobile devices, and the proliferation of low-power terminals, over-the-top video delivery is a hugely popular use case.

The humble web browser plays a very important role in the modern video distribution landscape. HTML 5 (most specifically the <video> element) and associated technologies have largely replaced proprietary browser plugins that were popular earlier this century. A majority of the smartphones and tablets shipped in the past five years include an HTML 5 capable browser.

This provides a unique opportunity for those interested in measuring delivered audio, video, and multimedia quality. A subjective testing system based on web technologies allows researchers to measure quality on a multitude of devices wherever a network connection is available.

This system represents a strategic shift from traditional standardized test methods such as ITU-R BT.500 [1] and ITU-T P.911 [2]. Absolute control over the viewing environment and delivery mechanism is traded for an experience that is much closer to that which the subject would experience outside of a laboratory. Being able to deploy the testing framework once and only

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needing to make small, modular changes for device-specific browser quirks can potentially represent an enormous efficiency gain compared with developing device-specific applications for devices encompassing many platforms.

An earlier revision of this software was used to conduct the test described in [3]. The test measured delivered multimedia quality on six different devices in both a typical standards-compliant environment and a more typical living room environment.

1.1 Testing Methods Included

The Web-Enabled Subjective Test (WEST) software package consists of three different programs that conduct subjective tests on perception of video and/or audio quality. The three programs are web applications and include four testing methods. The first two testing methods are combined into one program.

All testing methods require the human subject to view a predetermined number of media clips and answer questions about each media clip.

1. **Absolute Category Rating** – during this test, after participants view a media clip, they are tasked with rating the video or audio quality. The scale used to describe the quality can vary. The most common is a five-level scale in the following order: excellent, good, fair, poor, and bad. A participant can only choose one answer per clip.
2. **Forced Choice Rating** – during this test, after participants view a media clip, they are tasked with answering a multiple-choice question relating to the clip. Questions are designed by the test administrators and can vary from clip to clip. A participant can only choose one answer per clip.
3. **Free Response** – during this test, after participants view a media clip, they are tasked with writing a response to a question relating to the clip. Questions are designed by the test administrators and can vary from clip to clip. Participants are required to enter an attempt at an answer for each clip. However, participants may enter a response signifying they do not know the answer for the question.
4. **Transcript** – during this test, after participants view a media clip, they are tasked with completing a partial transcript of the clip. The partial transcript will represent the dialog from the clip with text boxes replacing portions of the dialog. Participants must enter a response in each text box representing a missing portion of the complete dialog. Participants are required to enter an attempt for each text box. However, participants may enter a response signifying they do not know the missing portion dialog.

1.2 System Structure

The software consists of three basic parts.

1. A database to keep track of all pertinent data: stimulus filenames, session order and video playlists, questions and answers, and subject responses to stimuli and survey questions.
2. Code that runs on the Web server to control the flow of the experiment for each subject, interact with the database to store subject responses, ensure that the subject sees each stimulus as specified, and send the proper code to the subject's terminal to initiate display of experiment stimuli and questions as appropriate for the terminal.
3. Code that runs on the subject's terminal to interpret HTML and JavaScript in order to do things like prevent replays and ensure valid responses are submitted to the Web server.

1.3 Deployment Alternatives

There are two ways to deploy the test, each with advantages and disadvantages. The Web server and database could be deployed on a typical server system, allowing any device with network connectivity to the server to participate in the test. This can be referred to as a client-server setup. Alternatively, the Web server and database could be installed on a computer that also uses a web browser to access the test—the computer's browser would be accessing the Web server running on itself. This can be referred to as a self-contained setup.

When running as a self-contained setup, the web application will be accessible by the system on which it is installed. This system will access the application with a web browser through its loopback IP address, *localhost*. In the interest of simplicity, this manual provides instructions for running the WEST software on a self-contained setup. The self-contained setup can be useful if it is necessary to conduct a test in a place where a reliable Internet connection may not be available. A laptop could serve as a portable self-contained testing terminal or could be connected to a switch or wireless router serve as a portable client-server setup hosting other testing devices connected to it.

When the application is run as a client-server set up, devices can access the application with a web browser through the host's IP address or fully qualified domain name. Due to the myriad configurations of servers, firewalls, switches, routers, hosting services, and domain name servers, this manual does not provide full instructions for running the WEST software in a client-server setup. Knowledge of the administrator's specific network configuration is required to fully enumerate the steps needed to install the WEST software in a client-server set up.

2 REQUIREMENTS

In order to run the WEST software package a system must meet the following requirements. The following platform requirements must also be installed on the system.

2.1 Hardware and Operating System Requirements

2.1.1 Server Hardware

The WEST software has not been load tested, so specific hardware requirements based on expected loading are not available. At a minimum, however, the server must have sufficient capacity to run a Web server and database without overloading processor(s). Additionally, the server's storage mechanism must be able to read a video file and send it through a network connection many times faster than real time.

As far as network transmission bandwidth is concerned, the requirements vary based on the resolution of video being delivered. For example, it is recommended that only one subject access the test over an 802.11g (54 megabits per second) wireless link connection when using 1080p/30fps video material. Encoding video with H.264 at this resolution and frame rate can result in a file with a bit rate of 2.5 megabytes per second which is near the maximum practical transfer rate for 802.11g.

2.1.2 Server Software Stack

The WEST software has been used and tested on a machine running Ubuntu 12.04, Apache HTTP Server (version 2.4.2 and loading the modphp.so module), PHP (version 5.4.3) and PostgreSQL (version 9.1.4). It is possible to use the WEST software using a different operating system, however complete instructions on how to do so are not addressed here. These software packages can be installed separately or as a package (such as BitNami LAPP) as explained in Section 2.1.3. This manual provides instructions to build a self-contained setup using the LAPP stack.

2.1.3 LAPP (Linux Apache PostgreSQL PHP)

LAPP is a software package that will install PHP, Apache, and PostgreSQL together. The LAPP package that the WEST software has been used and tested on is BitNami LAPP Stack version 5.3.15-0. BitNami supplies other software packages that can be used as a web platform on operating systems other than Linux, but we have not conducted tests on other operating systems.

2.2 Limitations and Disclaimer

Warning: The WEST software has only been used and tested on a self-contained setup. The WEST software has not been fully tested on a Web server hosting multiple clients. Using the WEST software on an Internet-facing Web server poses security risks that are beyond the scope

of this manual. **Additional steps not described in this manual may be necessary to make the software secure for use on an Internet-facing Web server.**

3 INSTALLATION PROCEDURES

3.1 Server Configuration

It is important to ensure the server is correctly configured before downloading and installing the WEST source code. Directions are given here to configure the Apache server for a self-contained system. To begin, a few changes to the Apache configuration file, `http.conf`, are necessary. If the BitNami LAPP software was installed correctly the file is located at `/home/user_name/lappstack-5.3.1.3-0/apache2/conf/http.conf`. Open the file in a text editor and make the following changes as necessary:

1. Check which port the server is set up to listen on and make a note of the number. This information can be found in the `Listen` section of the `http.conf` file. For example if the `http.conf` file contains the following line:

```
Listen 80
```

Then then the server is set up to listen on port 80.

Next, set the `ServerName` to the IP address of the computer upon which you are installing the software, followed by the listening port. Enter this information below the commented area of the `ServerName` section of the `http.conf` file. For example, if the machine's IP address is 10.0.0.2, the `http.conf` file should contain the following:

```
ServerName 10.0.0.2:80
```

2. Next, establish the document root where the Apache server will look for files to display as Web pages. This is the location where the administrator will later place the source code for the WEST software. Define the *complete* file path for the folder you wish to use as the document root. The default location for the document root when using the LAPP package is the `htdocs` folder located in the `apache2` folder. Enter the desired path in quotations below the `DocumentRoot` section of the `http.conf` file. For example, if the desired path is `/home/user_name/lappstack-5.3.15-0/apache2/htdocs/WEST`, then the `http.conf` file should contain the following:

```
DocumentRoot "/home/user_name/lappstack-5.3.13-0/apache2/htdocs/WEST"
```

3. Ensure that PHP is enabled on the Apache server. Find the following line in the `http.conf` file (located in the `LoadModules` section):

```
LoadModule php5_module          modules/libphp5.so
```

This line should be uncommented (meaning the `#` at the beginning of the line, if present, should be removed).

4. When the preceding configuration steps are complete, save and close the `http.conf` file.

5. To prevent certain errors, uncomment the line in `php.ini` specifying the time zone in which the server is located. The `php.ini` file exists at the path `/home/user_name/lappstack-5.3.15-0/apache2/php/etc` and the lines in question should look similar to this:

```
[Date]
; Defines the default timezone used by the date functions
; http://php.net/date.timezone
date.timezone = "America/Denver"
```

There should be no semicolon in front of the final line, and the time zone specified must be valid.³

Once all of the necessary changes have been made to the `http.conf` file, save and close it.

3.2 Server Status Check

After configuring the server, do a quick check to make sure the server is running correctly.

1. In a text editor create a file named `info.php` with one line:

```
<?php phpinfo(); ?>
```

Save this file and move it to the document root folder established in step 2 of Section 3.1.

2. Next, start the server. The BitNami LAPP Stack has a GUI that can be used to start the Web server. Launch the program by executing the `linux-manager.run` file. Once this is running, start the Apache server.

Alternatively, the Apache server can be started via a command line. Open a terminal window, navigate to the `/home/user_name/lappstack-5.3.1.3-0/apache2/bin` folder, and enter the following command:

```
sudo ./apachectl -k start
```

3. A web browser on the computer hosting the Web server can be used to access the content that has been put on the Web server. To do this, type `localhost` followed by the port that Apache is listening on as determined in step 1 of Section 3.1, followed by `/info.php` into the address bar. For example:

```
localhost:80/info.php
```

If PHP has been enabled properly, a page will display information about PHP and the Web server's environment.

If the three steps above were completed with no issues, then the Apache server was been set up correctly and will successfully host the software package on a self-contained setup.

³ A list of valid time zones can be found here: <http://www.php.net/manual/en/timezones.php>

3.3 Source Code Installation

The source code for the WEST software is split into three different versions, each for a specific kind of test: ACR (Absolute Category Rating)/Forced Choice, Free Response, and Transcript. Each test's source code comes with a total of seventeen files in the form of ten PHP files, two JavaScript files, one Cascading Style Sheet file, and four text files used for configuring the test and database.

- db_tasks.php
- db_creds.php
- finished.php
- functions.php
- access_data.php
- index.php
- run_expt.php
- set_cookies.php
- survey.php
- user_status.php
- db_tasks.js
- west.js
- west.css
- answers.txt
- dbsetup.txt
- sessions.txt
- survey.txt

Copy the source code for the desired test to the Web server's document root folder established in step 2 of Section 3.1.

3.4 Database Creation

Each test in the WEST software must have its own database to store information. The databases need to be created using a shell terminal, but can be managed using a web browser. To create a database for any of the tests, follow these steps:

1. Start the database server. The BitNami LAPP Stack has a GUI that can be used to start the database server. Launch the program by executing the linux-manager.run file. Once the window has opened start the PostgreSQL server.

Alternatively, the PostgreSQL server can be started via the command line. Open a terminal window, navigate to the /home/user_name/lappstack-5.3.1.3-0/postgresql/bin folder and enter the following command:

```
sudo -u postgres ./pg_ctl -D <data_folder_path> -l <psqllog_file_path> start
```

The data folder and psqllog file are both located in the postgresql folder. For example, if the path to postgresql is /home/user_name/lappstack-5.3.13-0/postgresql, the entire command will be as follows:

```
sudo -u postgres ./pg_ctl -D /home/user_name/lappstack-5.3.13-  
0/postgresql/data -l /home/user_name/lappstack-5.3.13-0/postgresql start
```

2. The database and database users need to be created using the terminal by logging into PostgreSQL. In the terminal, navigate to the /home/user_name/lappstack-5.3.13-0/postgresql/bin folder. Then enter the following command:

```
sudo -u postgres ./psql
```

A password prompt will appear. If the LAPP software was configured correctly, the expected password is the password of the user who installed the software. Once logged into PostgreSQL, enter the appropriate information for the type of test you wish to perform. It is recommended that the specified passwords be changed; however, the names for the database and users of each test are specified in db_creds.php, so any deviations from this listing must be reflected in that file.

ACR/Forced Choice:

```
CREATE DATABASE "FC_Survey";  
CREATE USER "FCsclient" WITH PASSWORD 'C113nt';  
CREATE USER "FCSadmin" WITH PASSWORD '@dm1n';
```

Free Response:

```
CREATE DATABASE "FR_Survey";  
CREATE USER "FRsclient" WITH PASSWORD 'C113nt';  
CREATE USER "FRSadmin" WITH PASSWORD '@dm1n';
```

Transcript:

```
CREATE DATABASE "Transcript_Survey";  
CREATE USER "TSclient" WITH PASSWORD 'C113nt';  
CREATE USER "TSadmin" WITH PASSWORD '@dm1n';
```

Once the database and users have been successfully created, log out of PostgreSQL with the following command:

```
\q
```

3. The tables used to store data can be set up using the web browser. Ensure that both the Apache and PostgreSQL servers are running, then navigate to the following address in a web browser:

```
localhost:<listening_port4>/db_tasks.php
```

From here, click the dropdown menu and select the "Create Database" option. Then push the submit button.

⁴ The listening port was determined in step 1 of Section 3.1.

The database has been set up and is ready for use.

3.5 Custom CSS for Specific Devices

The WEST software uses a cascading style sheet (`west.css`) to properly size the `<video>` element for various devices.⁵ As it stands, the style sheet includes considerations for smart phones (with 320×480 pixel display), high-resolution smart phones (with 640×960 pixel display), tablets (with 768×1024 pixel display), small laptops (with 600×1024 pixel display), medium-sized laptops (with 768×1366 pixel display) and large laptops (with 1200×1920 pixel display).

When using a device with a screen resolution not listed above, custom modifications of `west.css` are required to specify the correct size for the `<video>` element. This, however, is an exercise for the administrator, as custom CSS rules are outside the scope of this manual.

⁵ Do not rely on the browser to rescale video to fit a device's screen. The dimensions specified in `west.css` should match the dimensions of the videos meant to be played back on that device.

4 SOFTWARE CONFIGURATION

The WEST software requires each test to be configured before it is run. Configuration files are used to specify the filenames of stimuli to test, the number of sessions in the test, which stimuli to test during which session, which questions to ask for each stimulus, the correct answers for each question, and, optionally, a post-test survey (useful for gathering demographic data, for example).

4.1 Stimulus Specifications

The WEST software expects each stimulus to adhere to a specific naming convention and has only been tested using H.264-encoded .mp4 video files. The naming convention specifically allows for a stimulus name, an audio quality level, and a video quality level. It is possible to use the three fields in a different manner as long as the structure of the syntax itself is respected.

4.1.1 Naming Convention

The filename for each video must include no spaces and follow a specific filename convention for the WEST software to run correctly. The basic structure is as follows:

`<video name><video impairment level><audio impairment level>.mp4`

The video name can be up to 50 alphanumeric characters long and should be a unique identifier for a specific video sequence. The video impairment level can be a combination of up to 7 alphanumeric characters that identifies a specific impairment level. For example, V0 could be used to represent original quality and V1, V2, etc. could be used to represent increasingly harsh impairment levels. The same convention could be used for the audio impairment level, represented by an A followed by a number. Following is an example of the filename for a video.

`reporterV1A0.mp4`

4.1.2 Video Format Constraints

Preparing video for use with the WEST software requires an additional step when compared to most subjective experiments. All video must be encoded using a codec that is compatible with the HTML5 `<video>` tag. The recommended procedure for generating audio and video impairments follows.

Begin with a copy of an uncompressed video. Separate the audio and video into two separate files and generate copies with impairments as necessary. Recombine the audio and video files (ensuring audio/video sync is preserved) in all combinations such that the experiment design is satisfied. Create uncompressed copies of each combination. Finally, use a codec compatible with the HTML5 `<video>` tag to transparently compress each file, and if necessary rescale the video to a resolution that is appropriate for the target device.

The WEST software has only been tested with H.264-encoded video files. Because the mechanism used to display video in a web browser is the HTML5 <video> tag, it is theoretically possible to use Ogg Theora-encoded or WebM-encoded video. However, this is not recommended for two reasons. At this writing, H.264 is supported by most browsers (Google Chrome, Internet Explorer, and Safari, with Firefox support announced for 2014), whereas Ogg Theora and WebM are only supported by Google Chrome and Firefox. Additionally, most smartphones and tablets do not ship with dedicated WebM or Ogg Theora codec hardware, meaning video playback is more likely to be affected by operating system events if decoding is possible at all. However, in 2013 two major mobile device processor manufacturers released products with hardware accelerated WebM encoding and decoding, so in future it may be desirable to test the WEST software with video encoded with different video compression standards.

When mobile devices are a target device for a test managed with the WEST software the administrator must pay attention to which decoder profiles and resolutions the mobile device supports. Additionally, the administrator must be conscious of a device's aspect ratio and native resolution. It is not recommended to force mobile devices or web browsers to rescale video to fit the device's screen.

For example, based on the technical specs of the iPod Touch (3rd generation),⁶ the administrator should rescale a video such that the long dimension of the video is no greater than 480 pixels, the short dimension is no greater than 320 pixels. The video should be encoded at a frame rate no higher than 30 frames per second using the baseline H.264 profile at level 3.0 or lower. It is a good idea to load encoded videos onto a device before conducting an experiment to verify their functionality on that device.

Given this information, it is important that the bit rate used to encode the video does not introduce any further impairments to the video. The efficiency of different codec implementations varies greatly, as does the complexity of any given video sequence. Thoroughly inspecting each video for impairments introduced by an encoder is highly recommended.

Encoding videos for laptops or computers is not as straightforward as encoding for mobile devices. If deploying a self-contained setup, the upper limit on bit rate is determined by disk read speed and the upper limit on decode complexity is bounded by processor power. Videos limited by either will likely stutter or drop frames to maintain audio/video synchronization. Knowing whether disk read speed or processing power create a bottleneck may take some experimentation.

When deploying a client/server setup, network bandwidth is almost certainly the limiting factor on encoding bit rate. Transparently-coded 1080p/30fps video can easily saturate an 802.11g wireless link. If two or more subjects accessed the test software over a wireless link and requested a video sequence at the same time their browsers would be forced to buffer the video, introducing an unwanted impairment to video playback.

⁶ <http://support.apple.com/kb/SP570>

4.1.3 Video Location

Once the desired videos have been named correctly and verified for transparent coding, they must be placed in the appropriate folder. The WEST software will look for videos in a /video subfolder relative to its path. For example, if the source code is located in the /home/user_name/lappstack-5.3.1.3-0/htdocs/WEST folder, the path for the location of all the videos is as follows:

```
/home/user_name/lappstack-5.3.1.3-0/apache2/htdocs/WEST/video/
```

4.2 Test Configuration

Test configuration consists of enumerating the questions, answers, filenames and sessions. This task requires editing the text files answers.txt and sessions.txt. Each file must be created using the following conventions, explained below, for the software to function correctly.

4.2.1 Session Listing Specification

Regardless of which test is being configured, the viewing sessions for each test are configured in the same manner. Each test must consist of at least one session. Each session has a name and an associated list of videos (specified by filename stubs) that a subject will view in the session. Each session is defined in sessions.txt and must conform to the following convention.

```
*
<SessionName>
+
<VideoName1> <video impairment level> <audio impairment level>
<VideoName2> <video impairment level> <audio impairment level>
<VideoName3> <video impairment level> <audio impairment level>
```

An asterisk (*) appears on its own line before each session name. On the next line, the session name appears by itself. The line that follows contains only a plus symbol (+). The lines that follow contain the filenames for the videos to appear in the session, each on its own line. The filename is based on the video naming convention described in Section 4.1.1, with the name, video impairment level, and audio impairment level are all separated by the space character.

Following is an example of sessions.txt.

```
*
Practice
+
f1femalepresident V1 A0
f1mountainhike V0 A2
f1newdelhi V3 A1
*
Session 1
+
f4art V1 A0
m1director V2 A0
```

```

m2guitaraudio V3 A0
*
Session 2
+
m3sportsman V1 A0
m3summersports V1 A1
m4garden V1 A2

```

There is no limit to the number of sessions in the test. Each session's name has a limit of 50 alphanumeric characters. There is no limit to the number of videos in each session. Each video's name has a limit of 50 alphanumeric characters, each video impairment level and audio impairment level tag has a limit of 7 alphanumeric characters. If the convention for sessions.txt is not followed exactly the test will not run correctly.

4.2.2 Forced Choice answers.txt Specification

In a forced choice test, subjects are asked one or more questions and must select one answer from a list of answers for each question. To configure the Forced Choice test, the answers.txt file must be configured with one or more questions with answers for each video. *Every video listed in sessions.txt must have a corresponding entry in the answers.txt file.* It is possible to have more than one question for each video, and each question may have as many answers as needed but must have at least one. Additionally, there is the option to display text before each video which can be used as a leading question or an instruction for the user. Questions and answers must be enumerated for each video. The entry for each video must conform to the following convention.

```

*
<VideoFileName>
<Text before video>
<Question or instruction after video>
<Optional 2nd question or instruction after video >
<Optional 3rd question or instruction after video >
+
[<CorrectnessValue>] <Answer 1>
[<CorrectnessValue>] <Answer 2>
[<CorrectnessValue>] <Answer 3>
[<CorrectnessValue>] <Answer 4>
++
[<CorrectnessValue>] <Answer 1>
[<CorrectnessValue>] <Answer 2>
[<CorrectnessValue>] <Answer 3>
++
[<CorrectnessValue>] <Answer 1>
[<CorrectnessValue>] <Answer 2>
[<CorrectnessValue>] <Answer 3>
[<CorrectnessValue>] <Answer 4>
[<CorrectnessValue>] <Answer 5>

```

An asterisk (*) appears on its own line before the filename for the video. On the next line, the video filename, following the naming convention described in Section 4.1.1, appears by itself

with no spaces between the video name, video quality tag, and audio quality tag. The line that follows contains text to display before the video begins playback.

If no pre-video text is desired, leave a blank line for the first line after the video filename. The line or lines that follow contain the questions, each on their own line, to be asked after the video is finished playing. The line following the questions should contain only a plus symbol (+). The lines following the “+” contain the answers pertaining to the first post-video question (the question in the second line after the video filename).

Each answer is paired with a rating value. If a five-level rating scale is used, then each of five answers should be paired with a bracketed integer (1 through 5) to represent its rating value. When there is only one correct answer for a question, the correct answer is given a correctness value of [1] while the others are given a correctness value of [0]. It is possible to use an arbitrary (integer) scale if the test requires it. On the same line, separated from the bracketed rating value by a space character, is the actual text to be displayed for the answer. If more than one post-video question is specified, the remaining sets of answers must be separated with a line containing solely “++”. Following is an example of answers.txt.

```
*
f1femalepresidentV1A0
Pay attention to the female speaking in this video.
What color was the woman’s dress in this video?
+
[0] Red
[1] Orange
[0] Blue
[0] Green
*
f1mountainhikeV0A2

Which state did the woman say she was hiking in?
This question and its answers will appear below the first question/answer.
+
[0] Utah
[0] Wyoming
[0] Washington
[1] Colorado
++
[50] This is one answer to the second question.
[51] This answer is better than the first.
[0] This is the wrong answer.
*
m3sportsmanV1A0

What is the speaker’s favorite sport?
+
[0] Baseball
[0] Basketball
[1] Hockey
[0] Football
```

The number of videos in answers.txt must correspond to the number of videos listed in sessions.txt. Each video must have a minimum of two lines of questions following it, though the first/instruction line may be left blank. Questions and instructions must use fewer than 300 characters. Each question must have at least one answer and each answer must have a rating value. Answers must consist of fewer than 80 characters and the rating value must be an integer in square brackets. If the convention for answers.txt is not followed exactly the test will not operate correctly.

4.2.3 Absolute Category Rating answers.txt Specification

An ACR test operates the same way as a forced choice test. To configure an ACR test, use the Forced Choice version of the software. The answers.txt file must be configured with one or more questions with answers for each video. *Every video listed in sessions.txt must have a corresponding entry in the answers.txt file.* It is possible to have more than one question for each video. Additionally, there is the option to display text before each video which can be used as a leading question or an instruction for the user. For this specific kind of test it is likely that there will be only one question per video and that the questions and answers for each test will be the same. Even so, the questions and answers must be enumerated for each video. The entry for each video must conform to the following convention.

```
*
<VideoFileName>
<Text before video>
<Question or Instruction after video>
+
[<RatingValue>] <Answer 1>
[<RatingValue>] <Answer 2>
[<RatingValue>] <Answer 3>
[<RatingValue>] <Answer 4>
[<RatingValue>] <Answer 4>
```

An asterisk (*) appears on its own line before the filename for the video. On the next line, the video filename, following the naming convention described in Section 4.1.1, appears by itself with no spaces between the video name, video quality tag, and audio quality tag. The line that follows contains the question or instruction to display before the video begins playback.

The line or lines that follow contain the questions, each on their own line, to be asked after the video is finished playing. Use a blank line for the first line after the video filename if no pre-video question or instruction is desired. The line following the questions should contain only a plus symbol (+). The lines following the “+” contain the answers pertaining to the first post-video question, or the question in the second line after the video filename.

Each answer is paired with a rating value. If a five-level rating scale is used, then each rating should be paired with an integer 1 through 5 to represent its rating value. It is possible to use an arbitrary (integer) scale if the test requires it. On the same line as the rating value, separated by a space character, is the actual text to be displayed for the answer. If more than one post-video question is specified, the remaining sets of answers must be separated with a line containing solely “++”. Following is an example of answers.txt.

```

*
f1femalepresidentV1A0
You will be asked to rate the quality of this video clip.
Please rate the quality of the previous video clip.
+
[5] Excellent
[4] Good
[3] Fair
[2] Poor
[1] Bad
*
f1mountainhikeV0A2

Rate the audio quality of the previous video clip.
Please rate the listening effort.
+
[5] Excellent
[4] Good
[3] Fair
[2] Poor
[1] Bad
++
[5] Complete relaxation possible; no effort required.
[4] Attention necessary; no appreciable effort required;
[3] Moderate effort required.
[2] Considerable effort required.
[1] No meaning understood with any feasible effort.

```

The second video clip (“f1mountainhikeV0A2”) shows an example where two questions are asked for the same stimulus and demonstrates an example of the listening quality scale and the listening effort scale from ITU-T P.800.

The number of videos in answers.txt must correspond to the number of videos listed in sessions.txt. Each video filename must have a minimum of two lines following it, though the first line may be left blank. Questions and instructions must use fewer than 300 characters. Each video must have at least one answer and each answer must have a rating value. The rating value must be an integer in brackets. Answers must consist of fewer than 80 characters. If the convention for answers.txt is not followed exactly, the test will not operate correctly.

4.2.4 Free Response answers.txt Specification

A free response test allows a test administrator to ask an open-ended question and requires the subject to type in a free-form response. To configure the Free Response test, the answers.txt file must be configured with one or more questions with answers for each video. The subject will respond to each question by filling in a blank textbox. The subject’s response will be saved in the database along with the predetermined answer for the question. The subject will never see the predetermined answer; it is saved in the database with the subject’s response for analysis. *Every video listed in sessions.txt must have a corresponding entry in the answers.txt file.* It is possible to have more than one question for each video. Additionally, there is the option to have a question/instruction sentence before each video which can be used as a leading question or an

instruction for the user. Questions and answers must be enumerated for each video. The entry for each video must conform to the following convention.

```
*
<VideoFileName>
<Text before video>
<Question or Instruction after video>
<Optional 2nd question or instruction after video >
<Optional 3rd question on instruction after video >
+
<Correct Answer>
++
<Correct Answer>
++
<Correct Answer>
```

An asterisk (*) appears on its own line before the filename for the video. On the next line the video filename, following the naming convention described in Section 4.1.1, appears by itself with no spaces between the video name, video quality tag and audio quality tag. The line that follows contains text to display before the video begins playback.

Use a blank line for the first line after the video filename if no pre-video question or instruction is desired. The line or lines that follow contain the questions, each on their own line, to be asked after the video is finished playing. The line following the questions should contain only a plus symbol (+). The line following the '+' symbol contains the predetermined correct answer answers pertaining to the first post-video question, or the question in the second line after the video filename.

If more than one post-video question is specified, the remaining answers must be separated with a line containing solely “++”. Following is an example of answers.txt.

```
*
f1femalepresidentV0A0
Pay attention to the woman the speaker is talking about.
What is the title of the person this woman was talking about?
+
Secretary of State
*
f1mountainhikeV0A0

How long was the hike this woman described?
Where did the hike take place?
Who is buried in Grant's tomb?
+
three days
++
Oddly, in a metropolitan area, despite the filename.
++
I am so sick of that joke.
*
f1newdelhiV0A0
What were the beggars selling?
```

```
What were the beggars selling?  
+  
gas masks
```

Note that in the example, for the third video clip (“f1newdelhiV0A0”) the same question will appear both before and after the video, yet the text entry box will only appear after the video clip has finished playing.

The number of videos in answers.txt must correspond to the number of videos listed in sessions.txt. Each video filename must have a minimum of two lines of questions following it, though the first/instruction line may be left blank. Questions and instructions must use less than 300 characters. Each question may have only one answer. Answers must consist of less than 300 characters. If the convention for answers.txt is not followed exactly, the test will not operate correctly.

4.2.5 Transcript answers.txt Specification

A transcript test presents the subject with an incomplete transcript after the video has finished playing. The subject must use knowledge of the just-played video to fill in the blanks. To configure the Transcript test, the answers.txt file must be configured with a question, transcript and answers for each video. The transcript for the video will consist of a sentence with missing portions, which will appear in the form of text boxes when the subject is taking the test. The subject is tasked with completing the transcript by filling in the missing portions. The subject’s response for each missing portion will be saved in the database along with the actual answer for the portion. *Every video listed in sessions.txt must have a corresponding entry in the answers.txt file.* It is possible to have more than one transcript for each video. Additionally, there is the option to have a question/instruction sentence before each video which can be used as a leading question or an instruction for the user. Transcripts and answers must be enumerated for each video. The entry for each video must conform to the following convention.

```
*  
<VideoFileName>  
<Text before video>  
<Transcript after video with [#] [#] representing missing portions>  
<Optional additional transcript>  
<Optional additional transcript>  
+  
[#] <Answer for missing portion>  
[#] <Answer for missing portion>  
++  
[#] <Answer for missing portion>  
++  
[#] <Answer for missing portion>  
[#] <Answer for missing portion>  
[#] <Answer for missing portion>
```

An asterisk (*) appears on its own line before the filename for the video. On the next line the video filename, following the naming convention described in Section 4.1.1, appears by itself

with no spaces between the video name, video quality tag and audio quality tag. The line that follows contains the question or instructions to display before the video begins playback.

Use a blank line for the first line after the video filename if no pre-video question or instruction is desired. The line or lines that follow contain the transcripts, each on their own line and wrapped in double quotation marks, to appear after the video is finished playing. The transcript will have missing portions represented by “[#]” where “#” is replaced with an integer representing the missing portion. Each missing portion should have a unique number. The line following the transcripts should contain only a plus symbol (+). The lines following the “+” contain the answers pertaining to the first post-video transcript, or the transcript in the second line after the video filename. *Each missing portion must have one corresponding answer.* Each answer line must begin with “[#]”, where “#” is replaced by the number corresponding to the missing portion the answer represents, followed by the text for the answer, the two separated by a space character. If more than one post-video question is specified, the remaining sets of answers must be separated with a line containing solely “++”. Following is an example of answers.txt.

```
*
f1countriesV0A0
Pay attention to the countries this woman lists in the following clip.
"Well we went to: [1], Costa Rica, the U.K., and [2]."
"Nobody expects the [1] Inquisition."
+
[1] Canada
[2] Tahiti
++
[1] Spanish
*
m2busV0A0

"I would stand next to the bus driver and I would [1] the [2] on the bus."
+
[1] shift
[2] gears
*
m7countrymusicV0A0

"My dad always listened to [1]. I remember [2] country all the time."
+
[1] country
[2] hearing
```

The number of videos in answers.txt must correspond to the number of videos listed in sessions.txt. Each video filename must have a minimum of two lines of questions following it, though the first line may be left blank. Transcripts must use fewer than 300 characters and instructions must use fewer than 600 characters. Each transcript must have at least one missing portion; there is no limit to the number of missing portions in the transcript. Each missing portion in the transcript must have a corresponding answer. Answers must consist of fewer than 80 characters. If the convention for answers.txt is not followed exactly, the test will not operate correctly.

4.3 Survey Configuration

Writing and configuring a survey is not required for the WEST software to work properly. The survey can be added to any test and the subject will have the option to complete the survey after all sessions in the test have been completed. The survey is designed to gather additional information about the test or demographics from the subjects. If no survey is to be used in the test, leave the survey.txt file blank.

To configure the survey for subjects to take after the test, the survey.txt file must contain the desired survey questions. There are four different types of questions that can be put on the survey: Multiple Choice, Free Response, Drop Down, and Check Box. Multiple Choice questions have multiple answers displayed for the subject and the subject is forced to select only one answer. Free Response questions have a text box for the subject to type a response to the question. Drop Down questions have a drop down list of answers for the question and the subject is forced to choose only one answer. Check Box questions have multiple answers displayed for the subject and the subject may select any number of answers for the question. The entry for each type of question must conform to the following convention.

```
*
Multiple Choice
<Question1>
+
<Answer1>
<Answer2>
<Answer3>
<Answer4>
*
Free Response
<Question1>
*
Drop Down
<Question1>
+
<Answer1>
<Answer2>
<Answer3>
<Answer4>
*
Check Box
<Question1>
+
<Answer1>
<Answer2>
<Answer3>
<Answer4>
```

As with the prior conventions, any number of questions and answers may be given.

4.4 Database Configuration

After setting up the sessions.txt, answers.txt, and survey.txt (optional) files, the information contained in those files must be loaded into the database. This allows the Web server to access the information in an efficient manner. To load the information into the database, follow these steps:

1. Make sure that Apache and PostgreSQL are running.⁷ Next, use a web browser to navigate to the db_tasks.php page by entering the following in the address bar:

localhost:<listening_port>/db_tasks.php

2. On this page, the following selections are available from the drop down menu:

- Create Database

This option creates all the database tables needed to store data for the experiment. This option must be executed before any other option.

- Configure Sessions, Questions, and Answers

This option will transfer the information from the text files used to configure the sessions, questions, and answers for the test (described in Sections 4.2.1–4.2.5) to the database. This option must be executed after the Create Database command and is required for the test to become functional.

When selecting this option two more drop down menus appear. The first is entitled Sessions and the second is entitled Videos. Each drop down menu has two options: random and ordered. For the Sessions menu, random specifies that the sessions for the test should be completed by the subject in a random order; ordered specifies the sessions should be completed in the order they are written into the sessions.txt file. For the Videos menu, random specifies that the videos within a session should be viewed by the subject in a random order; ordered specifies the videos should be viewed by the subject in the order they are written into the answers.txt file.

- Test Reset

This option deletes all data collected when conducting a test. It will clear the tables in the database that are populated when subjects take the test. This can be useful for the administrator to verify the test's functionality before guiding subjects through the test. Note this option will not clear the information used to configure the test, only the data collected when the subjects take the test.

⁷ Starting Apache is explained in step 2 of Section 3.2. Starting PostgreSQL is explained in step 1 of Section 3.4.

⁸ The listening port is determined in step 1 of Section 3.1.

- **Configure Survey**

This option transfers the information from the text file used to configure the survey for the test (described in Section 4.3) to the database. Adding a survey to the test is optional, only choose this option if survey.txt is properly configured and is going to be used in the test.

- **Survey Reset**

This option deletes all data collected when conducting a survey. It will clear the tables in the database that are populated when subjects take the survey. Note this option will not clear the information used to configure the survey, only the data collected when subjects take the survey.

4.5 Client Configuration

The WEST software should work with any HTML5-compatible browser that is capable of playing back H.264-encoded .mp4 files specified by an inline <video> tag. The WEST software has been used successfully with the Chrome browser on Microsoft Windows and Ubuntu Linux and with Mobile Safari on iOS 5+.

When using a desktop computer or a laptop to access the WEST software, it is recommended to use the browser's "Full Screen" view option. To do this, first enter the Web server's configured address in the address bar. Once the page has loaded, one may push the F11 button or select the full-screen option from the browser's menu.

The best way to access the WEST software when using an iOS device is through the Add to Home Screen option in Mobile Safari's Share menu. To accomplish this, navigate to the Web server's configured address in Mobile Safari. Once the site has loaded, touch the Share button and then the Add to Home Screen button. Enter text that will help to identify the test and finally touch the Add button. This set of actions will create a new icon on the iOS home screen. Touching this icon will access the WEST software in a full-screen browser with no forward, back, or reload buttons.

5 TEST ADMINISTRATOR OPERATION OVERVIEW

The test administrator will have responsibilities beyond installing and configuring the WEST software. The administrator is responsible for managing the database, guiding subjects through the test, and accessing results for the test from the database.

5.1 Managing Database

The database can be managed using the `db_tasks.php` Web page for each test. In a web browser, navigate to this page by entering the following in the address bar:

```
Localhost:<listening_port9>/db_tasks.php
```

This page contains a drop down menu with four options that can be used for managing the database.

- Configure Sessions, Questions, and Answers

Select this option if the test needs to be reconfigured because of a change made to either `sessions.txt` or `answers.txt`. To reconfigure, changes first need to be made to the necessary text files used to configure the test (described in Section 4.2). Selecting this option then transfers the information from the text files to the database.

When selecting this option two more drop down menus appear. The first is entitled Sessions and the second is entitled Videos. Each drop down menu has two options: random and ordered. For the Sessions menu, random specifies that the sessions for the test should be completed by the subject in a random order; ordered specifies the sessions should be completed in the order they are written into the `sessions.txt` file. For the Videos menu, random specifies that the videos within a session should be viewed by the subject in a random order; ordered specifies the videos should be viewed by the subject in the order they are written into the `answers.txt` file.

- Test Reset

This option deletes all data collected when conducting a test. It will clear the tables in the database that are populated when subjects take the test. Note this option will not clear the information used to configure the test, only the data collected when the subjects take the test.

- Configure Survey

Select this option if the survey needs to be reconfigured because of a change in the questions or answers. To reconfigure, changes first need to be made to the necessary text files used to configure the survey (described in Section 4.2). Selecting this option then transfers the information from the text files to the database. Adding a survey to the test is

⁹ The listening port is determined in step 1 of Section 3.1.

optional, only choose this option if a survey for the test is configured and is going to be used in the test.

- Survey Reset

This option deletes all data collected when conducting a survey. It will clear the tables in the database that are populated when subjects take the survey. Note this option will not clear the information used to configure the survey, only the data collected when subjects take the survey.

After initial database configuration, it is a good precaution to remove the Test Reset and Survey Reset options from the drop-down menu to prevent data loss. This is easily accomplished by commenting out lines in `db_tasks.php` itself. For example, to prevent the Test Reset option from appearing in the drop-down menu, replace line 354:

```
<option value="Test Reset">Test Reset</option>
```

with

```
<!-- <option value="Test Reset">Test Reset</option> -->
```

5.2 Managing Subjects

The test administrator is responsible for guiding subjects through the test. Following are directions for this task.

1. Make sure that Apache and PostgreSQL servers are running.¹⁰ In a web browser navigate to the `index.php` page by entering the following in the address bar:

```
Localhost:<listening_port11>/index.php
```

This is the home page for the test. On this page, enter the subject number for the subject taking the test, then press submit. Each subject must have a unique subject number. If sessions are configured to take place in random order, the test will then pair the subject with a session they have not completed and the subject will complete that session. If sessions are configured to take place in a specified order, the test administrator should select the next session. It is not possible for a subject to score videos in any session more than once.

2. After the subject completes a session, a Web page explaining that the session has been completed will display. If necessary, the subject may take a break at this point. The test administrator may then return to `index.php`, enter the appropriate subject number (and session number, if appropriate) and the test software will automatically pair the subject with the next session.

¹⁰ Starting Apache is explained in step 2 of Section 3.2. Starting PostgreSQL is explained in step 1 of Section 3.4.

¹¹ The listening port is determined in step 1 of Section 3.1.

The administrator may observe the status of a subject by typing the following address in the address bar:

Localhost:<listening_port¹²10>/user_status.php

Once the page has loaded, push the Submit button. The server will return the status of the subject who has most recently submitted a vote. It will report the subject's subject number, location, the number of trials remaining, and the amount of time elapsed. This can be useful for monitoring subjects from a remote location.

5.3 Viewing and Exporting Results from the Database

All the information collected from subjects participating in an experiment run by the WEST software is stored in the database. This information can be viewed on a Web page or exported to a .csv (comma-separated values) file for use in Microsoft Excel®, MATLAB® or any number of data processing tools. These capabilities are accessed through the access_data.php page. In a web browser, navigate to this page by typing the following in the address bar:

Localhost:<listening_port¹³10>/access_data.php

For each test, a drop down menu appears with multiple options for viewing information from the database.

Below the drop down menu are two radio buttons that apply to every option on the drop down menu. The radio buttons read html table output and csv file output. Choosing html table output will cause the current selection to be displayed on the current Web page; choosing csv file output will cause the current selection to be downloaded as a .csv file.

When viewing the results of a test, file tags will be associated with multiple questions. The answers to each question can be uniquely identified using the src key and the qv_no key, where src correlates to the video filename and qv_no indicates which question is associated with the answer

¹² The listening port is determined in step 1 of Section 3.1.

¹³ The listening port is determined in step 1 of Section 3.1.

6 TEST PARTICIPANT OPERATIONAL OVERVIEW

In this section we discuss how a subject interacts with the WEST software.

6.1 Forced Choice

The experiment administrator should start the appropriate session before giving the subject control of the device that has been configured to access the WEST software. At the beginning of a trial, text alerting the subject to the upcoming task may or may not appear, depending on how the test was configured, and a button labeled Begin Video will appear. When the subject is ready to watch the video, she should push the Begin Video button. The pre-video question or statement (if present) will disappear, the Begin Video button will disappear, and a video will appear and begin playing. When the video finishes playing, it will disappear and the question or questions associated with that video will appear. The subject must select one answer for each question before pushing the Vote button. After the subject pushes the Vote button, the process will repeat.

6.2 Absolute Category Rating

ACR is a subset of forced choice, so the subject experience for this option will be very similar to forced choice option. Often, however, a test using the ACR methodology will only have one question to answer after the video is finished playing.

6.3 Free Response

The experiment administrator should start the appropriate session before giving the subject control of the device that has been configured to access the WEST software. At the beginning of a trial, text alerting the subject to the upcoming task may or may not appear, depending on how the test was configured, and a button labeled Begin Video will appear. When the subject is ready to watch the video, he should push the Begin Video button. The pre-video question or statement (if present) will disappear, the Begin Video button will disappear, and a video will appear and begin playing. When the video finishes playing, it will disappear and the question or questions associated with that video will appear. The subject must type an answer for each question before pushing the Vote button. After the subject pushes the Vote button, the process will repeat.

6.4 Transcript

The experiment administrator should start the appropriate session before giving the subject control of the device that has been configured to access the WEST software. At the beginning of a trial, text alerting the subject to the upcoming task may or may not appear, depending on how the test was configured, and a button labeled Begin Video will appear. When the subject is ready to watch the video, she should push the Begin Video button. The pre-video question or statement (if present) will disappear, the Begin Video button will disappear, and a video will appear and begin playing. When the video finishes playing, it will disappear and the transcript or transcripts associated with that video will appear. The subject must type one answer in each blank for each

transcript before pushing the Vote button. After the subject pushes the Vote button, the process will repeat.

7 KNOWN ISSUES, BUGS, AND DEFECTS

As is the case with modern software, the WEST software package can be continually improved to adapt to changing device or security requirements. The package currently functions as described, but stands to benefit from continued development. The following list enumerates new features or fixes that would improve the stability of the software.

1. The parsers used to read text configuration files are slow and error-prone. A documented, external parsing scheme/parser should replace the parsing code in `db_tasks.php`.
2. The server code makes many calls to the database, often one right after another. This should be optimized using whatever technique is necessary.
3. As it stands, data sent back and forth from the server to the client is sent in plain text. The software should be made to use HTTPS.
4. There are certainly outstanding security issues present in the code. It should be audited for security and any vulnerabilities should be patched.

8 REFERENCES

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