New Possibility of Using PsychoPy as Experimental System in Tactile Psychophysics

Anzu Kawazoe[1], Masashi Nakatani[2], Kouta Minamizawa[3] and Susumu Tachi[4]

***Abstract*— In this study, we describe a new possibility of PsychoPy application for building experimental program in tactile psychophysics. We implemented experimental program using PsychoPy and conducted an experiment with the implemented program with the TECHTILE toolkit. We found that PsychoPy is suitable experimental environment for building tactile psychophysics experiment especially for vibrotactile sensations. Our result also demonstrates the usability of PsychoPy in open source platform.**

I. Introduction

In recent years, tactile display using vibrotactile technology has been vigorously developed. In addition, vibrotactile displays are employed in consumer electronics such as smart phones and game controllers. From academic research side, several studies have also discussed taxonomy of vibrotactile haptic feedback[1]. TECHTILE toolkit[2] is another vibrotactile display that enables users to record frictional vibration using a microphone and give vibrotactile feedback by amplifying audio signal. More and more people are attracted to experience haptic feedback and its possible applications.

Even though the increase of social interests, it still requires some more efforts to fully understand vibrotactile sensation in both basic study and its practical use. The bottle neck of those research is that researchers need to develop their own experimental environments to test vibrotactile stimuli in their specific purpose. On the other hand, in vision and auditory study, there is experimental environment that enables to conduct psychophysics experiment. Phychtoolbox[3] is one example of psychophysics toolkit executable in MATLAB or GNU Octave. Alternatively, MLP 2009[4] is also an easy-to-use toolkit in order to conduct psychophysics experiment in sound. However, it is not quite easy to add user interface into experimental processing built by MLP 2009.

PsychoPy is recently developed experimental environment running in Python. Especially, PsychoPy is designed to develop psychophysics experiment, mainly for visual and auditory research. For example, PhychoPy has a collection of user interfaces which are helpful for developing experimental procedure, such as component buttons to add functions of stimuli and response and a movable trial box to insert trials into routine. Fortunately, we can drive the TECHTILE toolkit by audio signal, therefore it is suitable fit to combine PsychoPy and the TECHTILE toolkit for conducting tactile psychophysics.

[1]Graduate School of Soka University. (e14m5212@gmail.com)
[2]Institute of Gerontology, University of Tokyo. (nakatani@iog.u-tokyo.ac.jp)
[3]Graduate School of Media Design, Keio University. (kouta@tachilab.org)
[4]Institute of Gerontology, University of Tokyo. (tachi@ tachilab.org)

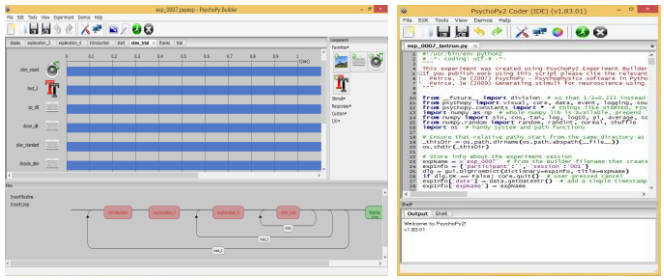

Figure 1. The view of the PsychoPy application.

There are two modes in PsychoPy for creating experimental setup. One is called PsychoPy Builder (Fig. 1, left) that enables to add and edit experimental flow in an intuitive way usig GUI. PsychoPy also has an ability to deliver various audio signals by loading arbitrary audio files. Moreover, PsychoPy Builder can generate source code in python syntax, and users can edit to customize details of the experimental procedure in PsychoPy Coder mode (Fig. 1, right). Combining with PsychoPy Builder and Coder, users can easily develop psychophysics experiment under Python environment.

In the following we describe a vibrotactile psychophysics experiment developed and conducted with PsychoPy and the TECHTILE toolkit, and discuss advantages of this experimental framework.

II. Method

We conducted basic psychophysics experiment by replicating Gescheider et al (2001)[5]. The way how we implemented experimental system was following:

1. Prepare audio files for vibrotactile feedback

First, we prepare audio files to provide vibrotactile feedback signal to the vibrator in the TECHTILE toolkit. We prepared thirteen kinds of sinusoidal wave file of different frequencies (20, 40, 60, 80, 100, 150, 200, 250, 300, 400, 500, 600, 700 Hz). We converted these audio files into vibrotactile signals using audio amplifier at fixed magnitude.

2. Build the experiment using PsychoPy Builder

Second, we built the experiment program in Builder mode. In the Builder mode, we could create experimental flows of each trial. In single trial, we specified what text should be presented in the display and its location. Then we chose audio and keyboard interfaces for the experiment. Audio component was used for providing vibrotactile feedback in our study. Keyboard interface is used to increase and decrease the intensity of vibrotactile feedback by changing the volume of audio output from PC. Also several keys were assigned to finish single trial after participants decided to adjust the intensity of vibrotacitle feedback to comparison stimulus with standard stimulus

Participants' identification number was input in the beginning of the experiment, and presented stimulus order were automatically registered in the spreadsheet.

3. Customize the experiment using PsychoPy Coder

Third, we tune the detail of the experiment by using PsychoPy Coder mode. When we switch to coder mode, Python codes were generated. We could also modify the duration of vibrotactile feedback and the number of trials after conducting several preliminary experiments.

Finally we run the Python code to execute experimental program. When we found there requires several minor tunings, we conducted test trials with a few participants in order to finalize the experimental procedure.

In the experiment, we measured individual difference of vibrotactile sensitivity for different frequencies. Twenty participants attended the experiments. Figure 2 shows the experiment environment. In the experiment, participants were asked to adjust the intensity of comparison vibrotactile stimulus to intensity of standard stimulus with a ten-key control pad. We used a 400 Hz of sine wave as standard stimulus. Comparison frequency was one of 13 vibrotactile frequencies as described above. Total number of trials were sixty five (thirteen frequencies x five trials each) and averaged duration for the experiment was about forty minutes.

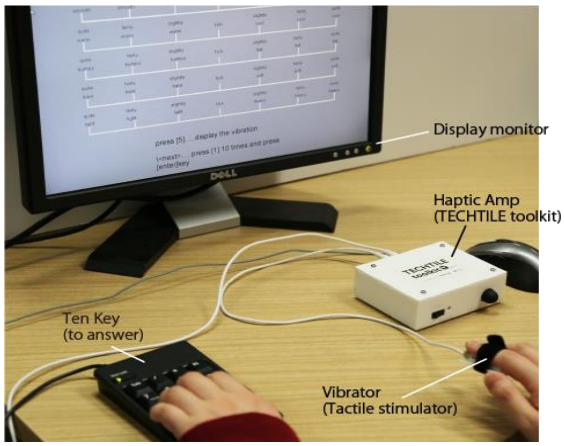

Figure 2. Scene of experiment environment.

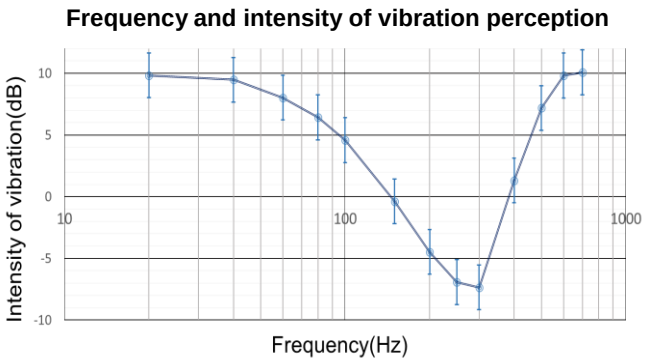

Figure 3. Result of our experiment.

III. Result and Discussion

Fig. 3 shows the result of our experiment (N=20). X-axis is the presented vibrotactile frequency and Y-axis is the intensity of reported comparison intensity in dB unit. This data showed that similar result in Gescheider et al. (2001)[5], in which participants answered lowest stimulus intensity at 250 Hz. Our result showed that highest sensitivity was observed at 300 Hz. This replicated result suggests that the same experimental procedure is possible using PsychoPy and the TECHTILE toolkit.

The advantage of using PsycoPy is that it is easy to develop experimental program. Moreover, Python is platform free environment so that the same experiment is possible in different OS platform (Windows, Linux, Mac) as long as Python can be executed. Moreover, another advantage of using PsychoPy is that it enables to build multiple user interfaces for developing easy-to-conduct experiment through keyboard input.

It is also worth noting that PsychoPy environment enables to combine tactile psychophysics with visual feedback. For example, color of background in the display monitor and the sequence of the stimulation may cause the bias error of result[6]. Such color interference with vibrotactile feedback can be interesting study to pursuit. There are other possibilities to combine with audio feedback by using an audio interface.

In summary, PsychoPy enables to build tactile psychophysics experiment for users from beginners to expertise. In the future we plan to develop an open community website for providing sample codes of PsychoPy for psychophysics of vibrotactile sensation including quick tutorials of PsychoPy.

Appendix

From the following URL, it is able to download the sample experiment program and to learn how to use PsychoPy. URL: http://e14m5212.wix.com/tactile-psychopy

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