

Procedure for measuring listening effort and perceived speech quality through attention-related task performance in an online dual-task experiment

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Introduction

Cognitive load is a crucial aspect that helps researchers to gain insights into people's listening experience. There is a lack of a scalable approach to measure the cognitive load resulting from listening. We proposed a web-based measure to capture cognitive load through the attention-related responses.

One of the challenges is that the changes in behavioural responses might not be observable due to failure in cross-modal interference or the ceiling effect. Here we show our preliminary findings of individuals' sensitivity to different levels of task load.

Experiment Setting

- Browser-based dual-task

Tasks

- Listening to 6-14s sentences
- Playing a web-based behavioural task

Measures

- Self-reported effort
- Attention-related responses

Development

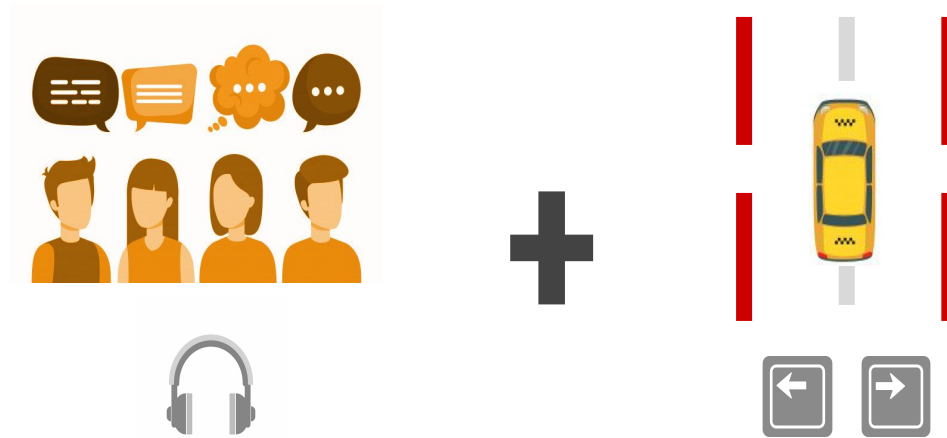
- jsPsych
- three.js

Methodology

The exploratory experiments consisted of both single and dual tasks.

- In dual-task trials, subjects were asked to perform a monitoring task in the browser while listening to speech recordings
- In single-task trials, subjects conducted the monitoring task only

Each type of task was tested on ten different load levels. At each load level, the responses for the single monitoring task and the dual-task were compared.



Subjects (N = 8)

- 5 native, 3 non-native English speakers

Self-reported measures

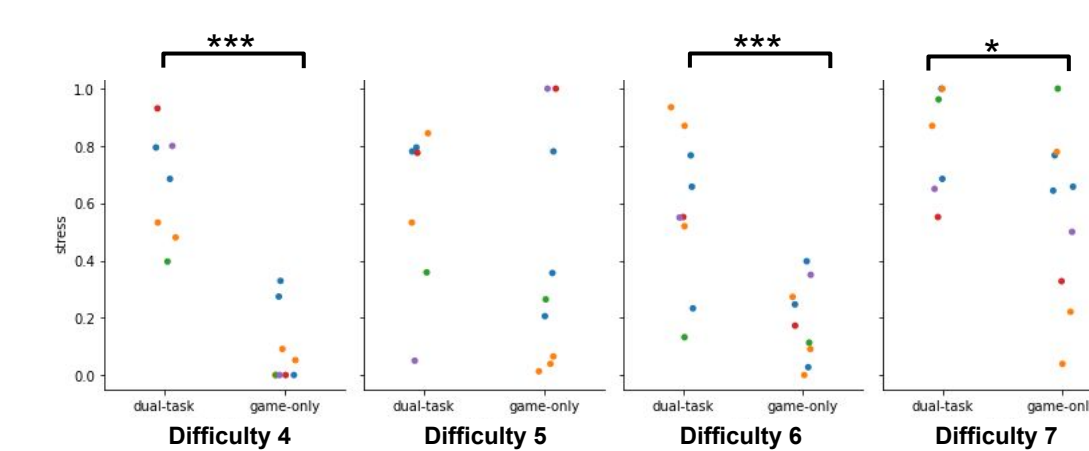
- Stress level
- Difficulty to concentrate
- Estimated task durability

Attention-related responses

- Border cross frequency
- Key-pressed frames frequency
- Average deviation from centre line

Cross-modal Interference Analysis

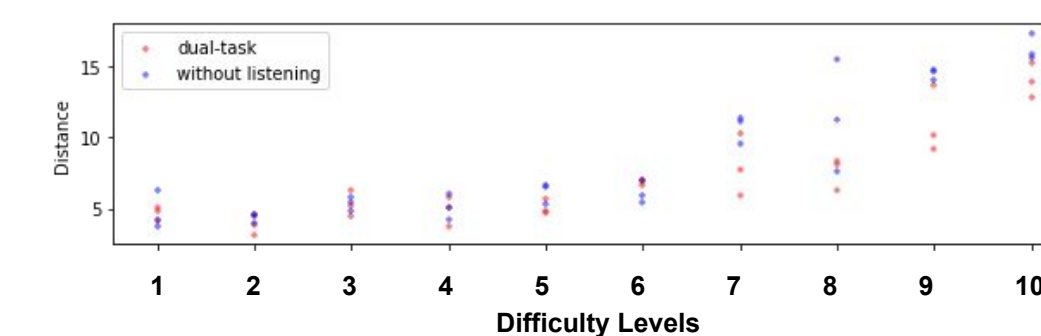
Fig. 1 Selected self-reported response across 4 difficulty levels (Stress level)



- Both self-reported and attention-related responses showed obvious difference level of responses between signal and dual-task
- Adding an extra listening task to the monitoring task does interfere with the task performance and add to the perceived effort

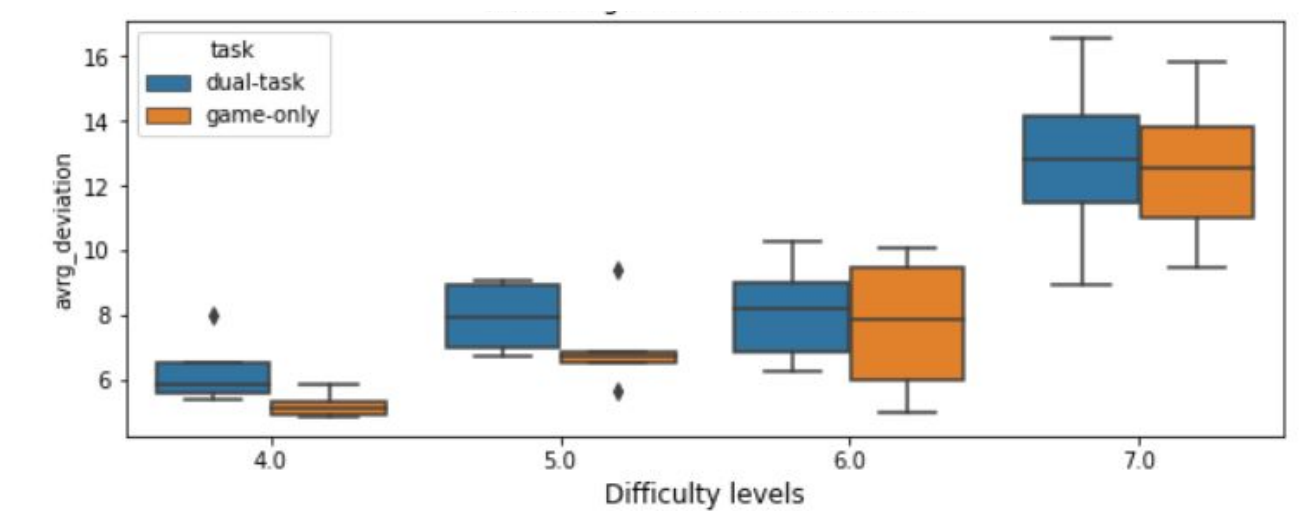
Effective Load Level Analysis

Fig. 2 Single-subject attention-related response across 10 difficulty levels (Average deviation from centre)



- Ceiling's effects were observed under 1--3 difficulty levels (Fig 2). This suggested subjects still had ample cognitive resources while performing a dual-task under the difficulty level 1-3.

Fig. 3 Selected attention-related response across 4 difficulty levels (Average deviation from centre)



- The monitoring task performance was generally better in the single task than in the dual-task across ten load levels (Fig 3).
- The divergence in the monitoring task performance was largest under medium load range (level 4 & 5). This suggested that individuals' attention-related responses were most sensitive under medium load conditions.

Future Development

The resulting calibration parameters for the dual task method provide an effective load range for future studies to capture listening effort using this web-based dual-task experiment.