One by One: A Shiny Web-app for the Design and Analysis of Single-Case Experiments

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Hosted and available for testing at
https://tamalkd.shinyapps.io/scda/

Introduction

A single-case experiment is an experiment in which the effect of at least one independent variable on a single entity is assessed by repeated measurements. Increase in popularity of single-case experiments in the fields of educational, behavioural, and psychological research has boosted the development of computer programmes for the design and analysis of these experiments.

Researchers at KU Leuven – University of Leuven have developed R packages for this purpose (**SCRT**, **SCVA** and **SCMA;** *Bulté and Onghena, 2013*). However, many potential users may not be comfortable with R, so we decided to develop a web-application which implements these R functions in a user-friendly GUI.

Design

We chose Shiny by Rstudio as the platform for **SCDA** (Single-Case Data Analysis). For ease of use, we grouped the available functionality in separate tabs, namely Design, Data, Visual Analysis, Randomization Test, and Meta-Analysis, based on a natural progression of functions needed over the course of designing an experiment and analyzing the data.

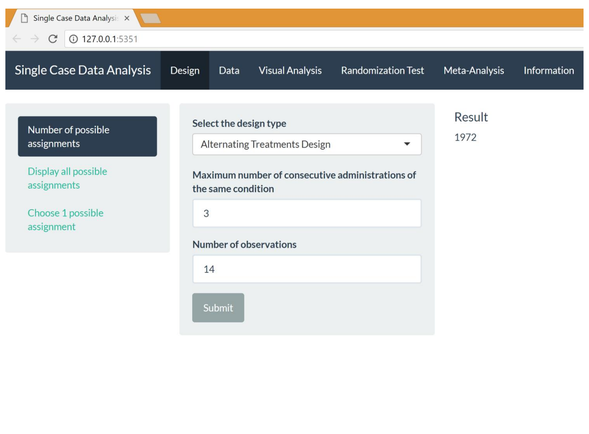

Figure 1: There are 1972 possible random assignments for the experiment.

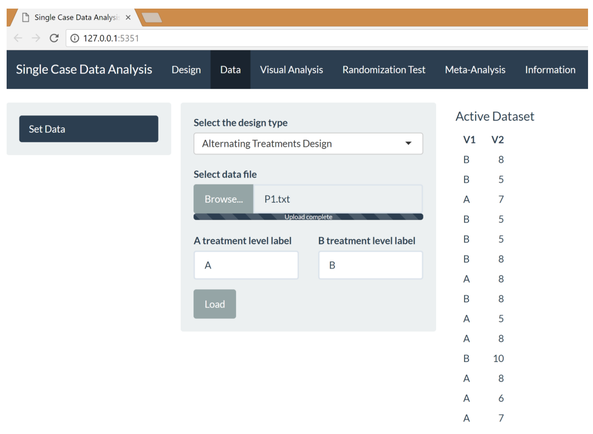

Figure 2: Observed data for the first participant.

Inside these tabs, we implemented a navigation panel on the left to navigate between different functions, an input panel in the middle, and an output panel on the right. A final tab, Information, contains examples and useful information for the user.

Example

We will replicate the design and analysis by Bredin-Oja and Fey (*2014*) in their experiment with 5 participants which implemented an alternating treatments design (ATD) with a maximum of 3 consecutive administrations of the same condition to determine whether children in the early stage of combining words are more likely to respond to imitation prompts that are telegraphic than to prompts that are grammatically complete.

The experiment was conducted over 14 sessions for each participant, with 7 applications of each prompt condition. For simplicity, we will focus on the first participant.

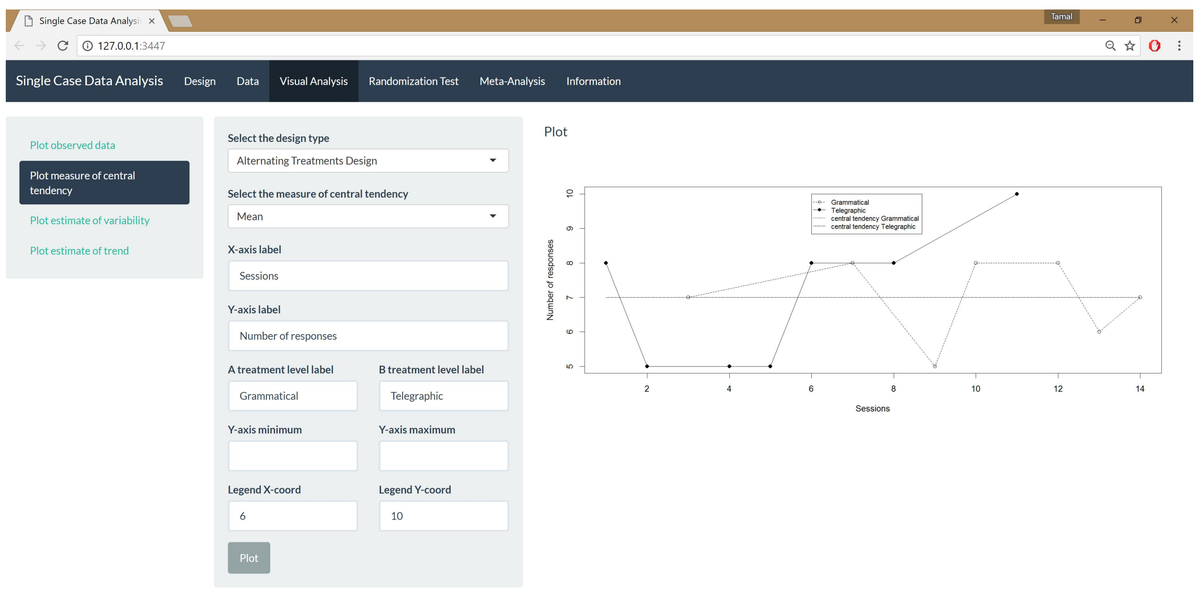

Figure 3: The plot of the observed data and the condition means.

We first calculate the number of possible assignments in the **Design** tab, which for this design is 1972 (Figure 1). We also calculate all possible assignments for our records and randomly choose one assignment for the experiment.

The assignment chosen for the first participant is B,B,A,B,B,B,A,B,A,A,B,A,A,A, where A represents grammatically correct prompts while B represents telegraphic prompts.

Next, we upload the observed data for the participant in the **Data** tab, which consists of one column each for the applied condition and the response variable. The response variable represents the number of responses by the participant to 15 prompts in a session (Figure 2).

Then we plot the data along with measures of central tendency, variation and trend in the **Visual Analysis** tab. In Figure 3, there does not seem to be a difference in the responses between the applied conditions and the response means for the two conditions coincide.

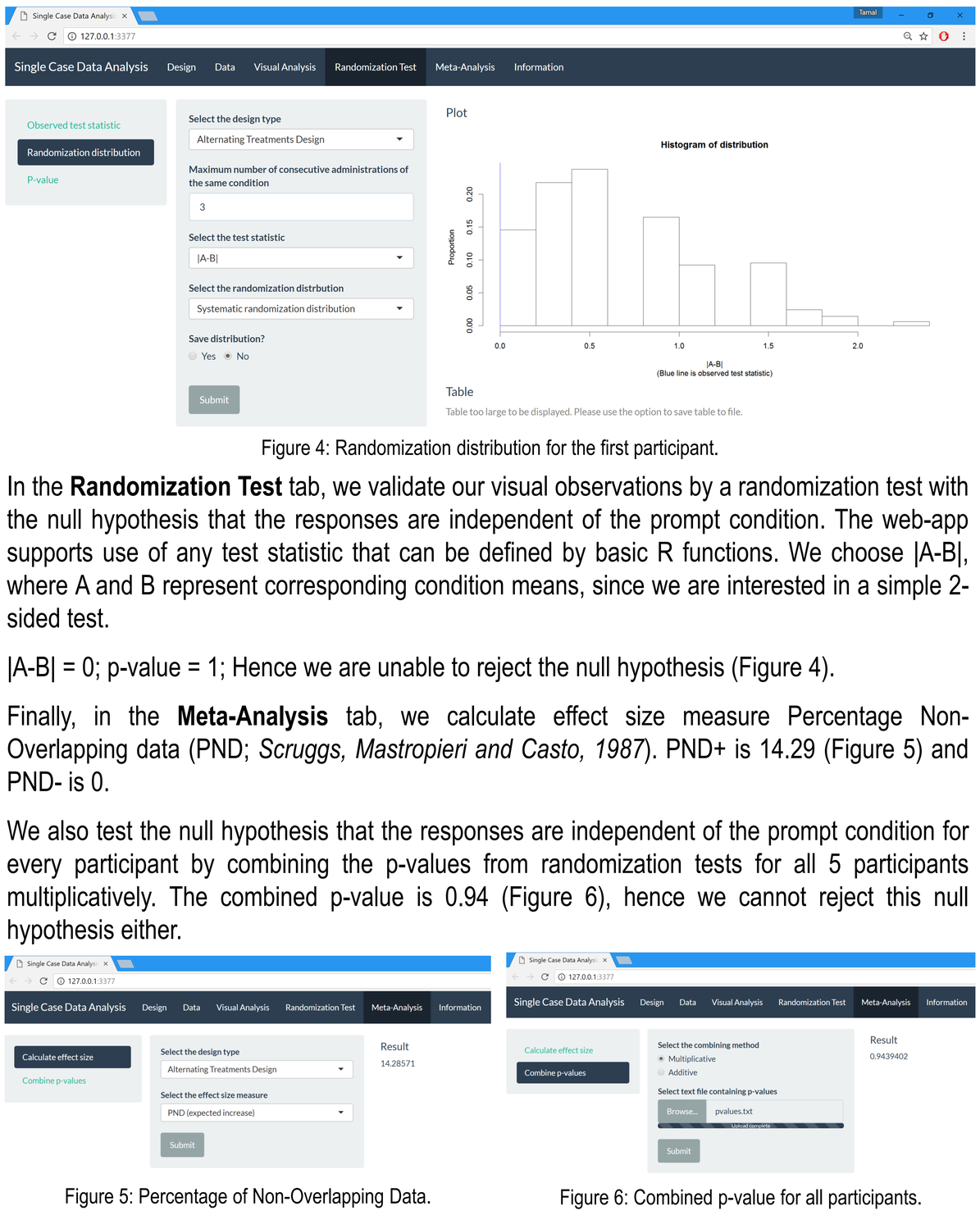

Figure 4: Randomization distribution for the first participant.

In the **Randomization Test** tab, we validate our visual observations by a randomization test with the null hypothesis that the responses are independent of the prompt condition. The web-app supports use of any test statistic that can be defined by basic R functions. We choose |A-B|, where A and B represent corresponding condition means, since we are interested in a simple 2-sided test.

|A-B| = 0; p-value = 1; Hence we are unable to reject the null hypothesis (Figure 4).

Finally, in the **Meta-Analysis** tab, we calculate effect size measure Percentage Non-Overlapping data (PND; *Scruggs, Mastropieri and Casto, 1987*). PND+ is 14.29 (Figure 5) and PND- is 0.

We also test the null hypothesis that the responses are independent of the prompt condition for every participant by combining the p-values from randomization tests for all 5 participants multiplicatively. The combined p-value is 0.94 (Figure 6), hence we cannot reject this null hypothesis either.

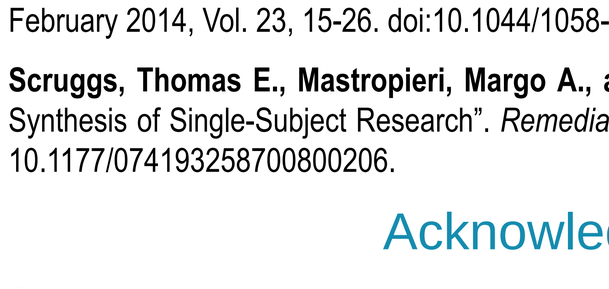

Figure 5: Percentage of Non-Overlapping Data.

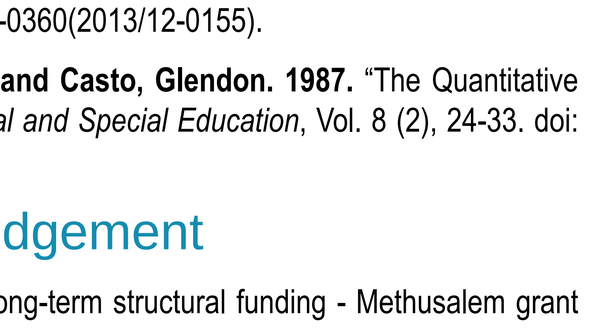

Figure 6: Combined p-value for all participants.

Conclusion

We conclude that the SCDA Shiny app makes designing and analyzing single-case experiments easier and more accessible to researchers and practitioners. We are working on adding more functionality to the R packages as well as new features to the SCDA Shiny app.

References

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Scruggs, Thomas E., Mastropieri, Margo A., and Casto, Glendon. 1987. "The Quantitative Synthesis of Single-Subject Research". *Remedial and Special Education*, Vol. 8 (2), 24-33. doi: 10.1177/074193258700800206.

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