

A tutorial on Bayesian and Frequentist Event History Analysis for psychological
time-to-event data

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Abstract

Time-to-event data such as response times, saccade latencies, and fixation durations are ubiquitous in experimental psychology. To move beyond mean performance measures, various distributional analyses have been proposed. Here we focus one particular distributional analysis known as discrete-time event history analysis, a.k.a. hazard analysis, duration analysis, failure-time analysis, survival analysis, and transition analysis. Across four tutorials that we make publicly available on Github and OSF, we illustrate how to calculate and interpret descriptive statistics, and how to implement Bayesian and frequentist regression models, using the R packages tidyverse, brms, and lme4. We discuss how to manage inter-individual differences, implications for experimental design, and various options when analysing time-to-event data using discrete-time survival analysis.

Keywords: response times, event history analysis, Bayesian regression models

Word count: X

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Introduction

In experimental psychology, it is standard practice to analyse response times (RTs) using analysis-of-variance. However, differences in mean RT conceal when an experimental effect starts, how long it lasts, and whether its onset is time-locked to other events. Such information is useful not only for interpretation, but also for cognitive psychophysiology and model selection (Panis, Schmidt, Wolkersdorfer, & Schmidt, 2020).

Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants

Material

Procedure

Data analysis

Results

We used R (Version 4.4.0; R Core Team, 2024)¹ for creating.

¹ We, furthermore, used the R-packages *citr* (Version 0.3.2; Aust, 2019), *dplyr* (Version 1.1.4; Wickham, François, Henry, Müller, & Vaughan, 2023), *forcats* (Version 1.0.0; Wickham, 2023a), *ggplot2* (Version 3.5.1; Wickham, 2016), *lubridate* (Version 1.9.3; Grolemund & Wickham, 2011), *papaja* (Version 0.1.2.9000; Aust & Barth, 2023), *patchwork* (Version 1.2.0; Pedersen, 2024), *purrr* (Version 1.0.2; Wickham & Henry,

Discussion

2023), *RColorBrewer* (Version 1.1.3; Neuwirth, 2022), *readr* (Version 2.1.5; Wickham, Hester, & Bryan, 2024), *stringr* (Version 1.5.1; Wickham, 2023b), *tibble* (Version 3.2.1; Müller & Wickham, 2023), *tidyr* (Version 1.3.1; Wickham, Vaughan, & Girlich, 2024), *tidyverse* (Version 2.0.0; Wickham et al., 2019), and *tinylabls* (Version 0.2.4; Barth, 2023).

References

- Aust, F. (2019). *Citr: 'RStudio' add-in to insert markdown citations*. Retrieved from <https://github.com/crsh/citr>
- Aust, F., & Barth, M. (2023). *papaja: Prepare reproducible APA journal articles with R Markdown*. Retrieved from <https://github.com/crsh/papaja>
- Barth, M. (2023). *tinylabels: Lightweight variable labels*. Retrieved from <https://cran.r-project.org/package=tinylabels>
- Grolemund, G., & Wickham, H. (2011). Dates and times made easy with lubridate. *Journal of Statistical Software*, 40(3), 1–25. Retrieved from <https://www.jstatsoft.org/v40/i03/>
- Müller, K., & Wickham, H. (2023). *Tibble: Simple data frames*. Retrieved from <https://CRAN.R-project.org/package=tibble>
- Neuwirth, E. (2022). *RColorBrewer: ColorBrewer palettes*. Retrieved from <https://CRAN.R-project.org/package=RColorBrewer>
- Panis, S., Schmidt, F., Wolkersdorfer, M. P., & Schmidt, T. (2020). Analyzing Response Times and Other Types of Time-to-Event Data Using Event History Analysis: A Tool for Mental Chronometry and Cognitive Psychophysiology. *I-Perception*, 11(6), 2041669520978673. <https://doi.org/10.1177/2041669520978673>
- Pedersen, T. L. (2024). *Patchwork: The composer of plots*. Retrieved from <https://CRAN.R-project.org/package=patchwork>
- R Core Team. (2024). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from <https://www.R-project.org/>
- Wickham, H. (2016). *ggplot2: Elegant graphics for data analysis*. Springer-Verlag New York. Retrieved from <https://ggplot2.tidyverse.org>
- Wickham, H. (2023a). *Forcats: Tools for working with categorical variables (factors)*. Retrieved from <https://forcats.tidyverse.org/>

- 71 Wickham, H. (2023b). *Stringr: Simple, consistent wrappers for common string operations*.
72 Retrieved from <https://stringr.tidyverse.org>
- 73 Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., . . .
74 Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43),
75 1686. <https://doi.org/10.21105/joss.01686>
- 76 Wickham, H., François, R., Henry, L., Müller, K., & Vaughan, D. (2023). *Dplyr: A*
77 *grammar of data manipulation*. Retrieved from <https://dplyr.tidyverse.org>
- 78 Wickham, H., & Henry, L. (2023). *Purrr: Functional programming tools*. Retrieved from
79 <https://purrr.tidyverse.org/>
- 80 Wickham, H., Hester, J., & Bryan, J. (2024). *Readr: Read rectangular text data*. Retrieved
81 from <https://readr.tidyverse.org>
- 82 Wickham, H., Vaughan, D., & Girlich, M. (2024). *Tidyr: Tidy messy data*. Retrieved from
83 <https://tidyr.tidyverse.org>