

Breaking Bad Habits in Experimental and Quantitative Research in Linguistics

Dr Massimiliano Canzi

mcanzi/2022__daw | May 5th 2022

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Section 1

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About me

Massimiliano “**Max**” Canzi

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- Lab Manager / Data Scientist @ Uni Konstanz

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About me

Interested in: **R**, experimental designs, **reproducibility**, open science, improving existing methodologies, data visualisation, honest scientific communication...

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About the LingLabs

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Consortium of linguistic laboratories at the University of Konstanz spanning a variety of research topics and fields.

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<https://www.ling.uni-konstanz.de/forschung/workshops/>

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Motion Pictures / Scientific Experiments

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Motion Pictures / Scientific Experiments

Planning a (linguistics) experiment and a movie production are not as far apart as you would think...

Motion Pictures / Scientific Experiments

Planning a (linguistics) experiment and a movie production are not as far apart as you would think...

- Write a script

Motion Pictures / Scientific Experiments

Planning a (linguistics) experiment and a movie production are not as far apart as you would think...

- Write a script
- Set a production budget

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Planning a (linguistics) experiment and a movie production are not as far apart as you would think...

- Write a script
- Set a production budget
- Casting, locations, props, storyboards

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- Set a production budget
- Casting, locations, props, storyboards
- Shoot the film

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- Set a production budget
- Casting, locations, props, storyboards
- Shoot the film
- Editing, colour grading, VFX

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- Set a production budget
- Casting, locations, props, storyboards
- Shoot the film
- Editing, colour grading, VFX
- Press, festivals

Motion Pictures / Scientific Experiments



Figure 1: Severance (2022)

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Motion Pictures / Scientific Experiments

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- Formulate a research question

Motion Pictures / Scientific Experiments

Planning a (linguistics) experiment and a movie production are not as far apart as you would think...

- Formulate a research question
- Budget, weigh methodologies, availability of participants and tools

Motion Pictures / Scientific Experiments

Planning a (linguistics) experiment and a movie production are not as far apart as you would think...

- Formulate a research question
- Budget, weigh methodologies, availability of participants and tools
- Recruitment, equipment setup, hardware and software

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- Recruitment, equipment setup, hardware and software
- Data collection

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- Data collection
- Data wrangling, analysis and visualisation

Motion Pictures / Scientific Experiments

Planning a (linguistics) experiment and a movie production are not as far apart as you would think...

- Formulate a research question
- Budget, weigh methodologies, availability of participants and tools
- Recruitment, equipment setup, hardware and software
- Data collection
- Data wrangling, analysis and visualisation
- Papers, conferences

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Motion Pictures / Scientific Experiments

Just like when shooting a film, **plan ahead.**

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Motion Pictures / Scientific Experiments

Just like when shooting a film, **plan ahead**.

The more things you can accurately predict and plan, the more solid your design and experiment will be. **That's pretty much all there is to it.**

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Thank you!

Questions?

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Thank you!

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Thank you!

Just kidding... let's get started.

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The Script

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The Script

Find a direct, achievable link between the **theory** and its **implementation**.

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The Script

Find a direct, achievable link between the **theory** and its **implementation**.

If your research question is too complex **scale down**, **zoom in**.

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The Script

Find a direct, achievable link between the **theory** and its **implementation**.

If your research question is too complex **scale down, zoom in**.

Develop clear, **testable** hypotheses.

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The Budgeting

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The Budgeting

Find a direct, achievable link between the **theory** and its **implementation**.

The Budgeting

Find a direct, achievable link between the **theory** and its **implementation**.

- What **method** is best to answer the question?

The Budgeting

Find a direct, achievable link between the **theory** and its **implementation**.

- What **method** is best to answer the question?
- How many experiments?

The Budgeting

Find a direct, achievable link between the **theory** and its **implementation**.

- What **method** is best to answer the question?
- How many experiments?
- What experimental **design**?

The Budgeting

Find a direct, achievable link between the **theory** and its **implementation**.

- What **method** is best to answer the question?
- How many experiments?
- What experimental **design**?
- How (and what) are variables going to be coded?

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The Genre (aka The Method)

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The Genre (aka The Method)

Choose a method that **fits your research question**, but keep **ease of implementation** in mind.

The Genre (aka The Method)

Choose a method that **fits your research question**, but keep **ease of implementation** in mind.

Know your method well! Methods comes with **baggage**, meaning that often the chosen method determines conventions in experimental design, data analysis, presentation of results, etc.

The Genre (aka The Method)

Choose a method that **fits your research question**, but keep **ease of implementation** in mind.

Know your method well! Methods comes with **baggage**, meaning that often the chosen method determines conventions in experimental design, data analysis, presentation of results, etc.

Don't be afraid to innovate.

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Film or Mini Series?

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Film or Mini Series?

Multiple experiments might allow for a less complex experimental design, follow-up studies, ...

Film or Mini Series?

Multiple experiments might allow for a less complex experimental design, follow-up studies, ...

However, more experiments also mean more time spent on participant recruitment, data collection, ...

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Camera and Lens

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Camera and Lens

If you were to take one thing home from today, make it this one:

Camera and Lens

If you were to take one thing home from today, make it this one:

» less is more «

Camera and Lens

If you were to take one thing home from today, make it this one:

» less is more «

Every time you add a categorical predictor with two levels, for example, you should double your data. **Can you afford it?**

Camera and Lens

If you were to take one thing home from today, make it this one:

» less is more «

Every time you add a categorical predictor with two levels, for example, you should double your data. **Can you afford it?**

Use tools like **simr** to help you determine sample size (Green and MacLeod 2016).

Camera and Lens

If you were to take one thing home from today, make it this one:

» less is more «

Every time you add a categorical predictor with two levels, for example, you should double your data. **Can you afford it?**

Use tools like **simr** to help you determine sample size (Green and MacLeod 2016).

For the now visibly upset Bayesians...

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Camera and Lens

Camera and Lens

Choosing an experimental method and design is equivalent to choosing the **resolution** of your study.

Camera and Lens

Choosing an experimental method and design is equivalent to choosing the **resolution** of your study.

It is, again, really important that your design allows you to confidently test your hypotheses as you intend to.

Camera and Lens

Choosing an experimental method and design is equivalent to choosing the **resolution** of your study.

It is, again, really important that your design allows you to confidently test your hypotheses as you intend to.

- Know your **limits**

Camera and Lens

Choosing an experimental method and design is equivalent to choosing the **resolution** of your study.

It is, again, really important that your design allows you to confidently test your hypotheses as you intend to.

- Know your **limits**
- Know your **goals**

Camera and Lens

Choosing an experimental method and design is equivalent to choosing the **resolution** of your study.

It is, again, really important that your design allows you to confidently test your hypotheses as you intend to.

- Know your **limits**
- Know your **goals**
- Choose a balanced design

Camera and Lens

Choosing an experimental method and design is equivalent to choosing the **resolution** of your study.

It is, again, really important that your design allows you to confidently test your hypotheses as you intend to.

- Know your **limits**
- Know your **goals**
- Choose a balanced design
- **Register your report?**

Registered Reports

- Mertzen, D., Lago, S., & Vasishth, S. (2021). The benefits of preregistration for hypothesis-driven bilingualism research. *Bilingualism: Language and Cognition*, 24(5), 807-812.
- Roettger, T. B. (2021). Preregistration in experimental linguistics: Applications, challenges, and limitations. *Linguistics*, 59(5), 1227-1249.

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Resoution

Resoution

One mistake I see often is related to variable coding, for example..

Resoution

One mistake I see often is related to variable coding, for example..

- Binary instead of continuous..

Resoution

One mistake I see often is related to variable coding, for example..

- Binary instead of continuous..
- 5-point instead of 100-point scales

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One mistake I see often is related to variable coding, for example..

- Binary instead of continuous..
- 5-point instead of 100-point scales
- 100-point scales instead of 5-point scales

Resoution

One mistake I see often is related to variable coding, for example..

- Binary instead of continuous..
- 5-point instead of 100-point scales
- 100-point scales instead of 5-point scales
- ...

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Find a Balance

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Find a Balance

Things to consider:

Find a Balance

Things to consider:

- Location of the experiment (e.g. lab, online)

Find a Balance

Things to consider:

- Location of the experiment (e.g. lab, online)
- Number of items

Find a Balance

Things to consider:

- Location of the experiment (e.g. lab, online)
- Number of items
- Number of participants

Find a Balance

Things to consider:

- Location of the experiment (e.g. lab, online)
- Number of items
- Number of participants
- What sample?

Find a Balance

Things to consider:

- Location of the experiment (e.g. lab, online)
- Number of items
- Number of participants
- What sample?
- ...

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Filming Locations

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Filming Locations

Don't underestimate the power of the internet.

Filming Locations

Don't underestimate the power of the internet.

Social medias, esp. **Twitter**, are a great place to advertise for your online studies.

Filming Locations

Don't underestimate the power of the internet.

Social medias, esp. **Twitter**, are a great place to advertise for your online studies.

Online platforms are getting better and better, allowing for more complex designs and data collection types (e.g. reaction times, Stoet 2017).

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Scenes

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Scenes

A balance between number of items and participants is necessary, and often dictated by the methodology

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Scenes

A balance between number of items and participants is necessary, and often dictated by the methodology e.g. ERP experiments.

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Scenes

A balance between number of items and participants is necessary, and often dictated by the methodology e.g. ERP experiments.

Ideally, you would have an infinite number of both.

Scenes

A balance between number of items and participants is necessary, and often dictated by the methodology e.g. ERP experiments.

Ideally, you would have an infinite number of both.

Always ask your participants a little more, especially if it's a lab-based experiment.

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Casting

Casting

Are university students in your university representative enough of the sample you're looking for?

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Bits and Pieces

Bits and Pieces

- Write everything down (hardware, software, locations, etc.)

Bits and Pieces

- Write everything down (hardware, software, locations, etc.)
- Get all the forms you need (participant consent, data protection)

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- Write everything down (hardware, software, locations, etc.)
- Get all the forms you need (participant consent, data protection)
- Plan a storage solution for data and anonymise whenever possible

Bits and Pieces

- Write everything down (hardware, software, locations, etc.)
- Get all the forms you need (participant consent, data protection)
- Plan a storage solution for data and anonymise whenever possible
- Hire a research assistant

Section 4

Post-Production

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Editing

Know your data!

Editing

Let's have a look at some R code

```
model_one <- rt_log %>% lmer(formula = rt ~ condition * fricative + partic
```

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Editing

Welcome back!

Editing

Welcome back!

Some references:

- Baayen, R. H., & Milin, P. (2010). Analyzing reaction times. *International Journal of Psychological Research*, 3(2), 12-28.
- Leys, C., Ley, C., Klein, O., Bernard, P., & Licata, L. (2013). Detecting outliers: Do not use standard deviation around the mean, use absolute deviation around the median. *Journal of experimental social psychology*, 49(4), 764-766.

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Editing

Editing

When modelling:

- Your most complex model should be clear to you before you even start collecting data.

Editing

When modelling:

- Your most complex model should be clear to you before you even start collecting data.
- What is a fixed effect and what is a random effect in your experiment?

Editing

When modelling:

- Your most complex model should be clear to you before you even start collecting data.
- What is a fixed effect and what is a random effect in your experiment?
- Slopes galore

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Sometimes, it's not as straightforward

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Editing

Sometimes, it's not as straightforward i.e. the story of event-related potentials (ERP)

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Reporting your results:

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Editing

Reporting your results:

- Standardise (e.g. APA)

Editing

Reporting your results:

- Standardise (e.g. APA)
- Provide supporting material

Editing

Reporting your results:

- Standardise (e.g. APA)
- Provide supporting material
- package **report**

Editing

We fitted a linear mixed model (estimated using REML and nloptwrap optimizer) to predict rt with condition, fricative and participant_device_type (formula: $rt \sim \text{condition} * \text{fricative} + \text{participant_device_type}$). The model included condition, participant_private_id and item as random effects (formula: $\text{list}(\sim \text{condition} \mid \text{participant_private_id}, \sim 1 \mid \text{item})$). The model's total explanatory power is substantial (conditional $R^2 = 0.41$) and the part related to the fixed effects alone (marginal R^2) is of 0.08. The model's intercept, corresponding to condition = NM, fricative = FF and participant_device_type = computer, is at 6.89 (95% CI [6.81, 6.97], $t(11044) = 171.01$, $p < .001$). Within this model:

- The effect of condition [WM] is statistically non-significant and positive (beta = $4.10e-03$, 95% CI [-0.04, 0.05], $t(11044) = 0.17$, $p = 0.867$; Std. beta = $7.57e-03$, 95% CI [-0.08, 0.10])
- The effect of fricative [SH] is statistically significant and negative (beta = -0.22, 95% CI [-0.30, -0.15], $t(11044) = -5.52$, $p < .001$; Std. beta = -0.41, 95% CI [-0.56, -0.27]) ...

Editing

Analyses were conducted using the R Statistical language (version 4.0.3; R Core Team, 2020) on macOS Big Sur 10.16, using the packages ggpubr (version 0.4.0; Alboukadel Kassambara, 2020), Matrix (version 1.3.2; Douglas Bates and Martin Maechler, 2021), lme4 (version 1.1.26; Douglas Bates et al., 2015), ggplot2 (version 3.3.5; Wickham. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2016.), stringr (version 1.4.0; Hadley Wickham, 2019), tidyr (version 1.1.2; Hadley Wickham, 2020), forcats (version 0.5.1; Hadley Wickham, 2021), readr (version 1.4.0; Hadley Wickham and Jim Hester, 2020), dplyr (version 1.0.4; Hadley Wickham et al., 2021), tibble (version 3.1.5; Kirill Müller and Hadley Wickham, 2021), lmerTest (version 3.1.3; Kuznetsova A et al., 2017), purrr (version 0.3.4; Lionel Henry and Hadley Wickham, 2020), sjPlot (version 2.8.9; Lüdtke D, 2021), viridis (version 0.5.1; Simon Garnier, 2018), viridisLite (version 0.4.0; Simon Garnier et al., 2021) and tidyverse (version 1.3.0; Wickham et al., 2019).

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Color Grading

Color Grading



Figure 2: Severance (2022)

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Color Grading

Color Grading

When modelling, I like to provide plots showing model estimates, rather than plotting raw data.

Color Grading

When modelling, I like to provide plots showing model estimates, rather than plotting raw data.

For example, you can use package `sjPlot`, or do it yourself with packages `ggeffects` and `ggplot2`.

Color Grading

Again, » less is more «. A few tips:

Color Grading

Again, » less is more «. A few tips:

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Introduction
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Pre-Production
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Production
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Post-Production
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Festivals

Introduction
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Experiment done, data analysed, results reported, paper written. Time to **get it out into the world.**

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Share your data and your code with your paper.

Ending Credits

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