

M21 LDT ERP HC SEMANTIC SENSITIVITY N400 Base Frequency

Joanna Morris

2025-11-05

Contents

Set parameters	1
1 Load data files	1
2 Format data files	1
3 N400 Nonword Data	2
3.1 Compute the ANOVA	2
3.2 Main Effects and Interactions	2

Set parameters

```
Set chunk parameters
Load libraries
Set ggplot parameters
Define standard error of the mean function
```

1 Load data files

```
dir_path <- "CSV files"

erp_4A <- read_csv(file.path(dir_path, "bf_m21_ldt_mea_300500_050050_1_AB.csv"))
erp_4B <- read_csv(file.path(dir_path, "bf_m21_ldt_mea_300500_050050_1_BA.csv"))
dmg_lng_vsl <- read_csv(file.path(dir_path, "demo_lang_vsl_pca_hc.csv"))

library(dplyr)

erp_4i <- bind_rows(
    erp_4A |> mutate(List = "AB"),
    erp_4B |> mutate(List = "BA")
)
```

Now we extract SubjID from the `ERPset` column

We then join the ERP data and language into a single data frame

2 Format data files

Divide into word, non-word and difference wave dataframes

Then we do some more formatting and cleanup of the dataframes. We create separate columns, one for each independent variable (anteriority, laterality, morphological family size). To do this we have to use `separate` function from the `stringr` package. Run `vignette("programming", package = "dplyr")` to see more about `tidy-selection` and `tidy-evaluation`.

Now we need to extract just the bins and channels that we intend to analyse. For this analysis we will use 9 channels: F3, Fz, F4, C3, Cz, C4, P3, Pz, P4. We will use the `mutate` function from the `dplyr` package along with the `case_when` function. The `case_when` function is a sequence of two-sided formulas. The left hand side determines which values match this case. The right hand side provides the replacement value.

3 N400 Nonword Data

```
n400_nonwords %>%
  count(Base_Frequency, Complexity, Semantic_Sensitivity)
```

3.1 Compute the ANOVA

```
anova_model_n400_nonwords <- mixed(
  value ~ Semantic_Sensitivity * Base_Frequency * Complexity +
  (1 + Base_Frequency + Complexity | SubjID) +      # by-subject intercept + slopes
  (1 | SubjID:chlabel),                                # electrode nested within subject
  data   = n400_nonwords,
  method = "KR"
)
anova_model_n400_nonwords

## Mixed Model Anova Table (Type 3 tests, KR-method)
##
## Model: value ~ Semantic_Sensitivity * Base_Frequency * Complexity +
## Model:   (1 + Base_Frequency + Complexity | SubjID) + (1 | SubjID:chlabel)
## Data: n400_nonwords
##          Effect      df      F p.value
## 1           Semantic_Sensitivity  1, 58  0.14  .705
## 2           Base_Frequency     1, 58  0.02  .886
## 3           Complexity       1, 58  1.40  .242
## 4 Semantic_Sensitivity:Base_Frequency  1, 58  0.15  .702
## 5 Semantic_Sensitivity:Complexity    1, 58  0.01  .904
## 6 Base_Frequency:Complexity      1, 1498 1.47  .226
## 7 Semantic_Sensitivity:Base_Frequency:Complexity 1, 1498 3.50 +  .062
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '+' 0.1 ' ' 1
m2 <- anova_model_n400_nonwords$full_model      # Extract the lmer model
ranova(m2)      # Run random effects comparison

## ANOVA-like table for random-effects: Single term deletions
##
## Model:
## value ~ Semantic_Sensitivity + Base_Frequency + Complexity + (1 + Base_Frequency + Complexity | SubjID) + (1 | SubjID:chlabel) + Semantic_Sensitivity
##          npar  logLik  AIC   LRT Df Pr(>Chisq)
## <none>          16 -6605.2 13242
## Base_Frequency in (1 + Base_Frequency + Complexity | SubjID)  13 -6864.1 13754 517.84 3 < 2.2e-16 ***
## Complexity in (1 + Base_Frequency + Complexity | SubjID)      13 -6901.2 13828 592.03 3 < 2.2e-16 ***
## (1 | SubjID:chlabel)                                         15 -7074.4 14179 938.34 1 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '+' 0.1 ' ' 1
# Extract effect sizes from your ANOVA model
eta_squared(anova_model_n400_nonwords, partial = TRUE)

## # Effect Size for ANOVA (Type III)
##
## Parameter          | Eta2 (partial) |      95% CI
## -----
## Semantic_Sensitivity | 2.49e-03 | [0.00, 1.00]
## Base_Frequency       | 3.60e-04 | [0.00, 1.00]
## Complexity           | 0.02 | [0.00, 1.00]
## Semantic_Sensitivity:Base_Frequency | 2.54e-03 | [0.00, 1.00]
## Semantic_Sensitivity:Complexity    | 2.55e-04 | [0.00, 1.00]
## Base_Frequency:Complexity        | 9.79e-04 | [0.00, 1.00]
## Semantic_Sensitivity:Base_Frequency:Complexity | 2.33e-03 | [0.00, 1.00]
##
## - One-sided CIs: upper bound fixed at [1.00].
# Compute Marginal(fixed effects only) and Conditional(fixed + random effects) R2
r2(anova_model_n400_nonwords)

## # R2 for Mixed Models
##
## Conditional R2: 0.842
## Marginal R2: 0.004
```

3.2 Main Effects and Interactions

No Main Effects or Interactions