M21 LDT ERP HC ORTHOGRAPIC SENSITIVITY N400 Base Frequency

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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 `seperate` 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

3.1 Compute the ANOVA

```
# n400_nonwords %>%
#   count(family_size, complexity, Orthographic_Sensitivity)

anova_model_n400_nonwords <- mixed(
    value ~ Orthographic_Sensitivity * Base_Frequency * Complexity +
    (1 + family_size + 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 ~ Orthographic_Sensitivity * Base_Frequency * Complexity +
|| Model:     (1 + family_size + complexity | SubjID) + (1 | SubjID:chlabel)
|| Data: n400_nonwords
||                                             Effect      df    F p.value
|| 1                           Orthographic_Sensitivity   1, 58 0.01    .905
|| 2                                     Base_Frequency   1, 58 0.01    .927
|| 3                                         Complexity   1, 58 1.53    .222
|| 4            Orthographic_Sensitivity:Base_Frequency   1, 58 0.09    .772
|| 5                Orthographic_Sensitivity:Complexity   1, 58 0.18    .671
|| 6                          Base_Frequency:Complexity 1, 1498 2.11    .146
|| 7 Orthographic_Sensitivity:Base_Frequency:Complexity 1, 1498 2.07    .151
|| ---
|| 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 ~ Orthographic_Sensitivity + Base_Frequency + Complexity + (1 + family_size + complexity | SubjID) + (1 | SubjID:chlabel) + Orthographic_
||                                                    npar  logLik   AIC    LRT Df Pr(>Chisq)
|| <none>                                               16 -6605.9 13244
|| family_size in (1 + family_size + complexity | SubjID)   13 -6864.8 13756 517.93  3  < 2.2e-16 ***
|| complexity in (1 + family_size + complexity | SubjID)    13 -6900.8 13828 589.83  3  < 2.2e-16 ***
|| (1 | SubjID:chlabel)                                     15 -7074.6 14179 937.45  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
|| ---------------------------------------------------------------------------------------
|| Orthographic_Sensitivity                           |       2.46e-04 | [0.00, 1.00]
|| Base_Frequency                                     |       1.45e-04 | [0.00, 1.00]
|| Complexity                                         |           0.03 | [0.00, 1.00]
|| Orthographic_Sensitivity:Base_Frequency            |       1.47e-03 | [0.00, 1.00]
|| Orthographic_Sensitivity:Complexity                |       3.14e-03 | [0.00, 1.00]
|| Base_Frequency:Complexity                          |       1.41e-03 | [0.00, 1.00]
|| Orthographic_Sensitivity:Base_Frequency:Complexity |       1.38e-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: 0.816
||      Marginal R2: 0.003
```

3.2 Main Effects

No Main Effects or Interactions