The P600 effect when singular gendered antecedents are co-indexed with (a) *himself* or *herself* (b) *themselves*

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This script, on the advice of reviewer 1, conducts an ANOVA examining the P600 PROST data with Referentiality and Gender as within-subject variables. Gender Identity status will be examined as a post-hoc variable. Analysis 1 examines the data for antecedents that are co-indexed with *himself* or *herself*, while Analysis 2 examines the P600 effect when antecedents are co-indexed with *themselves*

Define functions, set parameters and load

Define standard error of mean function

```
sem <- function(x) sd(x)/sqrt(length(x))
```

Before we begin, let's set some general parameters for `ggplot2`. We will set a general theme using the `theme_set()` function. We will use the 'classic' theme which gives us clean white background rather than the default grey with white grid lines. We will position the legend at the top of the graph rather than at the right side which is the default.

```
theme_set(theme_classic()+
            theme(legend.position = "bottom"))
```

```
prost_2022_singular <- read_csv("prost_2022_singular_p600.csv")
prost_2022_plural <- read_csv("prost_2022_plural_p600.csv")
prost_2024_combined <- bind_rows(list("Gendered Singular" = prost_2022_singular,
                                      "NonGendered Plural" = prost_2022_plural), .id = "Anaphor_Type")
```

Then we re-order factor levels for *Referentiality* and *Anaphor_Type*

```
prost_2024_combined$Referentiality <- factor(prost_2024_combined$Referentiality,
                                             levels=c('Referential',
                                                      'NonReferential'))
prost_2024_combined$Anaphor_Type <- factor(prost_2024_combined$Anaphor_Type,
                                           levels=c('Gendered Singular',
                                                    'NonGendered Plural'))
levels(prost_2024_combined$Referentiality)
levels(prost_2024_combined$Anaphor_Type)
```

Analysis

```
pander(ezANOVA(data = prost_2024_combined
               , dv = diff_score
               , wid = SubjID
               , within = .(Referentiality, Gender_Status, Anaphor_Type)
               , type = 3
               , return_aov = F
               ))
```

- **ANOVA**:

Table 1: Table continues below

	Effect	DFn	DFd	F
2	Referentiality	1	37	6.212
3	Gender_Status	1	37	2.094
4	Anaphor_Type	1	37	0.3171
5	Referentiality:Gender_Status	1	37	0.1358
6	Referentiality:Anaphor_Type	1	37	28.98
7	Gender_Status:Anaphor_Type	1	37	0.4098
8	Referentiality:Gender_Status:Anaphor_Type	1	37	11.7

	p	p<.05	ges
2	0.0173	*	0.01894
3	0.1563		0.008441
4	0.5768		0.0009849
5	0.7146		0.0006023
6	4.299e-06	*	0.08024
7	0.526		0.001088
8	0.001537	*	0.03579

Condition Means for Analysis 1

Significant Effects: **Referentiality; Referentiality x Anaphor Type; Referentiality X Gender Status X Anaphor Type**

```
kable(singular_means1 <- prost_2024_combined |>
  group_by(Referentiality) |>
  summarise(Mean = mean(diff_score),
            SE = sem(diff_score),
            SD = sd(diff_score),
            Max = max(diff_score),
            Min = min(diff_score)), digits = 2)
```

Referentiality	Mean	SE	SD	Max	Min
Referential	0.08	0.13	1.59	4.45	-4.41
NonReferential	0.51	0.14	1.76	6.52	-4.29

```
kable(singular_means1 <- prost_2024_combined |>
  group_by(Referentiality, Anaphor_Type) |>
  summarise(Mean = mean(diff_score),
            SE = sem(diff_score),
            SD = sd(diff_score),
            Max = max(diff_score),
            Min = min(diff_score)), digits = 2)
```

Referentiality	Anaphor_Type	Mean	SE	SD	Max	Min
Referential	Gendered Singular	-0.34	0.16	1.42	4.15	-4.41
Referential	NonGendered Plural	0.49	0.19	1.66	4.45	-4.03
NonReferential	Gendered Singular	1.03	0.20	1.78	6.52	-3.33
NonReferential	NonGendered Plural	0.00	0.18	1.60	3.52	-4.29

```
kable(singular_means2 <- prost_2024_combined |>
  group_by( Anaphor_Type,  Gender_Status, Referentiality) |>
  summarise(Mean = mean(diff_score),
            SE = sem(diff_score),
            SD = sd(diff_score),
            Max = max(diff_score),
            Min = min(diff_score)), digits = 2)
```

Anaphor_Type	Gender_Status	Referentiality	Mean	SE	SD	Max	Min
Gendered Singular	Gendered	Referential	-0.40	0.26	1.63	4.15	-4.41
Gendered Singular	Gendered	NonReferential	1.49	0.30	1.84	6.52	-1.66
Gendered Singular	NonGendered	Referential	-0.27	0.19	1.18	2.54	-2.50
Gendered Singular	NonGendered	NonReferential	0.57	0.26	1.62	4.02	-3.33
NonGendered Plural	Gendered	Referential	0.93	0.25	1.52	4.45	-2.35
NonGendered Plural	Gendered	NonReferential	-0.25	0.23	1.40	3.52	-2.77
NonGendered Plural	NonGendered	Referential	0.06	0.28	1.70	3.52	-4.03
NonGendered Plural	NonGendered	NonReferential	0.25	0.29	1.76	3.18	-4.29

Post-hoc tests

Runs post-hoc tests for the 3-way *"Gender Status x Referentiality * Anaphor Type"* Interaction

"Some woman...himself" vs. "Mary...himself"

```
pander(t.test(diff_score ~ Referentiality
        , filter(prost_2024_combined, Anaphor_Type == "Gendered Singular" & Gender_Status == "Gendered" )))
```

Table 6: Welch Two Sample t-test: `diff_score` by `Referentiality` (continued below)

Test statistic	df	P value	Alternative hypothesis
-4.747	72.97	1.002e-05 * * *	two.sided

mean in group Referential	mean in group NonReferential
-0.4045	1.489

"Someone. . . himself" vs. "The participant. . . himself"

```
pander (t.test(diff_score ~ Referentiality
        , filter(prost_2024_combined, Anaphor_Type == "Gendered Singular" & Gender_Status == "NonGendered")))
```

Table 8: Welch Two Sample t-test: `diff_score` by `Referentiality` (continued below)

Test statistic	df	P value	Alternative hypothesis
-2.571	67.79	0.01233 *	two.sided

mean in group Referential	mean in group NonReferential
-0.2699	0.5666

"Some woman. . . themselves" vs. "Mary..themselves"

```
pander(t.test(diff_score ~ Gender_Status
        , filter(prost_2024_combined, Anaphor_Type == "Gendered Plural" &  Gender_Status == "Gendered")))
```

Error in `t.test.formula()`: ! grouping factor must have exactly 2 levels Backtrace: 1. pander::pander(. . .) 3. stats:::t.test.formula(. . .)

"Someone. . . themselves" vs. "The participant. . . themselves"

```
pander(t.test(diff_score ~ Gender_Status
        , filter(prost_2024_combined, Anaphor_Type == "Gendered Plural" & Gender_Status == "NonGendered" )))
```

Error in `t.test.formula()`: ! grouping factor must have exactly 2 levels Backtrace: 1. pander::pander(. . .) 3. stats:::t.test.formula(. . .)

Interaction Plots

```
summary_data_2 <- prost_2024_combined |>
  group_by(Anaphor_Type,Gender_Status, Referentiality) |>
  summarise(mean = mean(diff_score), se = sem(diff_score))|>
  mutate(lwr = mean - (1.96*se), upr = mean + (1.96*se))
summary_data_2$label = c("John...herself","some man...herself","the participant...herself", "someone...herself", "John...themselves", "some man...

(plotA <- ggplot(summary_data_2, aes(x = Referentiality,
                        y = mean,
                        ymin = lwr,
                        ymax = upr,
                        fill = Gender_Status,
                        colour = Gender_Status,
                        group = Gender_Status,
                        label = label)) +
    geom_bar(position=position_dodge(), stat="identity") +
    geom_errorbar(width = .15, position = position_dodge(.9), colour = "black")  +
    geom_label_repel(show.legend = FALSE, cex = 1.5, colour = "black") +
    ylab("Voltage in microvolts") +
    theme(legend.text = element_text(size=10))+
    theme(legend.title = element_blank()) +
    facet_wrap(~ Anaphor_Type, ncol = 2) +
    scale_color_npg() +
    scale_fill_npg(alpha = 0.8))
```