

# Phase 3a

## rmANOVA

July 4, 2023

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## Setup

```
library(tidyverse)
library(flextable)

library(easystats)
library(afex)
library(emmeans)

knitr::opts_chunk$set(collapse = TRUE)

W131415_NEW <- haven::read_sav("data-raw/W131415_NEW.sav")

ReformAtt_labels <- attr(W131415_NEW$ReformAtt, "label") |>
  str_split(" ") |>
  getElement(1) |>
  str_remove("[0-9]=")

data_tidy <- W131415_NEW |>
  select(1:14) |>
  rename(W13Happy = happy13) |>
  rename_with(\(col) {
    prefix <- str_extract(col, "W1[0-9]")
    str_replace(col, "W1[0-9]", paste0(prefix, "_"))
  }) |>
  pivot_longer(cols = c(-userId, -ReformAtt),
               names_to = c("Time", ".value"), names_sep = "_") |>
  mutate(
    Time = str_replace(Time, "W", "T"),
    ReformAtt = factor(ReformAtt, labels = ReformAtt_labels),
    userId = factor(userId)
  )

DVs <- colnames(data_tidy)[-1:3]
DVs <- set_names(DVs, c("NA", "Anxiety", "Happy", "PA"))

# Run ANOVAs
AOVs <- map(DVs, \(dv) {
  aov_ez("userId", dv = dv, data = data_tidy,
        between = "ReformAtt", within = "Time",
```

```

      anova_table = list(correction = "none"))
})

AOV_tab <- map(AOVs, \(mod) {
  # Format anova table
  model_parameters(mod) |>
    select(Parameter, `F`, df, df_error, p) |>
    left_join(eta_squared(mod, ci = NULL), by = "Parameter") |>
    format() |>
    flextable() |> autofit()
})

AOV_contrasts <- map(AOVs, \(mod) {
  # Contrasts
  ems <- emmeans(mod, ~ Time + ReformAtt, emmeans_model = "multivariate")

  # ... between groups by Time
  contrs_ReformAtt <- contrast(ems, method = "pairwise", by = "Time") |>
    model_parameters()

  # (Format table)
  tab_ReformAtt <- format(contrs_ReformAtt) |>
    rename(Difference = Coefficient) |>
    relocate(Time, .before = 1) |>
    flextable() |>
    color(j = "p", i = contrs_ReformAtt$p < 0.025, color = "red") |>
    merge_v(j = c("Time")) |>
    valign(j = "Time", valign = "top") |>
    footnote(j = "p", ref_symbols = "a", part = "header",
      value = as_paragraph(
        "Using Tukey method for pairwise comparisons within each time."
      )) |>
    autofit()

  # ... between times by groups
  contrs_Time <- contrast(ems, method = "consec",
    by = "ReformAtt",
    adjust = "holm")

```

```

contrs_Time_d <- contrs_Time |>
  eff_size(sigma = sqrt(mod$anova_table[3,"MSE"]),
           edf = sqrt(mod$anova_table[3,"den Df"]),
           method = "identity") |>
  model_parameters() |>
  select(1:2, d = 3)
contrs_Time <- model_parameters(contrs_Time) |>
  mutate(d = contrs_Time_d$d)

# (Format table)
tab_time <- format(contrs_Time) |>
  rename(Difference = Coefficient) |>
  relocate(ReformAtt, .before = 1) |>
  flextable() |>
  color(j = "p", i = contrs_Time$p < 0.025, color = "red") |>
  merge_v(j = c("ReformAtt")) |>
  valign(j = "ReformAtt", valign = "top") |>
  footnote(
    j = "p", ref_symbols = "a", part = "header",
    value = as_paragraph(
      "Using Holm correction for consecutive comparisons within each group"
    )
  ) |>
  autofit()

list(ReformAtt = tab_ReformAtt, Time = tab_time)
})

# Make plots
ggplots <- imap(AOVs, \(mod, y_lab) {
  pd <- position_dodge(0.4)
  emmeans(mod, ~ Time + ReformAtt) |>
    as.data.frame() |>
    ggplot(aes(Time, emmean, color = ReformAtt)) +
    geom_errorbar(aes(ymin = lower.CL, ymax = upper.CL, group = ReformAtt),
                  color = "grey40",
                  width = 0.1, position = pd) +
  # geom_boxplot(aes(y = .data[[find_response(mod)]]),
  #             data = drop_na(data_tidy, ReformAtt),
  #             position = pd, width = 0.2, alpha = 0.4) +
  geom_point(position = pd, size = 2) +

```

```

geom_line(aes(group = ReformAtt), position = pd,
           linewidth = 1) +
scale_color_viridis_d(
  "Reform\nAttitude",
  labels = c("Supports", "Opposes", "Don't Know")
) +
scale_x_discrete(labels = c(13, 14, 15)) +
coord_cartesian(ylim = range(data_tidy[[find_response(mod)]], na.rm = TRUE)) +
theme_bw() +
labs(y = y_lab, caption = "Error bars are 95% CIs.")
})

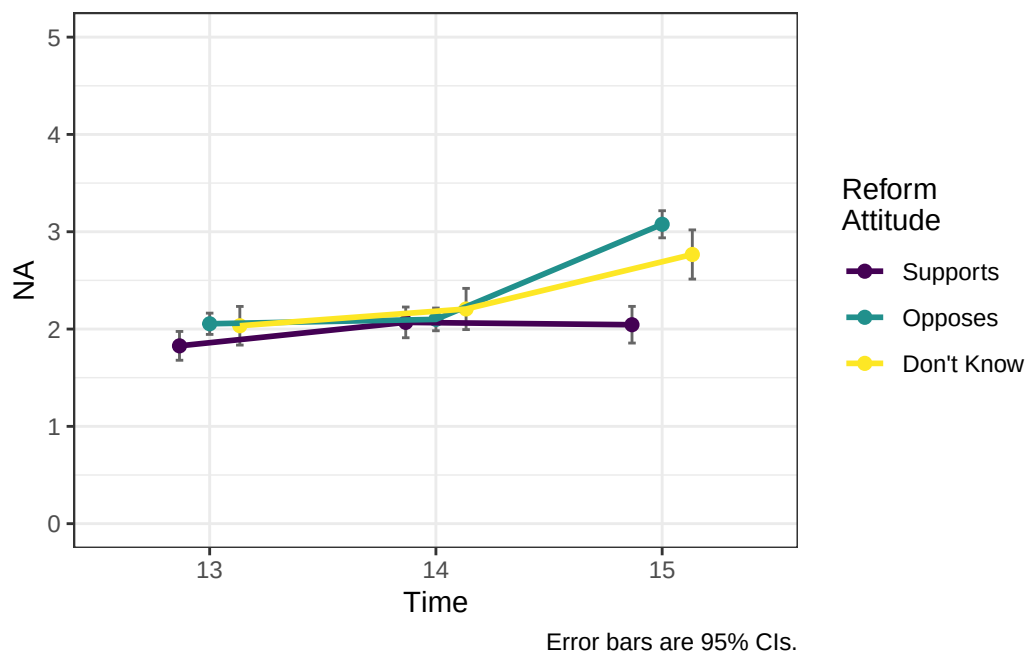
```

## NA

```
AOV_tab[["NA"]]
```

| Parameter      | F     | df | df (error) | p      | Eta2 (partial) |
|----------------|-------|----|------------|--------|----------------|
| ReformAtt      | 13.00 | 2  | 393        | < .001 | 0.06           |
| Time           | 88.54 | 2  | 786        | < .001 | 0.18           |
| ReformAtt:Time | 25.42 | 4  | 786        | < .001 | 0.11           |

```
ggplots[["NA"]]
```



By Time:

```
AOV_contrasts[["NA"]][["ReformAtt"]]
```

| Time | contrast           | Difference | SE   | 95% CI       | t(393) | p <sup>a</sup> |
|------|--------------------|------------|------|--------------|--------|----------------|
| T13  | Supports - Opposes | -0.23      | 0.09 | -0.41, -0.04 | -2.42  | 0.042          |
|      | Supports - DK      | -0.21      | 0.13 | -0.45, 0.04  | -1.64  | 0.231          |
|      | Opposes - DK       | 0.02       | 0.12 | -0.21, 0.25  | 0.18   | 0.983          |
| T14  | Supports - Opposes | -0.03      | 0.10 | -0.23, 0.17  | -0.31  | 0.949          |
|      | Supports - DK      | -0.14      | 0.13 | -0.40, 0.13  | -1.03  | 0.561          |
|      | Opposes - DK       | -0.11      | 0.12 | -0.35, 0.13  | -0.87  | 0.659          |
| T15  | Supports - Opposes | -1.03      | 0.12 | -1.27, -0.80 | -8.66  | < .001         |
|      | Supports - DK      | -0.72      | 0.16 | -1.04, -0.41 | -4.50  | < .001         |
|      | Opposes - DK       | 0.31       | 0.15 | 0.02, 0.60   | 2.12   | 0.088          |

<sup>a</sup>Using Tukey method for pairwise comparisons within each time.

By Group:

```
AOV_contrasts[["NA"]][["Time"]]
```

| ReformAtt | contrast  | Difference | SE   | 95% CI      | t(393) | p <sup>a</sup> | d     |
|-----------|-----------|------------|------|-------------|--------|----------------|-------|
| Supports  | T14 - T13 | 0.24       | 0.07 | 0.10, 0.39  | 3.29   | 0.004          | 0.37  |
|           | T15 - T14 | -0.02      | 0.09 | -0.20, 0.15 | -0.26  | 0.816          | -0.04 |
| Opposes   | T14 - T13 | 0.04       | 0.05 | -0.06, 0.15 | 0.83   | 0.816          | 0.07  |
|           | T15 - T14 | 0.98       | 0.07 | 0.85, 1.11  | 14.63  | < .001         | 1.51  |
| DK        | T14 - T13 | 0.17       | 0.10 | -0.02, 0.37 | 1.75   | 0.241          | 0.27  |
|           | T15 - T14 | 0.56       | 0.12 | 0.32, 0.80  | 4.62   | < .001         | 0.86  |

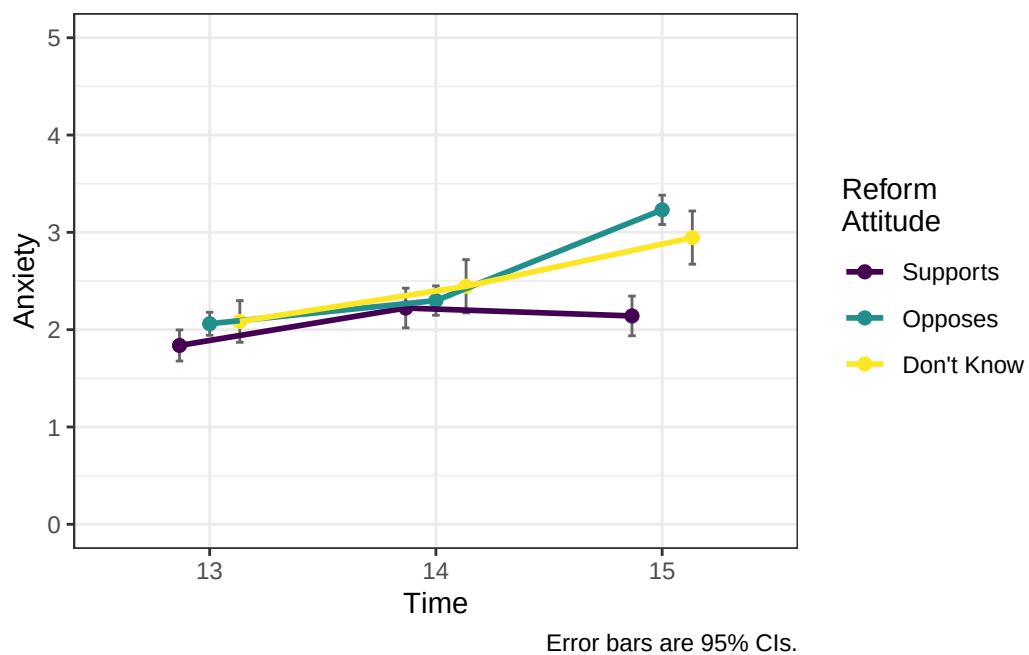
<sup>a</sup>Using Holm correction for consecutive comparisons within each group

## StateAnx

```
AOV_tab[["Anxiety"]]
```

| Parameter      | F     | df | df (error) | p      | Eta2 (partial) |
|----------------|-------|----|------------|--------|----------------|
| ReformAtt      | 12.64 | 2  | 393        | < .001 | 0.06           |
| Time           | 76.15 | 2  | 786        | < .001 | 0.16           |
| ReformAtt:Time | 18.06 | 4  | 786        | < .001 | 0.08           |

```
ggplots[["Anxiety"]]
```



By Time:

```
AOV_contrasts[["Anxiety"]][["ReformAtt"]]
```



| Time | contrast           | Difference | SE   | 95% CI       | t(393) | p <sup>a</sup> |
|------|--------------------|------------|------|--------------|--------|----------------|
| T13  | Supports - Opposes | -0.22      | 0.10 | -0.42, -0.02 | -2.21  | 0.072          |
|      | Supports - DK      | -0.25      | 0.14 | -0.51, 0.02  | -1.81  | 0.166          |
|      | Opposes - DK       | -0.02      | 0.12 | -0.27, 0.22  | -0.19  | 0.980          |
| T14  | Supports - Opposes | -0.08      | 0.13 | -0.33, 0.18  | -0.60  | 0.823          |
|      | Supports - DK      | -0.22      | 0.17 | -0.57, 0.12  | -1.29  | 0.402          |
|      | Opposes - DK       | -0.15      | 0.16 | -0.46, 0.17  | -0.93  | 0.625          |
| T15  | Supports - Opposes | -1.09      | 0.13 | -1.34, -0.84 | -8.46  | < .001         |
|      | Supports - DK      | -0.81      | 0.17 | -1.15, -0.46 | -4.64  | < .001         |
|      | Opposes - DK       | 0.29       | 0.16 | -0.03, 0.60  | 1.80   | 0.172          |

<sup>a</sup>Using Tukey method for pairwise comparisons within each time.

By Group:

```
AOV_contrasts[["Anxiety"]][["Time"]]
```

| ReformAtt | contrast  | Difference | SE   | 95% CI      | t(393) | p <sup>a</sup> | d     |
|-----------|-----------|------------|------|-------------|--------|----------------|-------|
| Supports  | T14 - T13 | 0.38       | 0.10 | 0.19, 0.58  | 3.93   | < .001         | 0.48  |
|           | T15 - T14 | -0.08      | 0.11 | -0.30, 0.14 | -0.72  | 0.474          | -0.10 |
| Opposes   | T14 - T13 | 0.24       | 0.07 | 0.10, 0.38  | 3.29   | 0.004          | 0.30  |
|           | T15 - T14 | 0.93       | 0.08 | 0.77, 1.10  | 11.12  | < .001         | 1.17  |
| DK        | T14 - T13 | 0.36       | 0.13 | 0.10, 0.62  | 2.75   | 0.012          | 0.46  |
|           | T15 - T14 | 0.50       | 0.15 | 0.20, 0.80  | 3.29   | 0.004          | 0.63  |

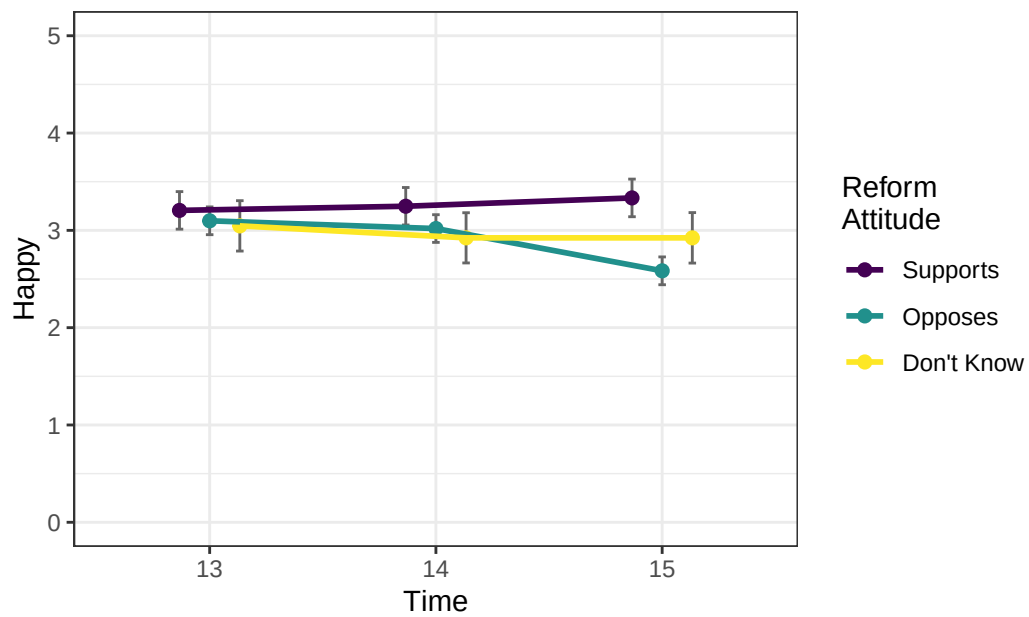
<sup>a</sup>Using Holm correction for consecutive comparisons within each group

## Happy

```
AOV_tab[["Happy"]]
```

| Parameter      | F    | df | df (error) | p      | Eta2 (partial) |
|----------------|------|----|------------|--------|----------------|
| ReformAtt      | 7.83 | 2  | 393        | < .001 | 0.04           |
| Time           | 3.29 | 2  | 786        | 0.038  | 8.30e-03       |
| ReformAtt:Time | 6.73 | 4  | 786        | < .001 | 0.03           |

```
ggplots[["Happy"]]
```



Error bars are 95% CIs.

By Time:

```
AOV_contrasts[["Happy"]][["ReformAtt"]]
```

| Time | contrast           | Difference | SE   | 95% CI         | t(393) | p <sup>a</sup> |
|------|--------------------|------------|------|----------------|--------|----------------|
| T13  | Supports - Opposes | 0.11       | 0.12 | -0.13, 0.35    | 0.88   | 0.655          |
|      | Supports - DK      | 0.16       | 0.16 | -0.16, 0.48    | 0.97   | 0.598          |
|      | Opposes - DK       | 0.05       | 0.15 | -0.24, 0.35    | 0.35   | 0.936          |
| T14  | Supports - Opposes | 0.23       | 0.12 | -0.01, 0.47    | 1.88   | 0.145          |
|      | Supports - DK      | 0.32       | 0.16 | 2.84e-03, 0.65 | 1.98   | 0.118          |
|      | Opposes - DK       | 0.10       | 0.15 | -0.20, 0.39    | 0.64   | 0.799          |
| T15  | Supports - Opposes | 0.75       | 0.12 | 0.51, 0.99     | 6.13   | < .001         |
|      | Supports - DK      | 0.41       | 0.16 | 0.09, 0.73     | 2.49   | 0.035          |
|      | Opposes - DK       | -0.34      | 0.15 | -0.64, -0.04   | -2.25  | 0.064          |

<sup>a</sup>Using Tukey method for pairwise comparisons within each time.

By Group:

```
AOV_contrasts[["Happy"]][["Time"]]
```

| ReformAtt | contrast  | Difference | SE   | 95% CI       | t(393)    | p <sup>a</sup> | d         |
|-----------|-----------|------------|------|--------------|-----------|----------------|-----------|
| Supports  | T14 - T13 | 0.04       | 0.11 | -0.17, 0.26  | 0.39      | > .999         | 0.05      |
|           | T15 - T14 | 0.09       | 0.10 | -0.12, 0.29  | 0.82      | > .999         | 0.10      |
| Opposes   | T14 - T13 | -0.08      | 0.08 | -0.24, 0.08  | -0.97     | > .999         | -0.09     |
|           | T15 - T14 | -0.43      | 0.08 | -0.59, -0.28 | -5.67     | < .001         | -0.51     |
| DK        | T14 - T13 | -0.12      | 0.15 | -0.41, 0.17  | -0.83     | > .999         | -0.15     |
|           | T15 - T14 | -5.13e-15  | 0.14 | -0.27, 0.27  | -3.69e-14 | > .999         | -6.05e-15 |

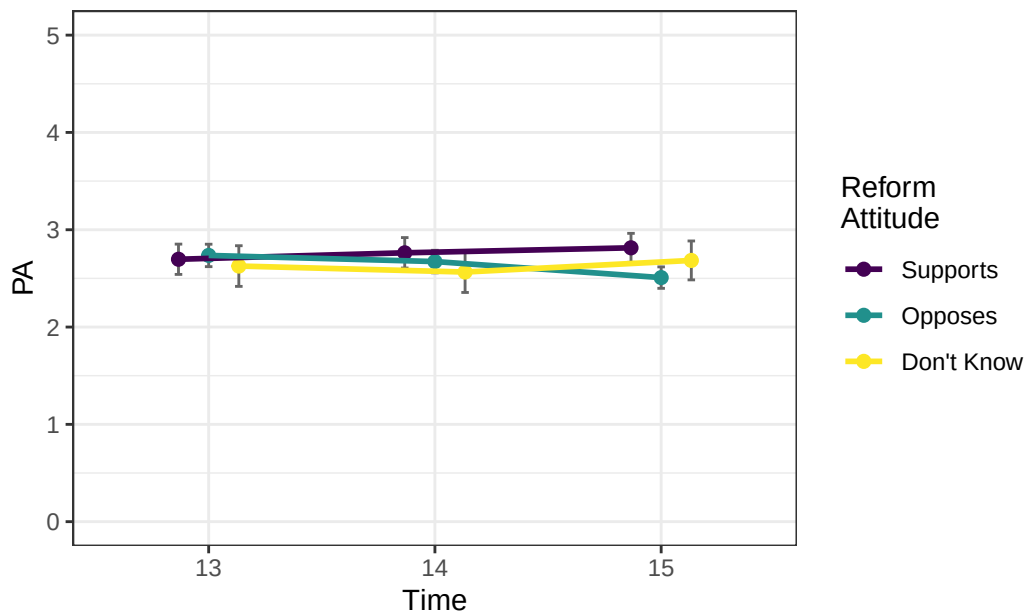
<sup>a</sup>Using Holm correction for consecutive comparisons within each group

## PA

```
AOV_tab[["PA"]]
```

| Parameter      | F    | df | df (error) | p     | Eta2 (partial) |
|----------------|------|----|------------|-------|----------------|
| ReformAtt      | 1.36 | 2  | 393        | 0.259 | 6.85e-03       |
| Time           | 0.09 | 2  | 786        | 0.912 | 2.35e-04       |
| ReformAtt:Time | 3.78 | 4  | 786        | 0.005 | 0.02           |

```
ggplots[["PA"]]
```



By Time:

```
AOV_contrasts[["PA"]][["ReformAtt"]]
```

| Time | contrast           | Difference | SE   | 95% CI      | t(393) | p <sup>a</sup> |
|------|--------------------|------------|------|-------------|--------|----------------|
| T13  | Supports - Opposes | -0.04      | 0.10 | -0.23, 0.15 | -0.40  | 0.916          |
|      | Supports - DK      | 0.07       | 0.13 | -0.19, 0.33 | 0.53   | 0.859          |
|      | Opposes - DK       | 0.11       | 0.12 | -0.13, 0.35 | 0.90   | 0.641          |
| T14  | Supports - Opposes | 0.09       | 0.10 | -0.10, 0.28 | 0.91   | 0.635          |
|      | Supports - DK      | 0.20       | 0.13 | -0.06, 0.46 | 1.48   | 0.301          |
|      | Opposes - DK       | 0.11       | 0.12 | -0.13, 0.35 | 0.88   | 0.652          |
| T15  | Supports - Opposes | 0.31       | 0.09 | 0.12, 0.49  | 3.25   | 0.004          |
|      | Supports - DK      | 0.13       | 0.13 | -0.12, 0.38 | 1.02   | 0.564          |
|      | Opposes - DK       | -0.18      | 0.12 | -0.40, 0.05 | -1.52  | 0.283          |

<sup>a</sup>Using Tukey method for pairwise comparisons within each time.

By Group:

```
AOV_contrasts[["PA"]][["Time"]]
```

| ReformAtt | contrast  | Difference | SE   | 95% CI       | t(393) | p <sup>a</sup> | d     |
|-----------|-----------|------------|------|--------------|--------|----------------|-------|
| Supports  | T14 - T13 | 0.07       | 0.08 | -0.09, 0.23  | 0.81   | > .999         | 0.11  |
|           | T15 - T14 | 0.05       | 0.08 | -0.10, 0.21  | 0.65   | > .999         | 0.08  |
| Opposes   | T14 - T13 | -0.06      | 0.06 | -0.18, 0.06  | -1.04  | > .999         | -0.10 |
|           | T15 - T14 | -0.16      | 0.06 | -0.28, -0.05 | -2.84  | 0.029          | -0.26 |
| DK        | T14 - T13 | -0.06      | 0.11 | -0.28, 0.15  | -0.56  | > .999         | -0.10 |
|           | T15 - T14 | 0.12       | 0.11 | -0.09, 0.33  | 1.13   | > .999         | 0.19  |

<sup>a</sup>Using Holm correction for consecutive comparisons within each group