05 CSI online typing: Plotting and analysis

Kirsten Stark 21 Mai, 2021

Load packages

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(tidyr)
library(lme4)
```

```
## Loading required package: Matrix

##
## Attaching package: 'Matrix'

## The following objects are masked from 'package:tidyr':
##
##     expand, pack, unpack
```

```
library(lmerTest)
```

```
##
## Attaching package: 'lmerTest'

## The following object is masked from 'package:lme4':
##
##     lmer

## The following object is masked from 'package:stats':
##
##     step
```

```
library(Rmisc)
```

```
## Loading required package: lattice

## Loading required package: plyr

## ------------------------------------------------------------------

## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr fi
## library(plyr); library(dplyr)

## ------------------------------------------------------------------

##
## Attaching package: 'plyr'

## The following objects are masked from 'package:dplyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

```
library(Cairo)
#library(strengejacke)
library(ggplot2)
library(sjPlot)
```

```
## Install package "strengejacke" from GitHub (`devtools::install_githu
```

```
options(scipen=999)
```

```r
rm(list = ls())
options( "encoding" = "UTF-8" )
set.seed(99)
```

Load and preprocess data

```r
# input
#input = "data_long_final.csv"
input = "data_long_anonymous.csv"
classification_type = "automatic" # select "manual" or "automatic"

# load data
df <- read.csv(here::here("data", input))
```

Check amount of participants and trials

```r
# no. of participants:
length(unique(df$subject))
```

```
## [1] 30
```

```r
# no. of trials is 160 per participant?
nrow(df) == 160 * length(unique(df$subject))
```

```
## [1] TRUE
```

Factorize columns

```r
# factorize columns
is.numeric(df$timing.01)
```

```
## [1] TRUE
```

```r
df$PosOr <- as.factor(df$PosOr)
df$subject <- as.factor(df$subject)
```

Select correct classification column

```
if(classification_type == "automatic") {
  df$answercode <- df$answer_auto_jaro
  df$correct <- df$correct_auto_jaro
} else if(classification_type == "manual") {
  df$answercode <- df$answercode
  df$correct <- df$correct_manual
} else {
  print("Select a correct type!")
}
```

```
as.data.frame(table(df$correct, df$answercode)) %>% filter(Freq != 0)
```

```
##    Var1                 Var2 Freq
## 1     1 alternative_corrected  302
## 2     1    approx_alternative   24
## 3     1        approx_correct  133
## 4     0 backspace_space_enter   25
## 5     1               correct 3519
## 6     1    correctedtocorrect  301
## 7     0  distance_based_error   12
## 8     0    first_letter_error  231
## 9     0                  isna  153
## 10    0           not_correct   90
## 11    0           shift_start   10
```

```
as.data.frame(table(df$correct, df$answercode)) %>% filter(Freq != 0) %
  mutate(Percentage = case_when(Var1 == 1 ~ Freq/sum(df$correct == 1),
                                Var1 == 0 ~ Freq/sum(df$correct == 0))
```

```
##    Var1                 Var2 Freq  Percentage
## 1     1 alternative_corrected  302 0.070577238
## 2     1    approx_alternative   24 0.005608787
## 3     1        approx_correct  133 0.031082029
## 4     0 backspace_space_enter   25 0.047984645
```

```
## 5      1                correct 3519 0.822388409
## 6      1      correctedtocorrect  301 0.070343538
## 7      0    distance_based_error   12 0.023032630
## 8      0      first_letter_error  231 0.443378119
## 9      0                    isna  153 0.293666027
## 10     0             not_correct   90 0.172744722
## 11     0             shift_start   10 0.019193858
```

```
# raw
table(df$correct)
```

```
##
##    0    1
##  521 4279
```

```
# in percent
round(table(df$correct)/nrow(df)*100,2)
```

```
##
##     0     1
## 10.85 89.15
```

```
## How many correct/incorrect non-filler trials?
table(df$correct[df$category != "Filler"])
```

```
##
##    0    1
##  422 3178
```

Show amount of incorrect trials per ordinal position (excluding fillers):

```
## How many correct/incorrect non-filler trials per ordinal position?
table(df$PosOr[df$category != "Filler" & df$correct == 0],
      df$correct[df$category != "Filler" & df$correct == 0])
```

```
##
##       0
```

```
##   1 75
##   2 87
##   3 82
##   4 83
##   5 95
```

Drop incorrect trials:

```
df <- df %>% filter(df$correct == 1)
```

Plotting

Make plots suitable for APA format, font sizes can be adjusted

```
apatheme <- theme_bw()+
  theme(plot.title=element_text(family="Arial",size=22,hjust = .5),
        panel.grid.major=element_blank(), panel.grid.minor=element_blan
        panel.border=element_blank(),axis.line=element_line(),
        text=element_text(family="Arial",size=16))
```

Descriptives

```
(means_final<- df %>%
   filter(category != "Filler") %>%
   Rmisc::summarySEwithin(.,"timing.01",idvar = "subject",
                          withinvars = "PosOr", na.rm = T))
```

```
##   PosOr   N timing.01       sd       se       ci
## 1     1 645  1152.220 444.1659 17.48902 34.34238
## 2     2 633  1228.071 553.3236 21.99264 43.18749
## 3     3 638  1247.875 525.8232 20.81754 40.87930
## 4     4 637  1285.638 593.4891 23.51489 46.17622
## 5     5 625  1317.224 562.0187 22.48075 44.14708
```

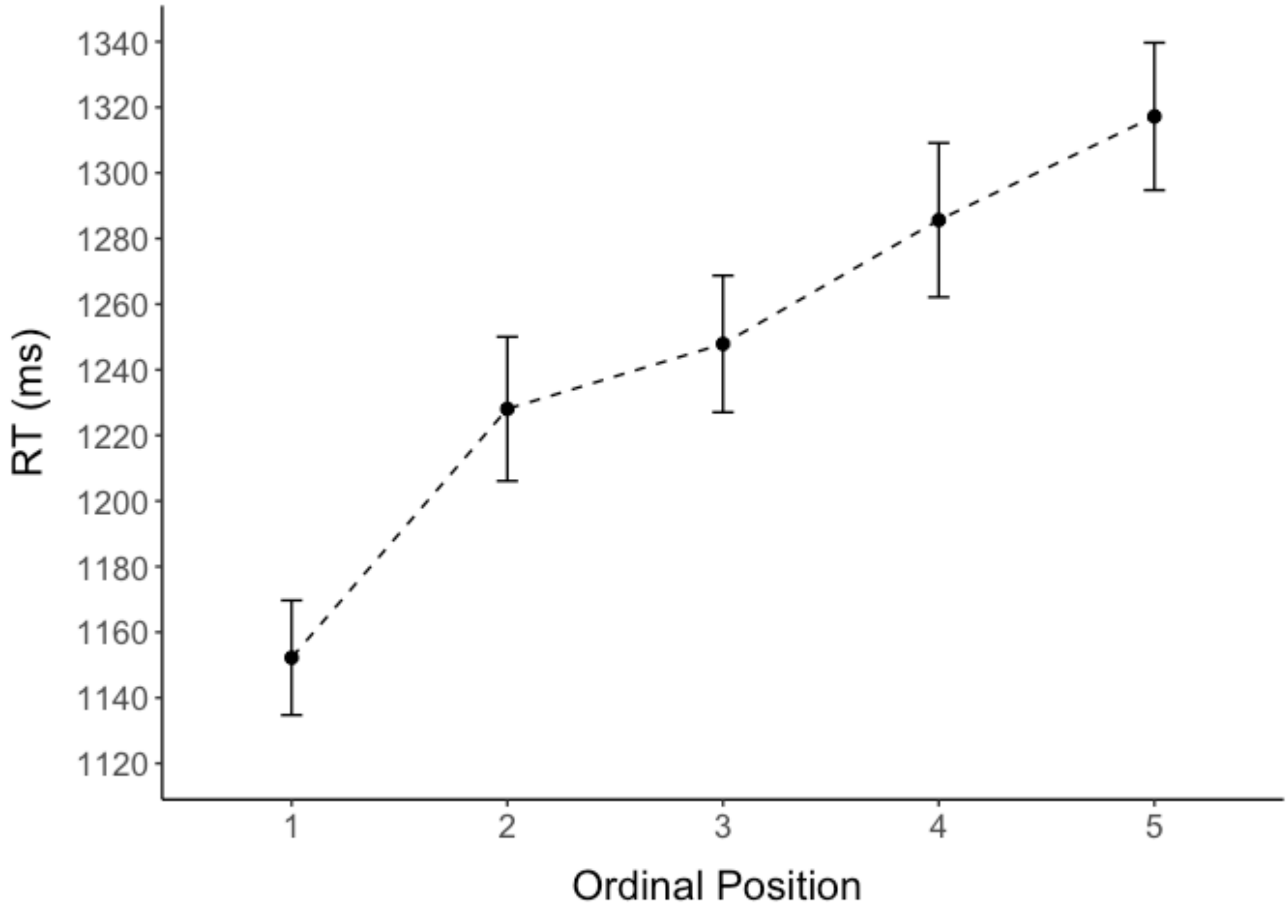
```
# Export as word file
library(flextable)
huxt_word <- huxtable::huxtable(means_final)
huxt_word <- huxtable::set_number_format(huxt_word, round(2))
```

```
huxtable::quick_docx(huxt_word,
                     file = here::here("tables",
                                       "CSI_online_typing_RT_summary.d
                                       open = FALSE)
```

RTs by ordinal position

Line graph (only correct trials, without fillers)

```
(plot_rt <- means_final %>%
    ggplot(., aes(x=PosOr, y=timing.01)) +
    geom_point(size = 2)+
    stat_summary(fun=mean,  geom="line", size = 0.5, group = 1, linety
    geom_errorbar(aes(ymin=timing.01-se, ymax=timing.01+se), width =.1
    apatheme+
    scale_y_continuous(limits = c(1120, 1340), breaks =seq(1120,1340, 
                       #breaks = c(1100, 1150, 1200, 1250, 1300, 1350)
    labs(x="Ordinal Position ",y ="RT (ms)") + #+
  # annotate(geom="text", x=1.5, y=1330, label="n = 30",
  #         color="black", size = 8))
    theme(
    axis.title.y = element_text(margin = margin(0,10,0,0)),
    axis.title.x = element_text(margin = margin(10,0,0,0))))
```




```
filename <- "CSI_online_typing_plot_rt.pdf"
ggsave(plot_rt, filename =
         here::here("figures", filename),
       width = 18, height = 13, units = "cm",
       dpi = 300, device = cairo_pdf)
embedFonts(file = here::here("figures", filename))
```

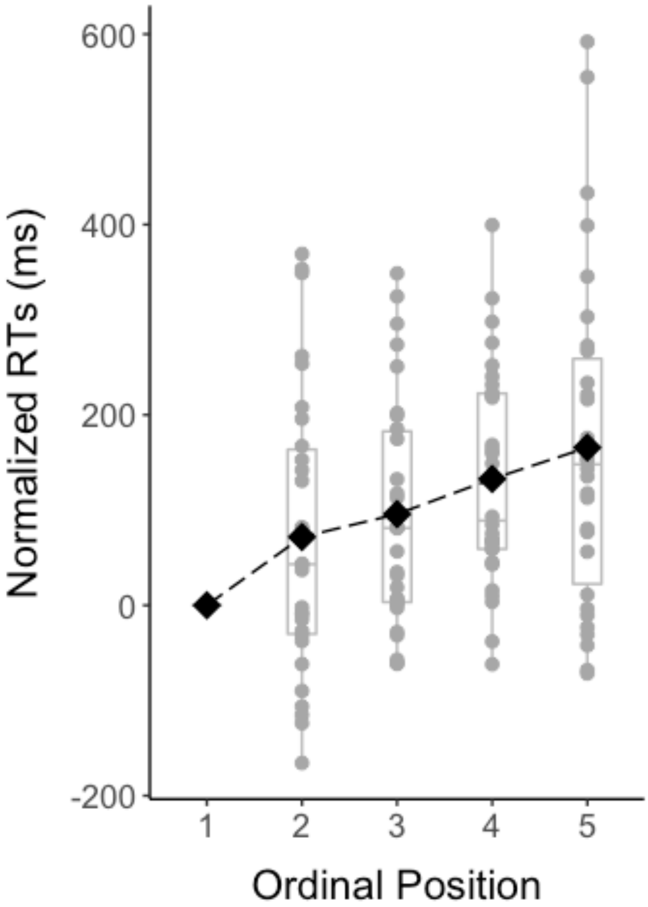
Normalized boxplot

```
means_subject <- df %>%
   filter(category != "Filler") %>%
   summarySEwithin(.,"timing.01",withinvars = c("subject","PosOr"))
(means_subject <- means_subject %>%
  group_by(subject) %>%
  dplyr::mutate(timing.01_norm = timing.01 - first(timing.01)))
```

```
## # A tibble: 150 x 8
## # Groups:   subject [30]
##     subject PosOr     N timing.01    sd    se    ci timing.01_norm
##     <fct>   <fct> <dbl>     <dbl> <dbl> <dbl> <dbl>          <dbl>
##   1 1       1        24     1127.  250.  51.1  106.              0
##   2 1       2        22     1269.  325.  69.3  144.           142.
```

```
##   3 1         3          22      1240.   277.   59.1  123.            113.
##   4 1         4          24      1348.   491.  100.   207.            221.
##   5 1         5          24      1526.   586.  120.   247.            399.
##   6 2         1          23      1030    332.   69.2  144.              0
##   7 2         2          22      1073.   478.  102.   212.             42.5
##   8 2         3          23      1087.   470.   97.9  203.             56.7
##   9 2         4          21      1098.   538.  117.   245.             68.3
##  10 2         5          24       962.   260.   53.0  110.            -68.1
## # … with 140 more rows
```

```
(boxplot <-
  ggplot() +

  ## boxplot
  geom_boxplot(data=means_subject, aes(x = PosOr,y =timing.01_norm),
               colour = "grey", width = 0.3,fatten = 1)+
  ### individual means
  geom_jitter(data=means_subject, aes(x = PosOr,y =timing.01_norm),
              position = position_dodge(0.6),
              shape=19,color = "dark grey", size=2)+
  ### group means
  stat_summary(data=means_subject, aes(x = PosOr,y =timing.01_norm),
               fun=mean, geom="point",colour = "black", shape=18, size=
  ### line
  stat_summary(data=means_subject, aes(x = PosOr,y =timing.01_norm),
               fun=mean, geom="line",colour = "black", linetype = "lon

  ## other stuff
  #scale_y_continuous(breaks = seq(600, 1300, by = 50))+
  labs(x="Ordinal Position",y ="Normalized RTs (ms)")+
  apatheme +
  theme(
    axis.title.y = element_text(margin = margin(0,10,0,0)),
    axis.title.x = element_text(margin = margin(10,0,0,0))) +
  coord_equal(ratio = 1/100))
```




```
filename <- "CSI_online_typing_boxplot.pdf"
ggsave(boxplot, filename =
         here::here("figures", filename),
       width = 13, height = 18, units = "cm",
       dpi = 300, device = cairo_pdf)
embedFonts(file = here::here("figures", filename))
```

Export plot grid

```
cowplot::plot_grid(plot_rt, boxplot,
          nrow = 1, labels = c("A", "B"), label_fontfamily = "Arial") %
  ggsave(filename = here::here("figures",
                               "CSI_online_typing_RTs_and_normalized_R
         width = 18, height = 13, units = "cm", dpi = 300,
         device = cairo_pdf)
```

```
## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n
```

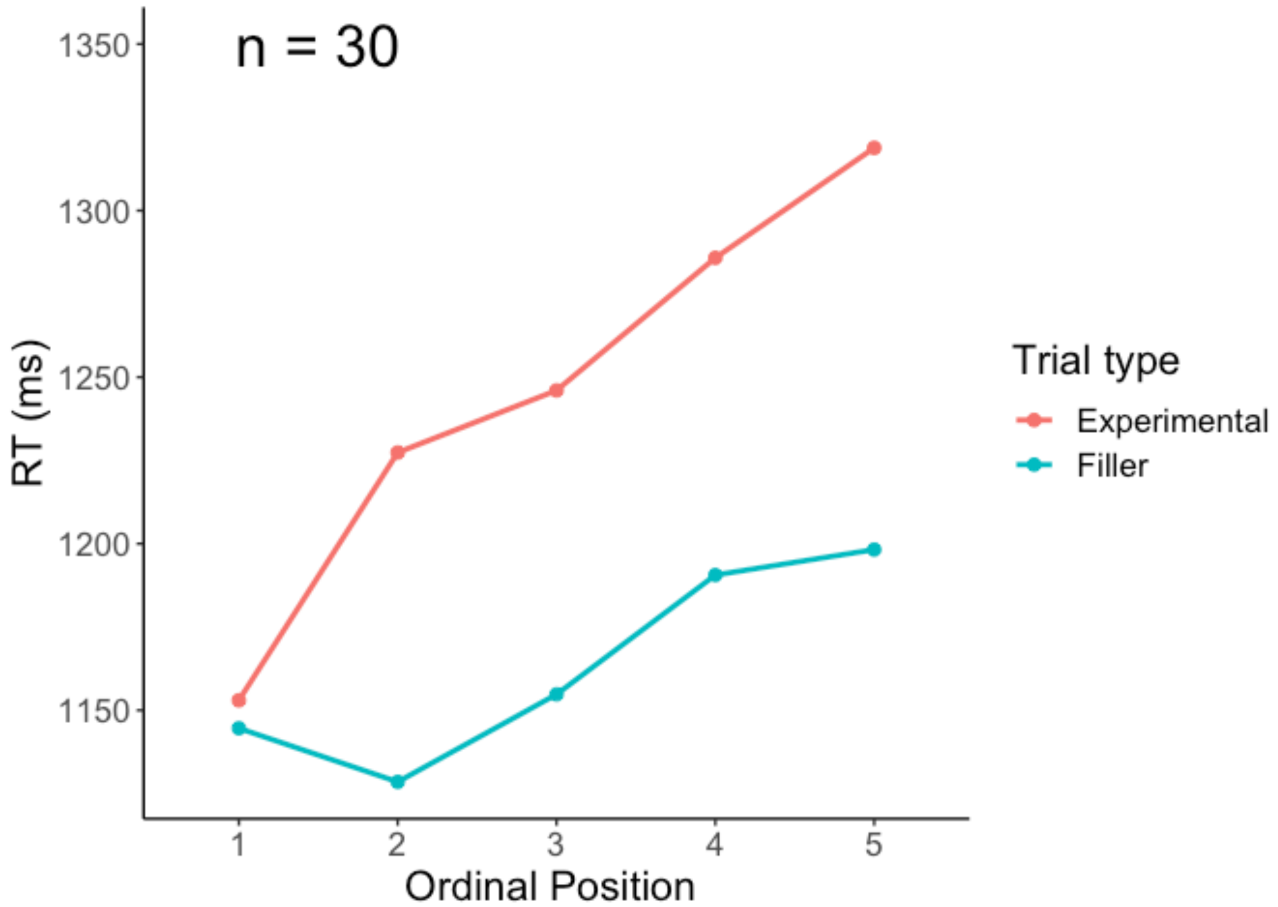
```
## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n:
```

```
## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n

## Warning in grid.Call(C_stringMetric, as.graphicsAnnot(x$label)):
## Zeichensatzfamilie 'Arial' in der PostScript-Zeichensatzdatenbank n
```

```
#embedFonts(file = here::here("figures", "CSI_online_typing_RTs_and_no
```

… with fillers for control

```
(plot_rt_fillers <- df %>%
    mutate(kind = case_when(category == "Filler" ~"Filler",
                            category != "Filler" ~"Experimental")) %>%
    ggplot(., aes(x=PosOr, y=timing.01, group=kind, color=kind)) +
    stat_summary(fun=mean,  geom="point", size = 2)+
    stat_summary(fun=mean,  geom="line", size = 1) +
    apatheme+
    labs(x="Ordinal Position ",y ="RT (ms)", color = "Trial type")+
  annotate(geom="text", x=1.5, y=1350, label="n = 30",
          color="black", size = 8))
```



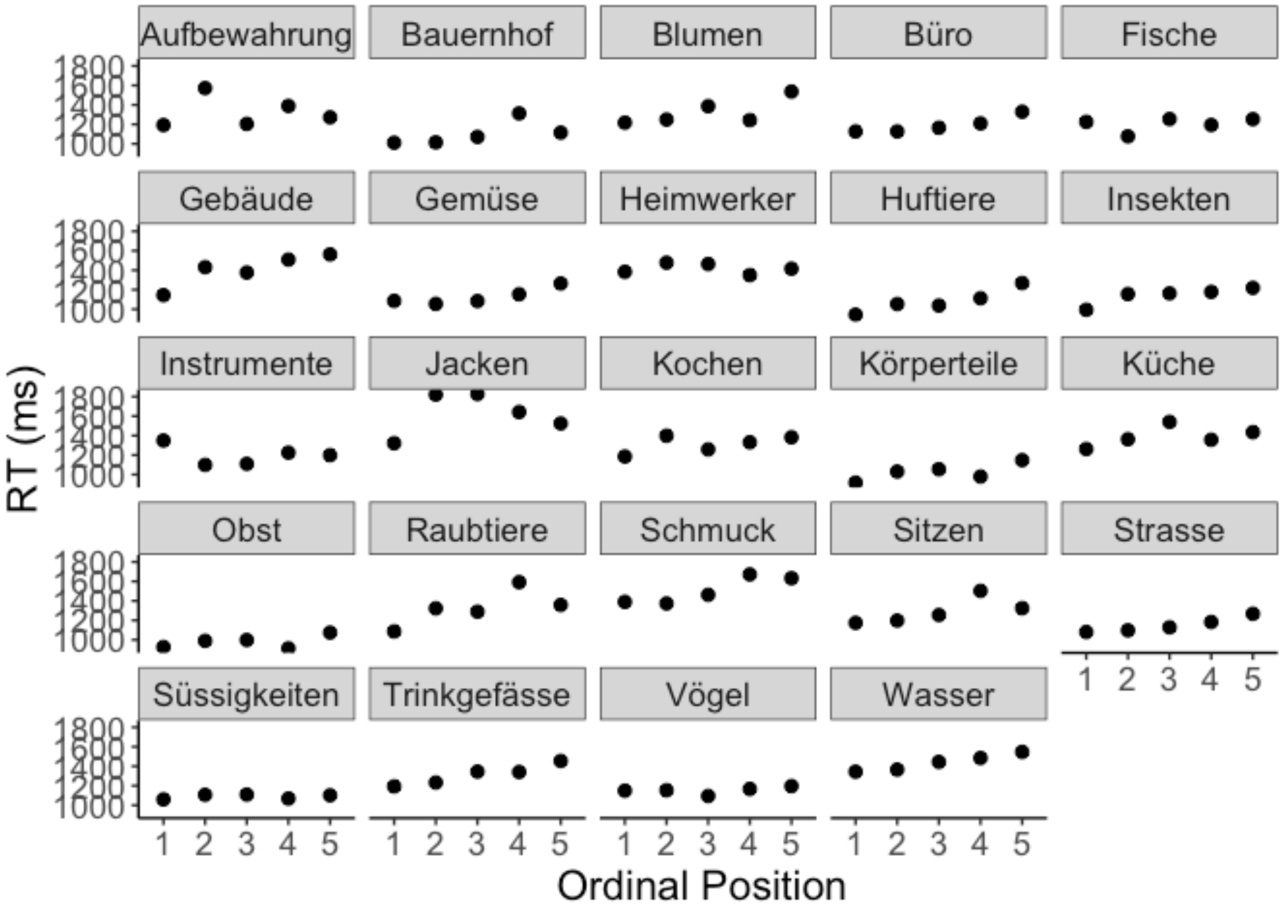

```
filename <- "CSI_online_typing_plot_rt_with_fillers.pdf"
ggsave(plot_rt_fillers, filename =
         here::here("figures", filename),
       width = 18, height = 13, units = "cm",
       dpi = 300, device = cairo_pdf)
embedFonts(file = here::here("figures", filename))
```

Plot by subcategory

```
(plot_rt_by_cat <- df %>%
   filter(category != "Filler") %>%
    ggplot(., aes(x=PosOr, y=timing.01)) +
    stat_summary(fun=mean,  geom="point", size = 2)+
    stat_summary(fun=mean,  geom="line", size = 1) +
    facet_wrap(~category) +
    apatheme+
    labs(x="Ordinal Position ",y ="RT (ms)"))
```

```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```

```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```




```
filename <- "CSI_online_typing_plot_rt_by_category.pdf"
ggsave(plot_rt_by_cat, filename =
         here::here("figures", filename),
       width = 18, height = 19, units = "cm",
       dpi = 300, device = cairo_pdf)
```

```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
```

```
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```

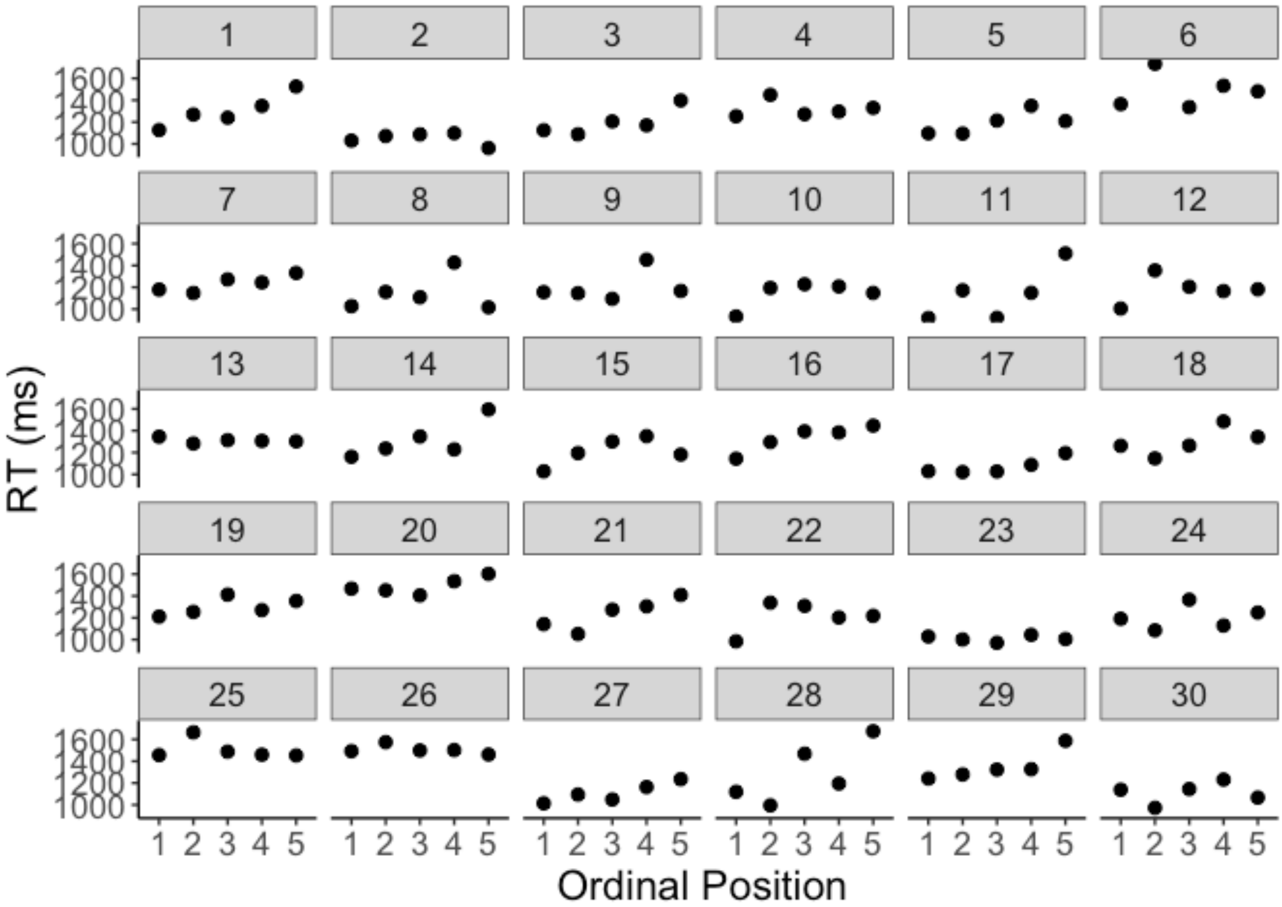
```
embedFonts(file = here::here("figures", filename))
```

Plot by subject

```
(plot_rt_by_subject <- df %>%
   filter(category != "Filler") %>%
    ggplot(., aes(x=PosOr, y=timing.01)) +
    stat_summary(fun=mean,  geom="point", size = 2) +
    stat_summary(fun=mean,  geom="line", size = 1) +
    facet_wrap(~subject) +
    apatheme+
    labs(x="Ordinal Position ",y ="RT (ms)"))
```

```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```

```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```




```
filename <- "CSI_online_typing_plot_rt_by_subject.pdf"
ggsave(plot_rt_by_subject, filename =
         here::here("figures", filename),
       width = 18, height = 19, units = "cm",
       dpi = 300, device = cairo_pdf)
```

```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```

```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```

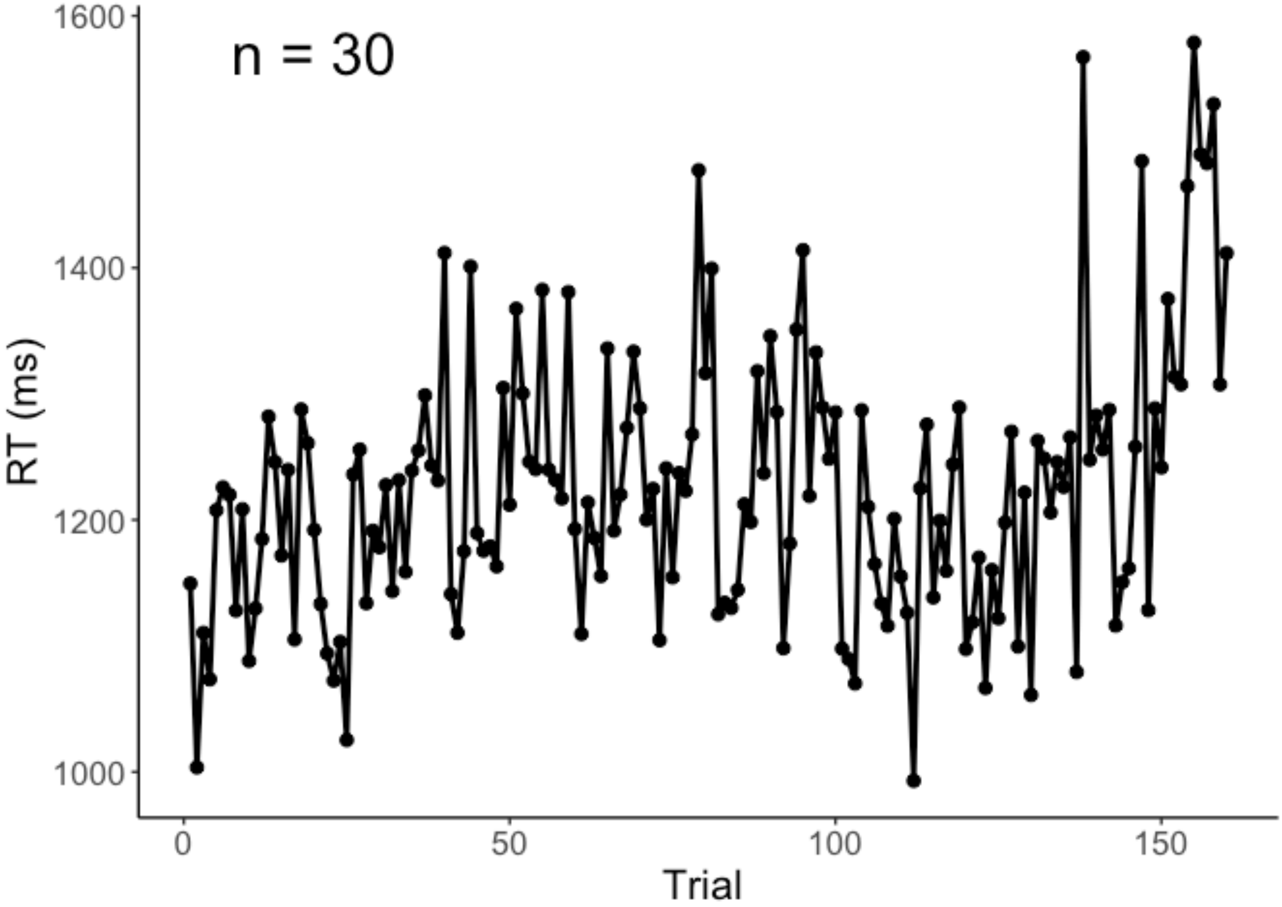
```
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
## geom_path: Each group consists of only one observation. Do you need
## the group aesthetic?
```

```
embedFonts(file = here::here("figures", filename))
```

Control: Plot RTs accross the experiment

All trials correct trials

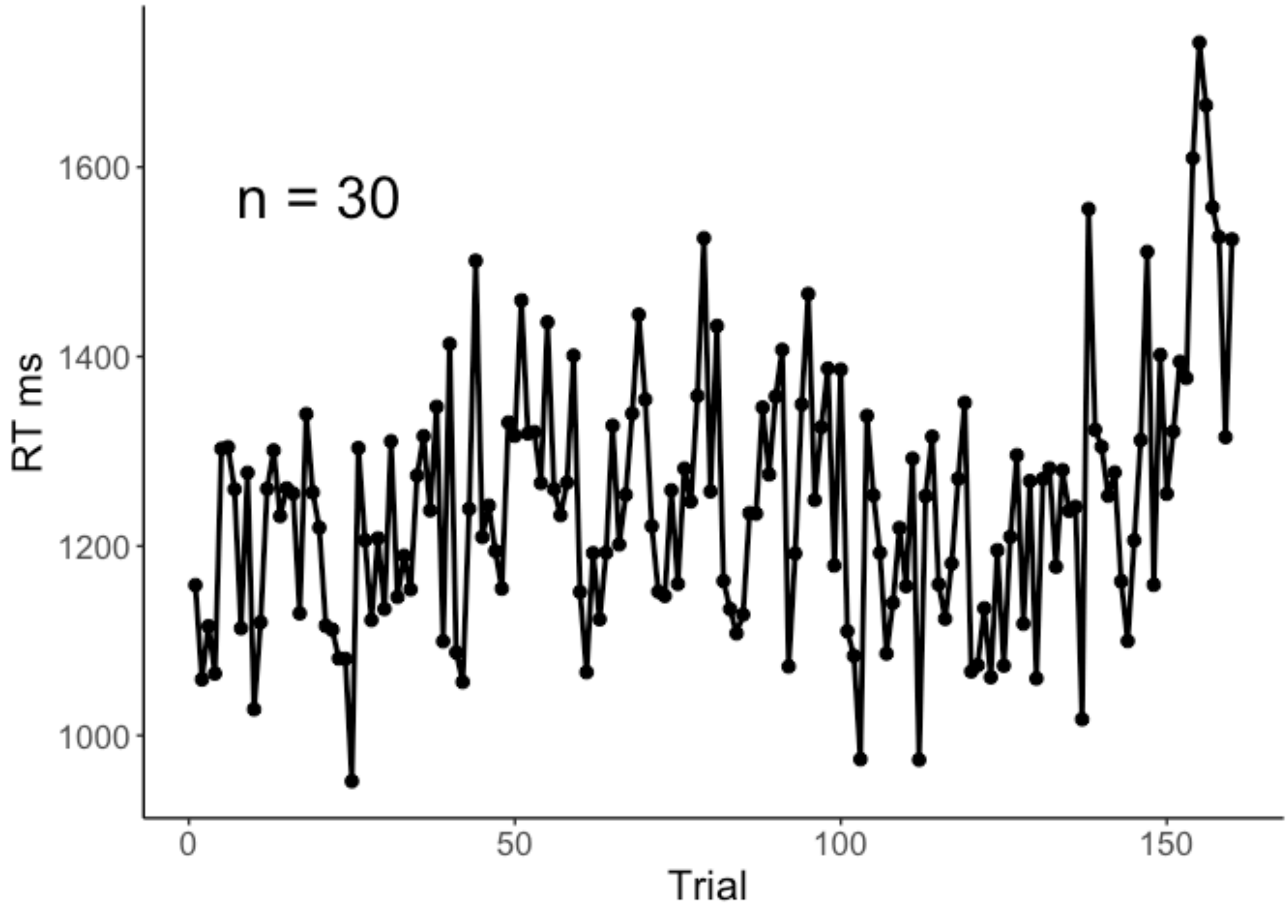
```
(plot_RTs_all <- ggplot(data=df, aes(x=trial, y=timing.01)) +
  stat_summary(fun=mean,  geom="point", size = 2)+
  stat_summary(fun=mean,  geom="line", size = 1) +
  apatheme+
  labs(x="Trial ",y ="RT (ms)")+
  annotate(geom="text", x=20, y=1570, label="n = 30",
           color="black", size = 8))
```




```
filename <- "CSI_online_typing_plot_rts_across_experiment.pdf"
ggsave(plot_RTs_all, filename =
         here::here("figures", filename),
       width = 18, height = 13, units = "cm",
       dpi = 300, device = cairo_pdf)
embedFonts(file = here::here("figures", filename))
```

Correct non-filler trials only:

```
(plot_RTs_correct <- df %>%
   filter(category != "Filler") %>%
    ggplot(., aes(x=trial, y=timing.01)) +
    stat_summary(fun=mean,  geom="point", size = 2)+
    stat_summary(fun=mean,  geom="line", size = 1) +
    apatheme+
    labs(x="Trial ",y ="RT ms")+
    annotate(geom="text", x=20, y=1570, label="n = 30",
             color="black", size = 8))
```




```
filename <- "CSI_online_typing_plot_rts_across_experiment_correct_expe
ggsave(plot_RTs_correct, filename =
          here::here("figures", filename),
       width = 18, height = 13, units = "cm",
       dpi = 300, device = cairo_pdf)
embedFonts(file = here::here("figures", filename))
```

Check distribution of data

Are the data normally distributed or does a gamma distribution fit the data better?

Subset data to correct trials only and exclude fillers

```
df_valid <- df %>% filter(category != "Filler") %>%
  filter(correct == 1) %>% droplevels()
```

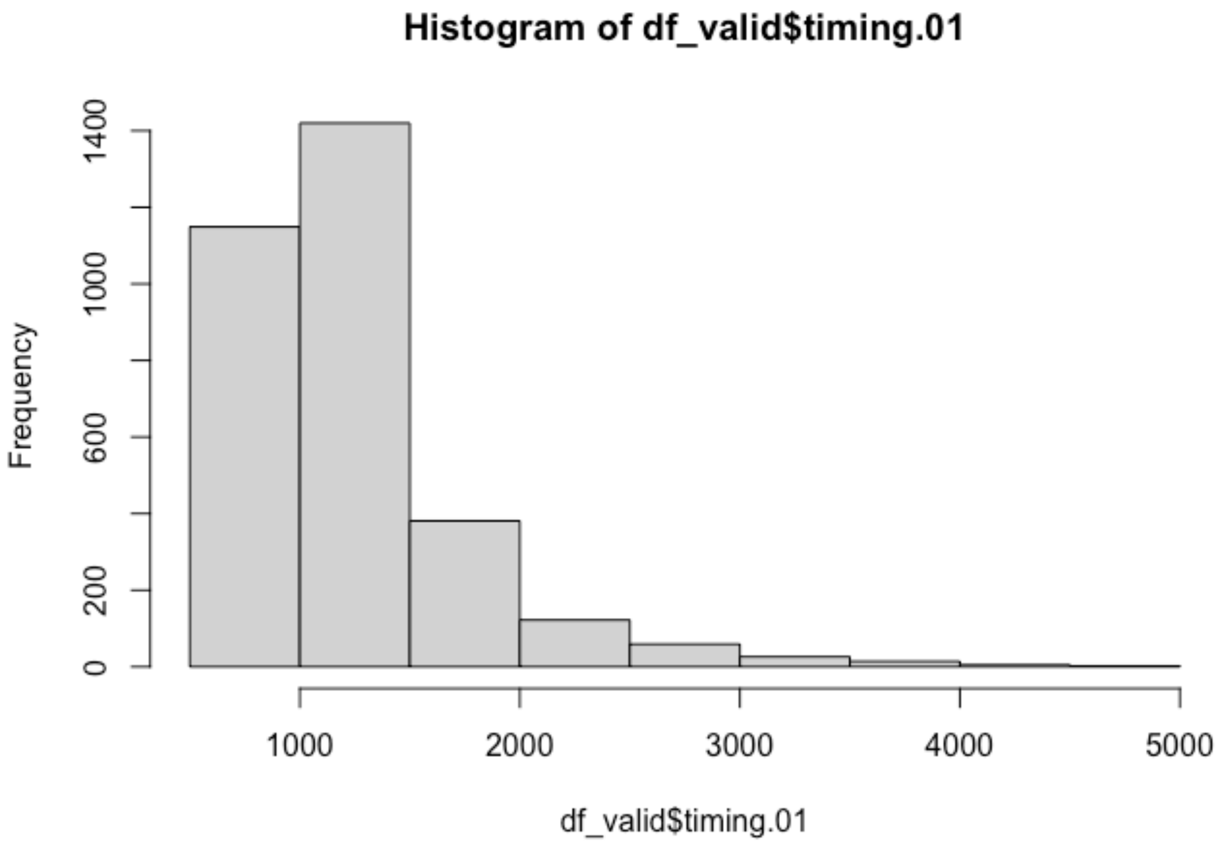
Center predictor variable

```
df_valid$PosOr.cont <- scale(as.numeric(as.character(df_valid$PosOr)),
                                                   center = T, scale = F)
```

```
# table(df_valid$PosOr.cont)
# mean(df_valid$PosOr.cont)
```

Histogram of the reaction time data

```
hist(df_valid$timing.01)
```



Check fit of normal vs gamma distribution in histograms, q-q-plots and using objective criteria:
1) Fit normal and gamma distributions to the reaction time data

```
library(fitdistrplus)
```

```
## Loading required package: MASS

##
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':
##
##     select
```

```
## Loading required package: survival
```

```r
fit.normal<- fitdist(df_valid$timing.01, distr = "norm", method = "mle'
summary(fit.normal)
```

```
## Fitting of the distribution ' norm ' by maximum likelihood
## Parameters :
##       estimate Std. Error
## mean 1245.7240   8.896466
## sd    501.5297   6.290638
## Loglikelihood:  -24269.12   AIC:  48542.24   BIC:  48554.37
## Correlation matrix:
##      mean sd
## mean    1  0
## sd      0  1
```

```r
#plot(fit.normal)
```

```r
fit.gamma <- fitdist(df_valid$timing.01, distr = "gamma", method = "mle
summary(fit.gamma)
```

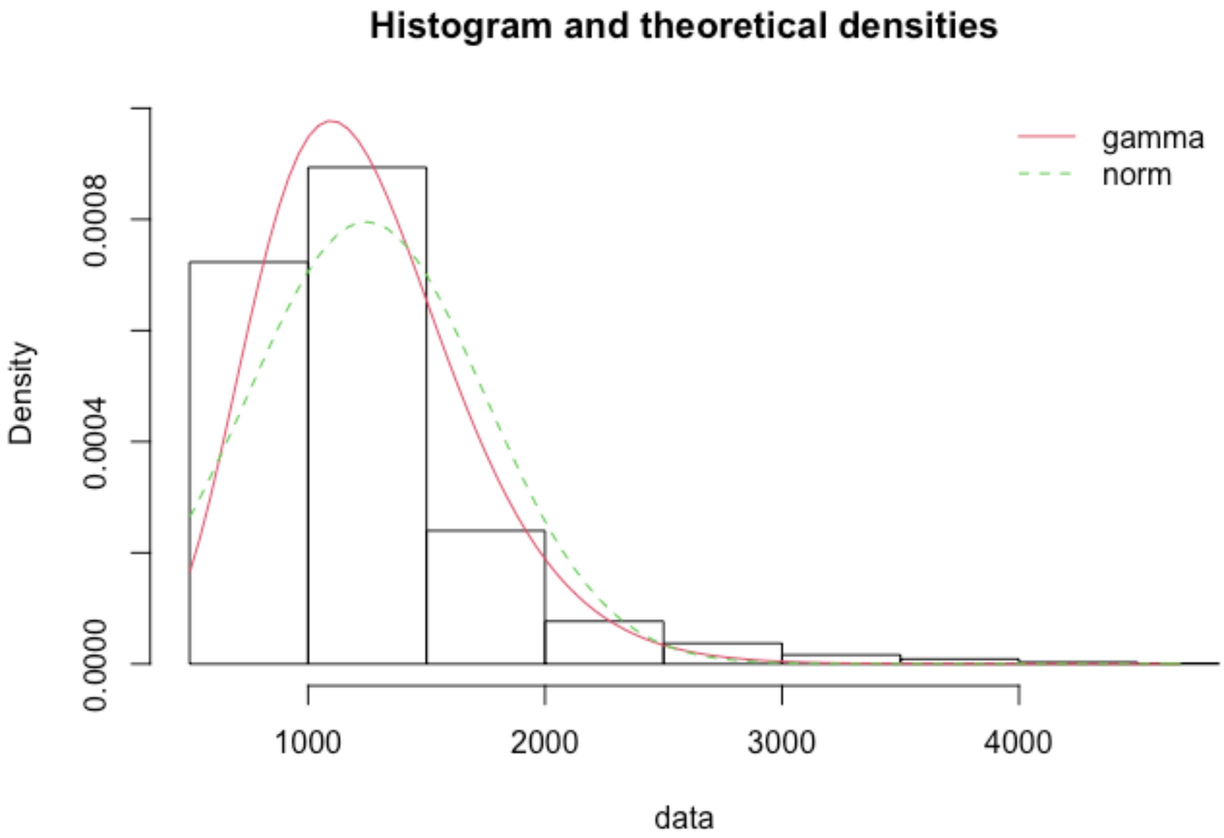
```
## Fitting of the distribution ' gamma ' by maximum likelihood
## Parameters :
##          estimate   Std. Error
## shape 8.393507247 0.1690773662
## rate  0.006738114 0.0001367073
## Loglikelihood:  -23650.2   AIC:  47304.39   BIC:  47316.52
## Correlation matrix:
##           shape      rate
## shape 1.0000000 0.9555099
## rate  0.9555099 1.0000000
```

```r
#plot(fit.gamma)
```

2. Compare the fit of the two distributions

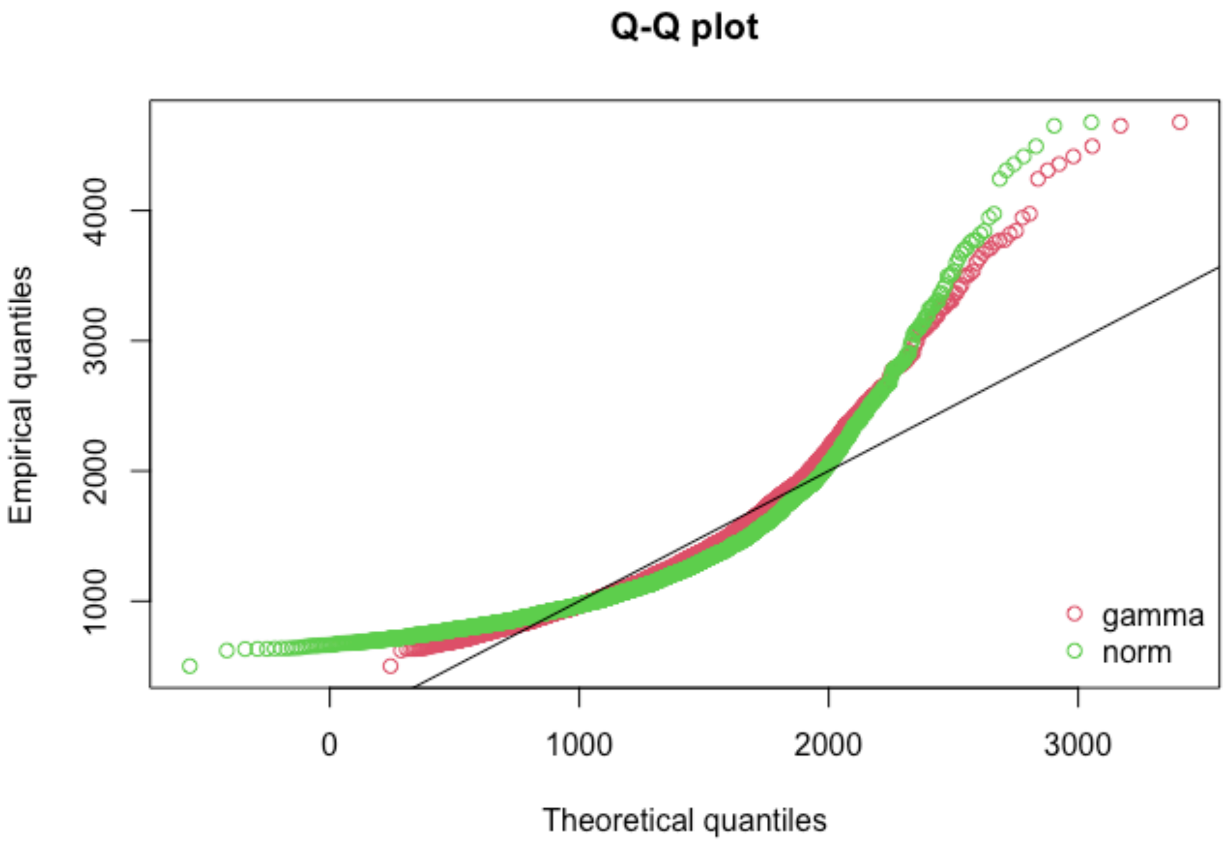
   Visually compare fit of both distributions in histogram

```
denscomp(list(fit.gamma, fit.normal))
```



Visually compare fit of both distributions in Q-Q-plots

```
qqcomp(list(fit.gamma, fit.normal))
```



Compare information criteria

```
gofstat(list(fit.gamma, fit.normal),
        fitnames = c("Gamma", "Normal"))
```

```
## Goodness-of-fit statistics
##                                  Gamma      Normal
## Kolmogorov-Smirnov statistic  0.096902   0.1443542
## Cramer-von Mises statistic   11.704816  27.3854717
## Anderson-Darling statistic   70.527683 158.4631104
##
## Goodness-of-fit criteria
##                                   Gamma   Normal
## Akaike's Information Criterion 47304.39 48542.24
## Bayesian Information Criterion 47316.52 48554.37
```

Conclusion: Both the visual inspection and the objective criteria suggest that a gamma distribution fits the data better (although not that well). Therefore, we fit a Gamma distribution in a GLMM with the continuous predictor ordinal position (Pos.cont), the factorial predictor (experiment), and their interaction. We compute the maximal random effects structure.

Inferential analyses: GLMM (Gamma distribution) with ordinal position as a continuous predictor

```
m1 <- glmer(timing.01 ~ PosOr.cont +
               (PosOr.cont|subject) +(PosOr.cont|category),
             data = df_valid,
            family =Gamma(link ="identity"),
            control=glmerControl(optimizer = "bobyqa"))
summary(m1)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: Gamma  ( identity )
## Formula: timing.01 ~ PosOr.cont + (PosOr.cont | subject) + (PosOr.co
##     category)
##    Data: df_valid
## Control: glmerControl(optimizer = "bobyqa")
##
##      AIC      BIC   logLik deviance df.resid
##  46561.2  46615.7 -23271.6  46543.2     3169
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.5333 -0.5849 -0.2585  0.2562  8.4387
##
## Random effects:
##  Groups   Name        Variance  Std.Dev. Corr
##  subject  (Intercept) 8171.0578  90.3939
##           PosOr.cont   661.5039  25.7197 -0.02
##  category (Intercept) 9999.1073  99.9955
##           PosOr.cont   491.0824  22.1604 0.22
##  Residual                0.1286   0.3586
## Number of obs: 3178, groups:  subject, 30; category, 24
##
## Fixed effects:
##             Estimate Std. Error t value             Pr(>|z|)
## (Intercept) 1298.489     11.434 113.561 < 0.0000000000000002 ***
## PosOr.cont    41.678      6.829   6.103         0.00000000104 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Correlation of Fixed Effects:
##           (Intr)
## PosOr.cont -0.072
```

```
# save model output
tab_model(m1,transform = NULL,
          show.re.var = F, show.stat = T,show.r2 = F,show.icc = F,
          title = "GLMM (Gamma distribution) with continuous predictor'
          pred.labels = c("(Intercept)", "Ordinal Position"),
          dv.labels = "Typing Onset Latency",
          #string.pred = "",
          string.stat = "t-Value",
          file = here::here("tables", "CSI_online_typing_glmm_cont.htm
```

GLMM (Gamma distribution) with continuous predictor

	Typing Onset Latency			
Predictors	*Estimates*	*CI*	*t-Value*	*p*
(Intercept)	1298.49	1276.08 – 1320.90	113.56	**<0.001**
Ordinal Position	41.68	28.29 – 55.06	6.10	**<0.001**
N $_{subject}$	30			
N $_{category}$	24			
Observations	3178			

— — — — — — — — — — — — — — —

Appendix

Line graph for each participant:

```r
modeloutput <- coef(m1)$subject
(means_final_subject <- df_valid %>%
   summarySEwithin(.,"timing.01",withinvars = c("subject","PosOr")))
```

```
##    subject PosOr  N timing.01       sd        se        ci
## 1        1     1 24 1127.1667 250.2039  51.07267 105.65186
## 2        1     2 22 1269.1818 324.9635  69.28246 144.08077
## 3        1     3 22 1240.1364 276.9747  59.05120 122.80370
## 4        1     4 24 1347.7917 490.7232 100.16846 207.21425
## 5        1     5 24 1526.1250 585.5397 119.52280 247.25175
## 6        2     1 23 1030.0000 332.0367  69.23443 143.58342
## 7        2     2 22 1072.5455 477.6513 101.83560 211.77873
## 8        2     3 23 1086.6522 469.7399  97.94753 203.13075
## 9        2     4 21 1098.3333 537.7769 117.35253 244.79310
## 10       2     5 24  961.8750 259.8432  53.04027 109.72217
## 11       3     1 23 1125.1304 396.1648  82.60606 171.31449
## 12       3     2 21 1087.6190 345.5195  75.39854 157.27860
## 13       3     3 19 1206.1053 530.3574 121.67233 255.62408
## 14       3     4 22 1170.1364 362.0938  77.19866 160.54340
## 15       3     5 24 1397.9167 470.2449  95.98834 198.56701
## 16       4     1 22 1253.0455 801.1153 170.79835 355.19461
## 17       4     2 21 1449.0476 787.0680 171.75231 358.26904
## 18       4     3 19 1271.8421 391.0446  89.71179 188.47748
## 19       4     4 22 1296.0455 440.3326  93.87922 195.23252
## 20       4     5 20 1330.0000 577.6966 129.17688 270.37031
## 21       5     1 17 1096.5882 359.7010  87.24031 184.94120
## 22       5     2 22 1094.4091 412.6754  87.98270 182.97004
## 23       5     3 20 1214.2000 423.1116  94.61064 198.02234
## 24       5     4 23 1348.6957 714.6734 149.01971 309.04796
## 25       5     5 24 1209.4583 366.0924  74.72830 154.58727
## 26       6     1 23 1364.5652 443.6025  92.49751 191.82809
## 27       6     2 21 1733.6667 849.1712 185.30435 386.53809
## 28       6     3 20 1336.3500 516.1572 115.41626 241.56901
## 29       6     4 21 1533.0476 761.7156 166.21997 346.72877
## 30       6     5 21 1482.1905 601.5430 131.26745 273.81911
## 31       7     1 23 1178.7391 209.3755  43.65781  90.54075
## 32       7     2 22 1147.5455 282.3848  60.20465 125.20243
## 33       7     3 23 1272.6087 384.0194  80.07359 166.06246
## 34       7     4 24 1244.7917 295.0707  60.23105 124.59742
## 35       7     5 24 1331.2500 292.3937  59.68461 123.46703
## 36       8     1 20 1027.0500 409.8643  91.64843 191.82238
## 37       8     2 22 1157.8182 726.3557 154.85955 322.04807
## 38       8     3 21 1108.6667 404.8430  88.34399 184.28234
## 39       8     4 19 1426.4737 971.5644 222.89216 468.27906
## 40       8     5 16 1016.5625 234.7102  58.67754 125.06821
## 41       9     1 17 1155.5294 348.1504  84.43887 179.00242
```

```
## 42         9      2 20 1145.9500 325.6807  72.82441 152.42325
## 43         9      3 17 1094.3529 242.7330  58.87139 124.80177
## 44         9      4 19 1453.3158 918.6585 210.75472 442.77923
## 45         9      5 20 1166.6000 351.2462  78.54104 164.38829
## 46        10      1 20  932.1000 136.9993  30.63397  64.11763
## 47        10      2 21 1193.9524 498.7240 108.83050 227.01644
## 48        10      3 22 1227.8182 345.6020  73.68258 153.23132
## 49        10      4 20 1207.8500 552.8266 123.61579 258.73082
## 50        10      5 19 1148.4211 221.7982  50.88400 106.90331
## 51        11      1 24  918.5417 209.2004  42.70285  88.33758
## 52        11      2 22 1172.4545 538.2818 114.76207 238.66080
## 53        11      3 24  920.5000 319.5387  65.22556 134.92935
## 54        11      4 24 1150.2083 478.8484  97.74452 202.19994
## 55        11      5 18 1510.6111 891.7547 210.18860 443.45919
## 56        12      1 24 1005.4167 201.0847  41.04623  84.91060
## 57        12      2 23 1354.5217 743.0699 154.94079 321.32753
## 58        12      3 23 1204.7391 402.5269  83.93267 174.06570
## 59        12      4 23 1165.0435 281.4450  58.68534 121.70595
## 60        12      5 21 1181.1905 409.4767  89.35514 186.39156
## 61        13      1 21 1344.7143 330.8071  72.18804 150.58161
## 62        13      2 21 1282.9048 375.6417  81.97174 170.99006
## 63        13      3 19 1313.1053 372.2789  85.40664 179.43270
## 64        13      4 16 1306.7500 383.3903  95.84757 204.29427
## 65        13      5 18 1302.6111 277.3390  65.36943 137.91743
## 66        14      1 18 1161.0556 211.5563  49.86430 105.20448
## 67        14      2 21 1236.5714 426.3008  93.02647 194.04982
## 68        14      3 22 1346.4545 450.0219  95.94499 199.52854
## 69        14      4 21 1228.6190 446.2716  97.38445 203.14041
## 70        14      5 14 1594.2857 955.7842 255.44407 551.85337
## 71        15      1 22 1027.5909 157.5616  33.59225  69.85891
## 72        15      2 24 1194.9167 444.9102  90.81692 187.86911
## 73        15      3 24 1301.4583 443.2788  90.48390 187.18020
## 74        15      4 23 1350.0870 333.4309  69.52515 144.18633
## 75        15      5 21 1181.4762 288.1033  62.86930 131.14306
## 76        16      1 21 1143.5714 165.0154  36.00932  75.11412
## 77        16      2 21 1296.3333 372.2194  81.22493 169.43224
## 78        16      3 23 1394.3913 621.6564 129.62431 268.82437
## 79        16      4 21 1383.8571 521.3832 113.77513 237.33077
## 80        16      5 20 1446.6500 277.8183  62.12206 130.02296
## 81        17      1 23 1029.2174 355.9347  74.21751 153.91770
## 82        17      2 22 1021.2273 370.5137  78.99380 164.27659
## 83        17      3 23 1026.3913 320.2372  66.77406 138.48093
## 84        17      4 24 1088.0000 446.6923  91.18069 188.62164
## 85        17      5 23 1194.7826 688.4576 143.55334 297.71141
## 86        18      1 21 1262.0476 610.2313 133.16338 277.77394
## 87        18      2 18 1146.7778 331.1965  78.06376 164.70013
## 88        18      3 24 1264.2083 438.2897  89.46551 185.07351
## 89        18      4 24 1485.2500 724.4612 147.88002 305.91313
```

```
## 90       18     5 16 1342.5000 429.0580 107.26449 228.62885
## 91       19     1 23 1210.3913 335.3167  69.91836 145.00181
## 92       19     2 20 1254.0500 365.6284  81.75699 171.11935
## 93       19     3 20 1412.4000 552.1191 123.45759 258.39971
## 94       19     4 23 1270.4348 369.6068  77.06834 159.82995
## 95       19     5 21 1353.9524 437.2338  95.41225 199.02646
## 96       20     1 22 1466.8182 587.8706 125.33443 260.64721
## 97       20     2 20 1451.9000 318.5293  71.22532 149.07631
## 98       20     3 20 1405.4000 366.4308  81.93641 171.49487
## 99       20     4 20 1534.8000 412.0346  92.13374 192.83813
## 100      20     5 22 1602.1364 439.1023  93.61693 194.68707
## 101      21     1 18 1141.6111 362.6397  85.47500 180.33648
## 102      21     2 18 1051.6667 196.3987  46.29161  97.66677
## 103      21     3 23 1274.0435 473.7208  98.77761 204.85223
## 104      21     4 22 1305.2727 492.6619 105.03587 218.43405
## 105      21     5 21 1409.0952 706.5518 154.18225 321.61854
## 106      22     1 24  984.6250 377.8534  77.12900 159.55350
## 107      22     2 21 1338.0000 833.0148 181.77872 379.18377
## 108      22     3 21 1309.0476 807.2226 176.15042 367.44334
## 109      22     4 19 1202.8421 583.4950 133.86292 281.23557
## 110      22     5 20 1218.3000 370.5427  82.85586 173.41932
## 111      23     1 22 1028.2727 642.6689 137.01747 284.94343
## 112      23     2 23 1001.3043 510.6175 106.47111 220.80757
## 113      23     3 24  971.1250 298.5011  60.93129 126.04597
## 114      23     4 22 1044.0000 440.0478  93.81851 195.10628
## 115      23     5 24 1005.2500 227.4543  46.42891  96.04552
## 116      24     1 23 1191.0870 396.2152  82.61658 171.33630
## 117      24     2 20 1084.8000 201.6264  45.08503  94.36404
## 118      24     3 21 1365.8095 736.3058 160.67510 335.16239
## 119      24     4 19 1129.1053 203.3442  46.65036  98.00877
## 120      24     5 23 1247.3913 261.3268  54.49041 113.00619
## 121      25     1 22 1456.2273 524.3499 111.79178 232.48374
## 122      25     2 22 1664.2727 604.9429 128.97426 268.21666
## 123      25     3 21 1487.5238 410.5383  89.58680 186.87478
## 124      25     4 20 1459.9000 486.0652 108.68748 227.48551
## 125      25     5 22 1452.6818 343.8970  73.31908 152.47538
## 126      26     1 20 1492.0500 503.8785 112.67065 235.82238
## 127      26     2 20 1574.1000 539.1449 120.55646 252.32757
## 128      26     3 21 1498.9048 644.0032 140.53302 293.14674
## 129      26     4 19 1502.2105 481.4382 110.44949 232.04578
## 130      26     5 22 1461.3182 430.7701  91.84048 190.99274
## 131      27     1 23 1014.1304 305.9043  63.78545 132.28293
## 132      27     2 21 1094.7619 492.1216 107.38973 224.01106
## 133      27     3 23 1049.0435 351.7792  73.35103 152.12072
## 134      27     4 19 1163.0000 774.6531 177.71760 373.37082
## 135      27     5 21 1235.3810 641.2629 139.93504 291.89937
## 136      28     1 22 1119.5455 391.8398  83.54052 173.73203
## 137      28     2 17  995.5882 137.4164  33.32838  70.65300
```

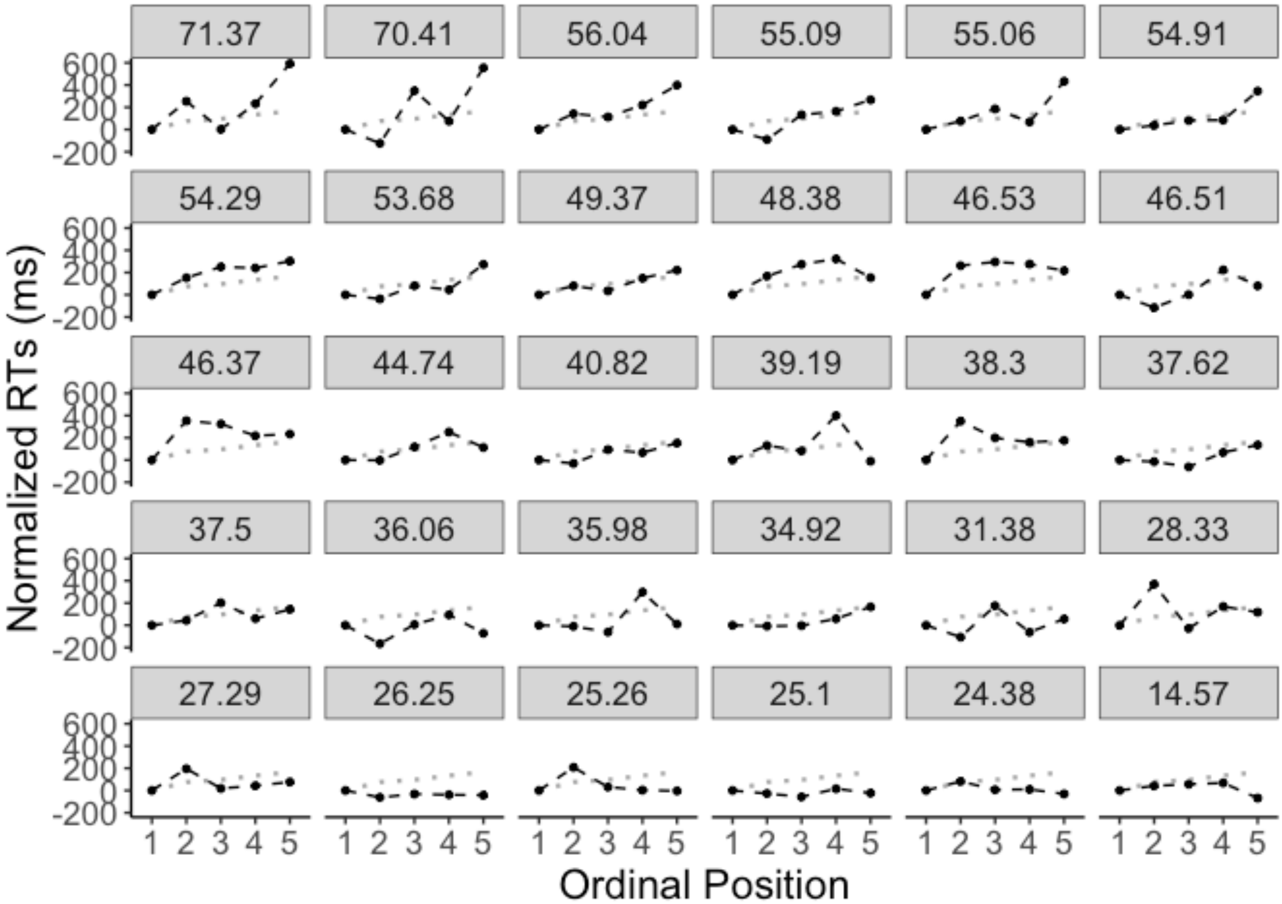
```
## 138      28     3 17 1468.2353 707.7288 171.64944 363.88056
## 139      28     4 21 1194.9048 452.0555  98.64659 205.77318
## 140      28     5 22 1674.4545 833.5255 177.70824 369.56451
## 141      29     1 17 1241.3529 372.8605  90.43195 191.70718
## 142      29     2 21 1278.4286 536.2322 117.01545 244.08995
## 143      29     3 18 1322.7222 541.8283 127.71015 269.44486
## 144      29     4 20 1326.1500 423.6310  94.72676 198.26539
## 145      29     5 20 1586.7500 735.6691 164.50061 344.30373
## 146      30     1 23 1138.4783 394.3009  82.21742 170.50850
## 147      30     2 24  972.7917 294.8757  60.19125 124.51509
## 148      30     3 21 1145.2381 542.8572 118.46115 247.10563
## 149      30     4 22 1231.6818 606.4584 129.29737 268.88859
## 150      30     5 20 1066.9500 362.4705  81.05088 169.64144
```

```
(means_final<- df_valid %>%
   Rmisc::summarySEwithin(.,"timing.01",idvar = "subject",
                          withinvars = "PosOr", na.rm = T))
```

```
##   PosOr   N timing.01       sd       se       ci
## 1     1 645  1152.220 444.1659 17.48902 34.34238
## 2     2 633  1228.071 553.3236 21.99264 43.18749
## 3     3 638  1247.875 525.8232 20.81754 40.87930
## 4     4 637  1285.638 593.4891 23.51489 46.17622
## 5     5 625  1317.224 562.0187 22.48075 44.14708
```

```
for(i in 1:nrow(means_final_subject)) {
  means_final_subject$grandmean[i] <- means_final$timing.01[means_fina
  means_final_subject$normalizedRT[i] <- means_final_subject$timing.01
    means_final_subject$timing.01[means_final_subject$subject == means_
  # prepare for ordering
  means_final_subject$effect[i] <- modeloutput$PosOr.cont[means_final_s
}
#means_final_subject$order <-order(means_final_subject$effect)-1
#means_final_subject$order <- means_final_subject$order %/% 5
means_final_subject <- means_final_subject[order(desc(means_final_subje
means_final_subject$effect <- as.factor(round(means_final_subject$effec
means_final_subject$effect <- factor(means_final_subject$effect, levels

(plot_rt <- means_final_subject %>%
    ggplot(., aes(x=PosOr,y=normalizedRT, na.rm=T)) +
    #geom_point(aes(x=PosOr,y=grandmean), size = 0.5, color = 'gray')+
    geom_line(aes(x=PosOr,y=grandmean), group = 1,size = 0.8, color =
    geom_point(size =1, color = 'black') +
    geom_line(group = 1,size = 0.5, color = 'black', linetype = "dashed
```

```
#geom_errorbar(aes(ymin=timing.01-se, ymax=timing.01+se), width =.1
apatheme+
scale_y_continuous(limits = c(-200, 600),
                   breaks = c(-200, 0,200,400,600)) +
labs(x="Ordinal Position",y ="Normalized RTs (ms)") +
facet_wrap(means_final_subject$effect))
```




```
filename <- "CSI_online_typing_effect_by_participant.pdf"
ggsave(plot_rt, filename =
         here::here("figures", filename),
       width = 13, height = 18, units = "cm",
       dpi = 300, device = cairo_pdf)
embedFonts(file = here::here("figures", filename))
```