Treasure Hunt Analysis

DVM Bishop & Adam Parker

10/02/2020

Location game accuracy

This R markdown details the analysis for Response Times analysis detailed in the preregistration for the project "Impact of Training Schedules on Language Learning in Children". This study was preregistered on the Open Science Framework (https://osf.io/ykacn/).

Output file from Gorilla

This is csv file with a row for each datapoint in the series of trials. Subjects, identified by random letter strings, are stacked on top of each other. We start by reading the data and cutting out unwanted information. This file was combined using the "combined_files_v13.R" script and cases meeting our data exclusion criteria were removed.

```
## Warning: Missing column names filled in: 'X1' [1]
```

```
## Parsed with column specification:
## cols(
##   .default = col_character(),
##   X1 = col_double(),
##   subject = col_double(),
##   X1.x = col_double(),
##   `Event Index` = col_double(),
##   `UTC Timestamp` = col_double(),
##   `Local Timestamp` = col_double(),
##   `Local Timezone` = col_double(),
##   `Experiment ID` = col_double(),
##   `Experiment Version` = col_double(),
##   `Repeat Key` = col_logical(),
##   `Schedule ID` = col_double(),
##   `Participant Private ID` = col_double(),
##   `Participant Starting Group` = col_logical(),
##   `Participant External Session ID` = col_logical(),
##   Checkpoint = col_logical(),
##   `Task Version` = col_double(),
##   `randomiser-q7g1` = col_logical(),
##   `Time Elapsed` = col_double(),
##   `Time Taken` = col_double(),
##   Correct = col_double()
##   # ... with 5 more columns
## )
```

```
## See spec(...) for full column specifications.
```

```
## [1] 1.551042
```

```
## [1] "Number of subjects =  96"
```

Preposition types are identified by hard coding here: beware if using with different spreadsheets. Here we just export a list of all items, and manually assign to item type. NB This is not used in Nicole analysis, but analysing this way made it clear there would be problems in using the preposition task to look at learning.

For vocabulary, the main measure of learning is accuracy, so we'll first plot that to see how it changes with training, and whether it differs by conditions. In fact, 'attempts' could be used to give a more graded measure of accuracy. Let's break into blocks of 10 trials and measure total attempts within a block.

```
## [1] "N completing given number of Vocabulary blocks:"
```

```
## b1 b2 b3 b4 b5
## 96 96 76 56 31
```

Process RTs

We anticipate non-normal RT data. We will inspect the data and compare impact of various ways of handling this. To do this we will first just focus on the correct responses to Vocabulary items. We will look at these separately for each subject.

Two functions created to a) remove outliers, and b) plot data

Function to check normality for each subject/vocab

We use these two functions to consider how transforming data and removing outliers affects normality of RT distribution. This involves creating additional columns with different versions of RT.

```
## [1] "Raw RT pick: 20 out of 96 meet p>.05 criterion for normality"
```

```
## [1] "Censored RTpick (RTpick.a): 29 out of 96 meet p>.05 criterion for normality"
```

```
## [1] "Outlier exclusion Hoaglin Iglewicz 1.65 (RTpick.k): 43 out of 96 meet p>.05 criterion for normal
```

```
## [1] "Logs after censoring/HI outliers (logRTpick.k): 79 out of 96 meet p>.05 criterion for normality
```

```
## [1] "Raw RT pick: 79 out of 96 meet p>.05 criterion for normality"
```

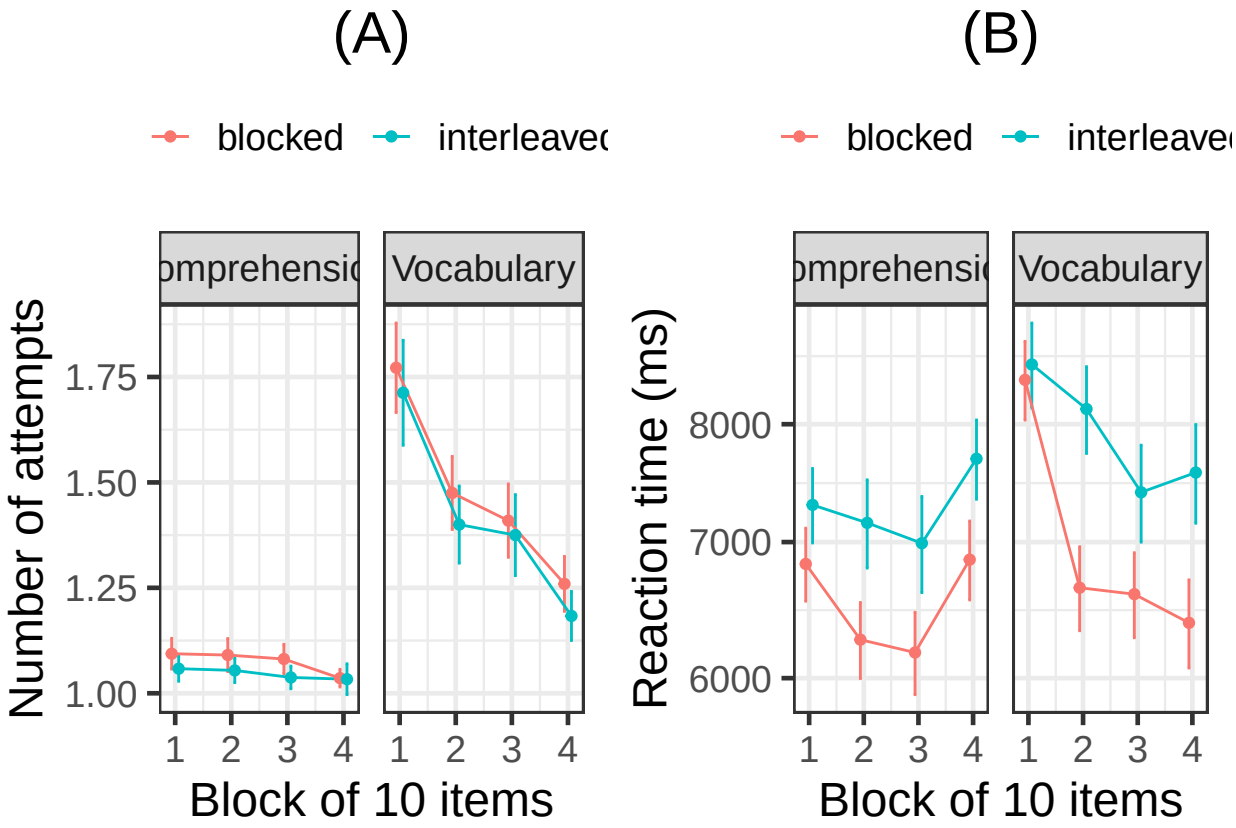
```
## [1] "Censored RTpick (RTpick.a): 14 out of 96 meet p>.05 criterion for normality"
```

```
## [1] "Outlier exclusion Hoaglin Iglewicz 1.65 (RTpick.k): 32 out of 96 meet p>.05 criterion for normal
```

```
## [1] "Logs after censoring/HI outliers (logRTpick.k): 76 out of 96 meet p>.05 criterion for normality
```

Now plot means

```
## `summarise()` regrouping output by 'condition', 'block' (override with `.groups` argument)
```



HYPOTHESIS 1: Learning

Reaction Time Analysis:

In order to investigate Hypothesis 1, we will use beta estimates (regression slopes) to estimate learning for spatial preposition and vocabulary items. This will be achieved by fitting a linear model to median RTs for blocks of 10 successive trials. For preposition and vocabulary items separately, we will then conduct a one-tailed one-sampled t-test where participant slopes are compared to 0 (indicating that no learning has occurred). Because reaction time decreases as learning occurs, learning is said to have occurred if the sample gradients are significantly less than 0.

In the Reaction Time analysis, we plan to only consider the trials in which the participants successfully completed the trial on their first attempt unless this results in a substantial loss of data

```
## [1] "one-group t-test vs zero for slopes"
```

```
##
##  One Sample t-test
##
## data:  vocmedians$slope[vocmedians$condition == "blocked"]
## t = -4.5012, df = 31, p-value = 8.922e-05
## alternative hypothesis: true mean is not equal to 0
```

```
## 95 percent confidence interval:
##  -0.04646907 -0.01748927
## sample estimates:
##   mean of x
## -0.03197917
```

```
## [1] 0.7957074
```

```
##
##  One Sample t-test
##
## data:  vocmedians$slope[vocmedians$condition == "interleaved"]
## t = -2.3322, df = 23, p-value = 0.02881
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.037113491 -0.002222194
## sample estimates:
##   mean of x
## -0.01966784
```

```
## [1] 0.47605
```

```
## [1] "T test comparing slopes"
```

```
##
##  Welch Two Sample t-test
##
## data:  vocmedians$slope by vocmedians$condition
## t = -1.1165, df = 48.942, p-value = 0.2697
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.034471694  0.009849045
## sample estimates:
##     mean in group blocked mean in group interleaved
##               -0.03197917               -0.01966784
```

```
## [1] 0.3026933
```

```
## Bayes factor analysis
## --------------
## [1] Alt., r=0.707 : 0.4580268 ±0.01%
##
## Against denominator:
##   Null, mu1-mu2 = 0
## ---
## Bayes factor type: BFindepSample, JZS
```

```
##
## Call:
## lm(formula = slope ~ condition * age, data = vocmedians)
##
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -0.09345 -0.02881  0.00210  0.03150  0.07464
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)                4.149e-03  4.175e-02   0.099    0.921
## conditioninterleaved       1.527e-02  6.220e-02   0.245    0.807
## age                       -3.436e-04  3.911e-04  -0.879    0.384
## conditioninterleaved:age -4.133e-05  5.936e-04  -0.070    0.945
##
## Residual standard error: 0.04086 on 52 degrees of freedom
##   (167 observations deleted due to missingness)
## Multiple R-squared:  0.0504, Adjusted R-squared:  -0.004381
## F-statistic:  0.92 on 3 and 52 DF,  p-value: 0.4377
```

Accuracy Analysis:

To address hypothesis 1, for each of the 4 conditions, the number of attempts to successfully complete the tasks will be averaged across the first 10 trials, and across the last 10 trials separately. The two averages will then be compared using a paired-sample t-test. Learning is said to have occurred if the average number of attempts of the last 10 trials is significantly lower than that for the first 10 trials. That said, we do note that there is a possible floor effect in the analysis of this dependent variable which may mask learning.

```
## [1] "one-group t-test vs zero for attmept reduction"
```

```
##
##  One Sample t-test
##
## data:  vocerrs$decline[vocerrs$condition == "blocked"]
## t = -7.4976, df = 31, p-value = 9.486e-09
## alternative hypothesis: true mean is less than 0
## 95 percent confidence interval:
##        -Inf -0.3966031
## sample estimates:
## mean of x
##   -0.5125
```

```
##
##  One Sample t-test
##
## data:  vocerrs$decline[vocerrs$condition == "interleaved"]
## t = -7.2146, df = 23, p-value = 1.204e-07
## alternative hypothesis: true mean is less than 0
## 95 percent confidence interval:
##        -Inf -0.4034605
## sample estimates:
##  mean of x
## -0.5291667
```

```
## [1] "T test comparing interleaved and blocked error decline block 1 to 4"
```

```
##
##  Welch Two Sample t-test
```

```
##
## data:  vocerrs$decline by vocerrs$condition
## t = 0.16623, df = 51.486, p-value = 0.8686
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1845674  0.2179008
## sample estimates:
##     mean in group blocked mean in group interleaved
##                -0.5125000                -0.5291667
```

```
## Bayes factor analysis
## --------------
## [1] Alt., r=0.707 : 0.2752989 ±0.01%
##
## Against denominator:
##   Null, mu1-mu2 = 0
## ---
## Bayes factor type: BFindepSample, JZS
```

```
## [1] "one-group t-test vs zero for slopes"
```

```
##
##  One Sample t-test
##
## data:  vocerrs$slope[vocerrs$condition == "blocked"]
## t = -7.1184, df = 31, p-value = 5.341e-08
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.14364459 -0.07966399
## sample estimates:
##  mean of x
## -0.1116543
```

```
## [1] 1.258371
```

```
##
##  One Sample t-test
##
## data:  vocerrs$slope[vocerrs$condition == "interleaved"]
## t = -6.5965, df = 23, p-value = 9.912e-07
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.14951611 -0.07812692
## sample estimates:
##  mean of x
## -0.1138215
```

```
## [1] 1.346495
```

```
## [1] "T test comparing slopes"
```

```
##
##  Welch Two Sample t-test
##
## data:  vocerrs$slope by vocerrs$condition
## t = 0.092939, df = 50.92, p-value = 0.9263
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.04464878  0.04898322
## sample estimates:
##     mean in group blocked mean in group interleaved
##                -0.1116543                -0.1138215
```

```
## [1] 0.02492029
```

```
## Bayes factor analysis
## --------------
## [1] Alt., r=0.707 : 0.2731811 ±0.01%
##
## Against denominator:
##   Null, mu1-mu2 = 0
## ---
## Bayes factor type: BFindepSample, JZS
```

```
## Warning: Removed 168 rows containing non-finite values (stat_ydensity).
```

```
## `stat_bindot()` using `bins = 30`. Pick better value with `binwidth`.
```

```
## Warning: Removed 168 rows containing non-finite values (stat_bindot).
```

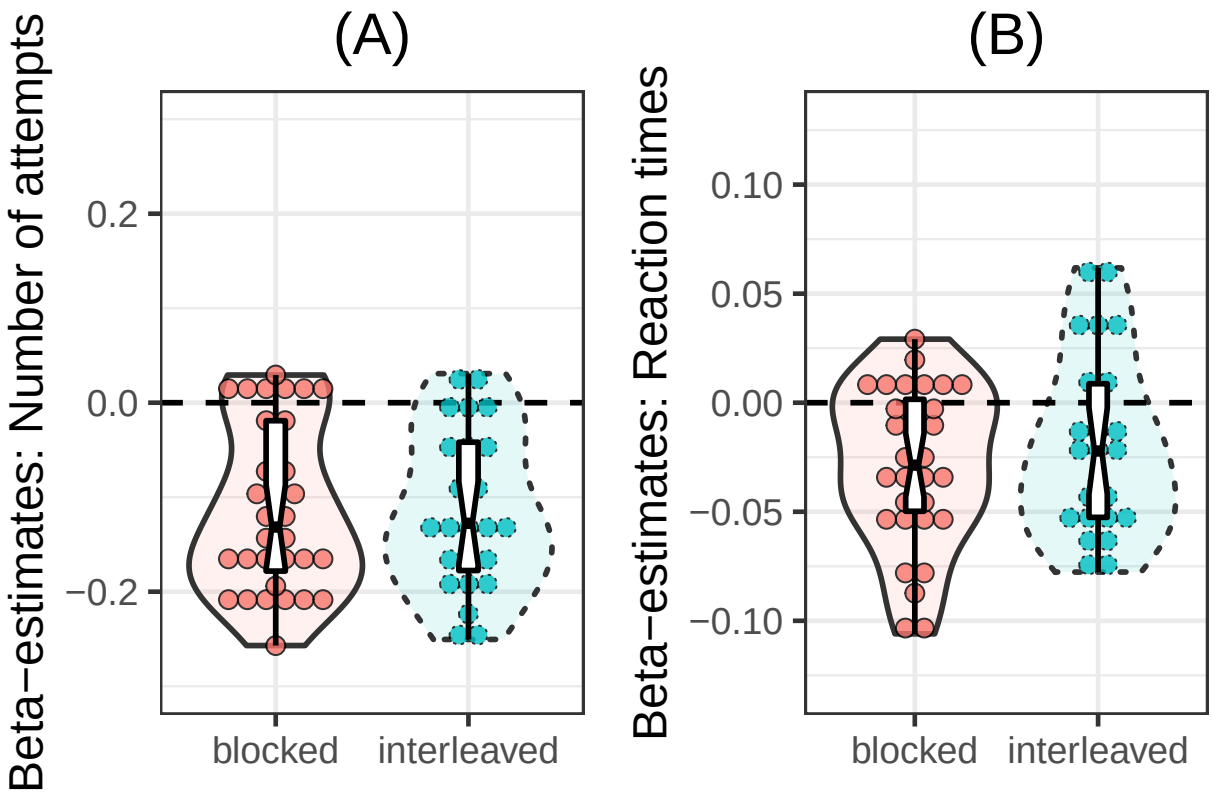
```
## Warning: Removed 168 rows containing non-finite values (stat_boxplot).
```

```
## Warning: Removed 168 rows containing non-finite values (stat_ydensity).
```

```
## `stat_bindot()` using `bins = 30`. Pick better value with `binwidth`.
```

```
## Warning: Removed 168 rows containing non-finite values (stat_bindot).
```

```
## Warning: Removed 168 rows containing non-finite values (stat_boxplot).
```


(A)
Beta−estimates: Number of attempts
0.2
0.0
−0.2
blocked
interleaved
(B)
Beta−estimates: Reaction times
0.10
0.05
0.00
−0.05
−0.10
blocked
interleaved