PORTFOLIO 8

Meta-analysis of pitch in schizophrenia

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The aim of this assignment is to do a meta-analysis on the current literature investigating distinctive patterns of pitch mean and pitch variability in schizophrenia.

The assignment answers the following questions:

1. What is the current evidence for distinctive patterns of pitch mean and pitch sd in schizophrenia? Report how many papers report quantitative estimates, your method to analyze them, the estimated effect size of the difference (mean effect size and standard error for pitch mean, same for pitch sd) and forest plots representing it.

Step 1: Looking at the data
Look through the dataset to find out which columns to use, and if there is any additional information written as comments.
There are 55 studies in the dataset. Of these studies many have missing values for either pitch mean or pitch variability. It is therefore expected that we will have few studies for the actual meta-analysis.

Step 2: Calculate effect size and standard error of the effect size
We calculated the effect size and standard error of the effect size per each study by using pitch mean, pitch standard deviation and sample size.
We created two random-effects models, one for pitch mean and one for pitch variability.

Model results pitch mean:

```
Model <- rma(yi, vi, data = data, slab=StudyID)
```

Random-Effects Model (k = 5; tau^2 estimator: REML)

estimate	se	zval	pval	ci.lb	ci.ub
0.2352	0.1810	1.2995	0.1938	-0.1196	0.5901

5 studies were included, which involved 192 participants with schizophrenia participants and 121 comparison participants. The overall estimated difference (Cohen's d) in pitch variability between the schizophrenia and the comparison groups was 0.24, SE= 0.18, p=0.19. This suggests that the summary effect size is not statistically significant.

Model results pitch variability:

```
Model2 <- rma(yi, vi, data = data2, slab=StudyID)
```

Random-Effects Model (k = 14; tau^2 estimator: REML)

estimate	se	zval	pval	ci.lb	ci.ub
-0.2286	0.3140	-0.7281	0.4665	-0.8440	0.3868

14 studies were included, which involved 605 participants with schizophrenia participants and 469 comparison participants. The overall estimated difference (Cohen's d) in pitch variability between the schizophrenia and the comparison groups was -0.23, SE= 0.31, p=0.47. This suggests that the summary effect size is not statistically significant.

Step 3: <u>forest plots</u>
Lastly, we created forest plots for both pitch mean (figure 1) and pitch variability (figure 2).
Both forest plots show the same tendency: bigger sample sizes generally equals to smaller confidence intervals.
For pitch mean the combined effect size seems to be positive as the diamond is located to the right. However, the edges of the diamond are overlapping the vertical line showing that the combined result is probably not statistically significant (as confirmed above).
For pitch variability the combined effect size seems to be negative. Again, the edges of the diamond are overlapping the vertical line showing that the combined result is probably not statistically significant (also confirmed above).

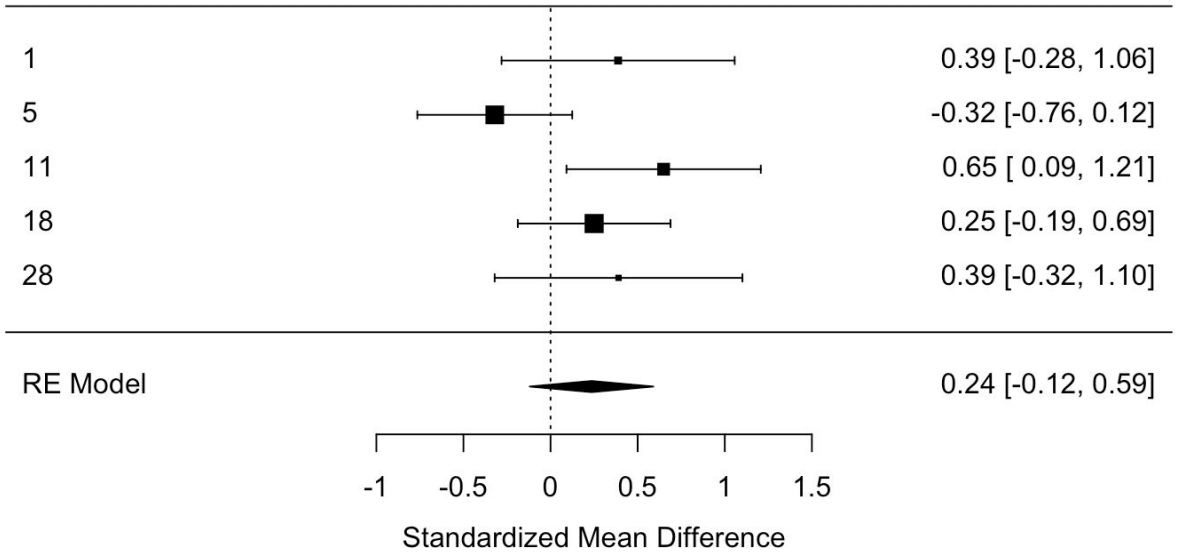

Figure 1 - forest plot of pitch mean

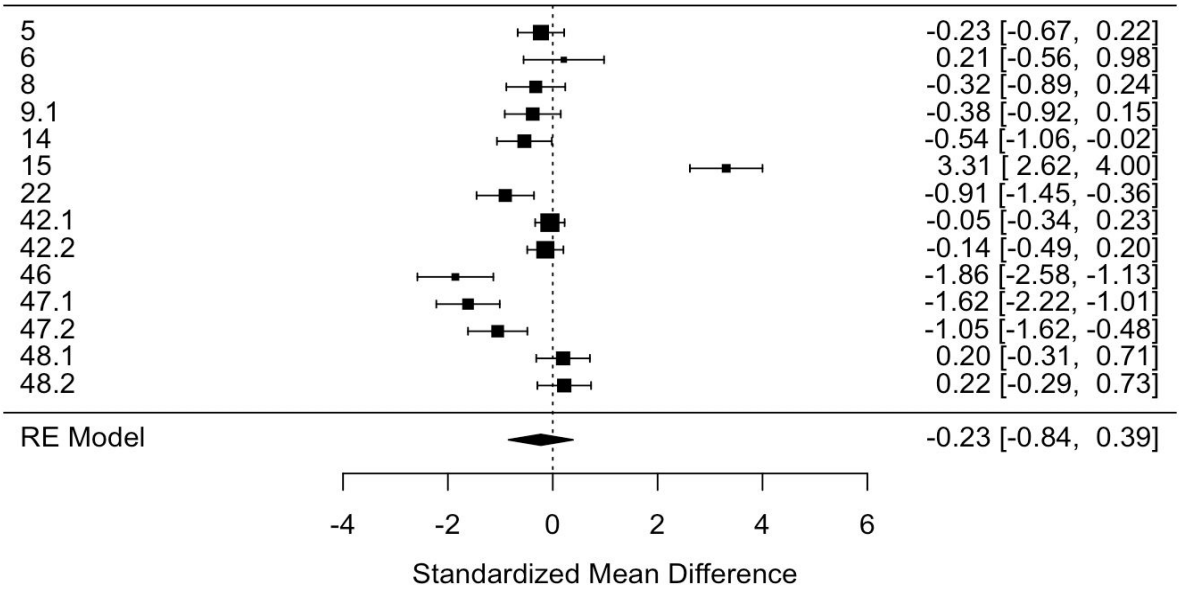

Figure 2 - forest plot of pitch variability

2. Do the results match your own analysis from Assignment 3? If you add your results to the meta-analysis, do the estimated effect sizes change? Report the new estimates and the new forest plots.

Step 1: Add data from assignment 3 to our data

The data from assignment 3 is on pitch mean. Therefore, the data is added to the dataframe with its sample size, mean and standard deviation.

Step 2: Re-run meta-analysis

We calculated the effect size and standard error of the effect size for the new studies by using pitch mean, pitch standard deviation and sample size.

We created a new random-effects model including the new data.

```
Model3  <-  rma(yi, vi, data = PitchRange3, slab=StudyID)
```

Model results pitch mean (with data from assignment 3):

Random-Effects Model (k = 8; tau^2 estimator: REML)

estimate	se	zval	pval	ci.lb	ci.ub
0.3587	0.1300	2.7595	0.0058	0.1039	0.6135

8 studies were included, which involved 277 participants with schizophrenia participants and 206 comparison participants. The overall estimated difference (Cohen's d) in pitch variability between the schizophrenia and the comparison groups was 0.36, SE= 0.13, p=0.0058. This suggests that the summary effect size is statistically significant.

Thus, adding the results from assignment 3 has changed the estimated effect size from 0.24 to 0.36. Furthermore, the result is now significant.

Step 3: Forest plot
A new forest plot is created (figure 3)
Adding the data from assignment 3 has changed the forest plot for mean pitch. The combined effect size still seems to be positive. However, the diamond, has moved more to the right supporting the results from above, that adding the studies from assignment 3 is giving us a more positive effect size. The edges of the diamond is no longer overlapping the vertical line showing that the combined effect size is statistically significant.

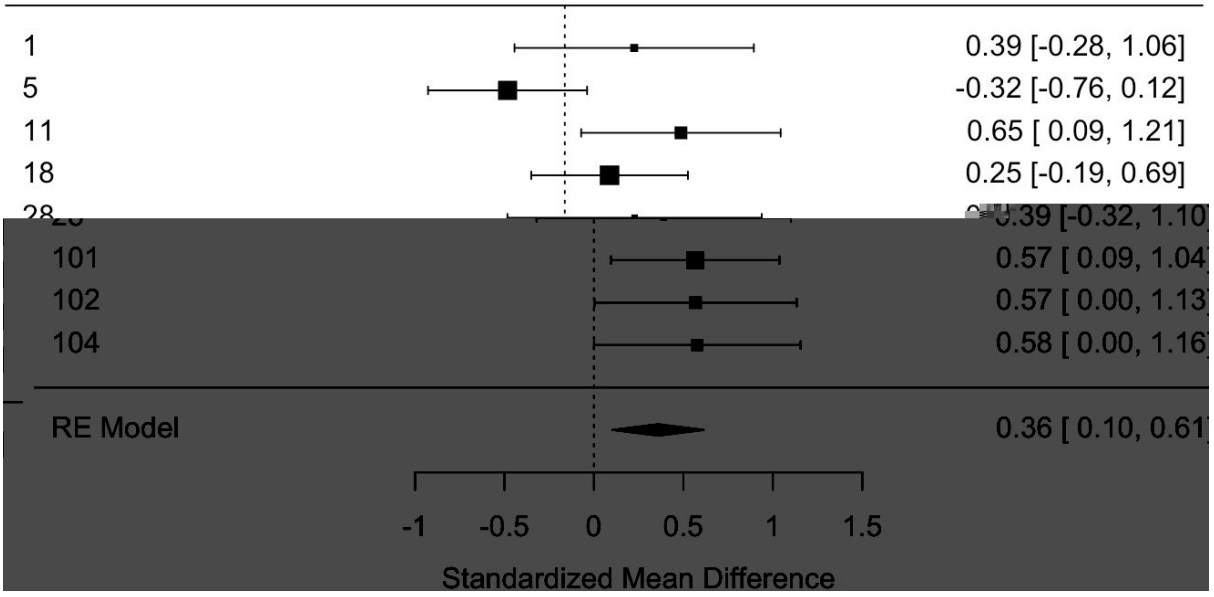

Figure 3 - forest plot of pitch mean with data from assignment 3

3. Assess the quality of the literature: report and comment on heterogeneity of the studies (tau, I2), on publication bias (funnel plot), and on influential studies.

For this question, we are again only looking at the data from question 1 since our own results cannot be seen as part of the literature.

Heterogeneity of the studies
We calculated overall variance ($\tau 2$) and assessed whether it could be explained by within-study variance (e.g., due to measurement noise or heterogeneity in the schizophrenia samples included in the studies) using Cochran's Q (Cochran, 1954) and I2 statistics (Higgins, Thompson, Deeks, & Altman, 2003)

For pitch mean
Overall variance (τ2) of 0.084 (95% CIs: 0.00, 1.01). Much of the variance (I2: 52.40%, 95% CIs: 0.00, 92.98) could not be reduced to random sample variability between studies (Q-stats = 8.38, p = 0.079).

For pitch variability
Overall variance (τ2) of 1.30 (95% CIs: 0.65, 3.67). Much of the variance (I2: 95.31%%, 95% CIs: 91.02, 98.29) could not be reduced to random sample variability between studies (Q-stats = 164.30, p-val < .0001).

Publication bias and influential studies
Finally, we investigated the effect of influential studies (single studies strongly driving the overall results) and publication bias (tendency to write up and publish only significant findings, ignoring null findings and making the literature unrepresentative of the actual population studied) on the robustness of our analysis. This was estimated using rank correlation tests assessing whether lower sample sizes (and relatedly higher standard error) were related to bigger effect sizes. A significant rank correlation indicates a likely publication bias and inflated effect sizes due to small samples.

For pitch mean
Step 1: Creating a funnel plot
When looking at the funnel plot (figure 4), it seems as if there is a bias as most studies are to the right. When using the trim and fill method to examine the sensitivity of the results to one particular selection mechanism (i.e., one particular form of publication bias), we also found evidence of an uneven distribution (figure 5).

Step 2: Test for biases
Oppositely to the funnel plot, neither Egger's regression test (p = 0.26) or the Rank correlation test (τ = 0.20, p = 0.82) was statistically significant so there's no evidence of publication bias according to these tests.

Step 3: Creating a baujat plot
The Bajaut plot can illustrate studies that are contribute to overall heterogeneity and the overall result. Study IDs are used to identify studies.
Studies that fall to the top right quadrant of the Baujat plot contribute most to both these factors. It seems that especially study 5 contributes to overall heterogeneity and the overall result (figure 6).

Step 4: Test for influential studies
A set of diagnostics are also available to identify potential outliers and influential cases.
The diagnostics are also plotted (figure 7). The plot shows us that removing study 5 would change tau^2 and the effect size (rstudent).

Thus, we can conclude that:
There was one obvious outlier (study 5), but no obvious publication bias (Kendall's τ = 0.20, p = 0.82).

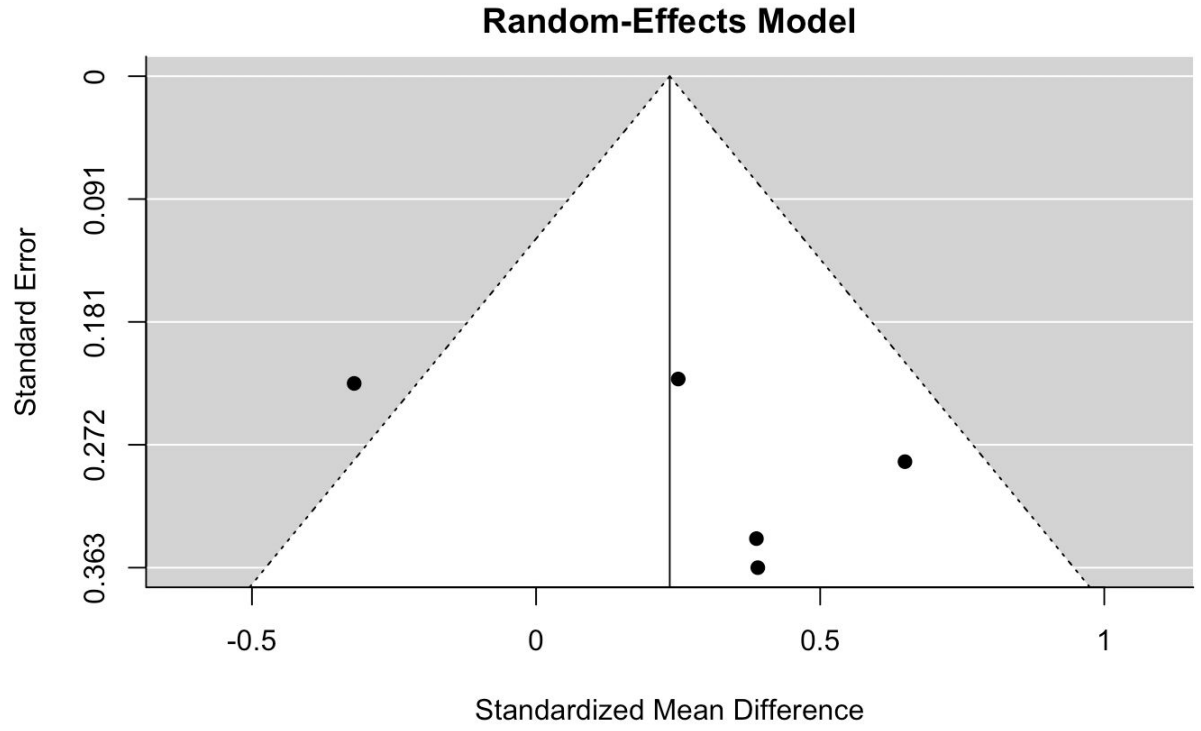

Figure 4 - funnel plot for pitch mean

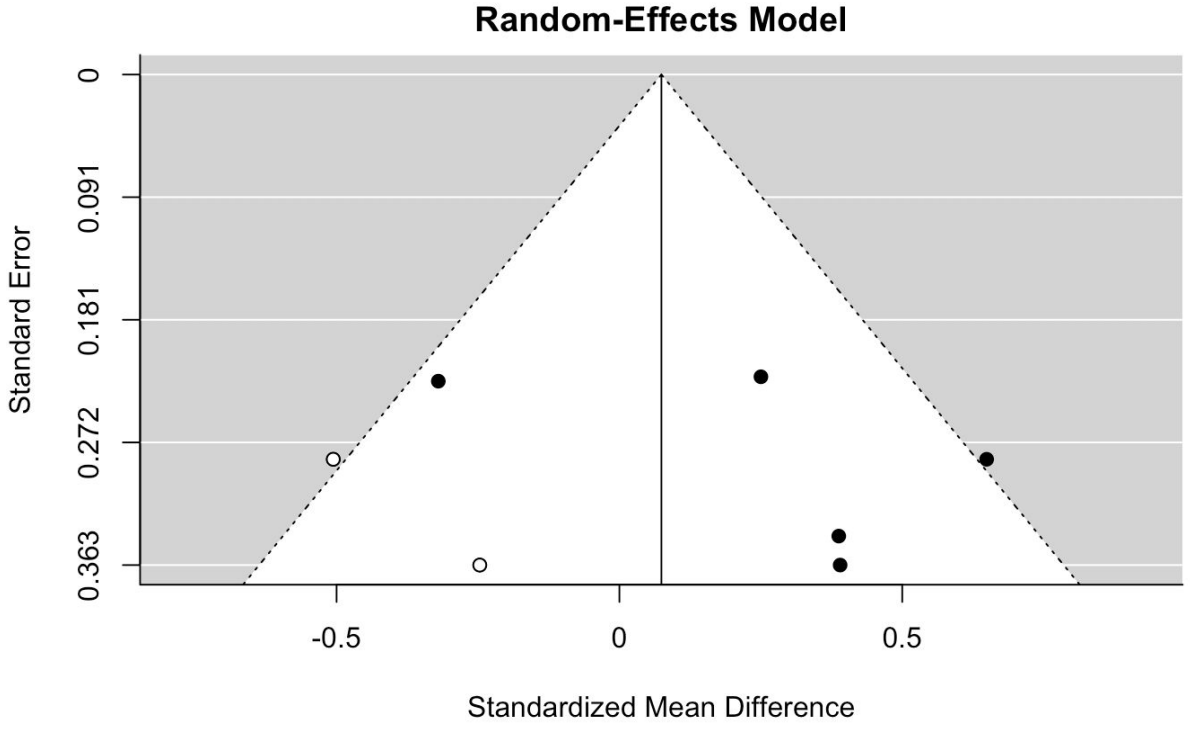

Figure 5 - funnel plot after trim and fill for pitch mean

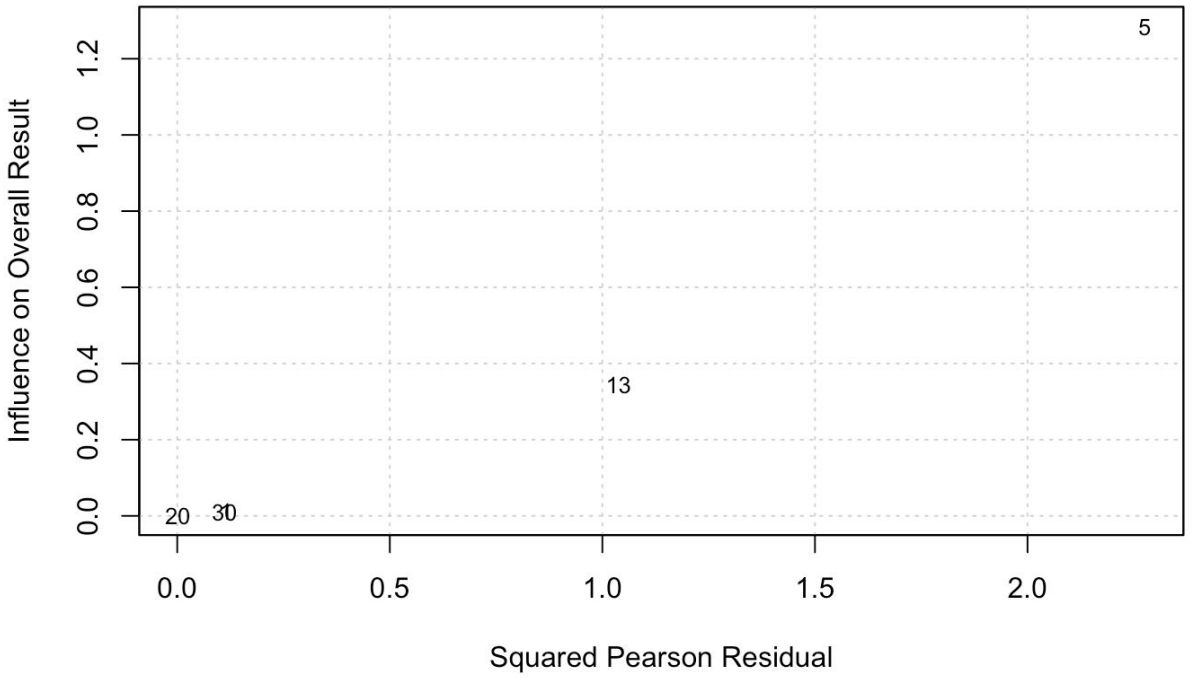

Figure 6 - Baujat plot for pitch mean

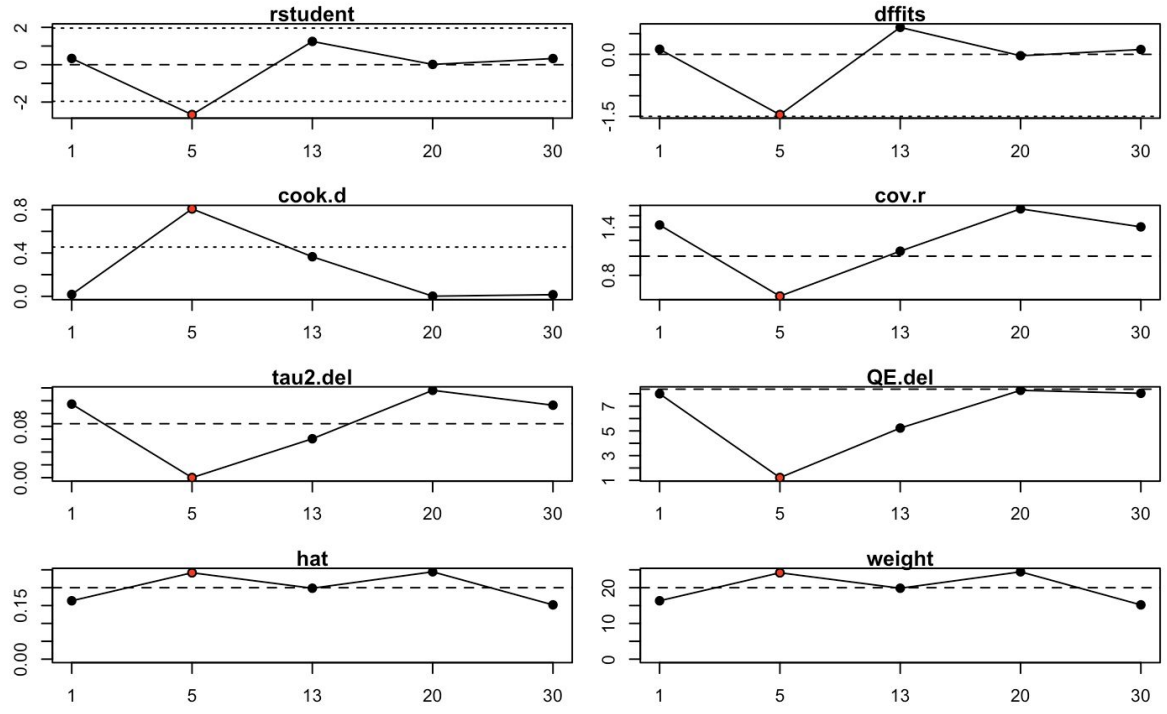

Figure 7 - plot of influential studies for pitch mean

For pitch variability

Step 1: Creating a funnel plot

When looking at the funnel plot (figure 8), it does not seem as if there is a bias as the studies are distributed to both the left and the right. When using the trim and fill method, no evidence was found for a publication bias (figure 9).

Step 2: Test for biases

In line with the funnel plot, neither Egger's regression test ($p = 0.83$) or the Rank correlation test ($\tau = -0.30$, $p = 0.16$) was statistically significant so there's no evidence of publication bias according to these tests.

Step 3: Creating a baujat plot

It seems that especially study 17 contributes to overall heterogeneity and the overall result (figure 10).

Step 4: Test for influential studies

A set of diagnostics are also available to identify potential outliers and influential cases.
The diagnostics are also plotted (figure 11). The plot shows us that removing study 17 would change tau^2 and the effect size (rstudent).

Thus, we can conclude that:
There was one obvious outlier (study 17), but no obvious publication bias (Kendall's $\tau = -0.30$, $p = 0.16$).

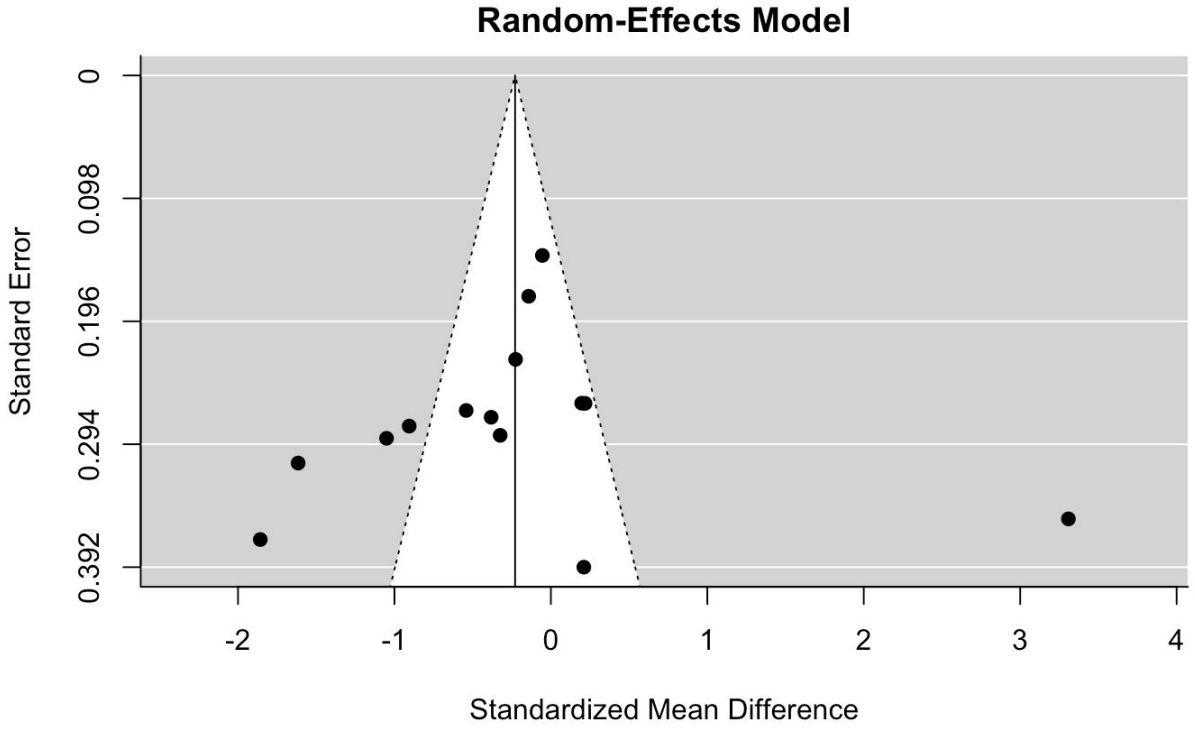

Figure 8 - funnel plot for pitch variability

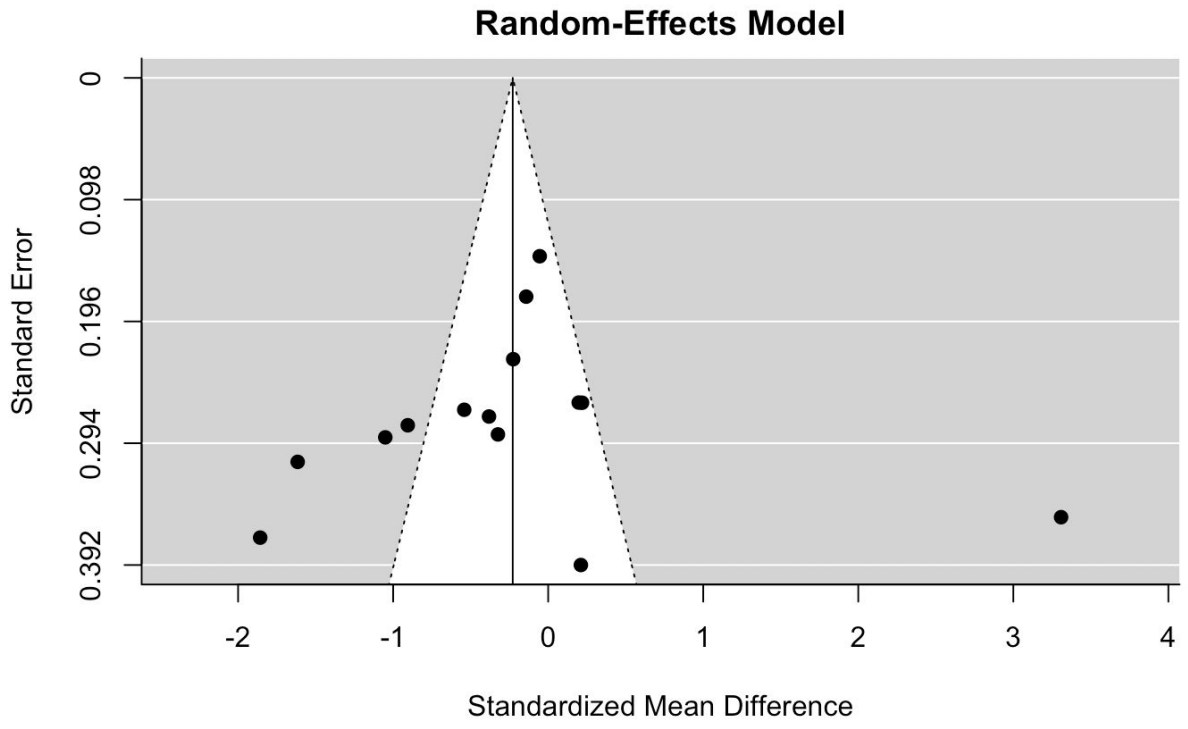

Figure 9 - funnel plot after trim and fill for pitch variability (no change)

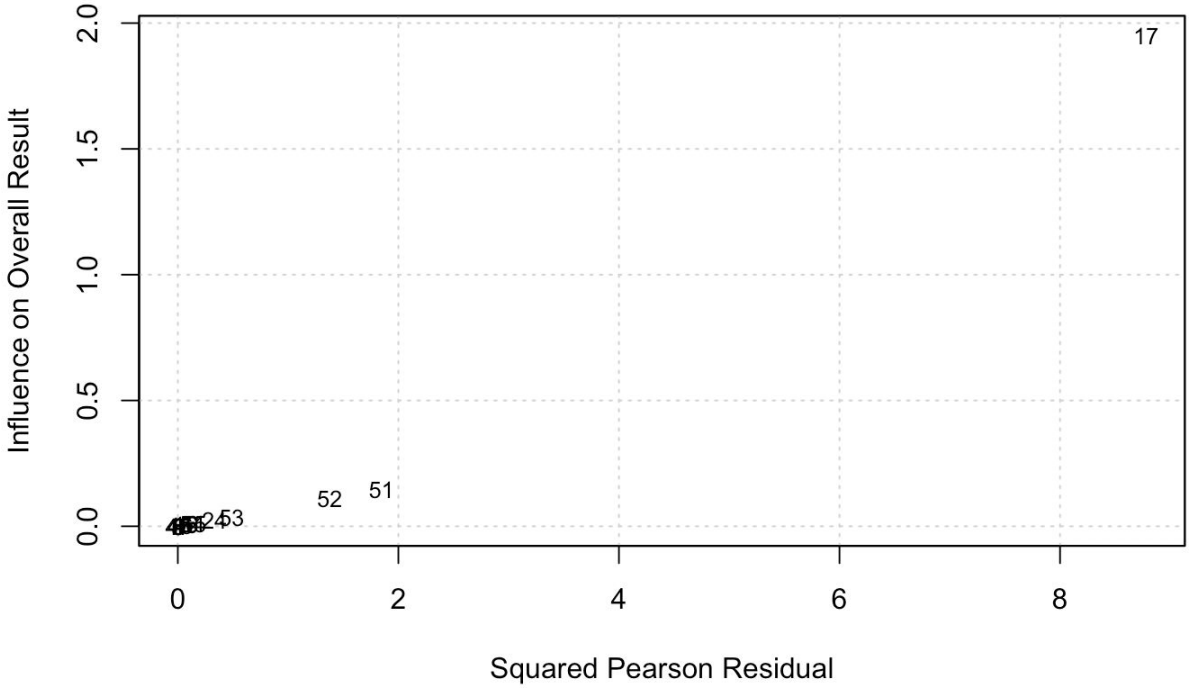

Figure 10 - Baujat plot for pitch variability

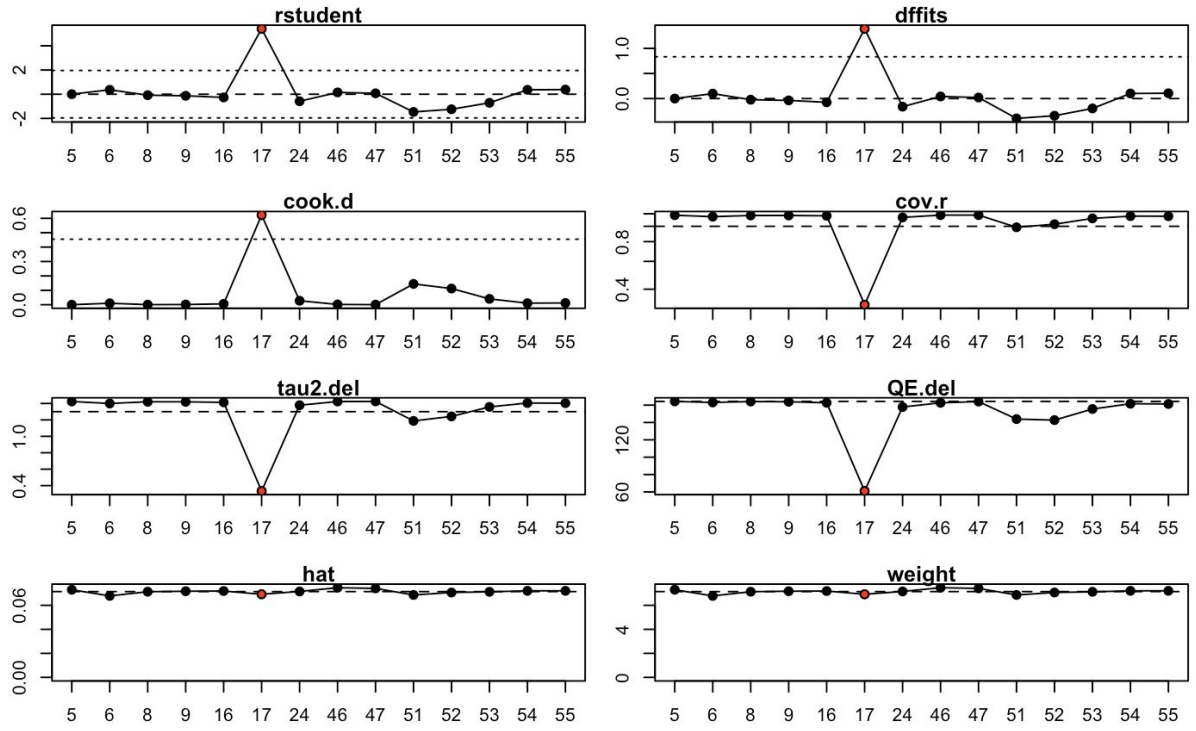

Figure 11 - plot of influential studies for pitch variability

Link to our code:
https://github.com/sebsebar/Alouishes/blob/master/Assignment5_MetaAnalysis_A5_MetaAnalysis.Rmd