https://github.com/StudiegruppeEM3/methods3_A3

Code is named (...)_final_code

Methods

Procedure
Every participant watched several videos of triangles moving across a computer screen and were instructed to describe them.

Data
When the participants described the triangles their voices were recorded and their pitch was extracted every 10th millisecond as a measure of fundamental frequency (hertz).

Each study collected demographic data from the participants, this includes: language, gender, education, age, SANS (total score of negative symptoms), SAPS (total score of positive symptoms, Verbal IQ score , Non verbal IQ score and a total IQ score.

From the recordings the clinical practitioners obtained data of number of syllables, number of pauses automatically inferred from the audio (absence of human voice longer than 200 milliseconds), duration of the full recording, duration of the recording where speech were present, average number of syllables per second, average number of syllables per spoken second and average syllable duration

Sample
Our initial data included 7 studies, 1-4 being danish studies, 5-6 being Chinese studies and the 7th study being japanese participants. Due to lack of data on the japanese participants we excluded them throughout the analysis.
As can be seen in table 1-3, not all of the 6 studies are perfectly balanced in regards to gender or the number of control participants to diagnosed participants. Especially study 5 is unbalanced in both aspects. All the other studies seem to be not perfectly balanced but somewhat balanced. The studies have balanced age between the two conditions very well, the only concern is study 6 where the control group seems to be a bit older. For the studies reporting verbal-nonverbal IQ it can be seen that the control group scores higher than the diagnosed group in both study 1 and 2 however in study 6 it is the opposite way around for verbalIQ. The diagnosed group has high scores of SANS and SAPS which makes perfect sense, since they are diagnosed whereas the control group has either missing data or as in study 4 has very low values. As for education the studies seem to somewhat balance the education level for the two groups, although every control group for every study has higher values for education than their diagnosed counterparts.

Tabel 1

Study	N	Schizophrenia / Control	Male/ female	Age(mean ± sd(ci)) Schizophrenia	Age (control)
1	70	34/36	37/33	22.8±3.1 (23-22.7)	22.7±3.2(22.8-22.6)
2	46	23/23	33/13	23.3±3.8 (23.5-23.1)	23.7±3.5(23.8-23.5)
3	47	19/28	23/24	41.1±12.2 (41.8-40.4)	37.5±12.9(38.2-36.9)
4	58	29/29	33/25	24.7±3.7(24.9-24.5)	24.3±4.5(24.5-24.1)
5	26	20/6	19/7	25.5±4.8(25.6-25.4)	27±1.3(27-26.9)
6	51	23/28	25/26	27.3±7.2(27.4-27.2)	35.7±9.3(35.9-35.6)
Total	298	148/150	170/128		

Tabel 2

Study	Nonverbal-IQ Schizophrenia	Nonverbal-IQ Control	VerbalIQ Schizophrenia	VerbalIQ Control
1	87.8±16.8 (88.3-87.2)	99.3±12.9 (99.7-98.8)	86.9±16.4 (87.4-86.3)	96.4±14.8 (96.9-95.9)
2	90.6±20.7 (91.7-89.5)	107.6±11.7 (108.2-107)	94.2±21.7 (95.3-93.1)	113±12.4 (113.7-112.4)
3	NA	NA	NA	NA
4	NA	NA	NA	NA
5	NA	NA	NA	NA
6	92.8 ± 18.9 (93.1- 92.5)	108±22.1 (108.5-107.6)	96.8±13 (97-96.6)	93.8±13.5 (94-93.5)

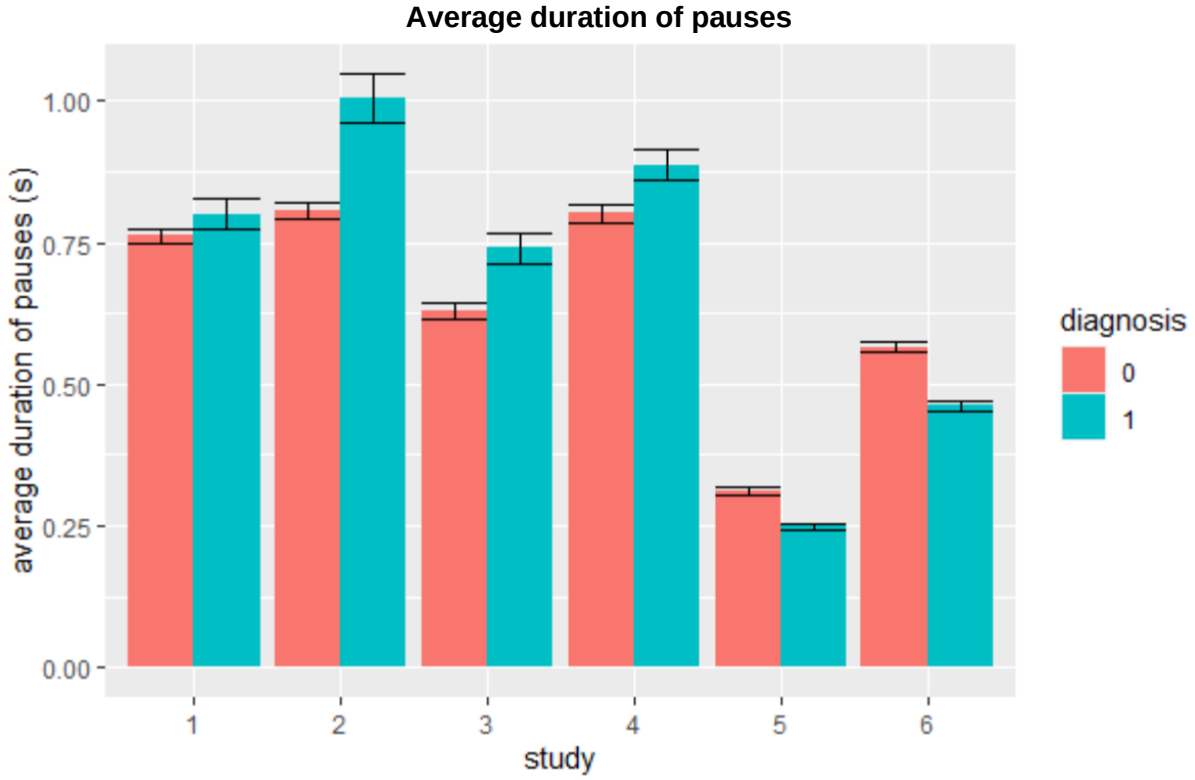
Tabel 3

Study	SANS Schizophrenia	SANS Control	SAPS Schizophrenia	SAPS Control	Education schizophrenia	Education Control
1	10.2±4.3 (10.4-10.1)	0	10.5±4.0 (10.6-10.4)	0	12.1±2.3 (12.2-12.0)	13.4±2.2(13.5-13.3)
2	9.9±5.2 (10.1-9.6)	0	14.5±4.3 (14.7-14.3)	0	12.2±2.5 (12.3-12)	15.2±2.6(15.3-15.1)
3	NA	NA	NA	NA	12.7±2.7 (12.9-12.6)	15.9±2.7(16-15.8)
4	8.6±3.6 (8.7-8.4)	1.3±1.9 (1.4-1.2)	7.0±3.9 (7.1-6.8)	0.3±0.8 (0.3-0.2)	14.7±2.6 (14.8-14.6)	15.8±2.2(15.9-15.7)
5	7.8±2.5 (7.8-7.77)	NA	11.6±4.0 (11.7-11.6)	NA	13.1±3 (13.2-13.1)	16.9±0.3(16.9-16.9)
6	6.6 ± 3.5 (6.6- 6.5)	NA	9.8±3.67 (9.8-9.7)	NA	12.5±2.3 (12.5-12.4)	12.7±2.5(12.7-12.6)

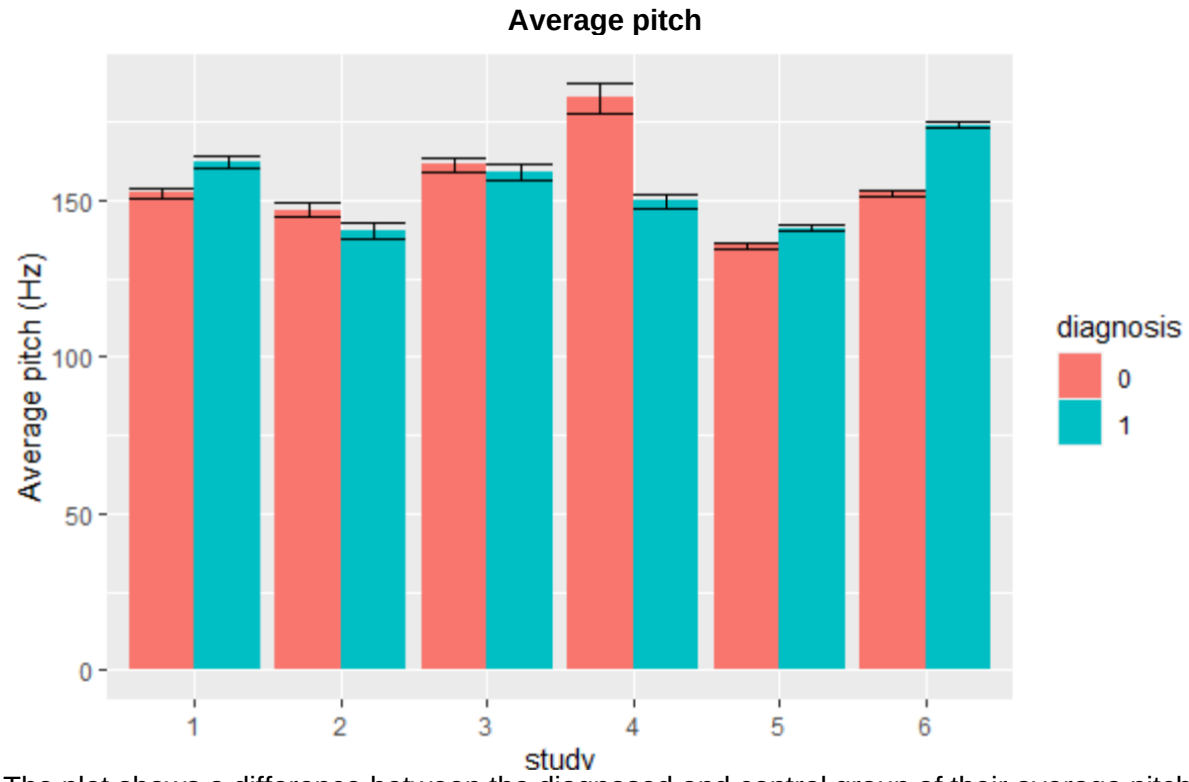
Acoustic profile

All the following plots error bars are displayed as 95% confidence intervals.

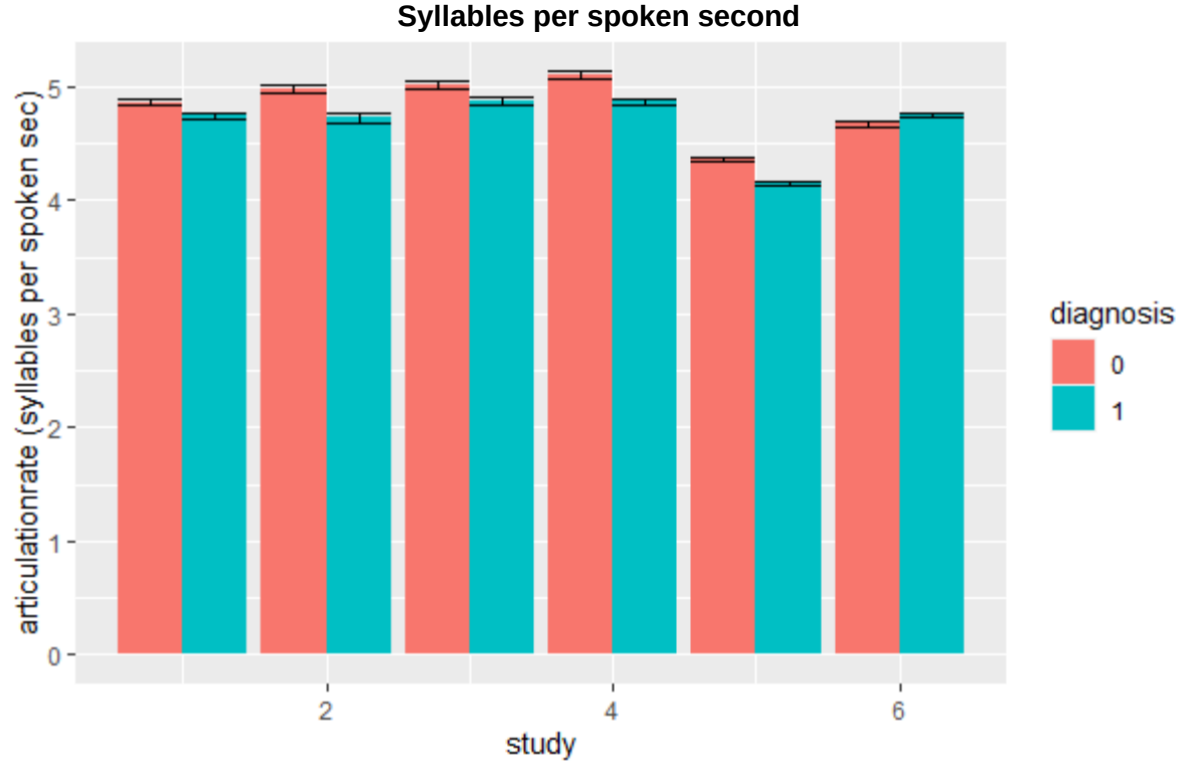
Plots.



The plot shows a difference between diagnosed and control groups of their average duration of pauses. The hypothesis from the meta-analysis stated that the duration of pauses would be longer for patients diagnosed with schizophrenia than those not diagnosed. We see a trend of this in the first four studies (Danish studies), and an opposite effect at study 5 and 6 (Chinese studies).

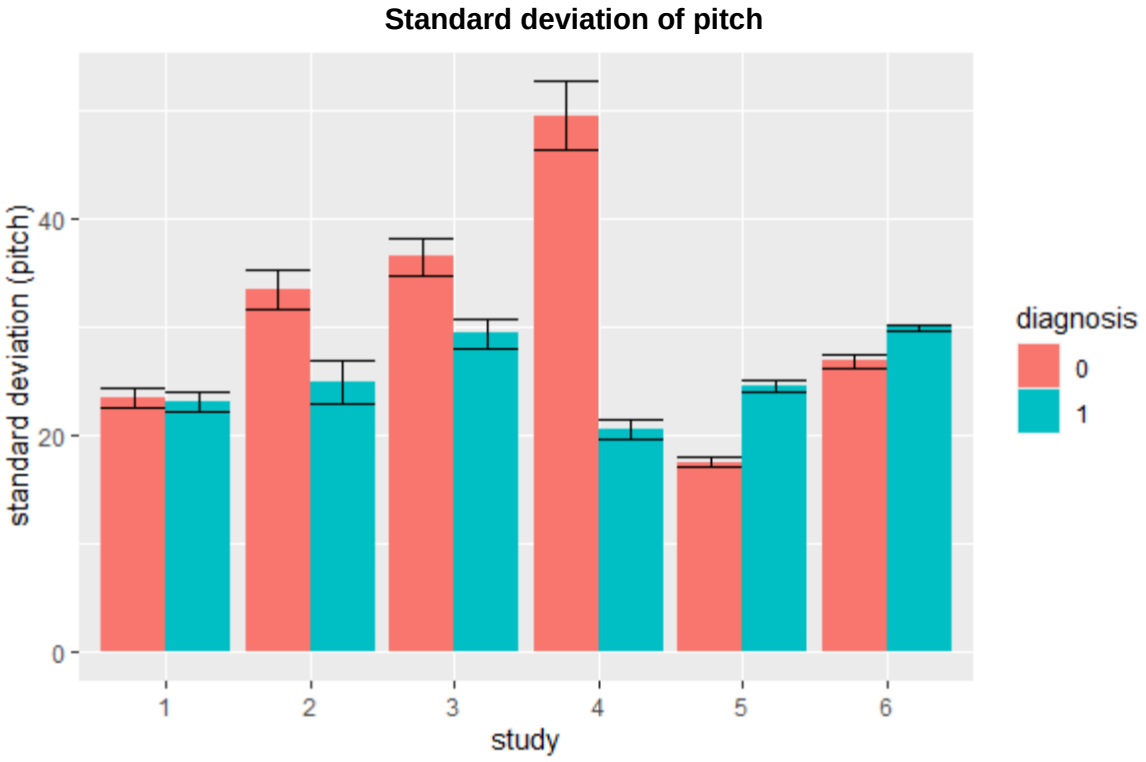


The plot shows a difference between the diagnosed and control group of their average pitch, measured in hertz.
In three of the six studies the diagnosed group has a higher pitch (1, 5 and 6), but in three of the four danish studies the opposite effect is found - the control group has a higher pitch than the diagnosed group.

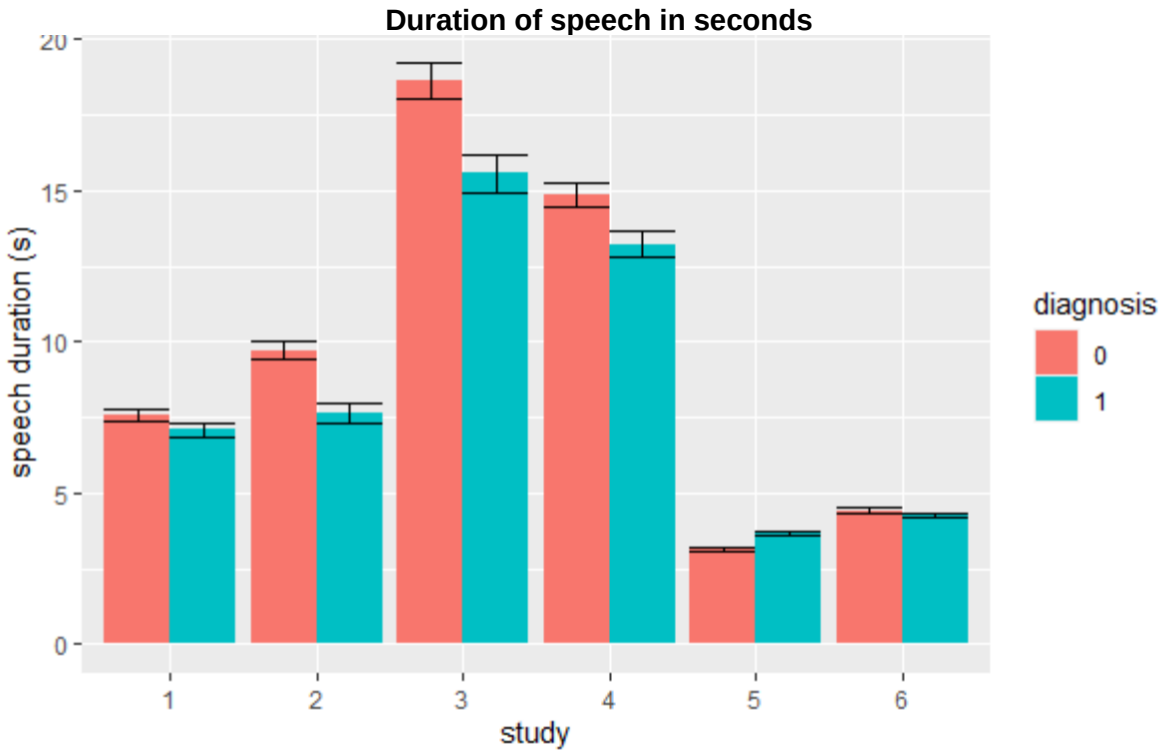


The plot shows a difference between diagnosed and control group of their average number of syllables per spoken second. The hypothesis from the meta-analysis stated that the

speech rate for the diagnosed would be slower than the control group. The higher the number of syllables per spoken seconds is the measure of how fast or slow one speaks. We see that in all the four danish studies and one of the chinese studies (five out of six studies) the rate at how quick one speech is different between the two groups, showing that people with schizophrenia are slower than the ones without.



The plot shows a difference between the diagnosed and control group of the standard deviation of the measured pitch. The hypothesis from the meta-analysis stated that the diagnosed participants with schizophrenia vary less in pitch than the control group.
In all the four danish studies the participants that are not diagnosed varies more in pitch than the ones who are. The two chinese studies do not indicate this.



The plot shows a difference between the diagnosed and control group of their duration of speech. How much they speak during a session. The hypothesis from the meta-analysis stated that the speech rate would be lower for diagnosed participants, indicating that schizophrenia participants speak less than the control group.
In five out of the six studies this effect is found, stating that the control group speaks more during a session than participants diagnosed with schizophrenia.

We have separated the studies according to language because as the plots show, study 5-6 (the chinese studies) seem to display different relationships between acoustic profile and diagnosis this could also be argued that it is due to the fact that the chinese studies are taken from a completely different population than the danish studies. We therefore only look at the danish studies.

Statistical analysis

We made a mixed effect logistic regression to try and replicate the meta-analysis findings.

First we look how correlated our predictor variables are in a correlation matrix see table 2.

Table 2:

	speechdur	articulationrate	fsd	pausedur
speechdur	1.00	0.06	0.05	-0.14
articulationrate	0.06	1.00	-0.08	0.02
fsd	0.05	-0.08	1.00	0.00
pausedur	-0.14	0.02	0.00	1.00

As can be seen in the correlation matrix, none of our predictor variables are especially correlated, the highest correlation coefficient is -0.14 which raises no concerns. We therefore include all 4 fixed effects in our model. We scale all our fixed effects so that we can compare our estimates to the meta-analysis findings, when scaling the fixed effects the estimates becomes a standardized effect size called standardized mean difference or hedges' g.
In the model we include random intercept for each participant, this ensures that we account for the fact that the studies are done using a repeated measure design. When having participants as a random intercept we also account for gender, age, education and study because every participant gets their own intercept.

Therefore our model was:

diagnosis ~ scale(speechdur)+ scale(fsd)+scale(articulation rate)+scale(pausedur)+(1|name)

Results

Fixed effect (scaled)	Estimate	Std.error	t-value	p-value
Intercept	-16.6	1.0	-16.79	>0.001
Proportion of spoken time	-0.05375	0.61365	-0.088	0.930
Pitch variability	-0.19020	0.59796	-0.318	0.750
Speechrate	-0.16750	0.56040	-0.299	0.765
pauseduration	0.17489	0.74894	0.234	0.815

The meta-analysis findings

Fixed effect	**Estimate**	**CI lower**	**Ci upper**
Pitch variability	-0.55	-1.06	0.09
Proportion of spoken time	-1.26	-2.26	0.25
Speech rate	-0.75	-1.51	0.04
Pause duration	1.89	0.72	3.21

Our estimates for the model are in the same direction as the meta-analysis findings but not to the same magnitude.