Acoustic patterns in schizophrenia. A systematic review and meta-analysis

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INTRODUCTION

• Reported **atypical voice patterns** in schizophrenia: poverty of speech, increased pauses, distinctive pitch and intensity (mean and variability).

• Atypical voice patterns are associated with **clinical features** (e.g. flat affect), and may play a role in the **social impairment** experienced by patients.

• However, there is **uncertain quantitative evidence**, and very little is known on the underlying mechanisms: how voice atypicalities relate to motor, cognitive, social and clinical factors.

• We systematically reviewed the literature and performed **a meta-analysis of the evidence** quantifying acoustic patterns in schizophrenia.

• We aimed at identifying evidence for **acoustic markers of schizophrenia** and its clinical features, as wells as needs for further research and **barriers to collective advancements** on these issues.

METHODS

• We adopted the "PRISMA Statement" guidelines and pre-registered the study at Open Science framework (OSF) and PROSPERO (details and pre-registration at: https://goo.gl/H1yDpm).

• Literature search conducted on Pubmed and Google Scholar: ((prosody) OR (inflection) OR (intensity) OR (pitch) OR (fundamental frequency) OR (speech rate) OR (voice quality) OR (acoustic) OR (intonation) OR (vocal)) AND (schizo*).

• Inclusion criteria were: (a) empirical study, (b) quantification of acoustic features in the vocal production, (c) at least two individuals with schizophrenia, (d) inclusion of a comparison group, or acoustic features in relation to severity of clinical features.

• The meta-analysis consisted of random-effects regression models, one per each relevant acoustic feature.

PRISMA 2009 Flow Diagram
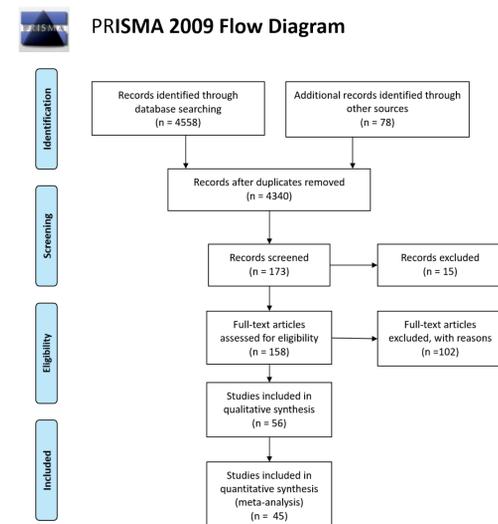
RESULTS

Meta-analysis of pitch variability
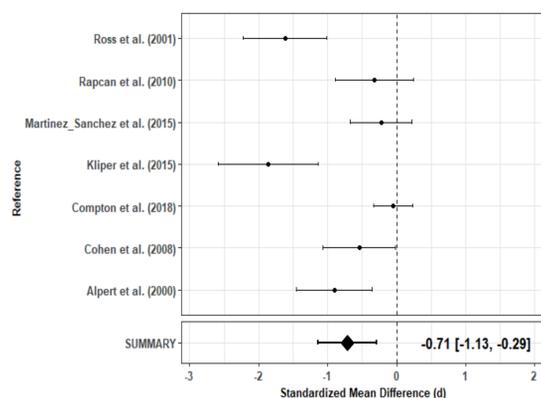
• **Reduced pitch variability.**
• A total of 351 participants with schizophrenia and 232 healthy controls.
• Variance in effects due to true between-studies variance (Q-stats: 47.7, p < .001).
• No influential study.
• The data revealed a likely publication bias (Kendall's tau = -0.89, p < .001).

Correlation - Pitch variability and flat affect
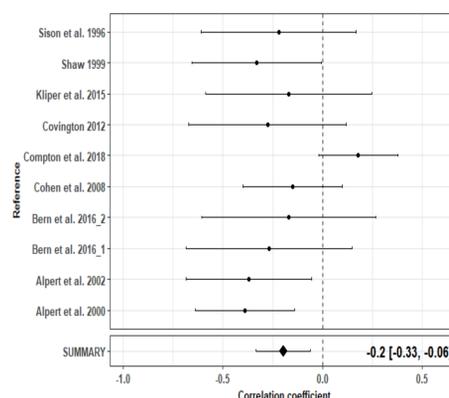
• **Reduction in pitch variability associated with flat affect.**
• A total of 367 participants with schizophrenia.
• The variance in effects due to true between-studies variance (Q-stats: 17.9, p = .035).
• One influential study (Compton et al., 2018). Removing it yielded an overall effect size of -0.27 (95% CI: -0.38 -0.16, p < .001).
• No publication bias (Kendall's tau = 0.16, p = .60).
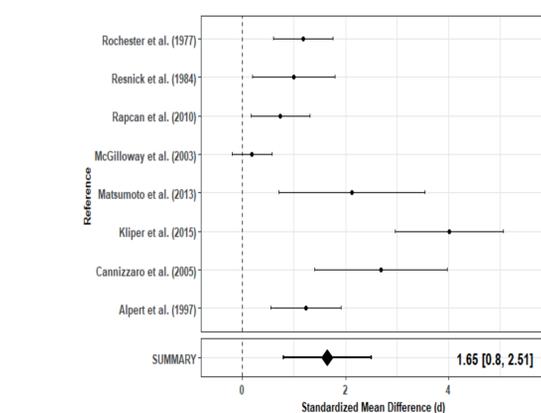
Meta-analysis of speech production (percentage)
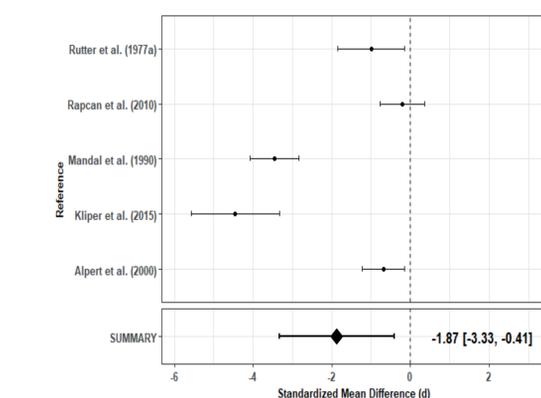
• **Reduced speech production.**
• A total of 159 participants with schizophrenia and 130 healthy controls.
• The variance in effects due to true between-studies variance (Q-stats: 98.4, p < .001).
• No influential study.
• The data did not reveal any likely publication bias (Kendall's tau = -0.47, p = .27).

Correlation - Speech production (percentage) and alogia
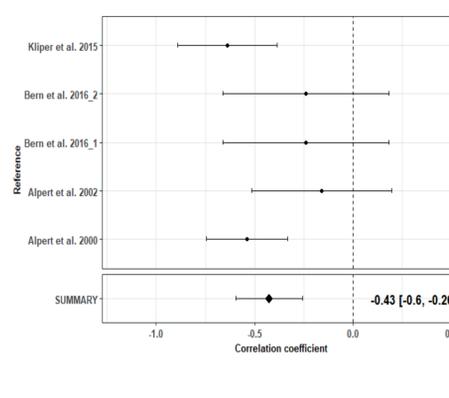
• **Reduction in speech production associated with alogia.**
• A total of 138 participants with schizophrenia.
• The variance in effects due to between-studies random-sample variability (Q-stats: 7.3, p = .12).
• No influential study.
• The data did not reveal any likely publication bias (Kendall's tau = 0.33, p = .44).

Meta-analysis of pause duration

• **Increased pause duration**
• A total of 221 participants with schizophrenia and 150 healthy controls.
• The variance in effects due to true between-studies variance (Q-stats: 75.6, p < .001).
• No influential study.
• The data revealed a likely publication bias (Kendall's tau = 0.67, p = .013).

CONCLUSIONS

DISCUSSION

• **Clear effects of reduced speech production** (speech percentage, pause percentage and speech rate), and **pitch variability and pause duration** (but with evidence for publication bias).

• No effects of pitch mean, mean intensity, number of pauses and mean utterance duration.

• **Limited effect sizes**, in contrast with the large effect sizes reported by studies using clinical rating scales.

OPEN ISSUES

• **Barriers to open data**: of the 71 authors contacted, 21 have non-working email addresses (29.5%), 36 responded (51%), but only 9 (13%) provided at least some of the data requested.

• **Lack of a systematic approach**.

• **Lack of theory driven hypotheses**.

RECOMMENDATIONS

• Larger sample sizes.

• **Systematic assessment** of multiple acoustic features and multiple speech tasks, standardized acoustic processing methods.

• **Shared standards** are needed to make individual level data available, as well as **more extensive data sharing** possible within privacy and ethical constraints.

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