



Factors Affecting Speech Naturalness in Young Adults with a History of Cleft Palate

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Background

- Individuals with a history of cleft palate with or without cleft lip (CP±L) are at risk for developing difficulties in speech and language. Some of the more common concerns relating to speech and language include: Excessive or abnormal nasality, audible nasal air emission, decreased intra-oral pressure, compensatory posterior articulation errors, breathy or rough voice, increased occurrence of vocal nodules, and delayed language development.
- Due to advances in treatment options, many of these individuals will be able to attain essentially typical speech.
- Many previous studies have examined which factors can predict positive speech outcomes (see review in Kuehn & Moller, 2000); however, the question of *which* variables contribute to such outcomes remains largely unanswered. The purpose of this project was to examine, through a retrospective analysis, factors predicting outcome measures of perceived speech naturalness. An ancillary purpose was to examine whether overt knowledge of the characteristics of cleft palate speech affected ratings of naturalness.

Purpose

- The purpose of this study was twofold:
- To determine the relative influence selected historic variables have on ratings of speech naturalness in young adults with CP±L.
 - To determine if knowledge of the diagnosis of cleft palate influences the perceptual ratings that people give of speech naturalness.

Participants

- Speakers: 35 patients from the University of Minnesota Cleft Palate Clinic.
 - Inclusionary criteria: Born between 1975 and 1990, non-syndromic CP±L, native English speakers, and completed a standardized speech recording between the ages of 15.5 and 21 years.
 - Exclusionary criteria: History of a two-staged palate repair, use of a speech prosthesis, significant permanent hearing loss, or a history of mental retardation.
- Listeners: 20 naïve listeners recruited from the University of Minnesota Twin Cities campus were divided into two groups. All listeners were between 18 and 30 years of age, were native English speakers, and had no history of speech, language, or hearing disorders.
 - Blind group: ten participants were not given any information in regards to the diagnoses of the speakers prior to rating the speech recordings.
 - Unblind group: ten participants were provided with an information sheet about clefting as well as a brief verbal overview of the diagnosis. Prior to rating the speech recordings, they were informed that each of the speakers had CP±L.

Methods

- All listeners passed a bilateral hearing screening.
- Following the instructions, they were given two practice trials, after which they were given the opportunity to ask for clarification.
- They were then presented with the 35 digitized and volume-equalized recordings of the "Lazy Jack" passage in a randomized order, and asked to rate the naturalness of speech following each recording.
- Natural speech was defined as "typical speech you would expect to hear in any given situation".
- Ratings were done using a visual analog scale, anchored with the terms "most natural" and "least natural". This allowed for precise differences to be recorded.

Analysis: 1

- A non-parametric Mann-Whitney U test was done to determine if there were systematic differences in the mean ratings across the 35 talkers of the blind and unblind groups. No systematic differences in mean ratings across talkers were found between the blind and unblind groups (Mann Whitney U = 36, Wilcoxon W = 91, $z = -1.058$, $p > 0.05$). The standard deviations of ratings across talkers also did not differ between groups (Mann Whitney U = 46, Wilcoxon W = 101, $z = -0.302$, $p > 0.05$).
- Average ratings for each talker, separated by group (blind vs. unblind) are shown in Figure 1. Average ratings for individual talkers were calculated separately for the blind and unblind groups. These were submitted to a non-parametric Wilcoxon signed ranks test. This difference was significant, $z = -4.16$, $p < 0.001$. The unblind group rated the talkers to sound significantly more natural than the blind group did.
- As shown in Figure 1, the magnitude of this difference was larger for some talkers than for others. These differences across talkers were explored in regression analyses.

Analysis: 2

- In order to determine which variables, if any, could account for the more natural perceptual ratings, a regression analysis pooled across the blind and unblind groups was conducted. The perceptual rating was the dependent variable. Seven independent variables were examined, and these included:
 - Sex
 - Age at primary palate repair
 - Age at insertion of first set of pressure-equalization tubes
 - Years in speech therapy
 - Resonance ratings at age 13 (eight point equal-appearing interval scale judgments)
 - Articulation ratings at age 13 (eight point equal-appearing interval scale judgments)
 - Percentage of hearing screenings passed at team visits
- Results: The regression was significant overall ($F[7,27] = 3.947$, $p = 0.004$, $R^2 = 0.51$), and demonstrated that over half the variance in naturalness ratings could be accounted for by these independent measures. However, inspection of the results of the regression revealed that the only variable to significantly predict naturalness ratings was articulation ratings at age 13.

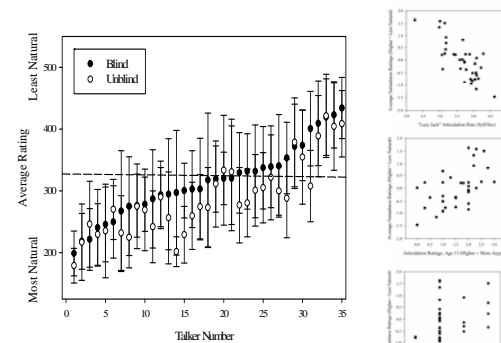


Figure 1. Average naturalness ratings for the 35 talkers, separated by listener group

Figures 2a (top), 2b (middle) and 2c (bottom).

Relationship between average ratings (pooled across listener groups) and speech rate (2a), Age 13 articulation ratings (2b), and Age 13 resonance ratings (2c)

Analysis: 3

- A third analysis examined the rate of speech of each speaker, and how that influenced perceptual ratings. This revealed that approximately 60% of the variance in perceptions of speech naturalness could be accounted for by rate of speech, with a tendency for slower speakers to be judged as less natural. In this regression, an additional 14% percentage of variance in naturalness ratings could be accounted for by articulation ratings at age 13.
- When separate regressions were run for the blind and unblind groups' ratings, the variance accounted for by speech rate was similar (55.2% and 57.5%, respectively), but the variance accounted for by articulation rate differed substantially (9.5% and 18%). The unblind group appeared to be listening more to articulation quality than the blind group was.

Discussion

- Ratings of naturalness were strongly affected by rate of speech. They were also predicted by historic measures of articulation ability at age 13. This has important clinical implications as physical and/or behavioral management should be pursued from a young age to ensure patients with CP±L attain precise articulation and an appropriate rate of speech.
- The knowledge of CP±L appears to have a small effect on ratings. Specifically, it biases listeners to attend to more subtle differences in articulation quality. Future research should determine which early variables can influence rate of speech and articulation ratings.
- Research in this area should continue to determine earlier factors impacting positive speech outcomes.

Acknowledgments

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