THE EFFECT OF CONSONANT-VOWEL BOUNDARY TO SPEECH PERCEPTION IN COCHLEAR IMPLANTS

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INTRODUCTION

- Cochlear Implant (CI) users report difficulty in understanding speech in noisy environments
  - ✓ No masking release from modulated maskers [5].
  - ✓ Cannot take advantage of temporal gaps
  - ✓ Can perform auditory stream segregation tasks [2].
- CI listeners have difficulty in successfully fusing interrupted speech signals into a coherent speech stream [6].
- Speech sounds are broadly classified into vowels and consonants.
- Consonants carry more information than vowels while reading.
- Vowels contribute more to speech intelligibility than consonants
- Vowel-only sentences led to a 2:1 intelligibility advantage over consonant-only sentences regardless of the type of segmental replacement in normal hearing listeners [1].

METHODS

Listeners: 8 adult CI users participated in this study.

Speech Corpus: Speech stimuli were taken from the AZTIMIT sentences [3]. All lists were equi-intelligible with a mean intelligibility of 73% [4].

List Characteristics:
- average of 128 words per list (range = 115 to 136 words)
- 18-20 unique talkers per list
- At least 6 male and 6 female talkers per list
- Talkers were from four dialectal regions (New England, Northern, North Midland, and Western)

Speech Processing strategies:
- Segment replacement paradigm on the AZRIMIT speech corpus was used to evaluate the effect of consonant-vowel boundary to speech perception.
- Two processing strategies were created to emphasize the duration of vowels and consonants by presenting different amounts (0%, 40%, 60%, 80%, and 90%) of consonants and vowels
- First strategy (**FVXC**) preserved full vowels and presented different amounts of consonants by replacing the consonant centers with either silence of speech shaped noise
- Second strategy (**FCXV**) preserved full consonants and presented different amounts of vowels by replacing the vowel centers with either silence of speech shaped noise
- Clean speech and interrupted speech (3Hz interruption rate, 50% duty cycle) were also presented
- PDA based research platform was used to present speech stimuli

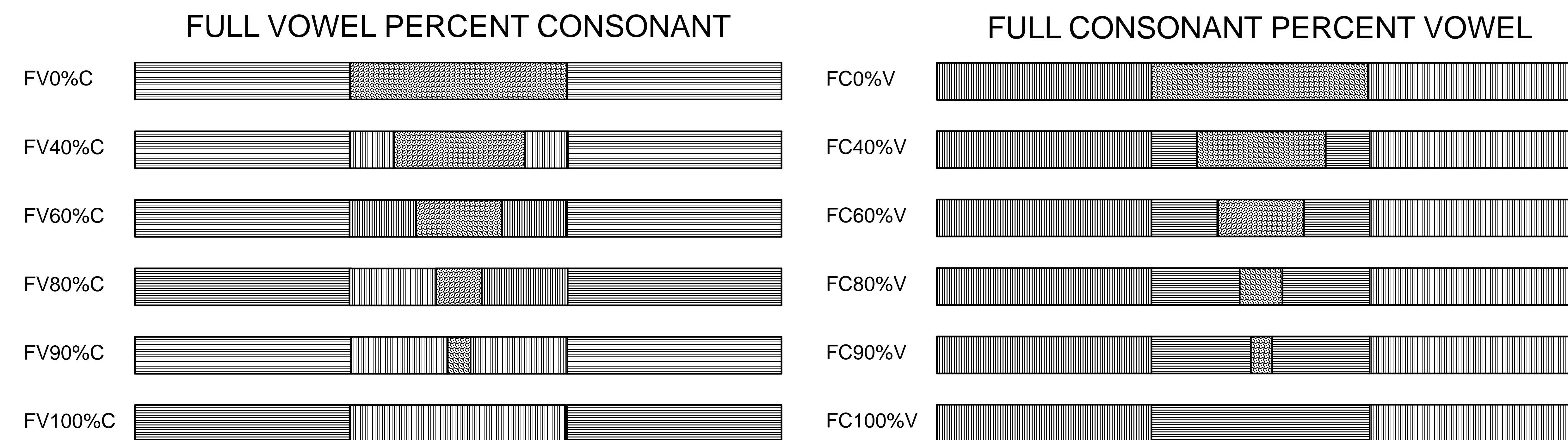## SPEECH PROCESSING STRATEGIES

Figure 1. Schematic of replacement paradigm depicted for a single VCV (panel a) or CVC (panel b). Horizontal bars indicate vowels, vertical bars indicate consonants and stippled bars indicate replaced portions (silence or speech shaped noise replacement).

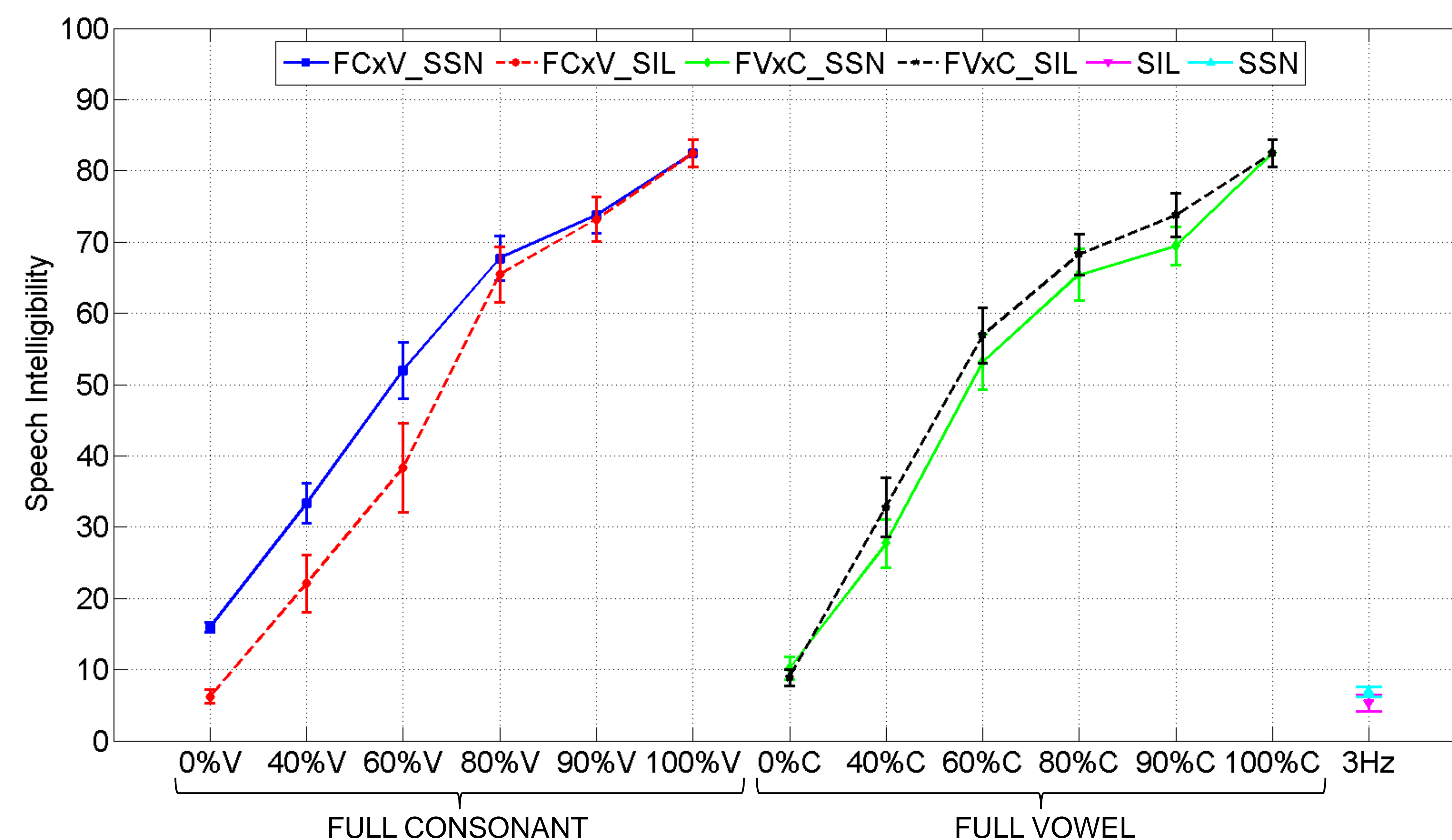## RESULTS – Average Speech Intelligibility

Figure 2. Mean speech intelligibility for all experimental conditions. The original TIMIT C-V boundary is at 0%V and 0%C. Error bars display standard error of mean.

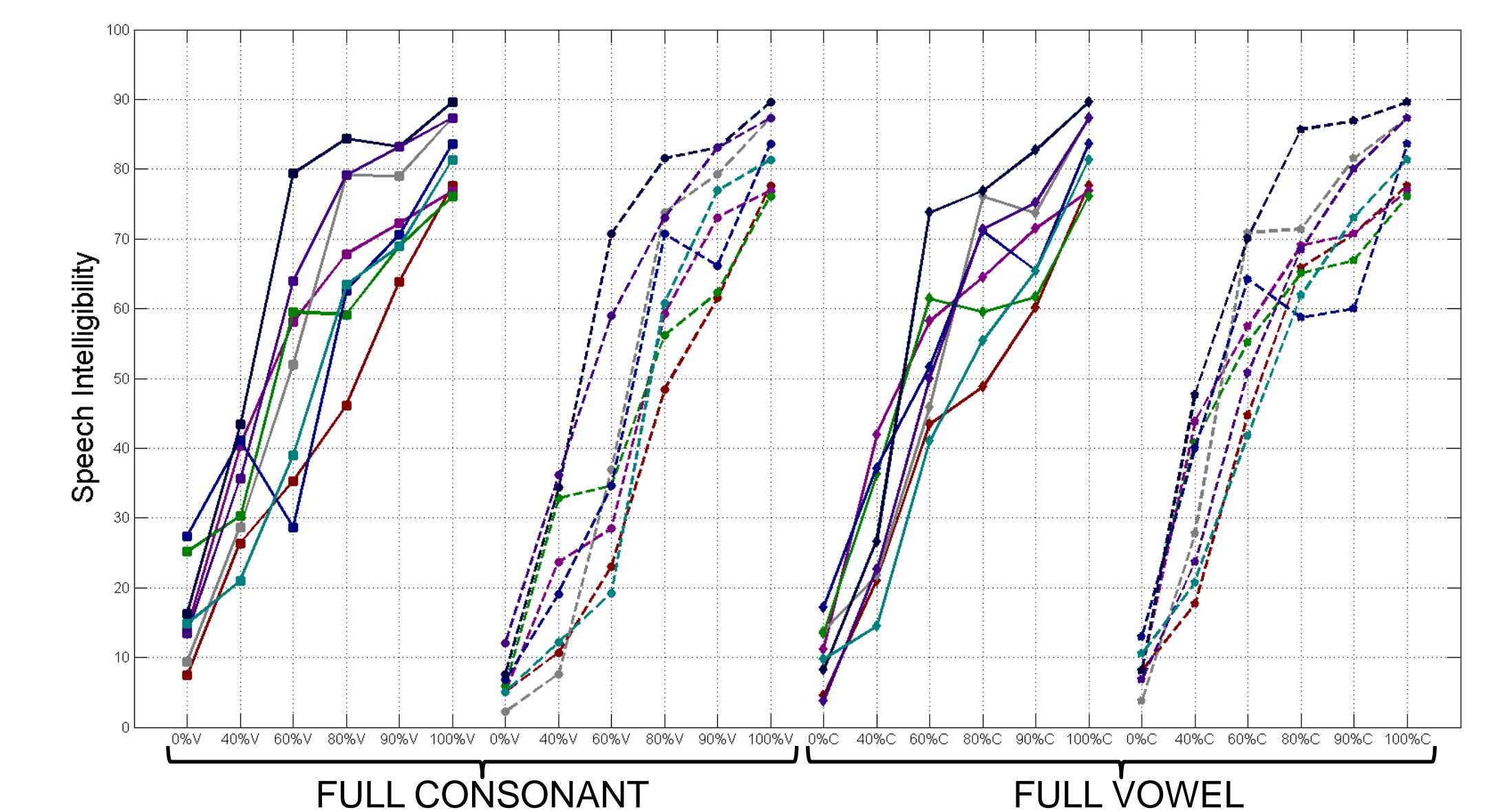## Individual Speech Intelligibility

Figure 3. Individual speech intelligibility for different conditions. Solid lines denote SSN and dotted lines represent silence replacements

RESULTS

- For FCXV condition, within groups repeated measures ANOVA confirmed a significant effect of filler ($F(1,7) = 44.5$, $p < 0.001$), significant effect of vowel percent ($F(5,35) = 99.9$, $p < 0.001$), and a significant interaction ($F(5,35) = 5.3$, $p = 0.001$). Post-hoc tests using Bonferroni correction (α=0.05) indicated SSN filled interrupted sentences' speech intelligibility was significantly greater than silence filled at 0%, 40%, and 60% vowel presentation.
- For FCXV condition, within groups repeated measures ANOVA confirmed a significant effect of filler ($F(1,7) = 15.7$, $p = 0.02$), significant effect of vowel percent ($F(5,35) = 74.9$, $p < 0.001$), and a non-significant interaction ($F(5,35) = 1$, $p = 0.42$).
- No significant difference in speech intelligibility for interrupted speech at a constant interruption rate filled with either SSN or silence (absence of classic phonemic restoration).

CONCLUSIONS

- CI listeners did not tolerate periodic interruptions in continuous speech signal
- Showed evidence to fuse interrupted speech signals into a coherent speech stream
- Vowels contribute more to speech intelligibility as compared to consonants for CI listeners

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