

Listening Effort with Simulations of Cochlear Implants

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Introduction

- Speech perception in quiet

In the early 1980s, the best one could hope for after implantation was low double-digit open-set sentence test scores. Currently, open-set speech recognition performances for implant patients (listening with the cochlear implant ear alone) average about 80% to 90% correct on sentence-level materials and 55% to 60% correct for monosyllabic word tests,¹ as illustrated in Figure 3.

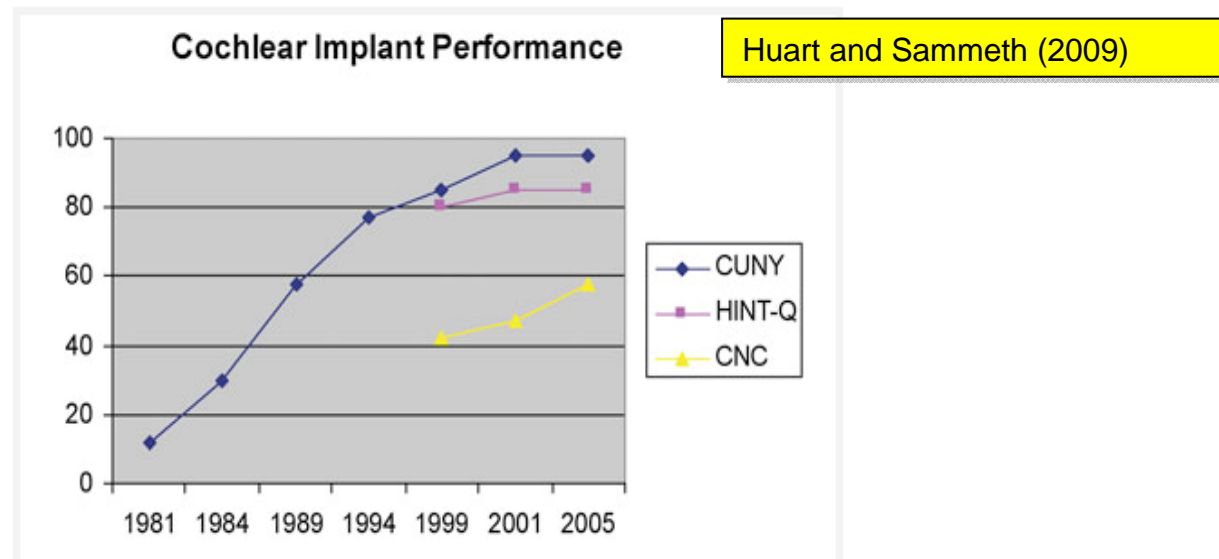


FIGURE 3. Advances in technology and signal processing in cochlear implants have resulted in improved performance outcomes over time. Shown are group mean percent correct scores for CUNY and HINT sentences in quiet, and for CNC monosyllabic words. Source: Internal data from Cochlear Americas clinical trials.



Introduction

- Speech perception in quiet
- Further improvements
 - Speech in noise
 - Music; Sound quality
 - Listening effort



Listening effort

- Benefits
 - Less fatigue
- Preference for a program
 - Noise reduction (Sarampalis et al, 2009)



Listening effort

How to quantify?

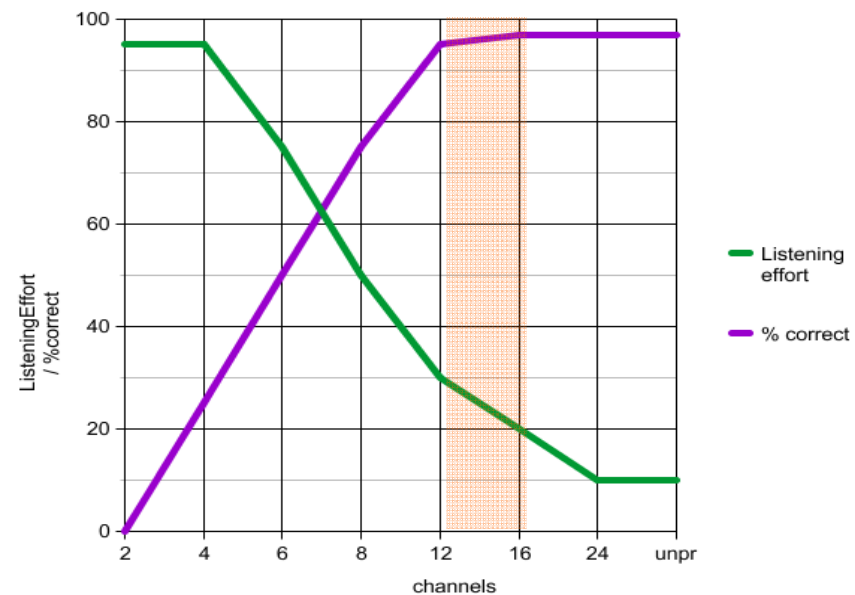
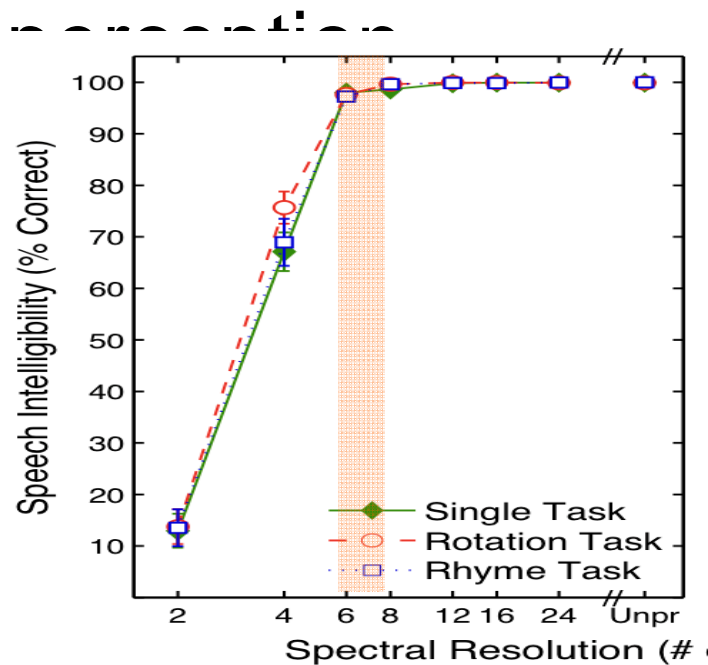
- Subjective methods
- Objective methods
 - Pupil dilation
 - Dual-task paradigm



Methods

As a first step

- Normal-hearing participants
- Simulated cochlear implant speech



Methods

Dual task

- Primary task: Intelligibility
- Secondary (Visual decision-making) task:
 - Rhyme-judgment task (linguistic)
 - Mental rotation task (non-linguistic)

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Methods

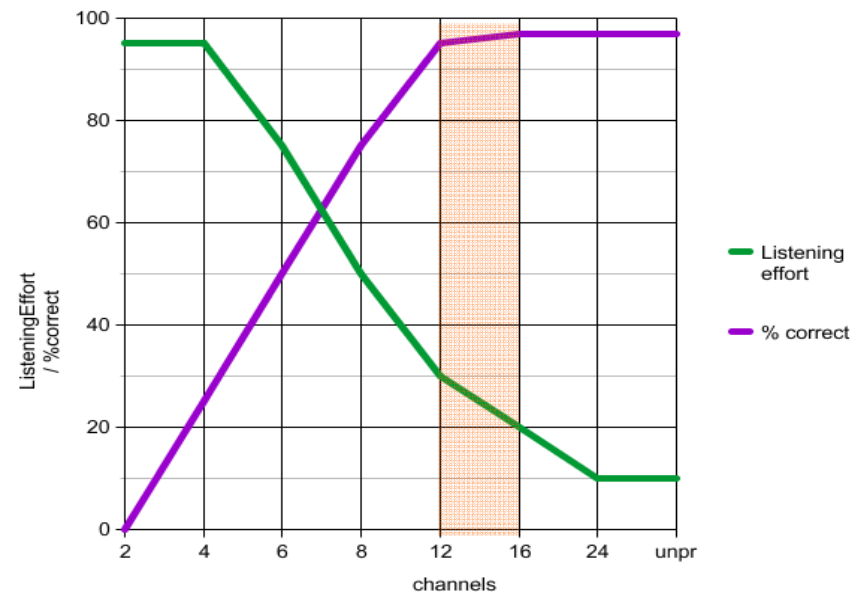
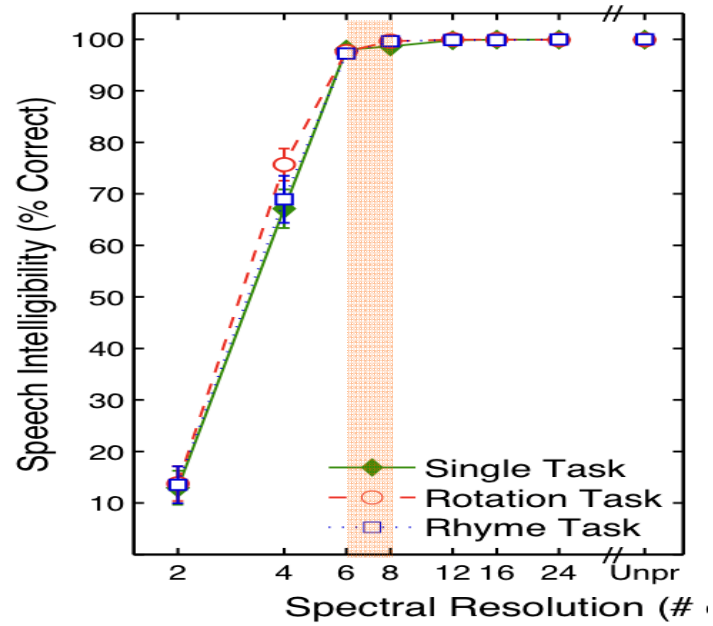
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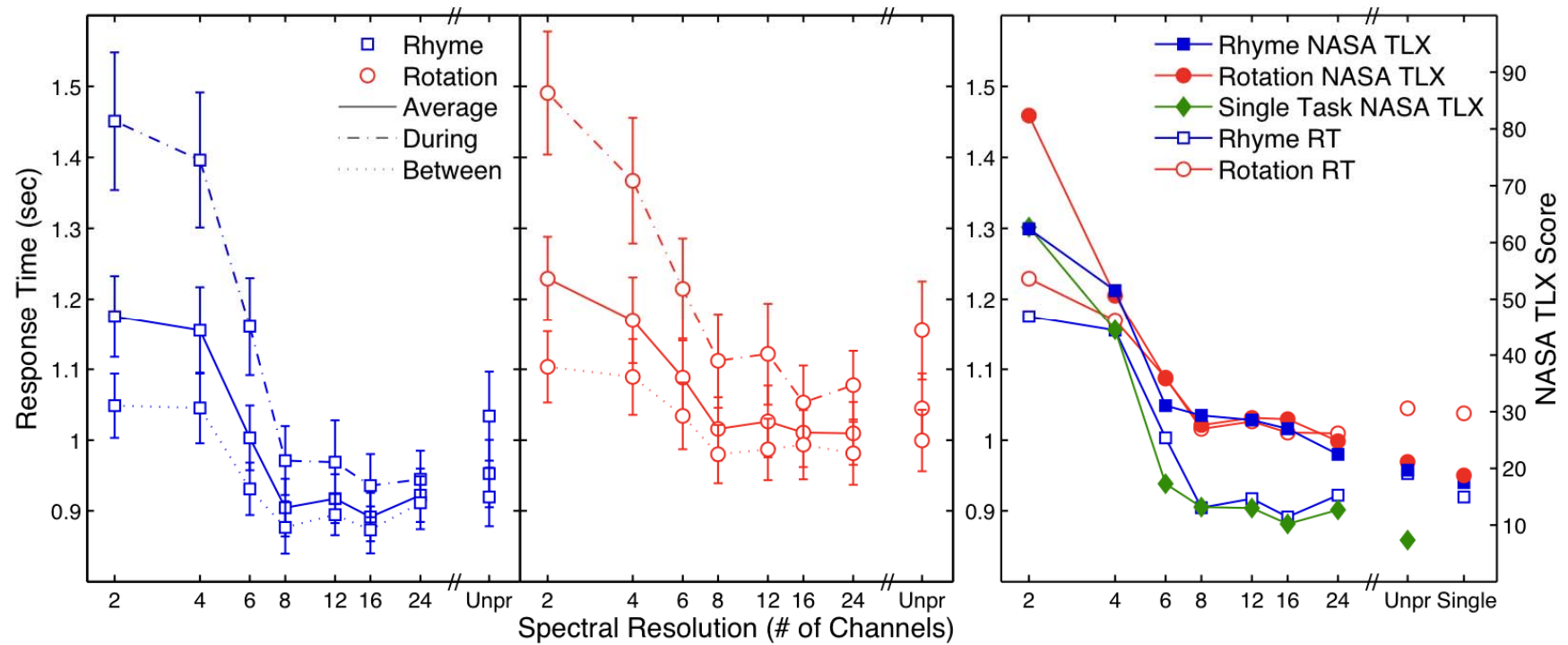
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Results



Results



Pals et al. (in prep.)



Results

- Intelligibility
2 to 6 channels
- Subjective measure (NASA-TLX)
2 to 6 channels
- Objective measure (Dual task)
2 to 8 channels



Results

- Intelligibility
2 to 6 channels
- Subjective measure (NASA-TLX)
2 to 6 channels

Response times captured extra benefit of increased spectral resolution that the NASA-TLX and intelligibility measures did not!



Conclusions

- Listening effort: Prolonged response times on secondary task
- ‘Information degradation hypothesis’
 - Interpreting degraded sensory input may require an increased allocation of cognitive resources, leaving less resources available for other cognitive tasks at hand (Lindenberger & Baltes, 1994).



Conclusions

- Practically:
 - Further benefit in listening effort after intelligibility plateaus
- Extra benefits not captured with traditional speech tests used in the clinic
- Better fitting possible



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