Efficient SpiN testing for the routine evaluation of French cochlear implanted subjects

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Co-authors / collaborators

- Marie-Laurence Laborde
  - Rehabilitation and sound processor programming for adult CI patients
  - One of the two originators of the MBAA sentence test
- Mathieu Marx
  - Research co-ordination, Dept. ORL Purpan Hospital
- Olivier Deguine, Bernard Fraysse, Mathieu Marx
  - Cochlear implant surgeons
- Alice Lamy, Maria Perrault
  - Masters students at the University of Montpellier who collected data comparing French MATRIX and MBAA

Outline

- History and context
- The MBAA sentence lists
- The Orthophonistes' algorithm
- Comparative data for normal listeners (A. Lamy)
- Comparative data for CI subjects (M. Perrault)
- Longitudinal data for CI subjects (M-L. Laborde)
- Recognition of SpiN by CI subjects
- Future development & software

Extending the indications for CI

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Cochlear Implants for Adults Obtaining Marginal Benefit From Acoustic Amplification

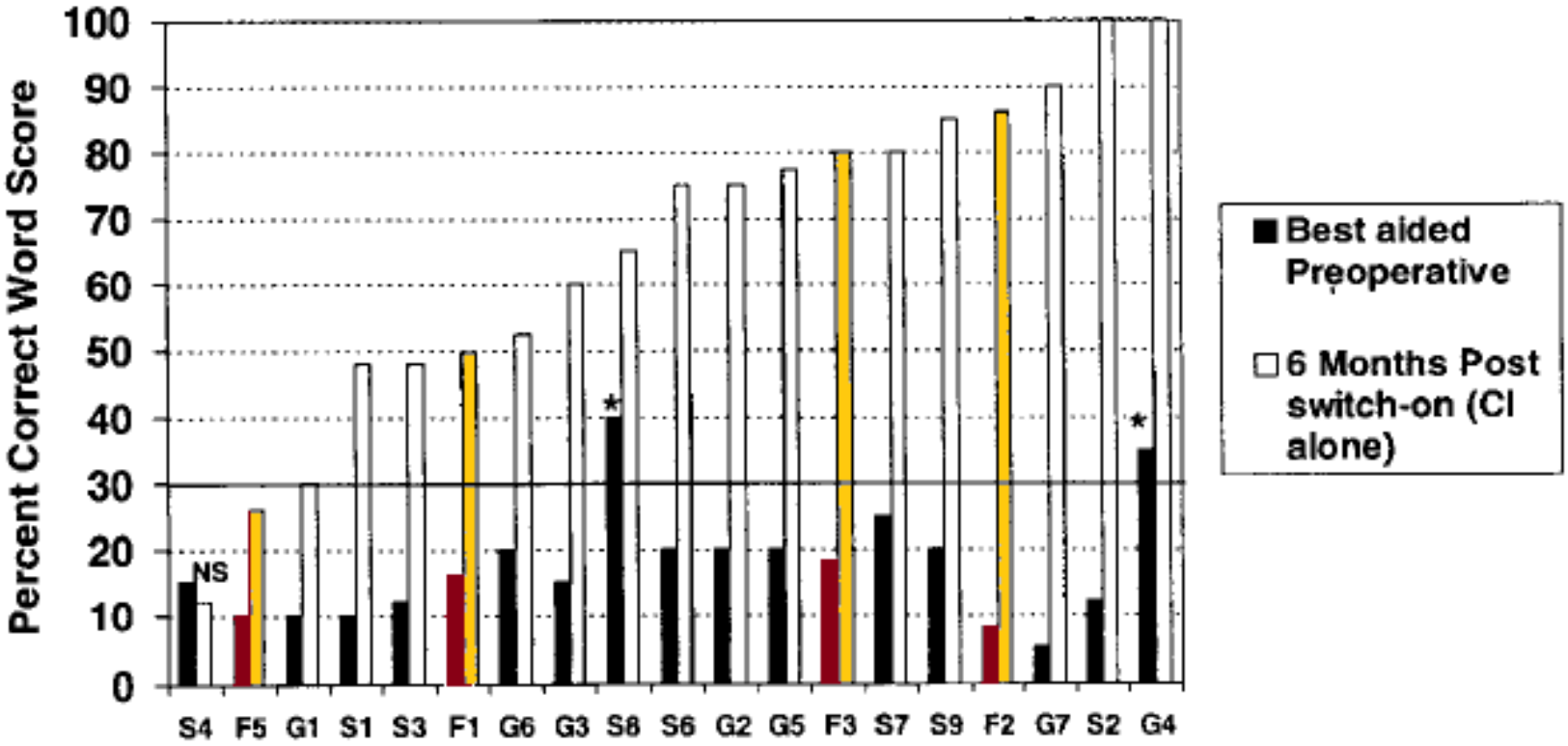
A European Study

*Bernard Fraysse, †Norbert Dillier, ‡Thomas Klenzner, ‡Roland Laszig, §Manuel Manrique, ||Constantino Morera Perez, ¶Alain H. Morgon, #Joachim Müller–Deile, and **Angel Ramos Macias

**C. H. U. Purpan, Toulouse, France; †Universitätsspital Zürich, Zürich, Switzerland; ‡Klinikum der Albert-Ludwigs-Universität Freiburg, Freiburg, Germany; §Clínica Universitaria, Facultad de Medicina, Universidad de Navarra, Pamplona, Spain; ||Hospital "La Fe," Valencia, Spain; ¶Hôpital Edouard Herriot, Lyon, France; #Klinikum der Christian Albrechts-Universität, Kiel, Germany; and **Hospital Insular de Gran Canaria, Las Palmas de Gran, Canaria, Spain.*

Words-in-sentence recognition in quiet

MBAA lists, live voice!!!



Origins

- Form equivalence as for CUNY sentence lists (1985)
  - Boothroyd, Hanin and Hnath, City University of New York
  - Originally developed to evaluate CI users / lipreading
- Everday spoken language / balance of topics
- Initial 24 sentence lists developed by Xavier Cormary
- Thirty-six lists completed by Marie-Laurence Laborde
- Variable sentence lengths / 15 sentences per list
- 100 to 103 words per list

Sentence length – 3 to 15 words

- 1. Cet enfant est trop petit pour monter dans le manège.
- 2. On va faire repeindre le plafond.
- 3. Il faut passer l'aspirateur.
- 4. Je cherche de nouveaux rideaux.
- 5. J'ai oublié d'acheter du pain.
- 6. Je n'en peux plus.
- 7. Est-ce que tu te rappelleras de tout ce que je t'ai dit?
- 8. Arrose les plantes.
- 9. Le train n'est pas encore parti.
- 10. Il faut changer les draps.
- 11. Il paraît **qu'il** est interdit d'arroser les jardins cet été.
- 12. Vous avez la monnaie de vingt euros ?
- 13. Mes cousins **m'ont** envoyé un faire-part de mariage.
- 14. Combien de temps il faut pour aller à Paris ?
- 15. Il me fait rire.

- 1. Vous auriez du feu, **s'il vous plait** ?
- 2. Le contrôleur va passer vérifier les billets.
- 3. Réveille moi si je m'endors tout à l'heure.
- 4. Est qu'on peut manger à cette heure ?
- 5. Je ne comprends pas ce que vous me dites.
- 6. Où est la gare ?
- 7. J'ai perdu mon portefeuille.
- 8. Il faut tourner la clef de contact.
- 9. Mon bébé marche tout seul depuis trois jours.
- 10. Tu es allé chez le coiffeur.
- 11. Hier, j'ai vu un bon film à la télé.
- 12. Je crois que tu peux doubler ce camion.
- 13. L'avion a pris du retard.
- 14. Les fleurs sont fanées.
- 15. Il a raté ses examens.

Score sheets

Nom: _____ Patient ID _____ Date: _____

Liste d'entraînement

Séance: _____ Condition: _____ SNR _____ dB

MBAA Liste 1

1. Il y a du monde aujourd'hui.
2. Bonjour, comment ça va ?
3. On va chez le médecin ce soir.
4. Ma voiture est encore en panne.
5. Quelle heure est-il ?
6. Je m'intéresse à cette histoire.
7. J'ai mis un poulet au four.
8. Les enfants se sont encore disputés ce soir.
9. Il faut payer les factures avant la fin du mois.
10. J'ai perdu les clefs du garage.
11. La voiture roulait beaucoup trop vite.
12. Il y a un bon film à la télévision.
13. Tu joues encore au foot ?
14. Il faut que tu achètes du sel et du poivre.
15. Cette maison est beaucoup trop chère.

Score: _____ / 100 mots Signé _____

Nom: _____ Patient ID _____ Date: _____

Séance: _____ Condition: _____ SNR _____ dB

MBAA Liste 36

1. Ce n'était pas la peine de faire tant d'histoires.
2. Méfiez-vous de lui !
3. Depuis cette affaire, ils sont à couteaux tirés.
4. C'est à lui de prendre la décision.
5. A-t-elle des frères et soeurs?
6. Il met toujours trois sucres dans son café.
7. Faites lui confiance !
8. Il me semble que nous nous sommes déjà rencontrés.
9. On n'arrive pas à comprendre comment ils se débrouillent.
10. Si j'avais su, je me serais bien gardé de lui donner ces détails.
11. Ces parents sont des gens charmants.
12. Il n'est pas là.
13. C'est un artiste sensationnel.
14. Je vais partir dans cinq minutes.
15. Il pleut depuis hier matin.

Score: _____ / 100 mots Signé _____

MBAA2 Recording

- Female speaker with “standard” French accent
  - Speech therapist
  - Normal speaking rate (slower than conversational speech)
- Digital recording PCM 16 bits, 44.1 kHz
- Individual sentence levels RMS equalized (-25 dB)
- Cue phrase “List X” and 5.5 second gaps = 2 min 7 sec
- Calibration signals
  - 1 kHz, 1/3 octave noise at +10 dB RMS
  - 1 kHz pure tone at +15 dB RMS

MBAA2 babble noise

- 2 female, 2 male French speakers reading ~12 min
- Gaps removed/minimised to 200 ms per speaker
  - Leaving around 8 min per speaker
- Levels equated to RMS of sentence recording
- One male speaker reduced in mix by 1 dB due to prominence
- Four voices mixed and then doubled
  - Final list tracks are 2.07 minutes long

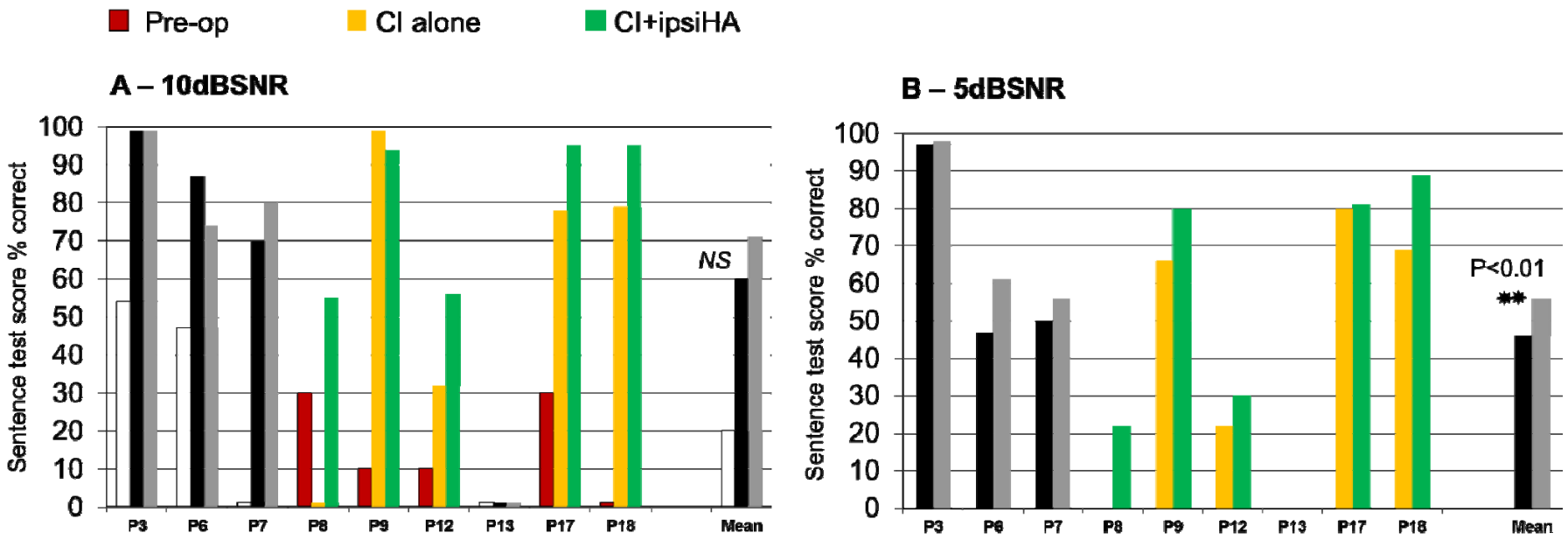
Media formats

- Provided on Audio CDs
  - Speech only L/R (Quiet)
  - Speech + babble at 10, 5, 2.5 & 0 dB SNR L/R (S0N0)
  - Speech L, babble R for audiometer/spatial testing etc
- Audio files
  - Separate sentences
  - Separate lists (with 5.5 seconds between sentences)
  - Separate babble file
  - Separate competing talkers (if you ask me nicely)
- Available on request for CI centres and researchers

Otology & Neurotology
27:624–633 © 2006, Otology & Neurotology, Inc.

Residual Hearing Conservation and Electroacoustic Stimulation with the Nucleus 24 Contour Advance Cochlear Implant

*Bernard Fraysse, †Ángel Ramos Macías, ‡Olivier Sterkers, §Sandro Burdo, ||Richard Ramsden, *Olivier Deguine, ¶Thomas Klenzner, #Thomas Lenarz, **Manuel Manrique Rodriguez, ††Ernst Von Wallenberg, and *††Chris James



FrMatrix – the French MATRIX test

	Name	Verb	Numeral	Object	Color
1	Agnès	achète	deux	anneaux	blancs
2	Charlotte	attrape	trois	ballons	bleus
3	Emile	demande	cinq	classeurs	bruns
4	Etienne	déplace	six	crayons	gris
5	Eugène	dessine	sept	jetons	jaunes
6	Félix	propose	huit	livres	mauves
7	Jean-Luc	ramasse	neuf	pions	noirs
8	Julien	ramène	onze	piquets	roses
9	Michel	reprend	douze	rubans	rouges
10	Sophie	voudrait	quinze	vélos	verts

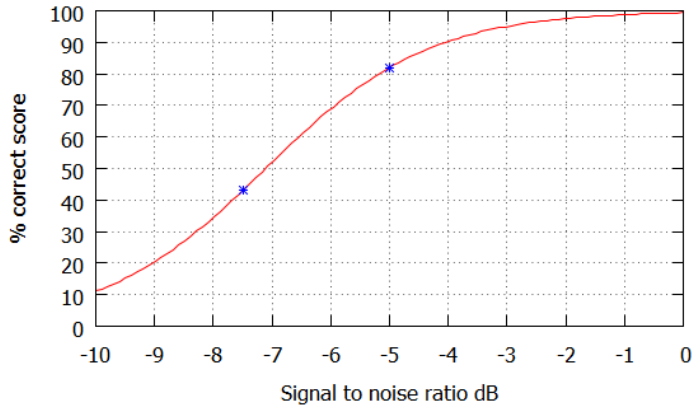
Jansen et al (2012). Int J Audiol, 51(3), 164–73. doi:10.3109/14992027.2011.633568

FrMatrix & MBAA2 – 18 normal listeners

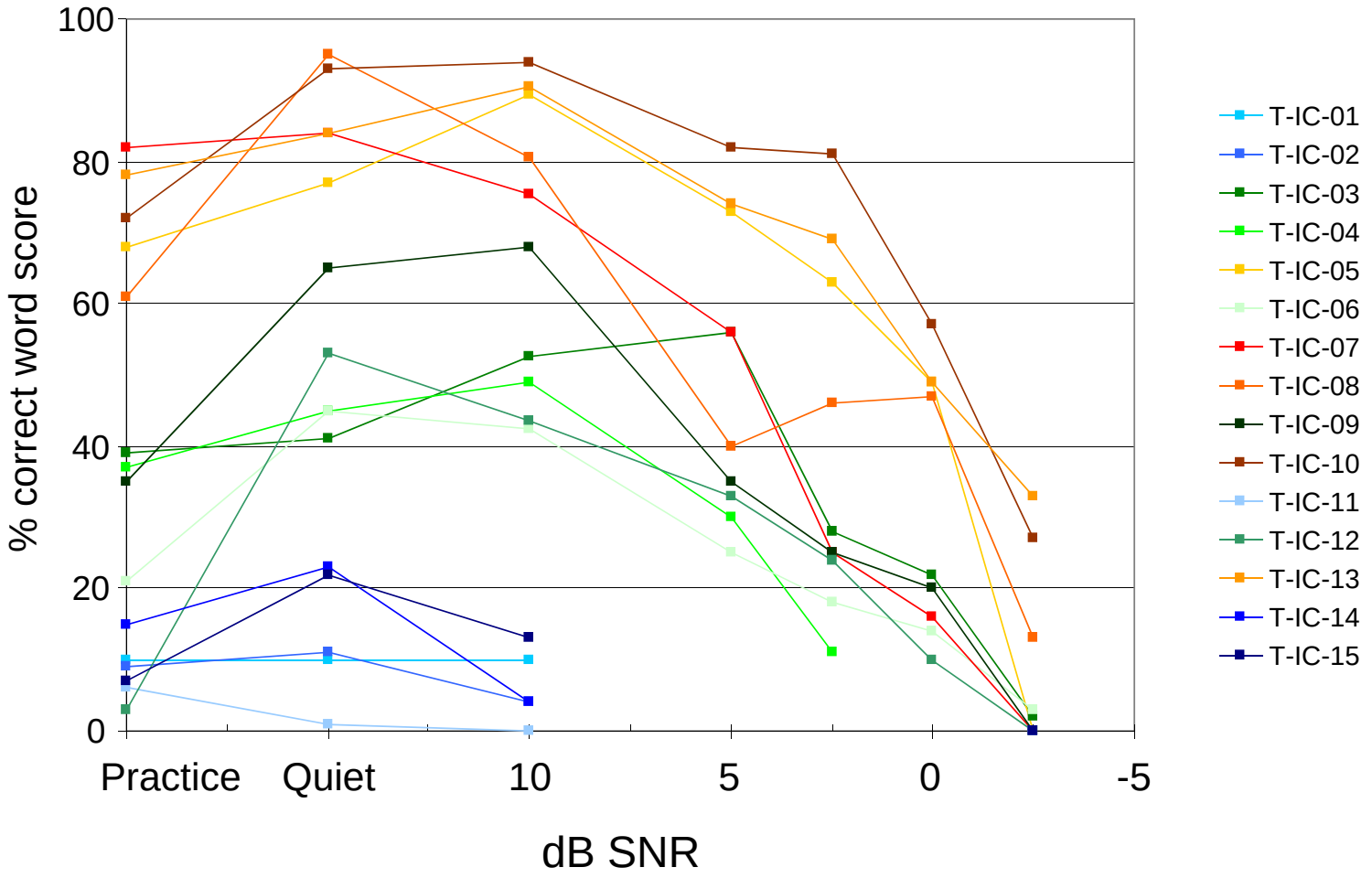
FrMATRIX + stationary noise	Training	Test	Re-test
Mean SNR50 dB	-3.75 (0.79)	-5.19 (0.79)	-5.7 (0.71)

MBAA2 + Babble	*Quiet*	-5 dB SNR	-7.5 dB SNR
Mean % correct	*100*	81.9 (8.9)	42.9 (12.8)
Mean SNR50 dB	-7.23 (1.08)		
Mean slope % per dB	19.3 (6.1)		

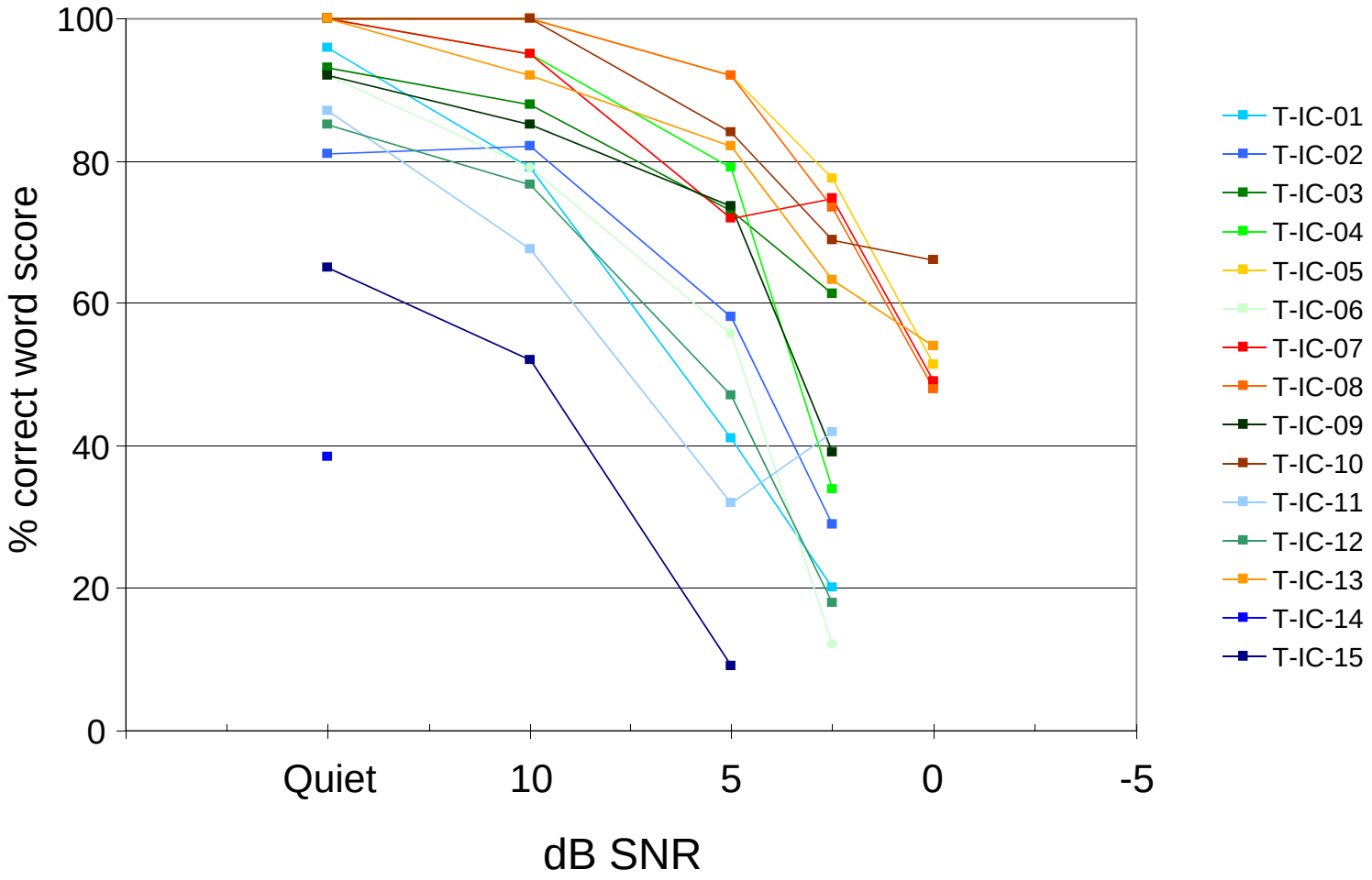
Gnuplot *fit*: "explosion-free" NLS curve



15 CI subjects – 20 sentence MATRIX lists



CI subjects – MBAA2 lists



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The Orthophonistes' algorithm

- Recall how it went when you tested the patient last time
  - If there was no last-time then talk to the patient and see if they seem to understand what you are saying
  - Test if they think the subject may achieve say >20%
- Run half a practice list in Quiet and see how it goes
  - If they seem to get > ~10% then run a full test list
- If the score in Quiet > 50% then run 10 dB SNR
  - Each time if they score > 50% continue with a poorer SNR
  - If > 80% then consider skipping an SNR
  - Stop testing at 0 dB SNR – there are no more CDs

CI subjects – longitudinal data

- 136 adults (series implanted between 2009 to 2013)
- Unilaterally implanted with 12 months follow-up
- Tested CI alone at 0, 1, 3, 6 and 12 months
- MBAA2 lists were selected at random from the 34 test lists, half a practice list was given in Quiet
- Speech level fixed at 65 dB SPL
- Conditions were Quiet, 10, 5, 2.5 and 0 dB SNR
- Conditions were tested in sequence with the Orthophonistes' algorithm

Factors which may affect outcomes

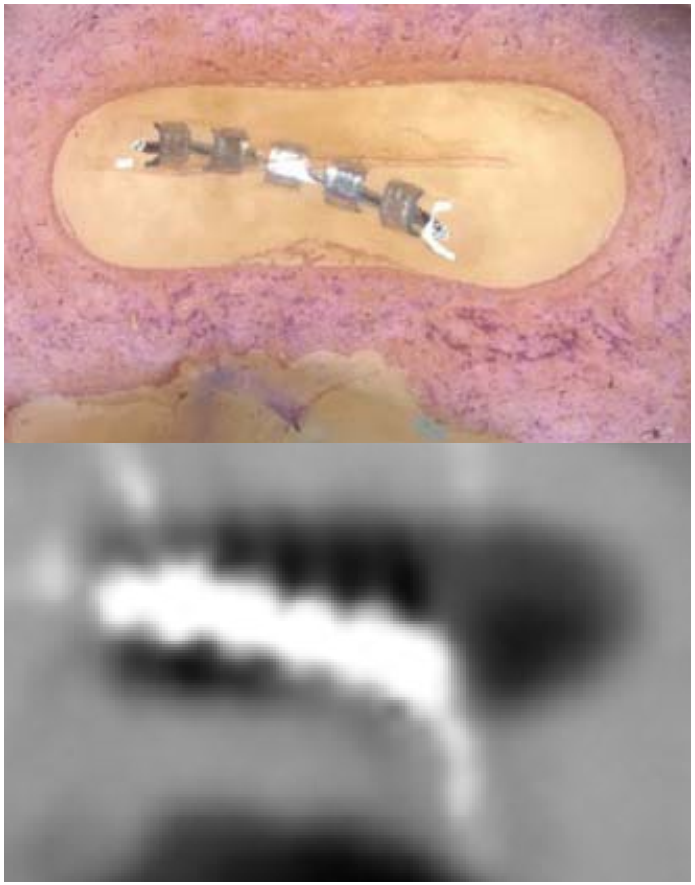
- Etiology
- Age
- Duration HL
- Pre-op score with HAs

Subject factors - immutable

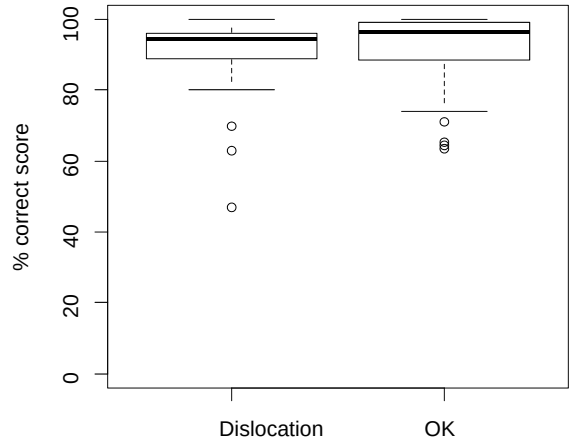
- Type of CI: Brand, perimodiolar/straight, N channels

- Position in scala: tympani/vestibuli or dislocated
- Insertion depth

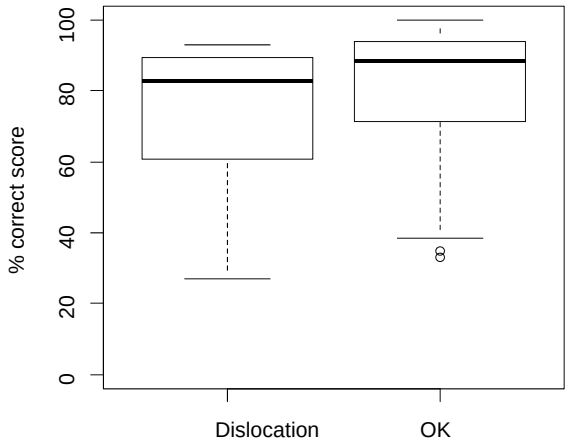
Ceiling effects versus missing data



Marx et al (2013) *Eur Arch Otorhino*
doi:10.1007/s00405-013-2448-6

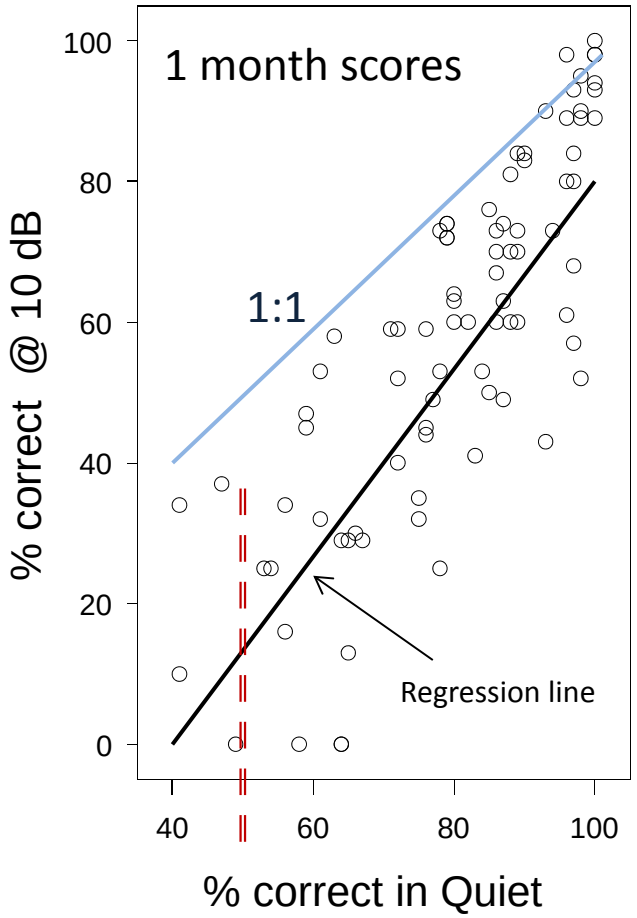


Quiet

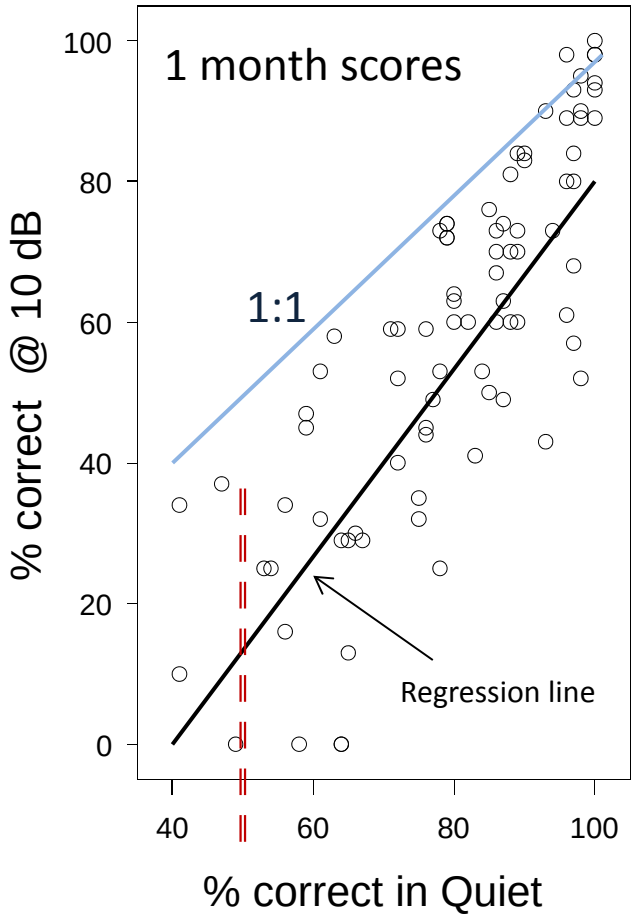


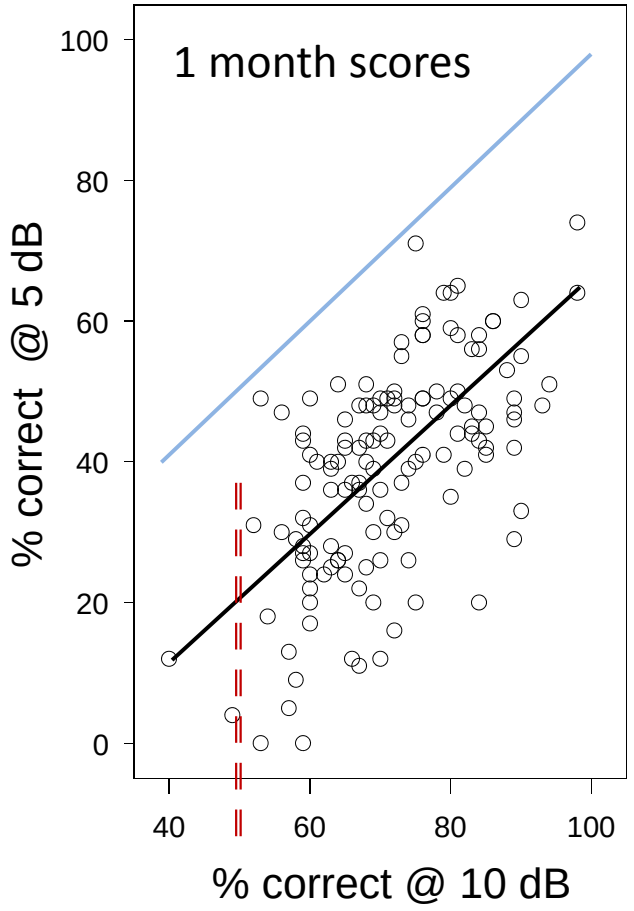
10 dB SNR

Updated orthophonistes' algorithm

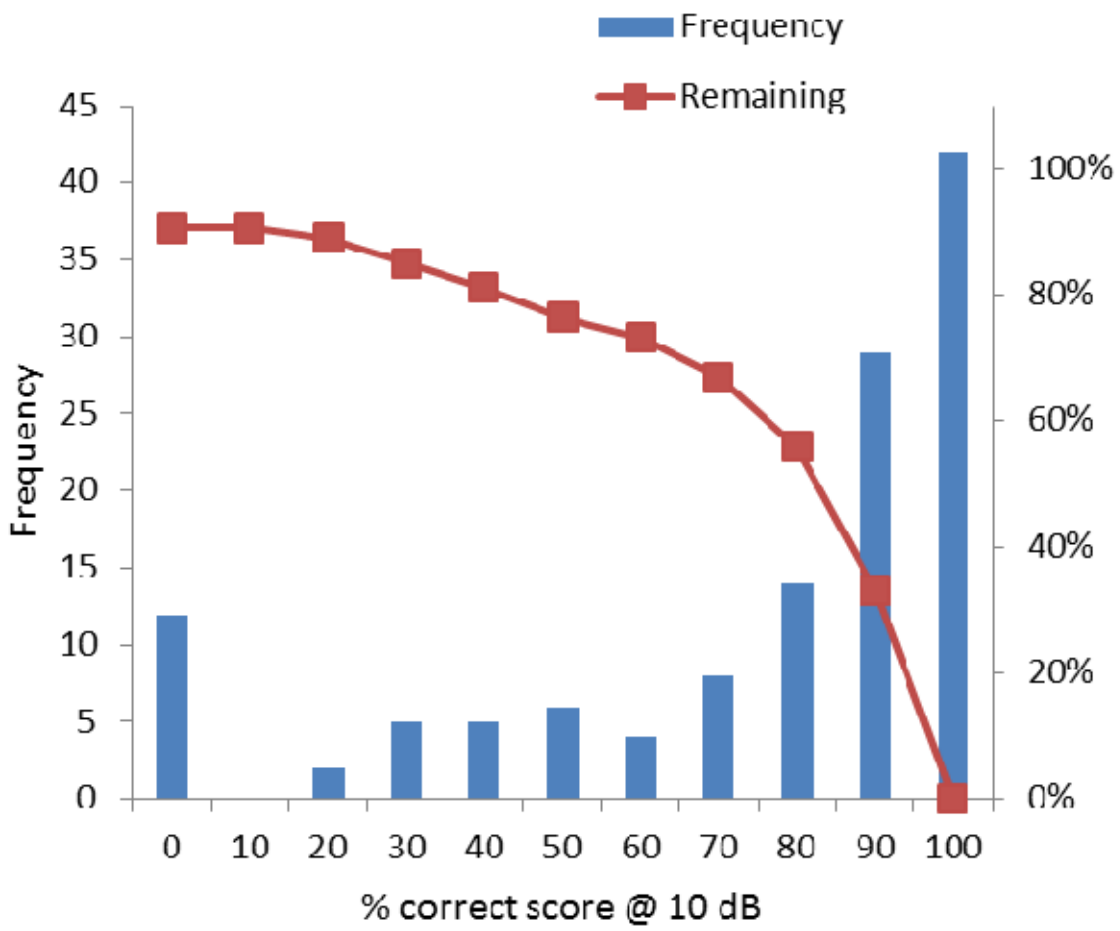


Updated orthophonistes' algorithm

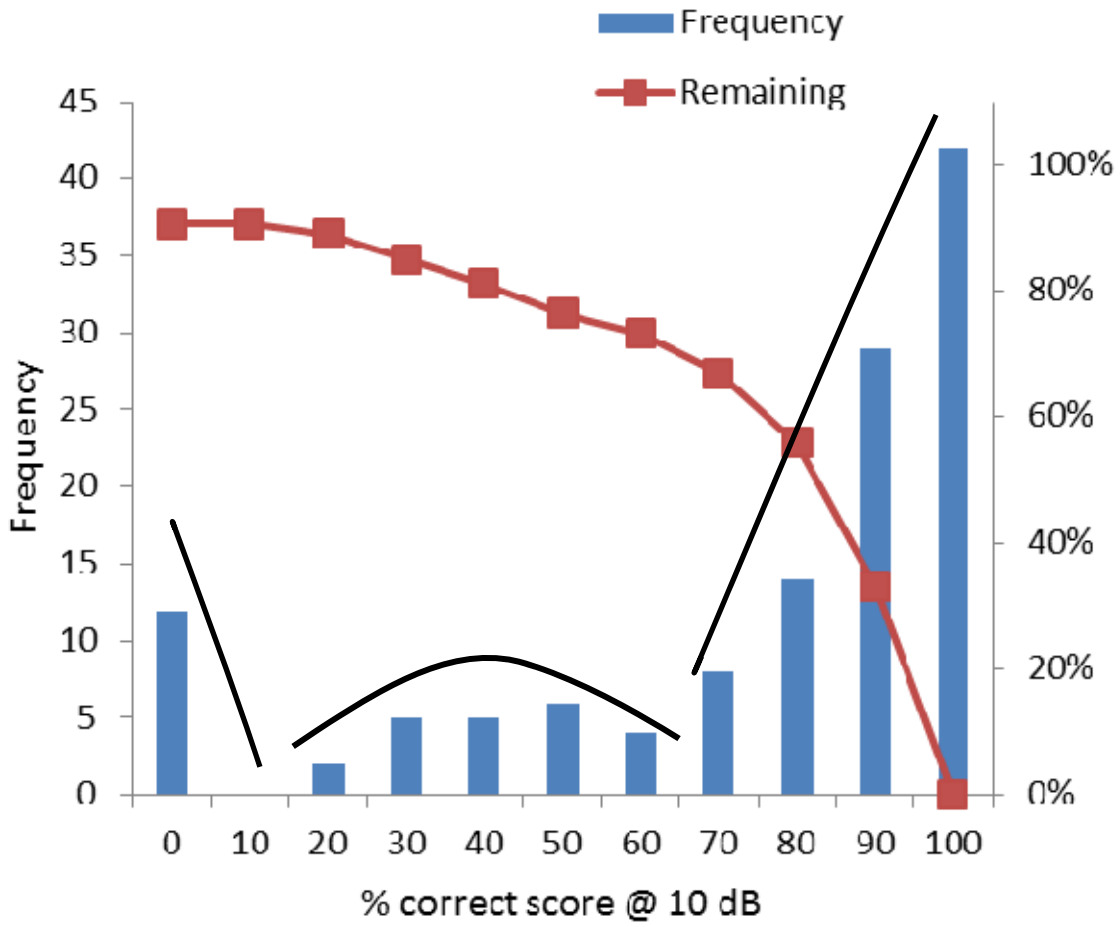




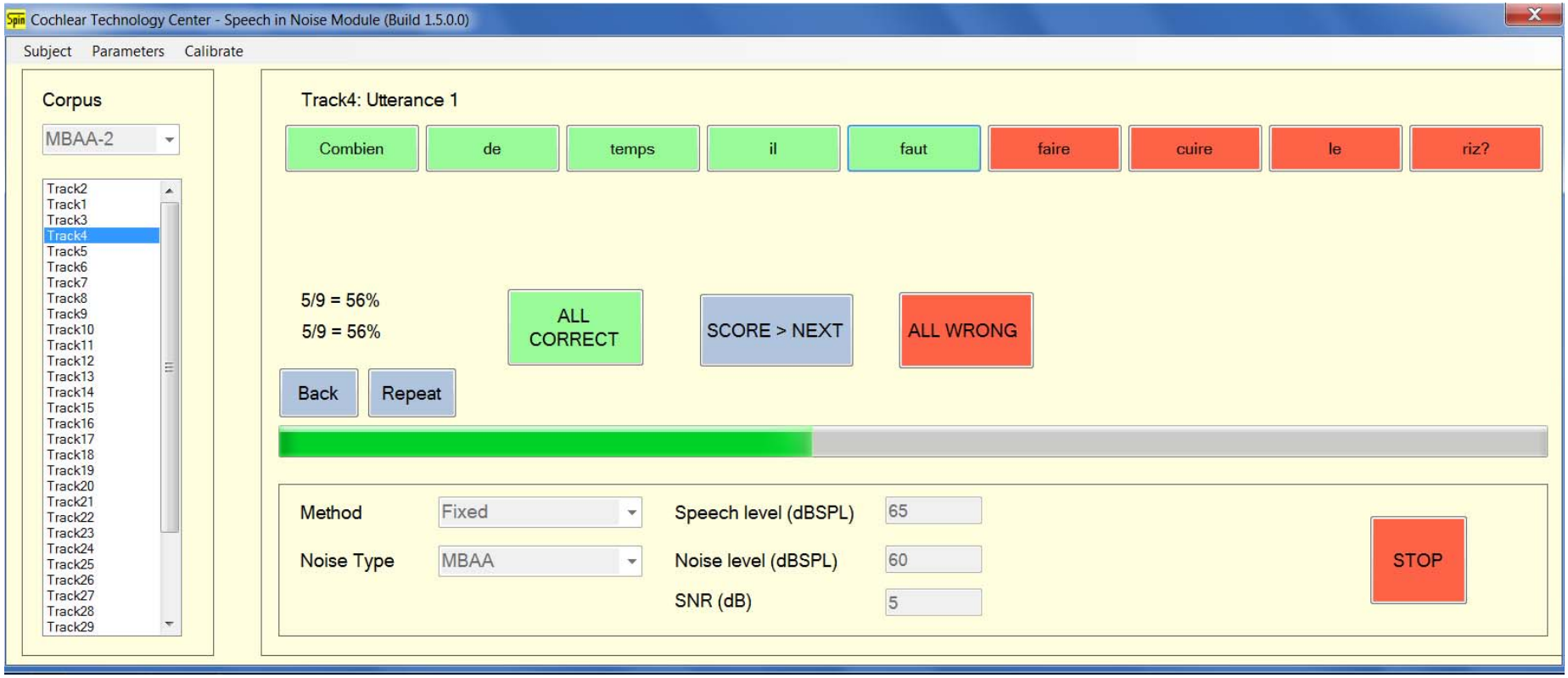
12 month scores @ 10 dB SNR



12 month scores @ 10 dB SNR



CTC Spin Module – courtesy Filiep vanPouke



Conclusions

- The MBAA2 sentence lists provide a reliable measure of speech recognition by French CI subjects
  - Test re-test reliability 8.01% pts, bias 0.67% pts
- The use of natural spoken utturances allows a range of CI performance to be accomodated
- The high performance in quiet for many CI subjects allows us estimate SNR50

Future (near)

- Evaluate list equivalence with CI users
- Validate a procedure with a revise Orthophonistes' algorithm
  - Start testing with 10 dB SNR
  - Allow increased SNR (i.e. 15 etc)
  - Use a simple forward prediction method to choose SNRs
  - Use a sigmoid fit to provide SNR50 and/or extrapolate
  - Validated imputation of zero scores!

Thank you

Chris James is employed by Cochlear France

A. Lamy and M. Perrault were sponsored by Cochlear France