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Considerations and Approaches for Complex CI Cases

Joshua D. Sevier, Au.D., LL.M.

AT THE FOREFRONT
UChicago Medicine

Joshua Sevier, AuD, LLM

Josh Sevier is an audiologist and clinical program manager of the cochlear implant program at UChicago Medicine. His clinical interests include objective measures and training in cochlear implants. He has been involved with advocacy and legislation both on a state and national level including the Government Relations Committee for the American Academy of Audiology, Executive Board for the Nebraska Commission for the Deaf and Hard of Hearing, Vice President of Advocacy for the Nebraska Speech Language and Hearing Association and is the current President-Elect of the Illinois Academy of Audiology. Dr. Sevier has published numerous articles in peer-review journals and continues research of cochlear implants.

Disclosures

- Presenter Disclosure: Financial: Joshua Sevier is an employee of UChicago Medicine. He received an honorarium for this presentation. Non-financial: Joshua Sevier has no relevant non-financial relationships to disclose.
- Content Disclosure: This learning event does not focus exclusively on any specific product or service.
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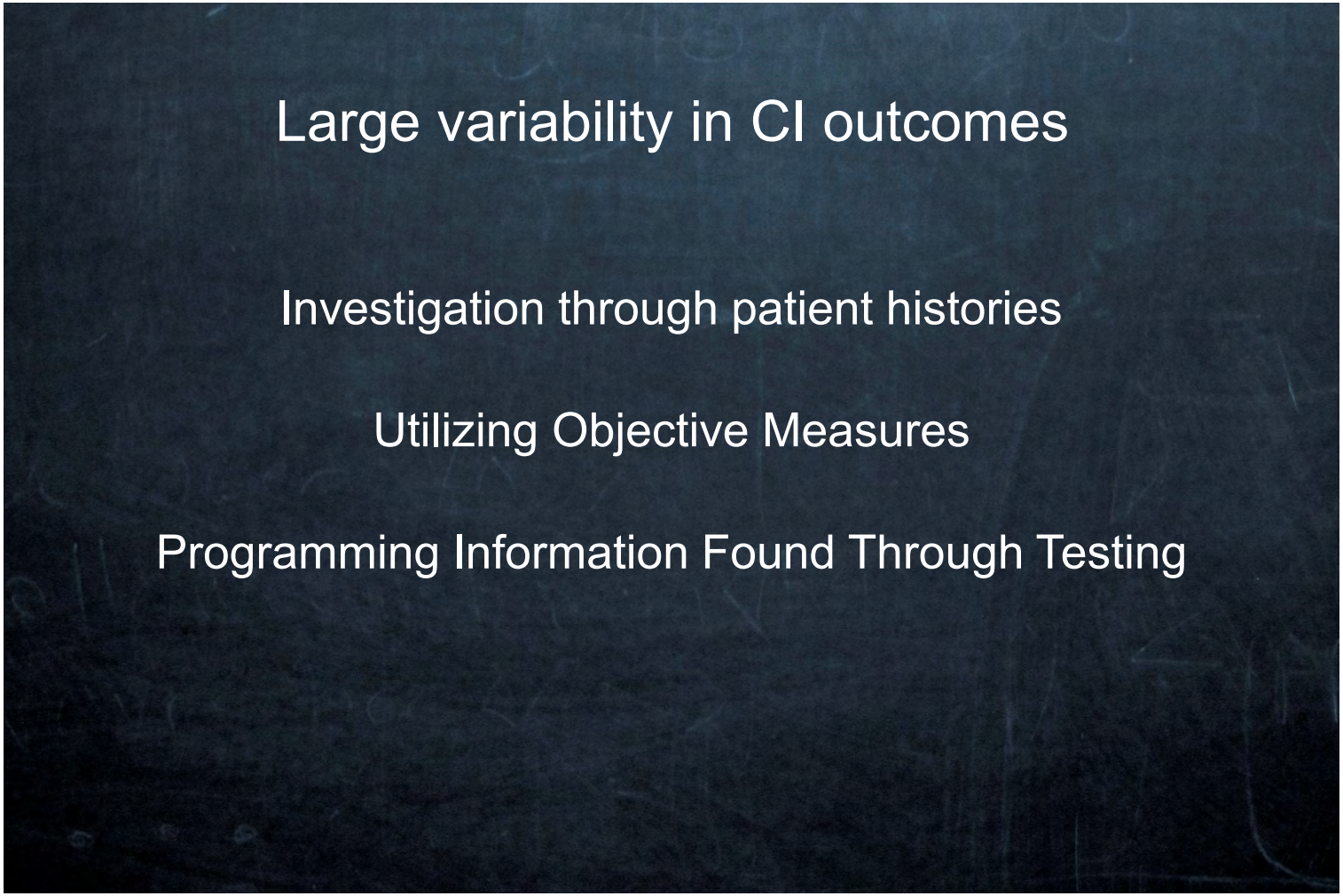
Learning Outcomes

After this course, participants will be able to:

- Explain how patient histories relate to programming issues and provide clues for resolution.
- Explain the role of objective measures in cochlear implant programming.
- Describe how to use audiologic test results as indications for programming changes in cochlear implants.

Focus on Patient Outcomes



Investigating Issues Through Patient Histories

Answers come from detailed questions

- Information about the internal implant
- Reading through medical records
- The problem and the duration
- Go through previous programming sessions
  - Why were previous changes made?
  - What were the reasons for the change?
- Is there anything that makes it better or worse?

Objective Measures/Programming

Objective measures are those where we can obtain data from a physiological response, not requiring any input from the patient.

This data can be used to solve problems experienced by patients by troubleshooting issues in programming and/or performance.

Objective Measures/Programming

Impedance

Electrode impedance measures the opposition of electrical current flow across the electrode lead and contact.

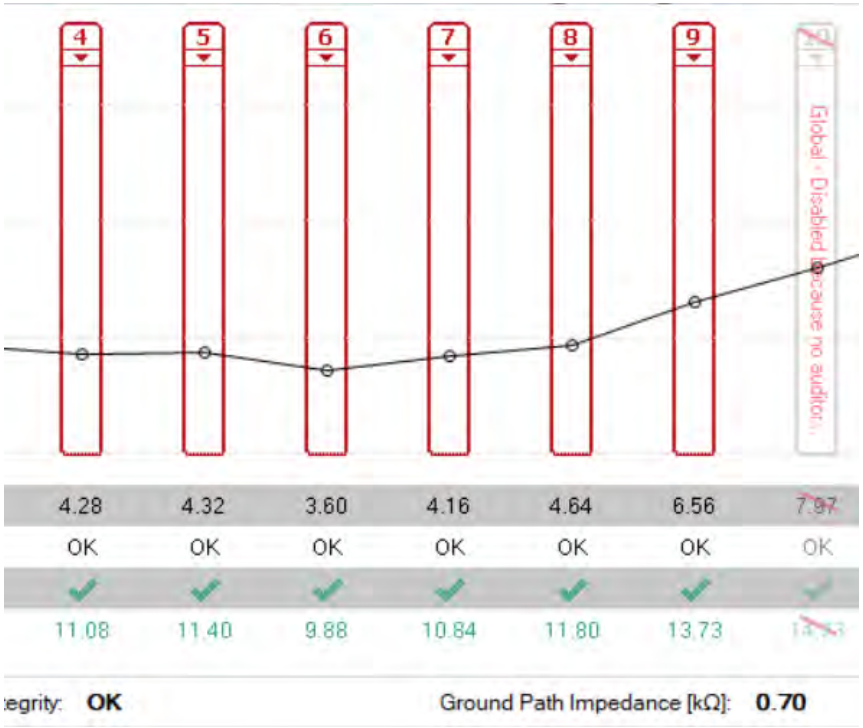
eCAPS

A recorded response that represents the synchronous firing of a population of electrically stimulated auditory nerve neurons.

eSRT

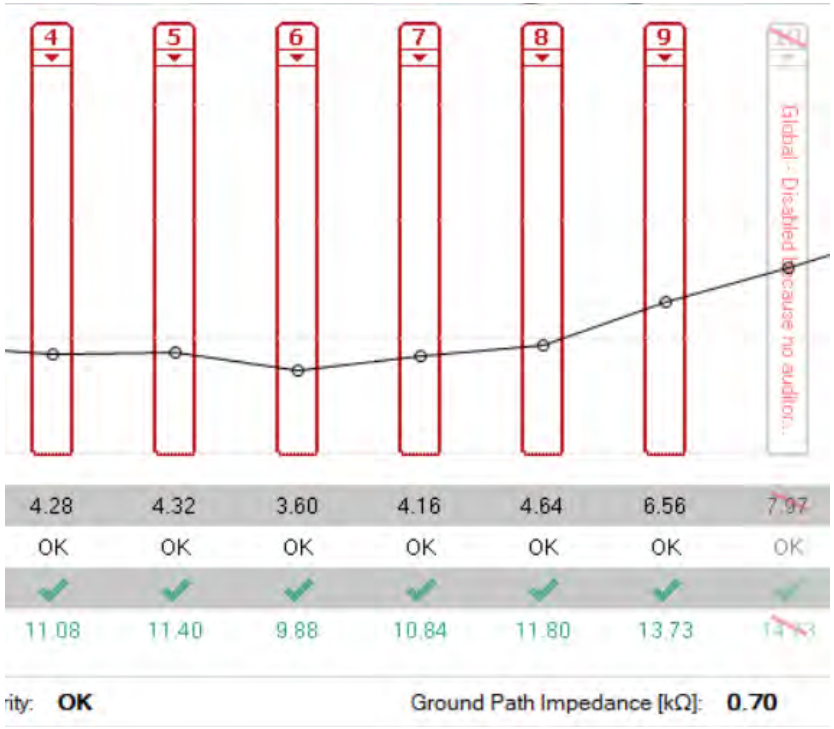
A recorded response from the contraction of the stapedius muscle following the introduction of a electrical pulse train through the cochlear implant

Impedance



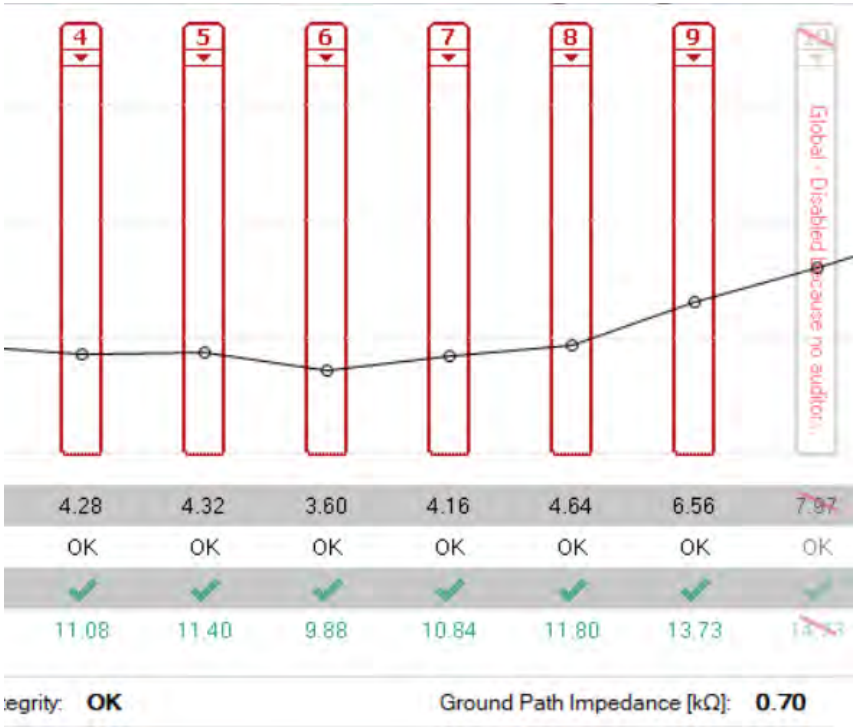
- Electrode impedance measures the opposition of electrical current flow across the electrode lead and contact.
- This test is performed at the start of each programming session.
- A small amount of current is delivered to each electrode, and how much current returns to the indifferent electrode is measured.

Impedance (cont'd)



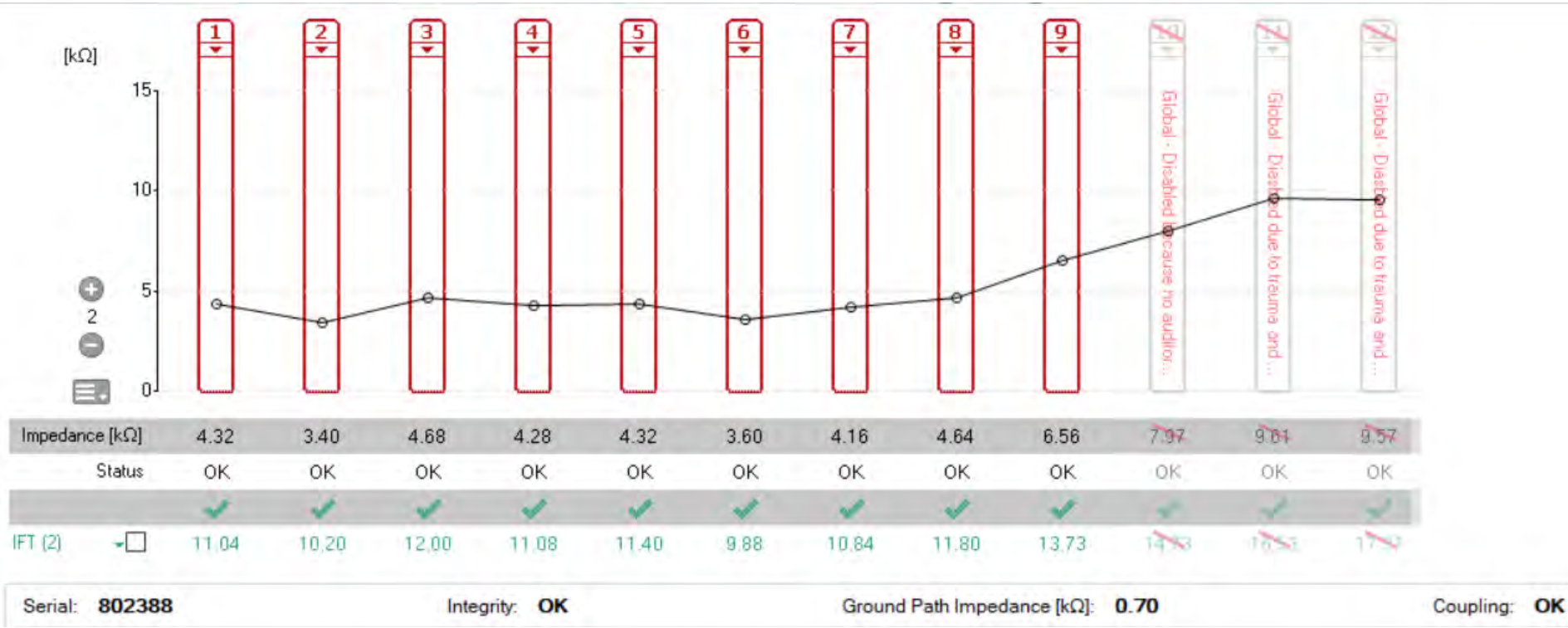
- Typically lowest at surgery
- Higher at activation
  - Device Inactivity
  - Middle Ear Dysfunction
  - High Stimulation Rate/ Out of Compliance Stimulation
  - Cold or Virus
  - Hormone Changes
  - Inflammatory Conditions
  - Fibrous Tissue Growth
  - Ground Electrode issues

Impedance Case Study

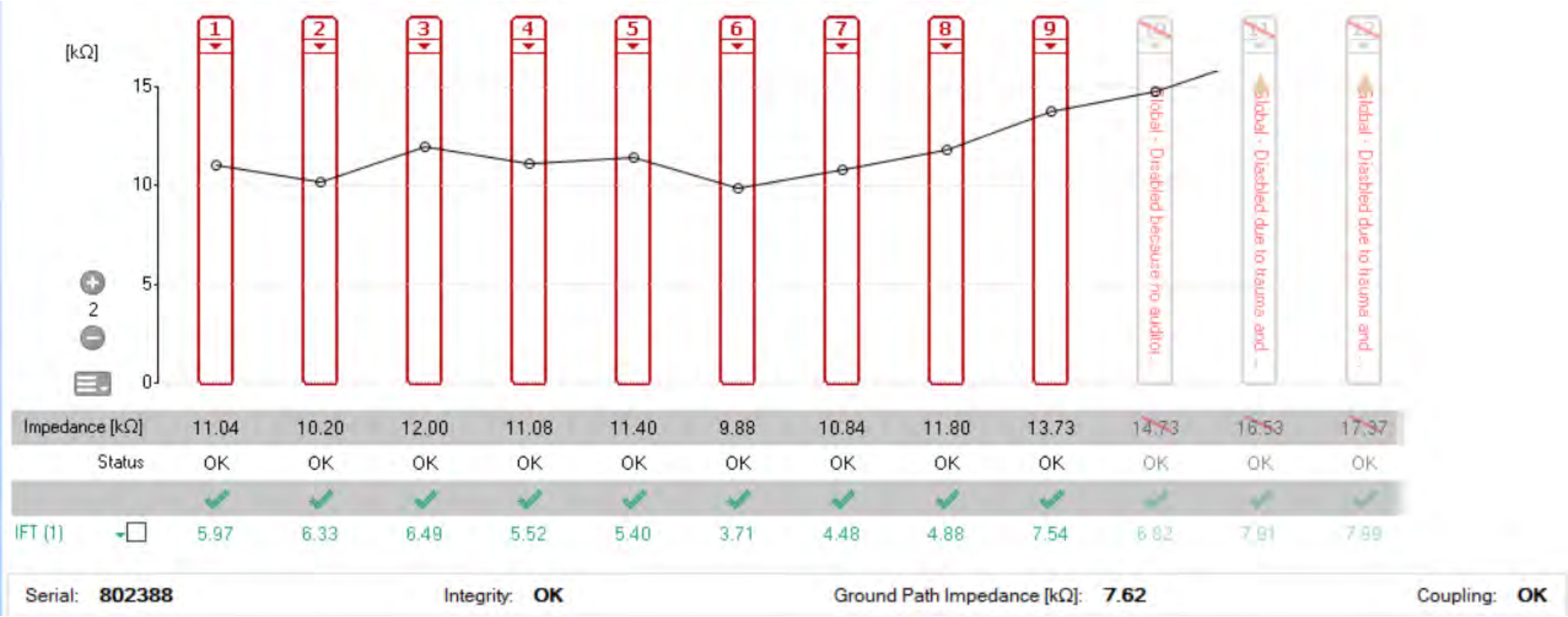


- 42- Year-old Female
- Sudden, Traumatic single-sided deafness
- Previous Baha user
- Seeking a cochlear implant shortly after FDA approval

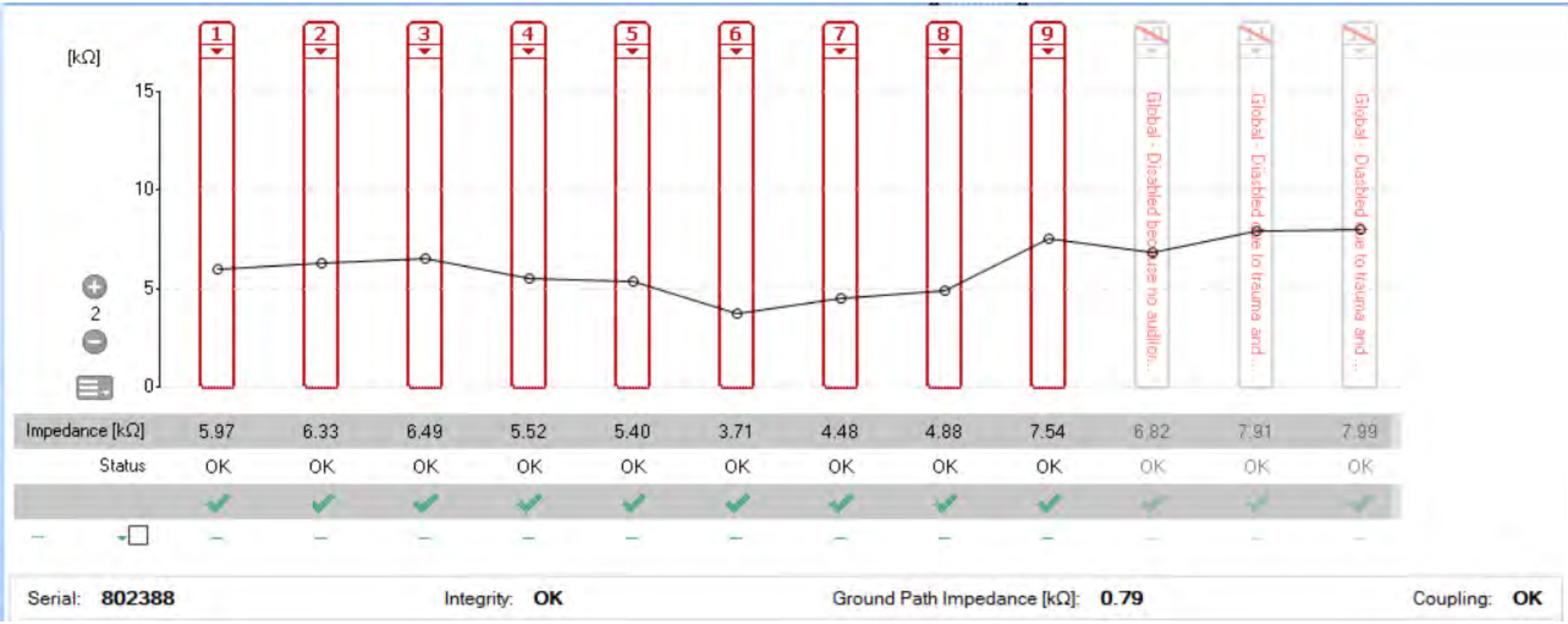
Impedance Case Study (cont'd)



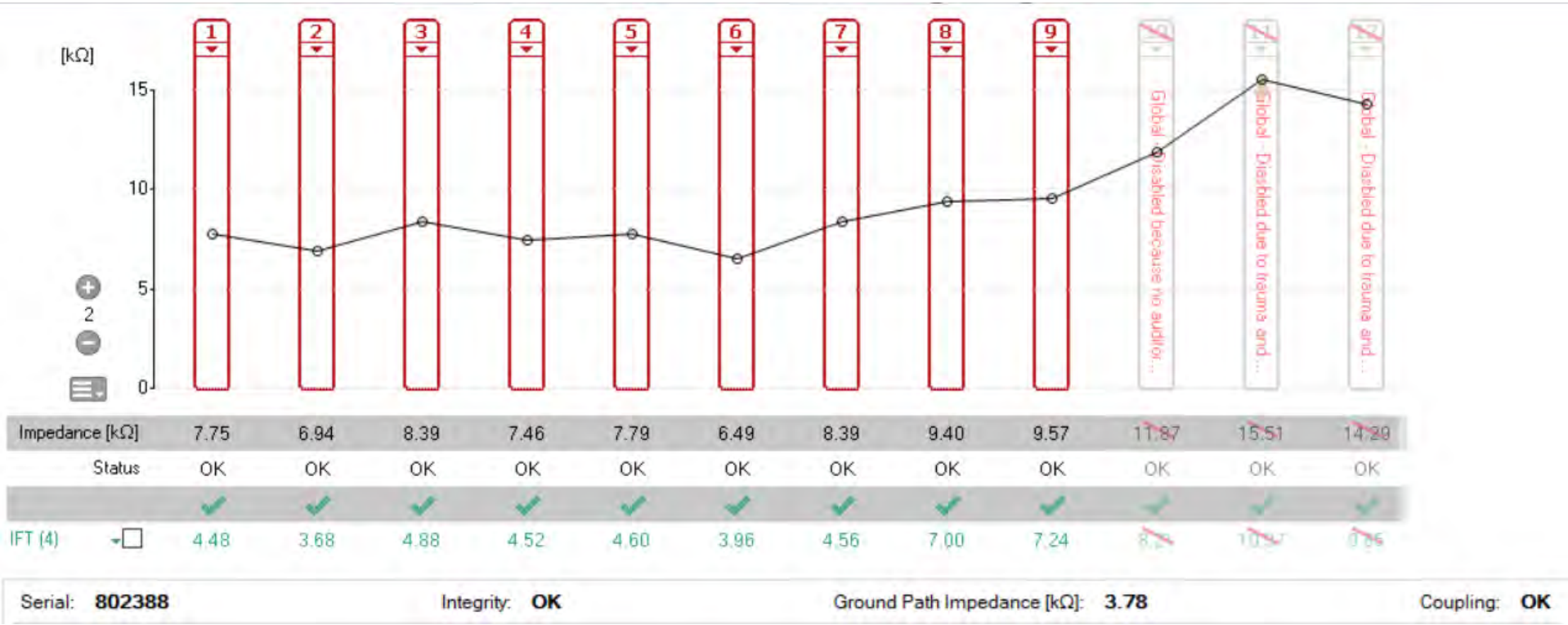
Impedance Case Study (cont'd)



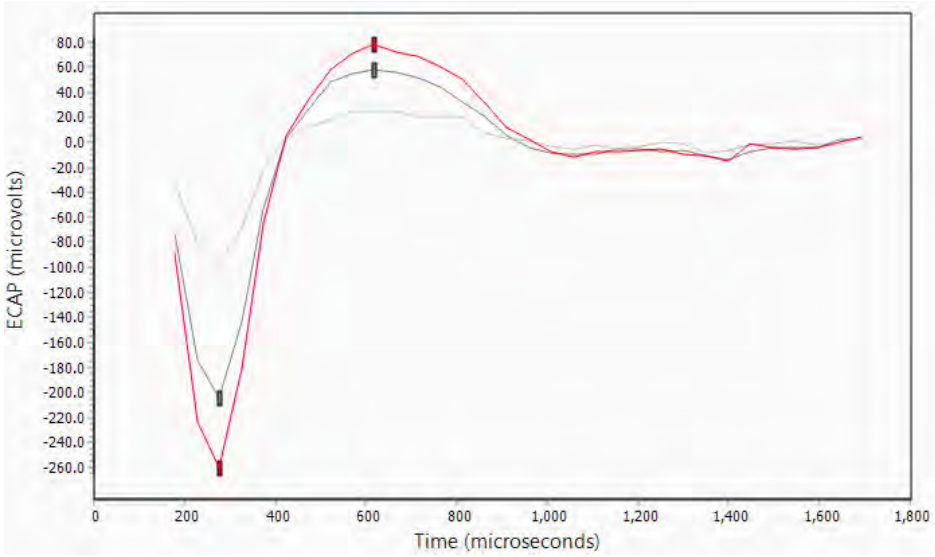
Impedance Case Study (cont'd)



Impedance Case Study (cont'd)

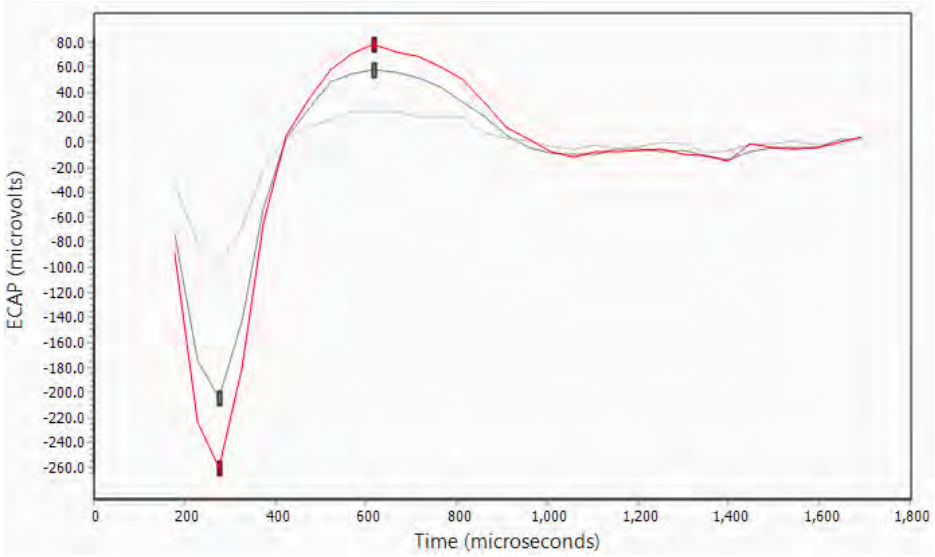


eCAPs



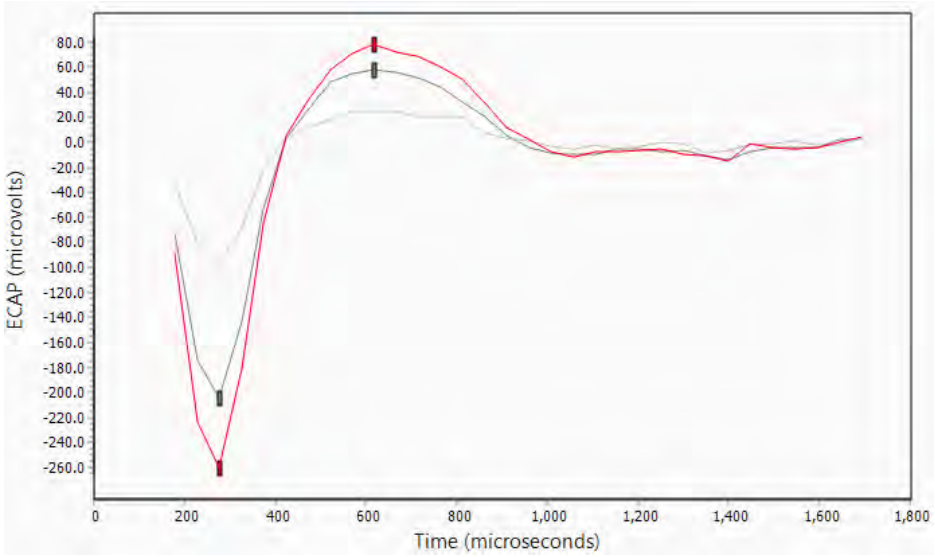
- An electrically-evoked compound action potential (eCAP) is a recorded response representing the synchronous firing of a population of electrically stimulated auditory nerve neurons.
- eCAPS
  - Determine the level of stimulation that is audible
  - Typically no one-to-one relationship between eCAP and behavioral threshold
  - Assess status and integrity of auditory nerve
  - Establish baseline and monitor physiologic function
  - Use WITH CAUTION as a guide to determine stimulation levels for MAPs

eCAPs



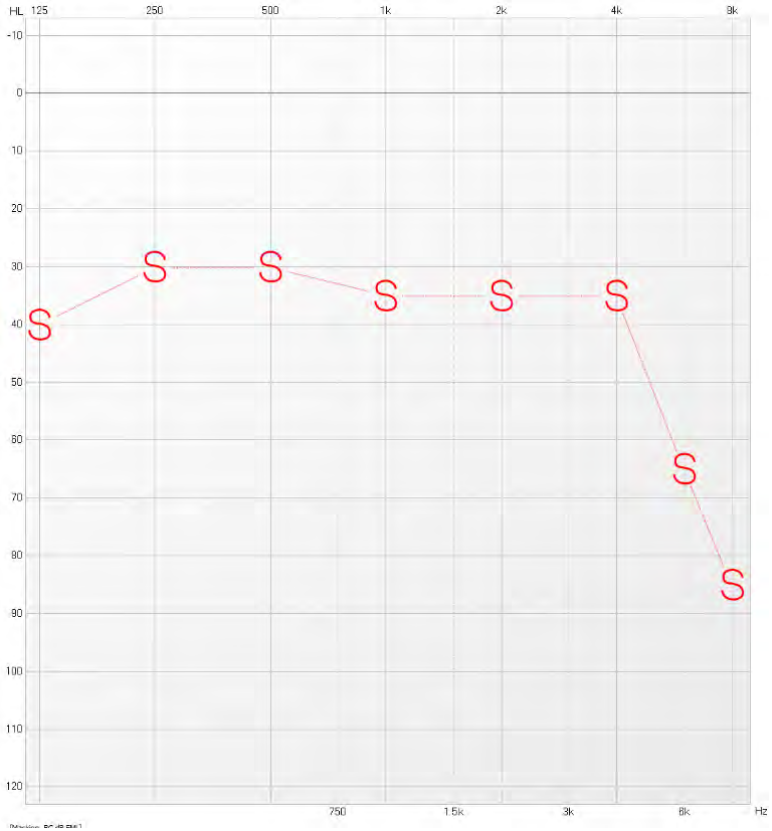
- How can we use this in programming?
- Are there instances where this can't be done?

eCAP Case Study



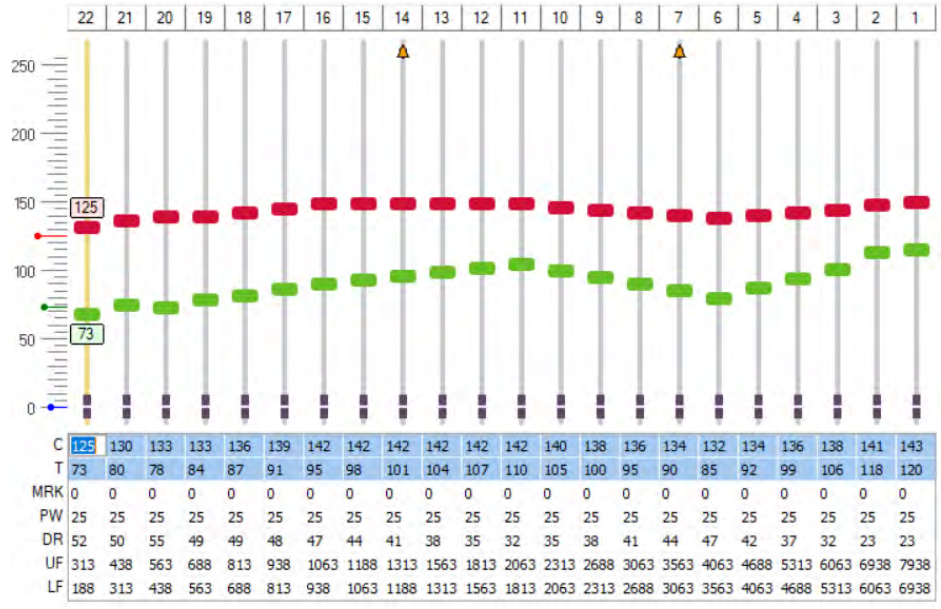
- 72- Year-old Female
- Bilateral progressive hearing loss
- Bimodal user
  - 6 years of cochlear implant use
- Seeking 2nd opinion

eCAP Case Study



- Initial aided audiogram (implant side)
- Bilateral progressive hearing loss
- Bimodal user
  - 6 years of cochlear implant use
- Seeking 2nd opinion

eCAP Case Study



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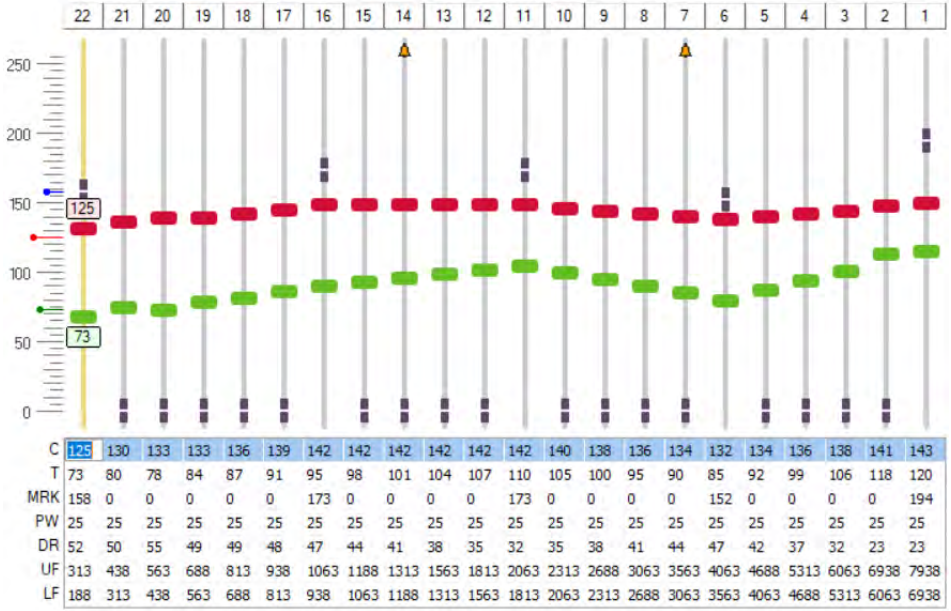
T	73	80	78	84	87	91	95	98	101	104	107	110	105	100	95	90	85	92	99	106	118	120
MRK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PW	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
DR	52	50	55	49	49	48	47	44	41	38	35	32	35	38	41	44	47	42	37	32	23	23
UF	313	438	563	688	813	938	1063	1188	1313	1563	1813	2063	2313	2688	3063	3563	4063	4688	5313	6063	6938	7938
LF	188	313	438	563	688	813	938	1063	1188	1313	1563	1813	2063	2313	2688	3063	3563	4063	4688	5313	6063	6938



C	125	130	133	133	136	139	142	142	142	142	142	142	140	138	136	134	132	134	136	138	141	143
T	73	80	78	84	87	91	95	98	101	104	107	110	105	100	95	90	85	92	99	106	118	120
MRK	158	0	0	0	0	0	173	0	0	0	0	173	0	0	0	0	152	0	0	0	0	194
PW	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
DR	52	50	55	49	49	48	47	44	41	38	35	32	35	38	41	44	47	42	37	32	23	23
UF	313	438	563	688	813	938	1063	1188	1313	1563	1813	2063	2313	2688	3063	3563	4063	4688	5313	6063	6938	7938
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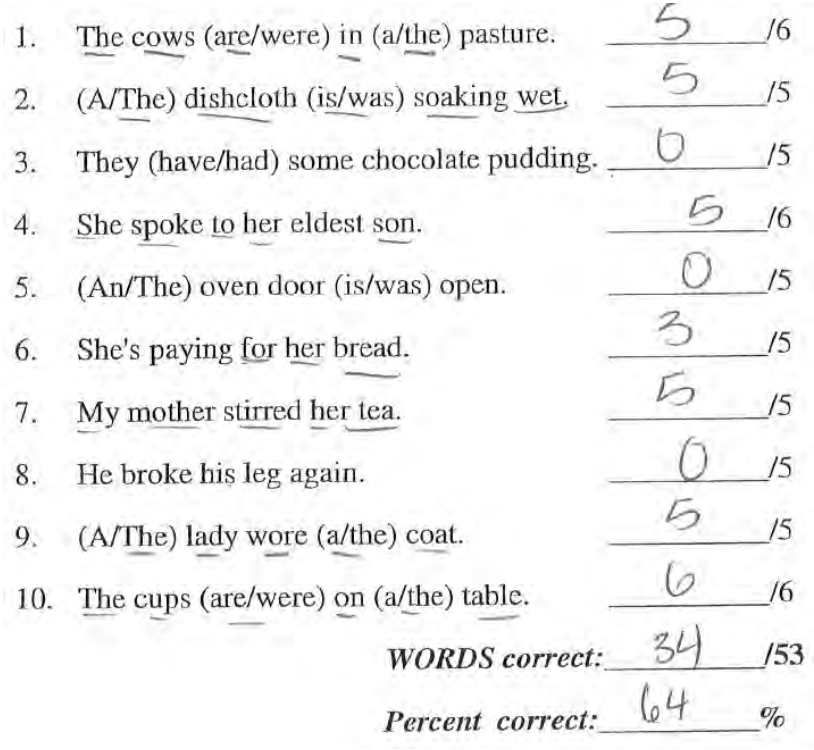
eCAP Case Study



1.	The cows (are/were) in (a/the) pasture.	5 /6
2.	(A/The) dishcloth (is/was) soaking wet.	5 /5
3.	They (have/had) some chocolate pudding.	0 /5
4.	She spoke to her eldest son.	5 /6
5.	(An/The) oven door (is/was) open.	0 /5
6.	She's paying for her bread.	3 /5
7.	My mother stirred her tea.	5 /5
8.	He broke his leg again.	0 /5
9.	(A/The) lady wore (a/the) coat.	5 /5
10.	The cups (are/were) on (a/the) table.	6 /6
	WORDS correct:	34 /53
	Percent correct:	64 %

HINT sentences 2 weeks following reprogramming

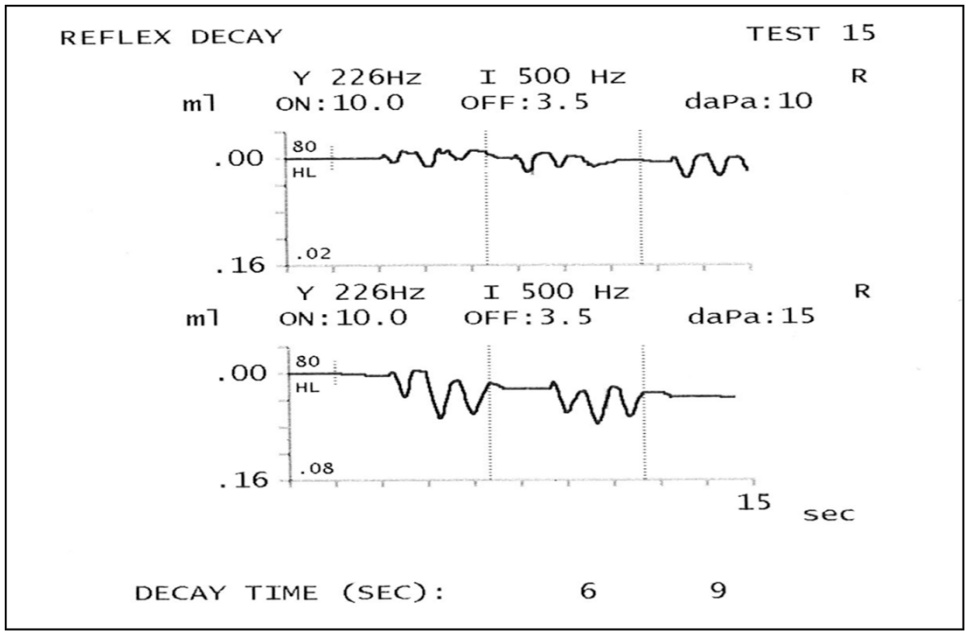
Based on test results, what could have been the reason for the difficulty in speech understanding?

Outcomes since and resolution

Wait, can you overstimulate someone?

- Why does this happen?
- Is it painful?
- Can it cause damage?

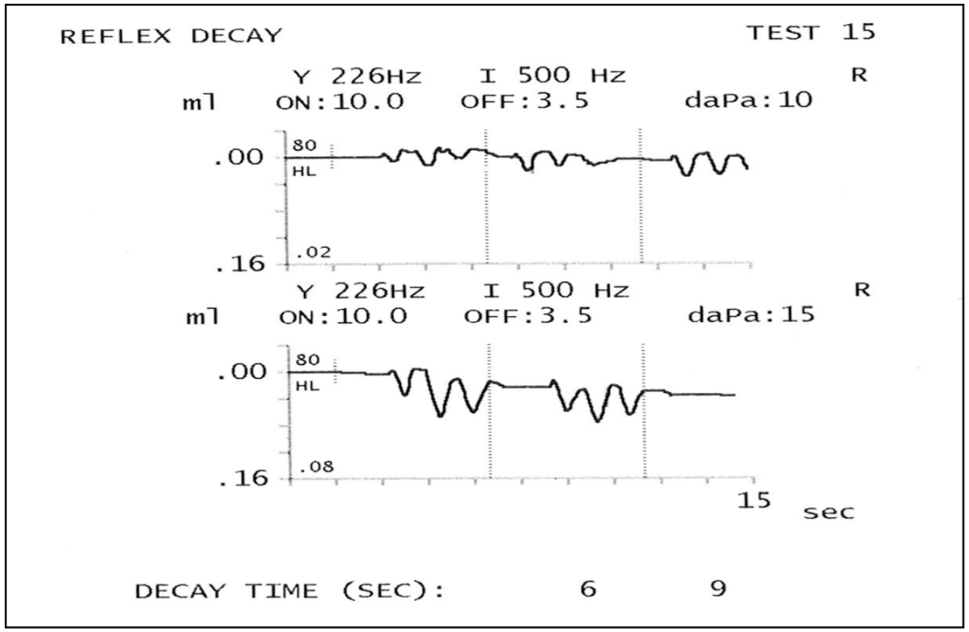
eSRTs



Wolfe, J., Gifford, R., & Schafer, E. (2018)

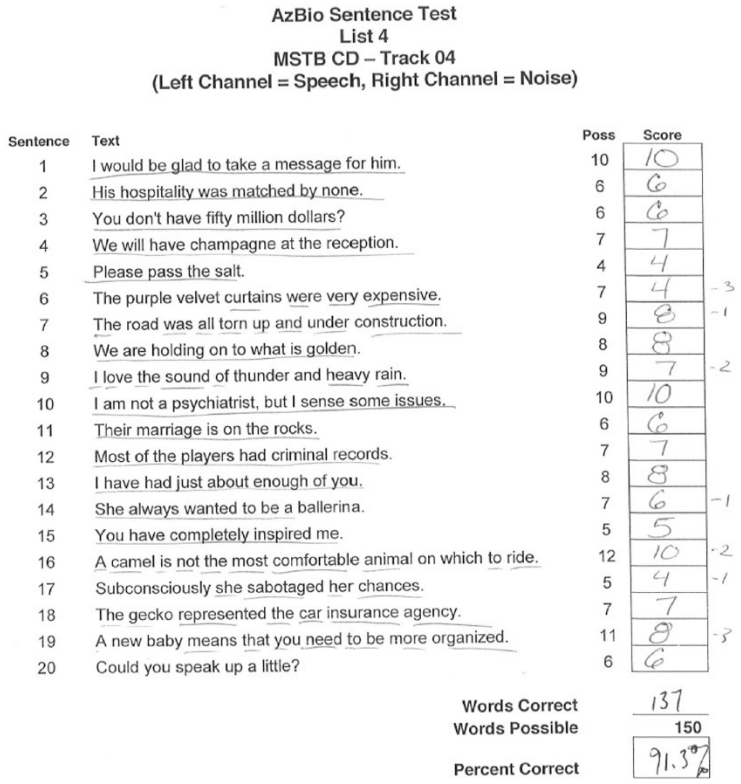
- A recorded response from the contraction of the stapedius muscle following the introduction of a electrical pulse train through the cochlear implant
- Strong correlation between eSRT and upper comfort levels in CI programming.
- Great tool for patients that can't communicate loudness while doing cochlear implant programming.

eSRTs



- Needed Equipment?
- Why not do this on everyone?
  - Middle ear dysfunction
  - Excessive Movement
  - Lack of response
- A case study involving eSRT will come later

Programming Information Found Through Testing



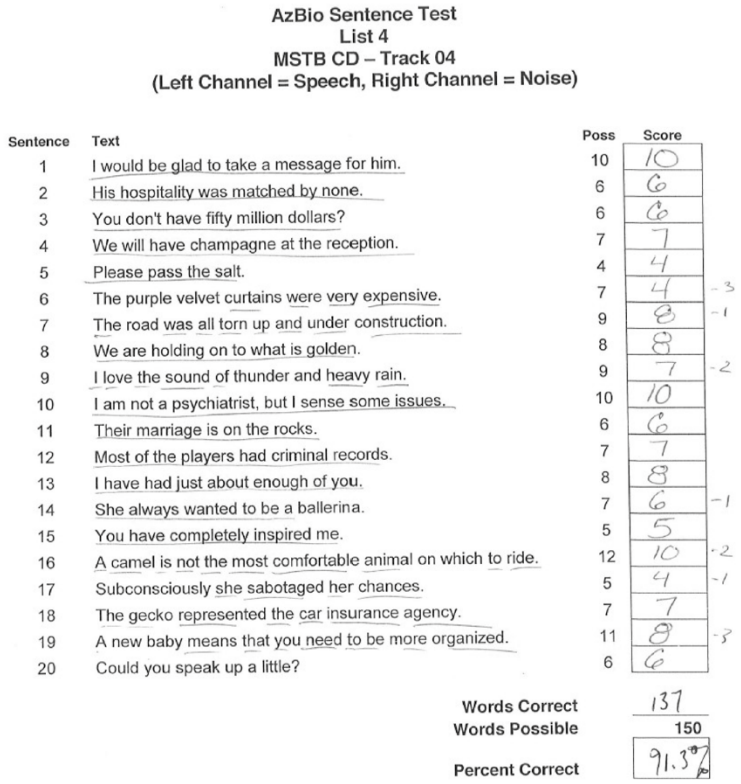
AzBio Sentence Test
List 4
MSTB CD – Track 04
(Left Channel = Speech, Right Channel = Noise)

Sentence	Text	Poss	Score	
1	I would be glad to take a message for him.	10	10	
2	His hospitality was matched by none.	6	6	
3	You don't have fifty million dollars?	6	6	
4	We will have champagne at the reception.	7	7	
5	Please pass the salt.	4	4	
6	The purple velvet curtains were very expensive.	7	4	-3
7	The road was all torn up and under construction.	9	8	-1
8	We are holding on to what is golden.	8	8	
9	I love the sound of thunder and heavy rain.	9	7	-2
10	I am not a psychiatrist, but I sense some issues.	10	10	
11	Their marriage is on the rocks.	6	6	
12	Most of the players had criminal records.	7	7	
13	I have had just about enough of you.	8	8	
14	She always wanted to be a ballerina.	7	6	-1
15	You have completely inspired me.	5	5	
16	A camel is not the most comfortable animal on which to ride.	12	10	-2
17	Subconsciously she sabotaged her chances.	5	4	-1
18	The gecko represented the car insurance agency.	7	7	
19	A new baby means that you need to be more organized.	11	8	-3
20	Could you speak up a little?	6	6	

Words Correct	137
Words Possible	150
Percent Correct	91.3%

- Test results from MSTB are used to track progress from candidacy to post-activation
- What if those same tools could be used to detect deficient patterns in outcomes?
- What if you could target those deficient patterns to improve speech perception?

What are we looking for in audiologic test results?



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Words Correct	137
Words Possible	150
Percent Correct	91.3%

- The voice and the words missed for sentences
- Male vs. Female voices
- Phonemes in CNC words
- Repeating patterns
- Relating information to the audiogram
- Finding associated frequencies with sounds

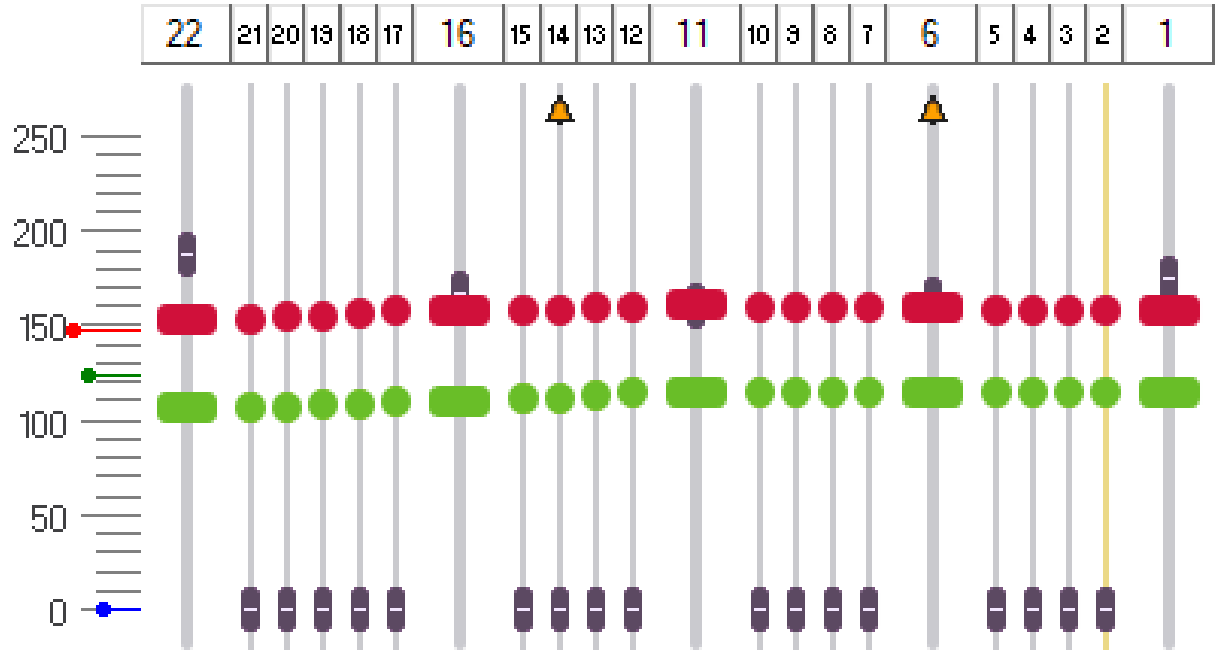
Case Studies and Other Parameters

- Pulse Width or Pulse Duration
- Compression
- Dynamic Range
- Threshold and Manipulation

Case Study 1

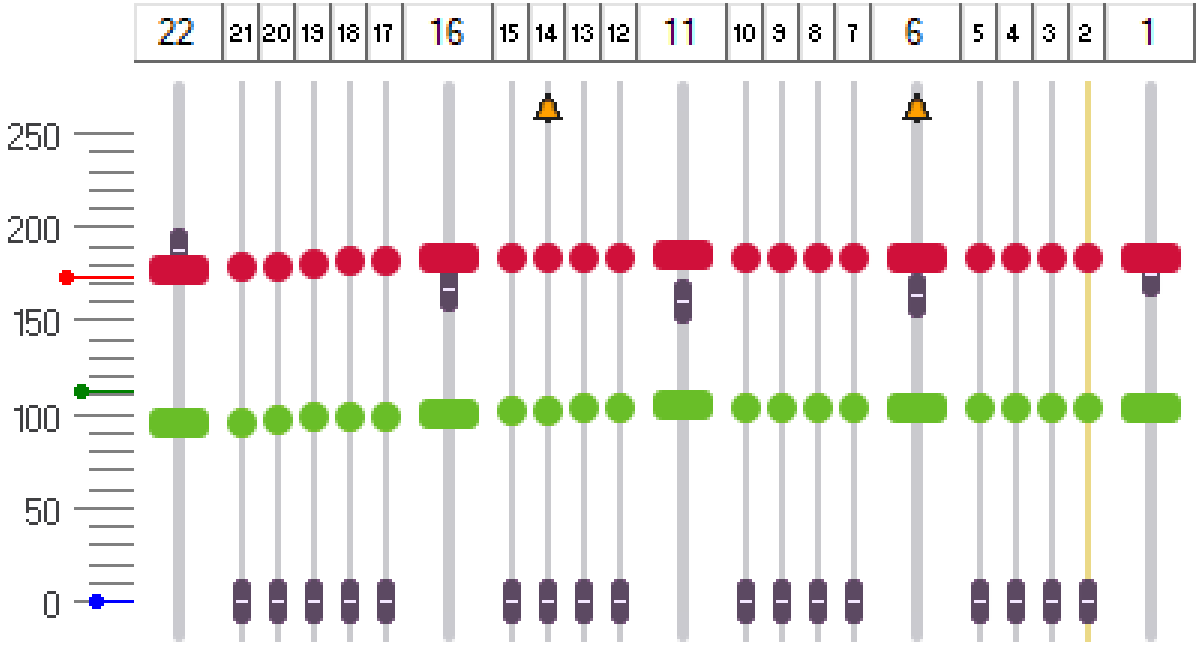
- 56 year-old-male
- Implanted with Cochlear Americas device in the left ear
- Complains of background noise and voices sounding very quiet
- Since last visit at other center for background noise issues, he notices a consistent humming sound no matter if quiet or noise

Case Study 1



C	142	148	150	149	148
T	115	119	124	123	123
MRK	187	167	160	164	175
PW	25	25	25	25	25
DR	27	29	26	26	25
UF	313	1063	2063	4063	7938
LF	188	938	1813	3563	6938

Case Study 1



C	167	173	175	174	173
T	105	109	114	113	113
MRK	187	167	160	164	175
PW	25	25	25	25	25
DR	62	64	61	61	60
UF	313	1063	2063	4063	7938
LF	188	938	1813	3563	6938

Case Study 1 Summary

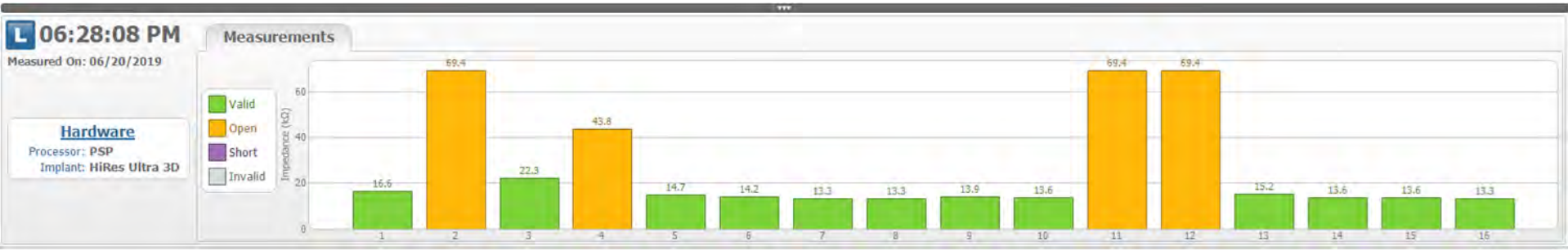
- Threshold levels relating to noise
- Other options in other manufacturers for addressing this issue.
- eCAPs let us know the patient may be slightly underfit
- eSRTs helped us address with the upper comfort levels should appropriately be set.
- Patient outcomes

Case Study 2

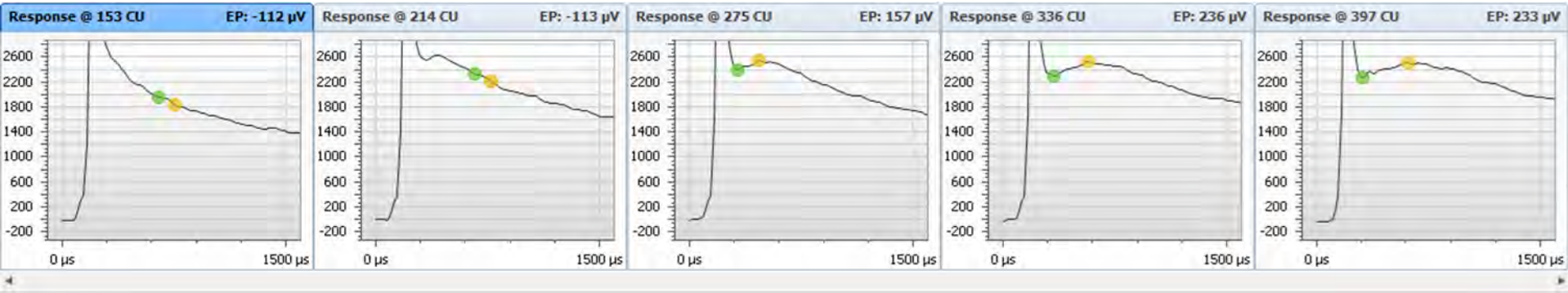
- 3-year-old female
- Was taken to ER with a high fever and later diagnosed with bacterial meningitis.
- Complications were identified later, and she stopped responding to her family members.
- What are some complications to consider with bacterial meningitis to consider? Because of this what might we find?

Case Study 2

Impedance



eCAPs



Case Study 2 Summary

- Ossification may prevent quality outcomes
- Compression following deactivated electrodes
- Sound awareness still present
- Communication via sign language

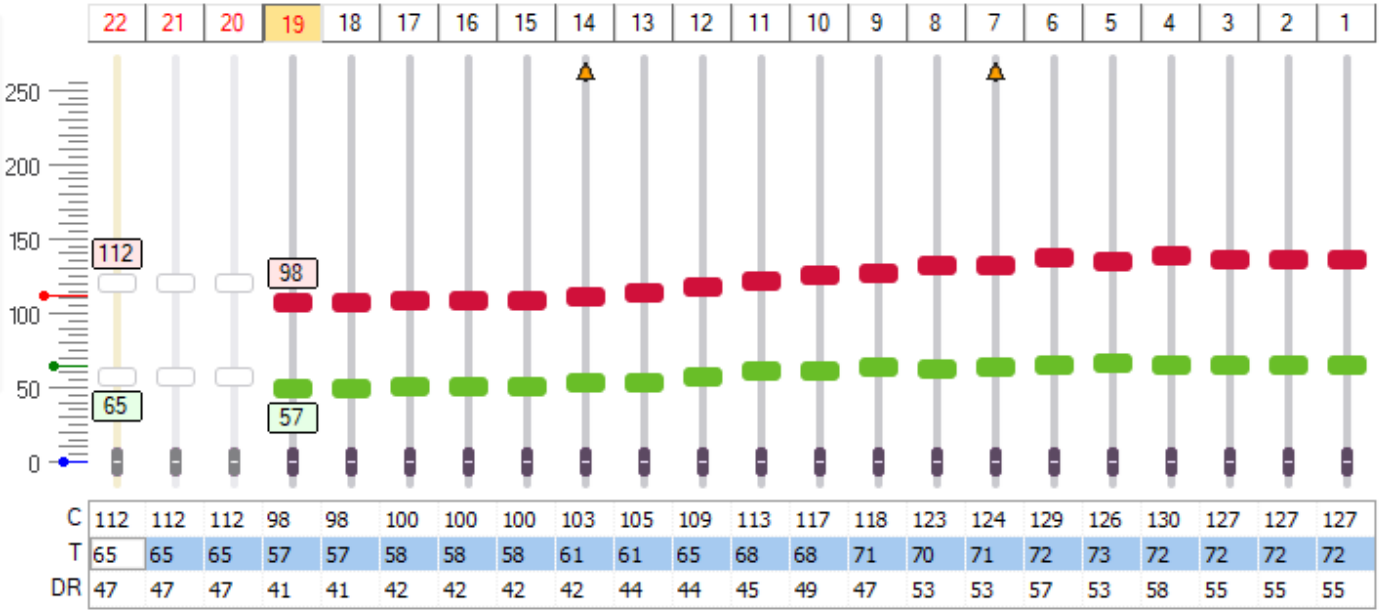
Case Study 3

- 74 year-old-female
- Implanted with Cochlear Americas device in the right ear with N22 internal implant
- Can communicate decently in one on one conversations but struggles in noise.
- Aided audiogram revealed thresholds between 25-30 dB from 250-3000 Hz, and between 40-55 dB from 4-8 kHz.
- During speech perception testing, she is consistently missing words ending with |s| and |sh|

Case Study 3

MAP Summary

Parent MAP	2
Strategy	SPEAK
Mode	BP+3
Rate	112 - 367
Maxima	8
Pulse width	0



	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
C	112	112	112	98	98	100	100	100	103	105	109	113	117	118	123	124	129	126	130	127	127	127
T	65	65	65	57	57	58	58	58	61	61	65	68	68	71	70	71	72	73	72	72	72	72
DR	47	47	47	41	41	42	42	42	42	44	44	45	49	47	53	53	57	53	58	55	55	55

Case Study 3

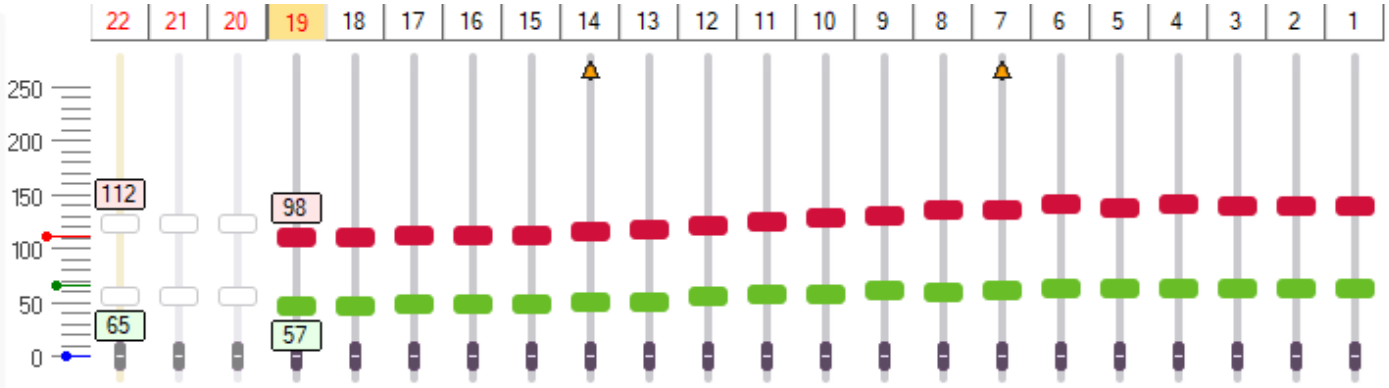
English Consonants

Consonant	1st Formant	2nd Formant	3rd Formant	4th Formant
/p/			1500-2000	
/t/			2500-3000	
/k/			2000-2500	
/d/	300-400		2500-3000	
/b/	300-400		2000-2500	
/g/	200-300		1500-2500	
/m/	250-350	1000-1500	2500-3500	
/n/	250-350	1000-1500	2000-3000Ł	
/ng/ (wing)	250-350			4500-6000
/f/				4000-5000
/s/				5000-6000
/sh/			1500-2000	4500-5500
/th/ (thin)				6000
/h/			1500-2000	
/v/	300-400			
/z/	200-300			
/TH/ (that)	250-350			
/ch/	200-300		1500-2000	4000-5000
/dg/ (jot)			2000-3000	
/l/	250-400		2000-3000	
/r/ (err)	600-800	1000-1500	1800-2400	

Case Study 3

MAP Summary

Parent MAP	2
Strategy	SPEAK
Mode	BP+3
Rate	112 - 367
Maxima	8
Pulse width	0



	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
C	112	112	112	98	98	100	100	100	103	105	109	113	117	118	123	124	129	126	130	127	127	127
T	65	65	65	57	57	58	58	58	61	61	65	68	68	71	70	71	72	73	72	72	72	72
PW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DR	47	47	47	41	41	42	42	42	42	44	44	45	49	47	53	53	57	53	58	55	55	55
UF	0	0	0	313	438	563	688	813	938	1063	1313	1563	1813	2188	2563	3063	3563	4188	4938	5813	6813	7938
LF	0	0	0	188	313	438	563	688	813	938	1063	1313	1563	1813	2188	2563	3063	3563	4188	4938	5813	6813

Case Study 3 Summary

- Known capabilities of internal implant plays a role in what can be done to address issue
- Frequency targeting may be effective in correcting deficiencies in speech perception
- Working in an interdisciplinary team is helpful in addressing issues such as these
- Patient outcomes

Putting it all together

- Next time you're stuck with a tough case, consider taking these steps:
  1. Investigate the issues with patient histories
  2. Make sure you use objective measures
  3. Take the information you learn from testing to lead your programming changes
  4. Never EVER be afraid to ask for help!

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Thank you

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