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20
YEARS OF SOUND
Sonic Spotlight Series: SmartCompress
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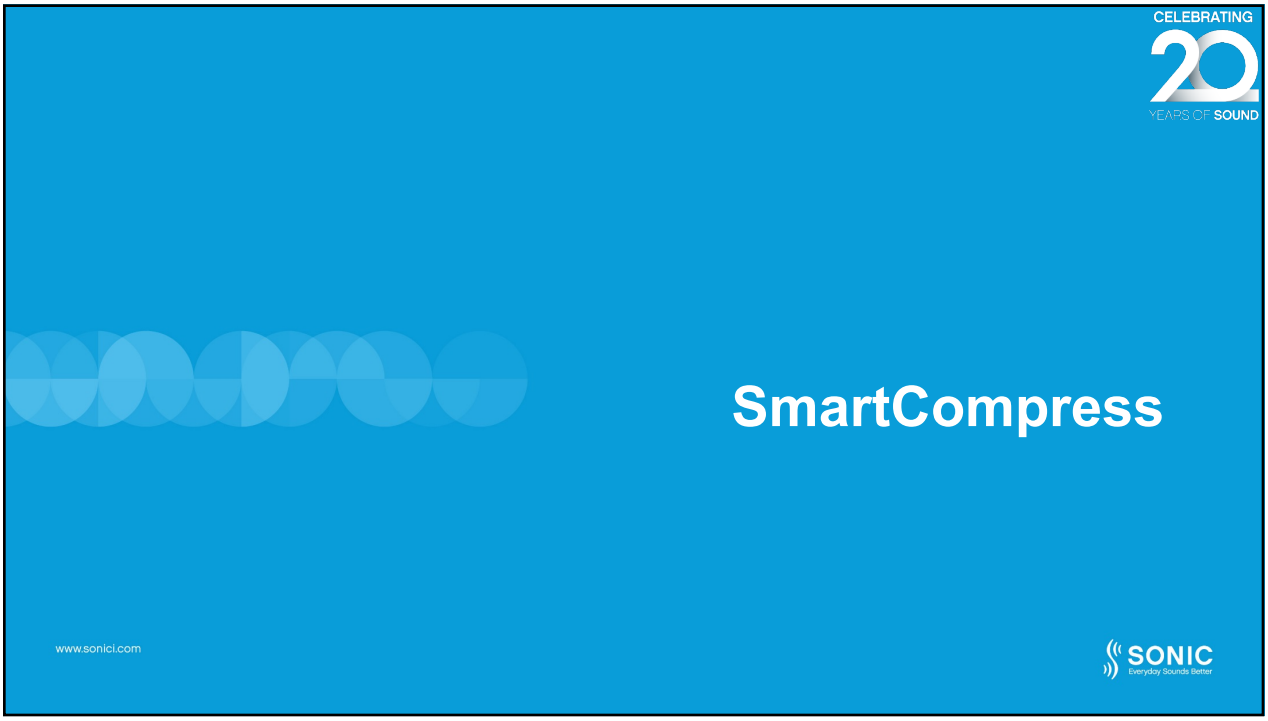
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SoundDNA Technology Platform

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Speech Variable Processing

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Sonic's DSP – Overview:

- Amplification with Speech Variable Processing (SVP)
- SVP measures and applies gain to the wideband acoustic signal
- Does not break up incoming signal into separate frequency regions
- Phoneme Focus & Envelope Focus address auditory resolution
- SVP uses Wide Dynamic Range Compression (WDRC)
  - Proprietary Fitting Rationales: Best Fit Fast, Best Fit Fast SE
  - Generic Fitting Rationales: NAL, DSL

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WDRC: Speech in Quiet

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Compression:

- Applies more gain to soft sounds and less gain to loud sounds to attempt to restore normal loudness levels

Outcome:

- Hearing aids apply gain and compression based on the overall level
- Level: Speech only
- SNR: HIGH
- Amplification with WDRC optimizes Speech in Quiet
- Sonic SVP Alone = suitable

WDRC: Speech in Noise

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Compression:

- Applies more gain to soft sounds and less gain to loud sounds to attempt to restore normal loudness levels

Outcome:

- Hearing aids apply gain and compression based on the overall level
- Level: Speech AND Noise
- SNR: LOW
- WDRC introduces distortion when amplifying noise signals
- Sonic SVP = needs support

WDRC: Noise Only

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Compression:

- Applies more gain to soft sounds and less gain to loud sounds to attempt to restore normal loudness levels

Outcome:

- Hearing aids apply gain and compression based on the overall level
- Level: Non-speech Signals
- SNR: VERY LOW
- WDRC Disproportionately amplifies signals where speech is not present
- Sonic SVP = needs support

Other considerations

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Directional Microphones & Noise Reduction:

- Optimizes DSP
- Improves the SNR of the input to provide a cleaner signal to amplify

(Valente et al., 1995; Stelmachowicz et al., 2010)

- If the compression system cannot distinguish the signal from the noise, it will amplify noise signals
- Compression technology by itself does not consider the signal type, nor the SNR of the input signal going into the hearing aid
- Compression is applied 'blindly' without regard to the presence or absence of noise in the environment

WDRC and Noise

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3 Reasons why SVP needs support in noise:

1. Compression causes temporal and spectral distortion to the speech envelope, making it harder for patients with SNHL to discriminate speech, particularly in noise (Moore, 2008)
2. Compared with linear processing, compression creates a noisier sound perception and makes listeners less willing to accept noise (Wu and Stangl, 2013)
3. Compression affects the 'Output SNR' of the aid in noise, because noise is amplified when it should be reduced (Naylor and Johannesson, 2009)

Expectations

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A hearing aid must be able to:

- Accurately perform signal analysis
- Distinguish the signal from the noise by knowing the real-time SNR as it occurs
- Amplify sounds of interest appropriately at a rate that keeps pace with changes
  - Listening environments constantly change from moment to moment
  - Speech in Quiet; Speech in Noise; Noise Only; Quiet Only
  - Rapid and slow changes occur in the environment

Previous technology

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Environment Classification

- Classifies listening environments as they change
- Applies different amounts of gain/compression to input signal

• Limitations

- Uses 'static' (non-adaptive) rules to classify environments
- In rapidly fluctuating environments, changes in performance are rigid and slow (300 msec delay)
- Imprecise hearing aid performance based on information from the past
- Requires manual adjustment to dedicated program
  - Speech-in-noise program, a noise-only program, a quiet program, etc.

SmartCompress

SmartCompress: Configurable adaptive compression system for intelligent amplification in noise

SVP + SmartCompress

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SVP with SmartCompress

- Advances DSP technology beyond the limitation of a static environment classification system to a real-time adaptive compression system

- The technology is based on a real-time assessment of the environment using short- and long-term SNR analysis
- Results in accurate application of gain and compression in response to rapidly fluctuating environments
- Amplification is applied according to level and environment

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SVP + SmartCompress

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Coordinated DSP:

- **SVP** optimizes amplification for Speech in Quiet
- **SVP with SmartCompress** optimizes amplification for all other listening environments

- SmartCompress allows the system to intelligently overcome the challenges associated with rapidly changing listening environments for a natural hearing experience
- No longer a need for Environment Classification with SmartCompress!

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SmartCompress - How does it do it?

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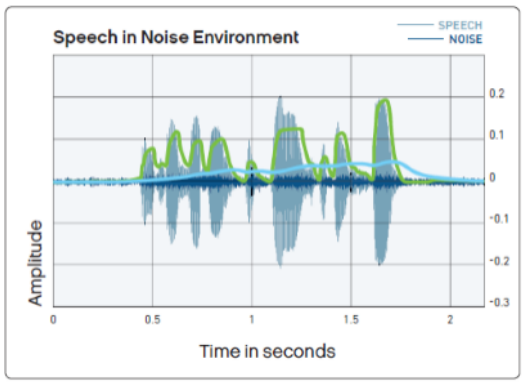
- SmartCompress uses two SNR level estimators, compared to one in traditional systems
  - Green – fast phonemic estimator
  - Blue – slow, long-term estimator
- Provides accurate measurement of environmental changes in real time



SmartCompress

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✓Controls **compression** in **speech-in-noise** environments
- Adaptively varies the compression in speech-in-noise environments
- Determines how much the compression has to be decreased, or made more linear, for less noise in the output

✓Controls **gain** in **non-speech** environments
- Adaptively limits gain when speech is not present
- Determines the occurrence of quiet and noise-only situations and applies less gain to the input

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SmartCompress Clinical & Field Tests

Testing, Results, Benefits

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SmartCompress Tested

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- Clinical Trial
- 30 Participants
- 23 males
- 7 females
- All experienced hearing aid users of the previous platform
- Moderate to severe hearing loss

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SmartCompress Tested

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- Test conditions
- Binaural amplification
- 1 set devices without SmartCompress (previous platform)
- 1 set devices with SmartCompress (current platform)
- Fit to NAL-NL2 targets
- Verified with REM

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SmartCompress Tested

- Test Materials
- Speech test: word recognition test
- Wallenberg and Kollmeier monosyllabic rhyme test (WaKo)
- WAKO determines speech intelligibility in noise

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SmartCompress Tested

- Test Method
- Speech and noise were presented from one single loudspeaker in the front
- SNR is fixed at +5 dB SNR
- Speech level is at 65 dB SPL
- The test presentation was automated
- For each word, the listener's response and response time were concurrently recorded and measured

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SmartCompress Tested

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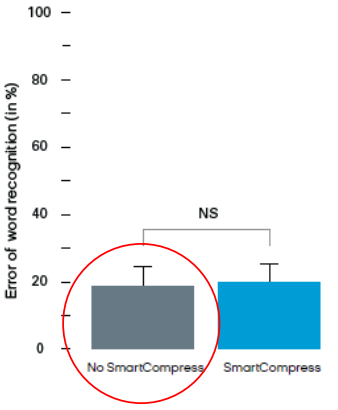
- The grey bar shows the devices without SmartCompress
- On average, participants incorrectly heard ~20% of the words in the speech-in-noise test when SmartCompress was not available
- Another perspective: ~80% of the words were heard correctly without the feature ☺



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SmartCompress Tested

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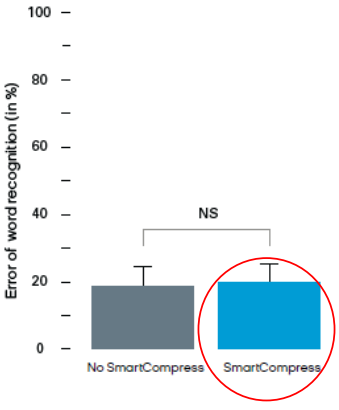

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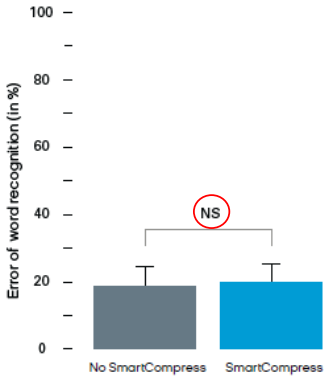
SmartCompress Tested

- NS = Not Significant!
- This result suggests that when SmartCompress is activated, it leaves the speech signal unchanged, preserving speech
- Remember, SmartCompress works by applying less gain to the noise signal
- If it was too aggressive or not accurate when limiting amplification to certain parts of the signal, it would have the potential to degrade word recognition



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SmartCompress Tested

- But that's not all!
- Recall the test design:
- "For each word, the listener's response and response time were concurrently recorded and measured"
- So we know the responses were ideal…
- What about response times?

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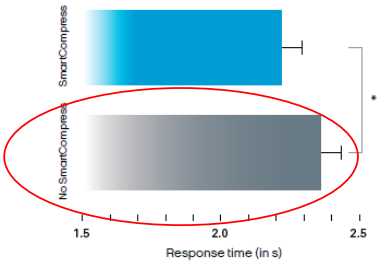
SmartCompress Tested

- This graph shows averaged response times measured with and without SmartCompress for all the tested words
- The grey bar shows response times for the WAKO words in the devices that do not have SmartCompress
- Nearly 2.4 seconds per word response time



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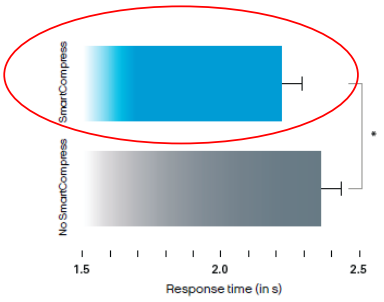
- The blue bar shows response times for the WAKO words in the devices that do have SmartCompress
- Nearly 2.2 seconds per word response time
- The blue bar is visibly shorter than the grey bar
- Which means?...



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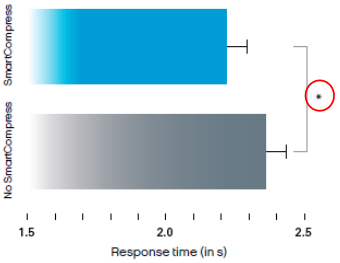
SmartCompress Tested

- Faster!
- * = SIGNIFICANT DIFFERENCE
- The average response time is significantly faster with SmartCompress activated
- Specifically, listeners responded 145 ms faster (p = 0.03) to give their answer at the same intelligibility level when SmartCompress is activated



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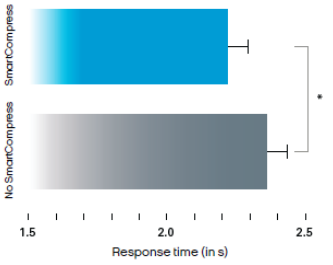
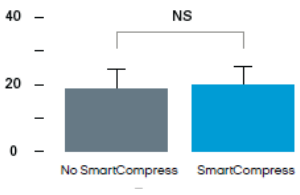
SmartCompress Tested

- Why is that important?
- Gustafson et al. (2014) reported that reduced response times reflect a benefit in terms of ease of listening
  - E.g., Reduced listening effort
- Likewise, these results show that SmartCompress reduces the response times while it preserves word recognition, suggesting that SmartCompress also has a **positive impact for ease of listening**





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- But that's not all!
- A hearing system can be designed to deliver certain clinical outcomes, but if it does not deliver on preferred sound quality measures, then it might be wasted effort
- Let's investigate further…

SmartCompress Tested

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- Experiment 2
- Same 30 subjects
- Blinded take-home field test wearing hearing aids with and without SmartCompress
- Subjects wore one set of aids one week
- They wore the next set the following week
- Test order randomized and counterbalanced
- Reported their listening experiences in journals

SmartCompress Tested

- Analysis
- The open-ended journal responses were analyzed via a qualitative research method
- Identifies the frequency of recurring key words for each test condition (Knudsen et al., 2012)
- Results revealed improved sound quality with the amplification from all tested hearing aids that belong to the SoundDNA platform…

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SmartCompress Tested

Two Main findings:

1. The participants reported the **overall sound quality as natural and detailed**, whether or not SmartCompress was activated
   - Sound Quality is natural and detailed in both conditions
   - SmartCompress preserves the natural sound quality of Sonic devices
   - SmartCompress preserves the details of sound needed to hear clearly
2. In the condition with SmartCompress activated, listeners reported **more listening comfort in noisy environments**

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Summary

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SmartCompress Advantages:

- Improved ease of listening (faster response times)
- Improved listening comfort in noise (field test)
- Natural sound quality (field test)

With these advantages, SmartCompress aims to increase hearing aid acceptance for hearing aid users in quiet or in noise.

SmartCompress Spotlight

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- SmartCompress Spotlight
- Find all the clinical and field test details in the updated technology paper at www.sonici.com

Final Comments

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- Thank you for joining us today for Sonic's Course:
  - Sonic Spotlight Series: SmartCompress
- Any Questions?
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