

Why People with a Cochlear Implant Listen to Music.

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Disclaimer!





"The best advice I can give to a new teacher is to listen to your students with your ears and heart."

The Cochlear Implant

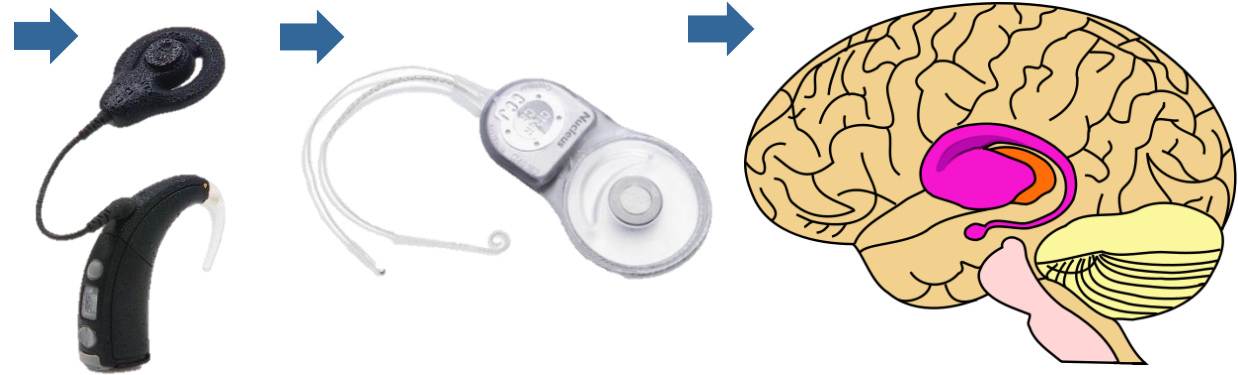
From Speech.... through the Sound Processor the Implant.....to the Perception.



-> 80% of words correctly perceived in a sentence presented in silence

The Cochlear Implant

From Music through the Sound Processor the Implant.....to the Perception.



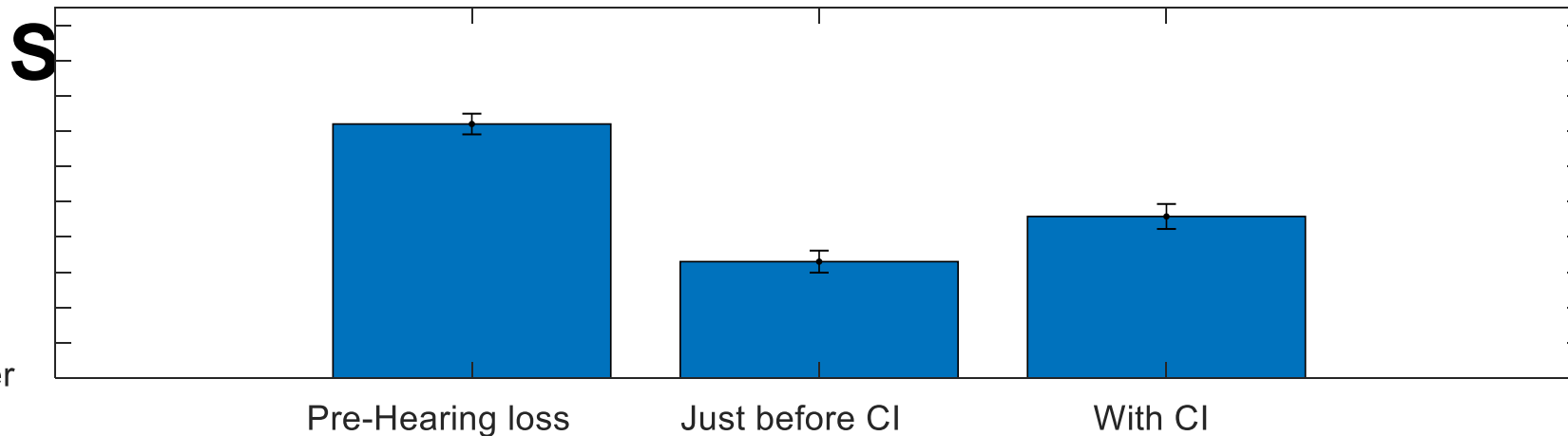
-> Many CI users report having great difficulties in perceiving and enjoying music

very often

sometimes

Never

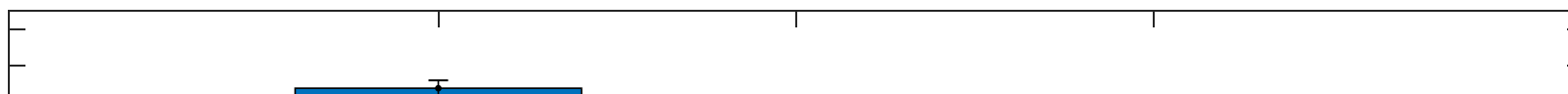
Amount of time spent listening to music



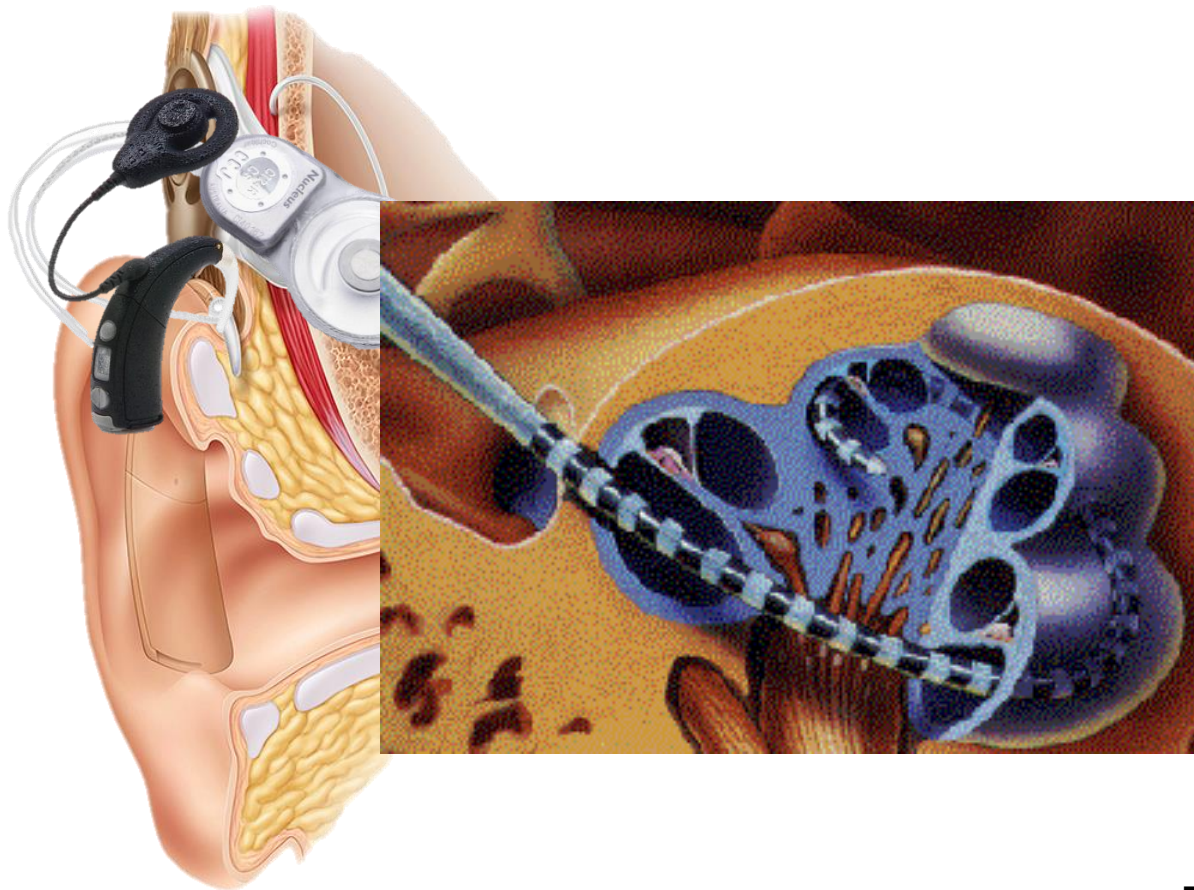
Li, 2007)

Music listening enjoyment

greatly enjoyed



did not enjoy



The sound processor

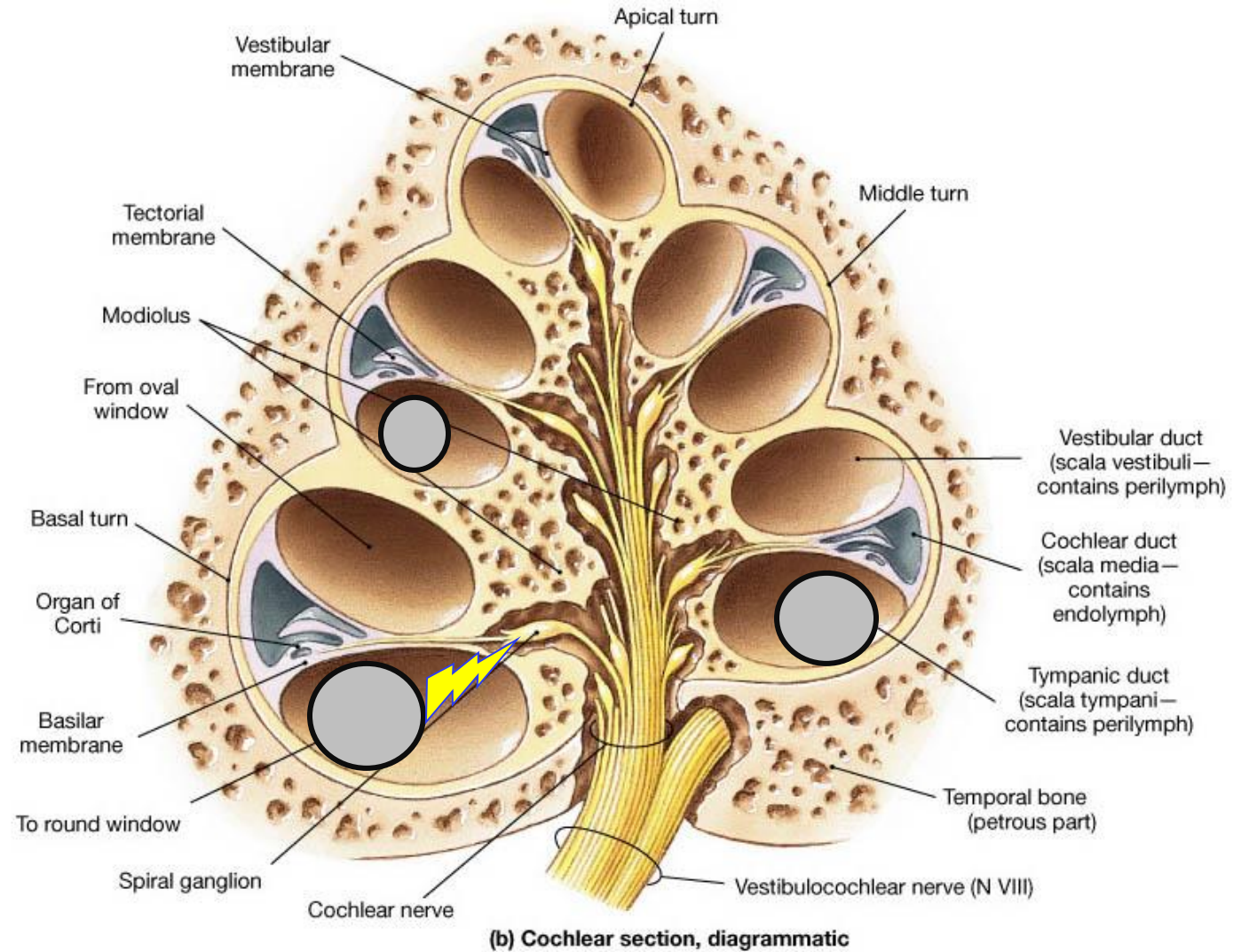
RF Link

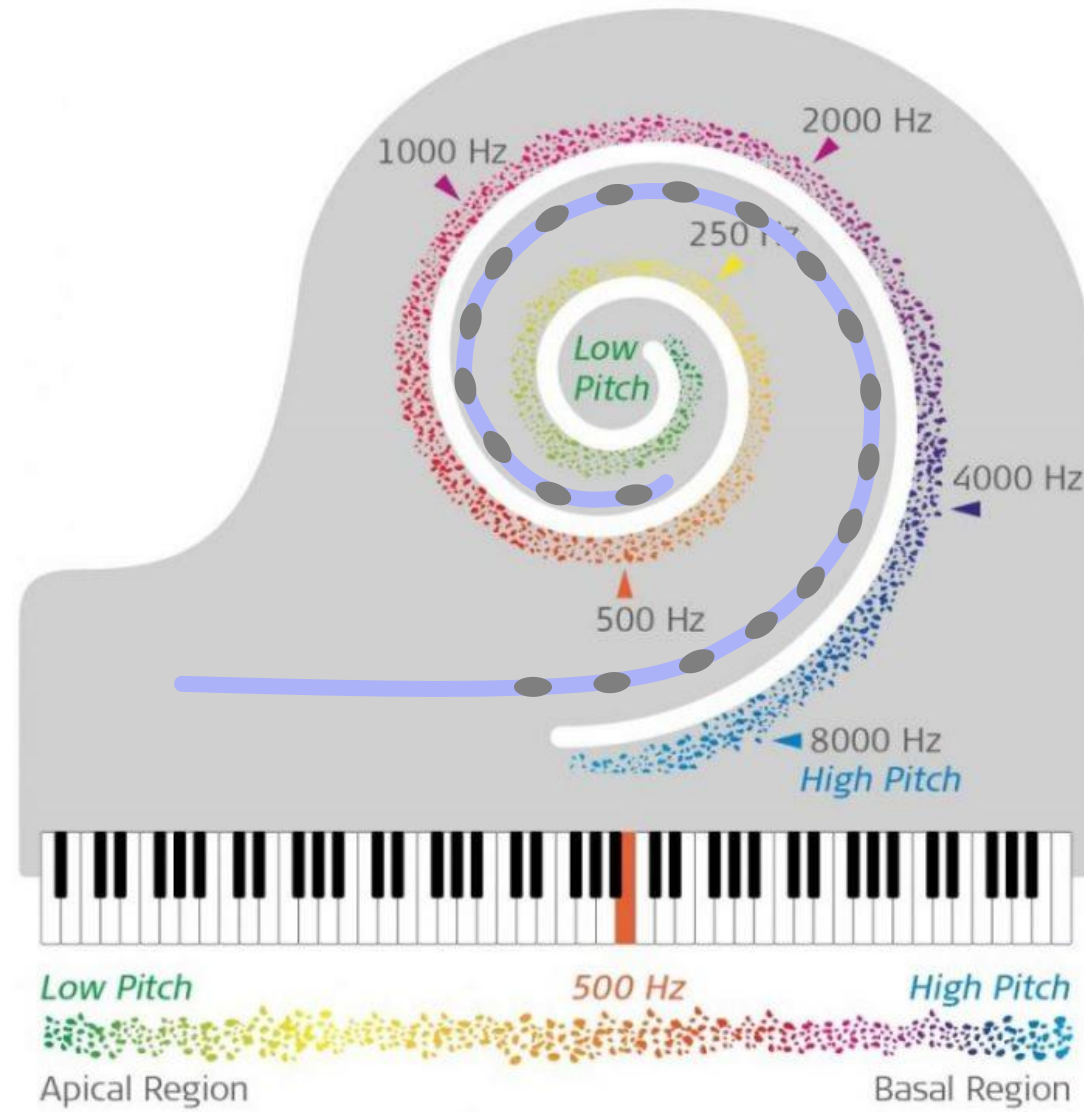
The implant

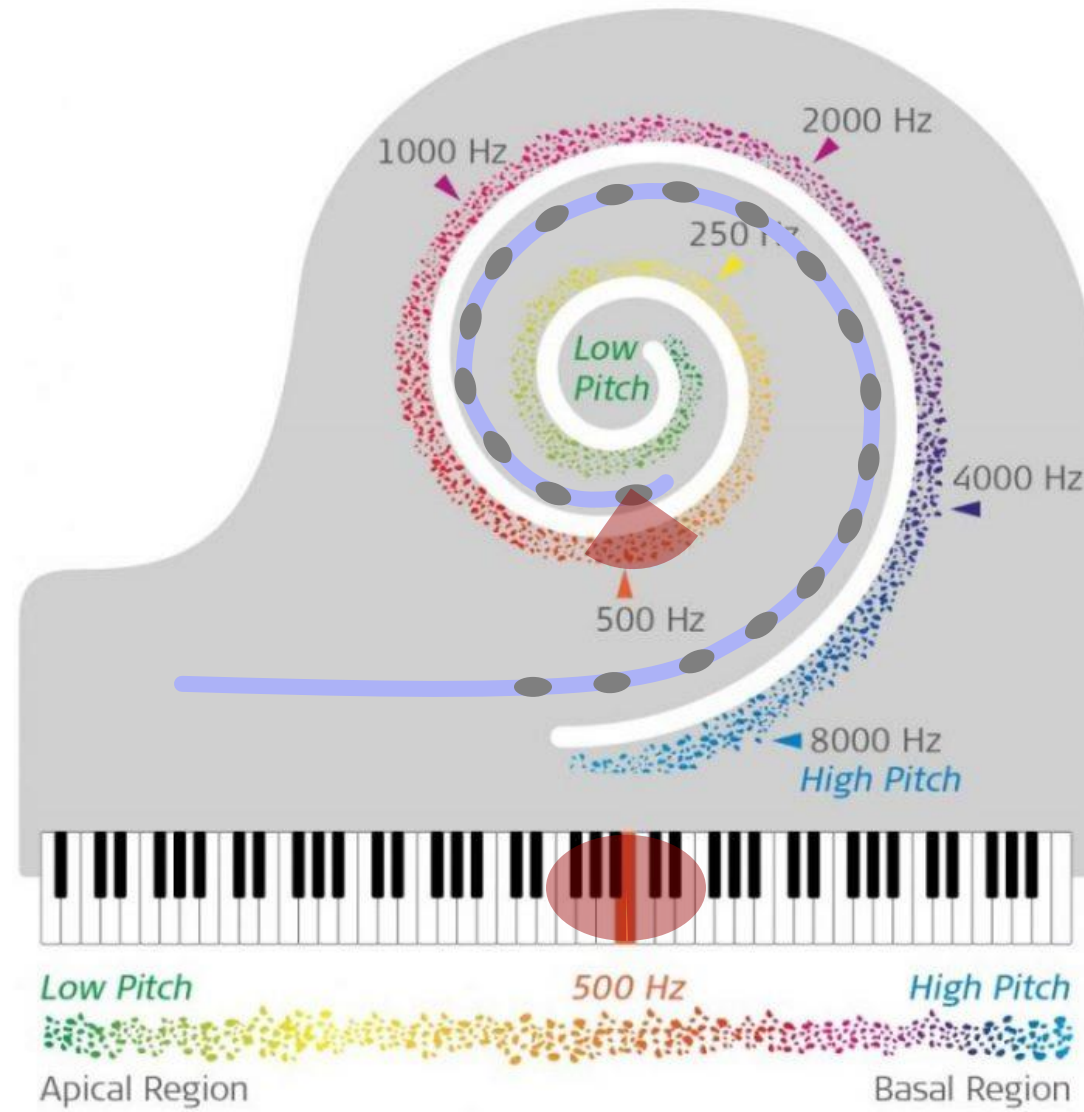


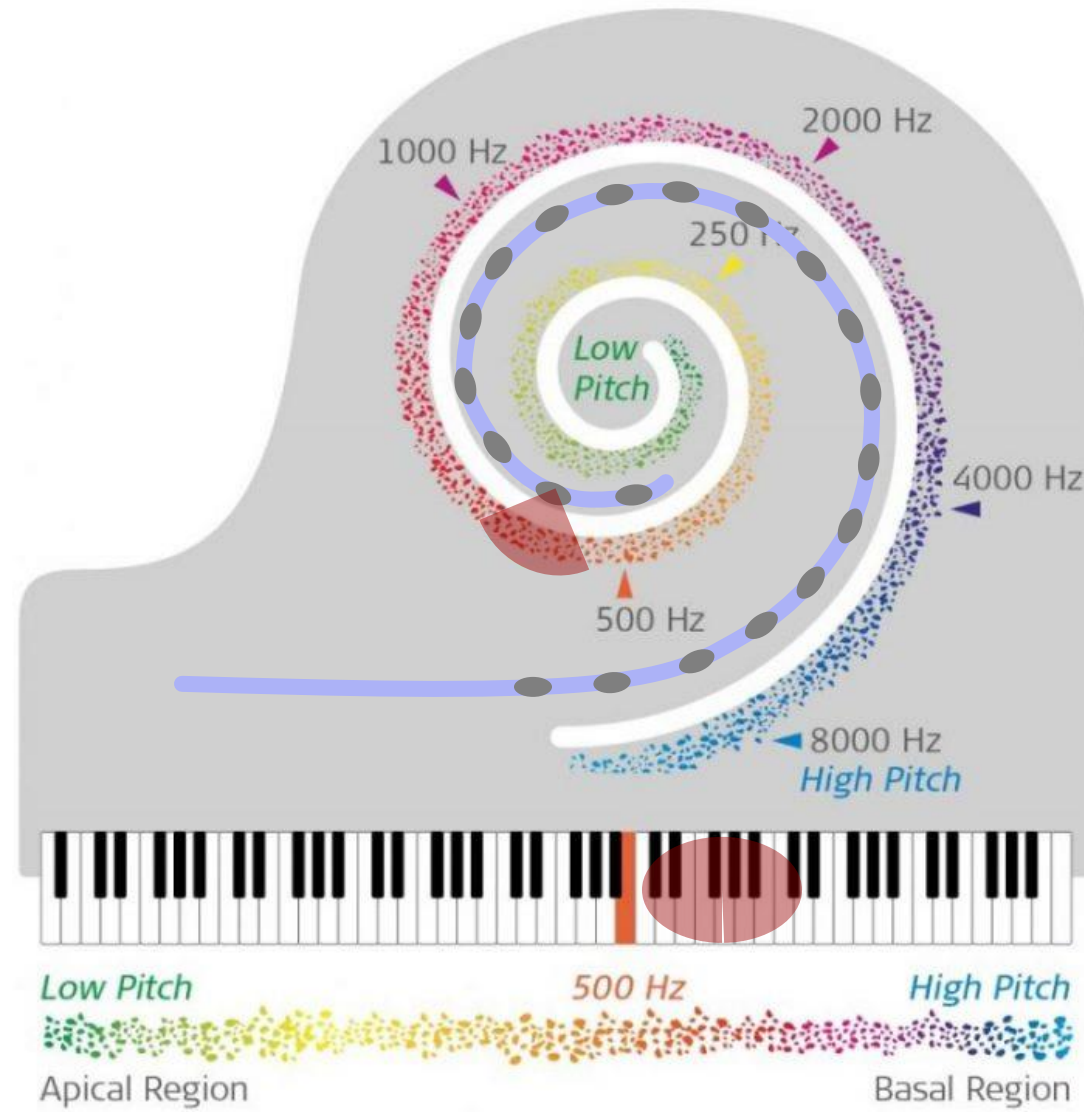
The electrodes

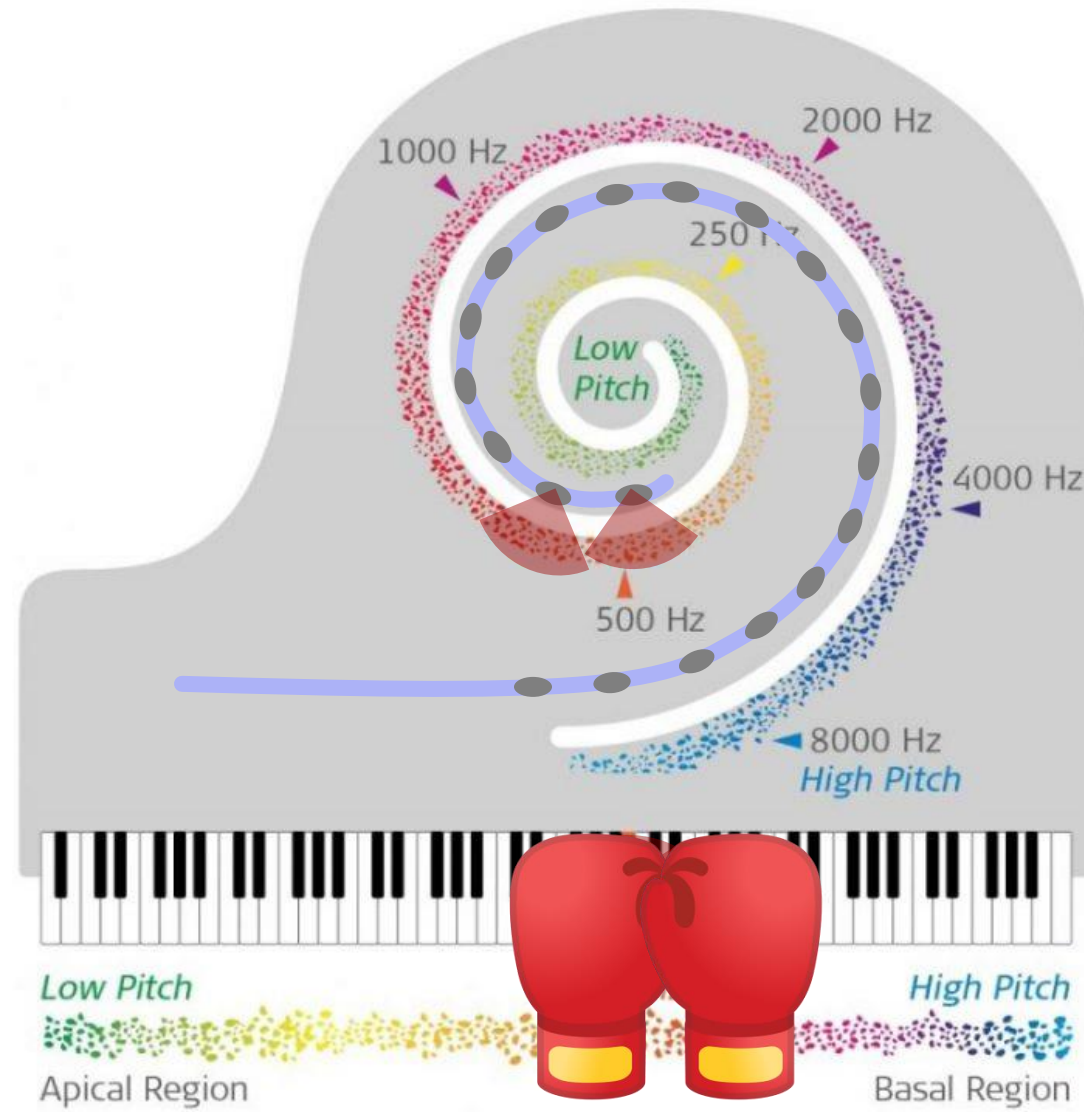
The Cochlea







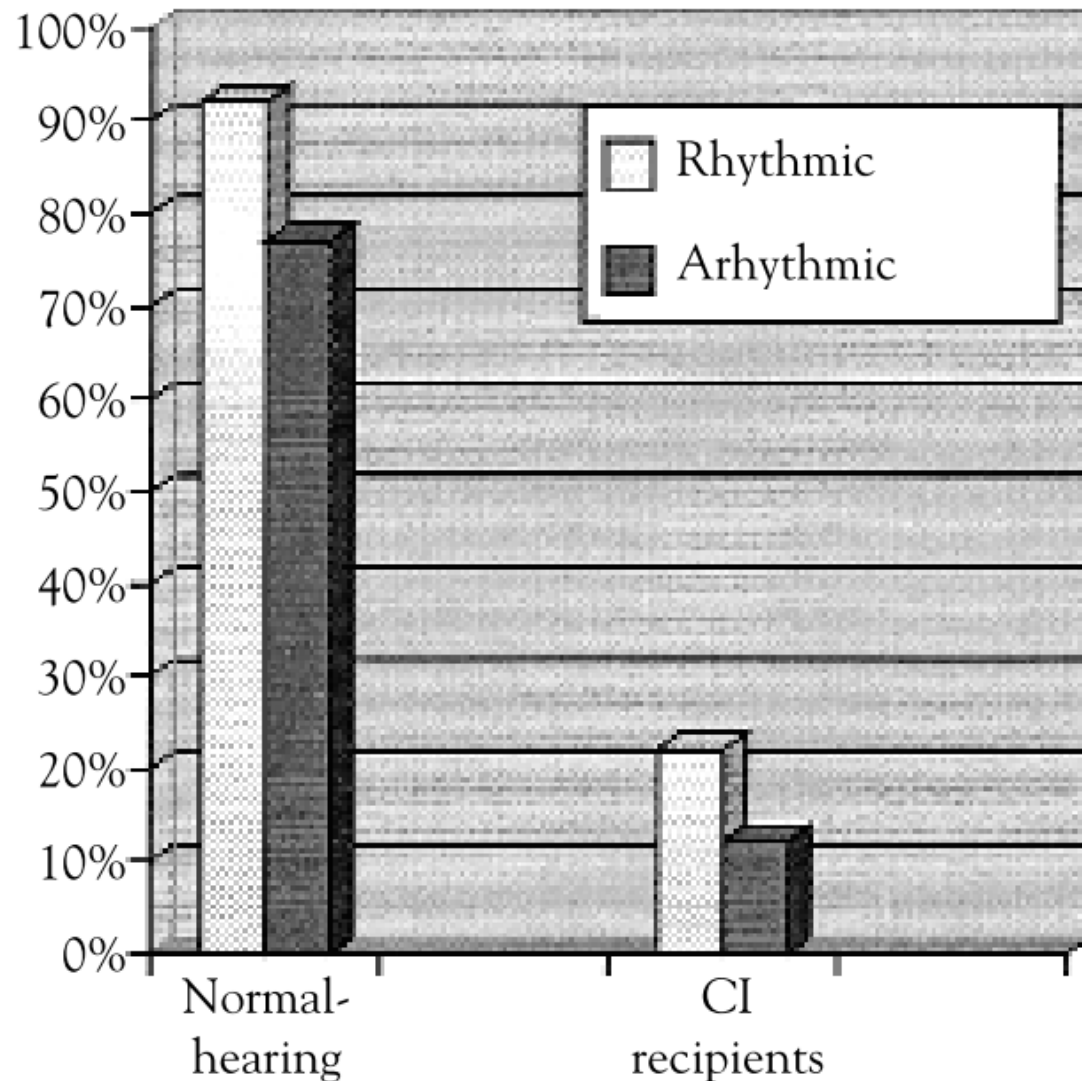


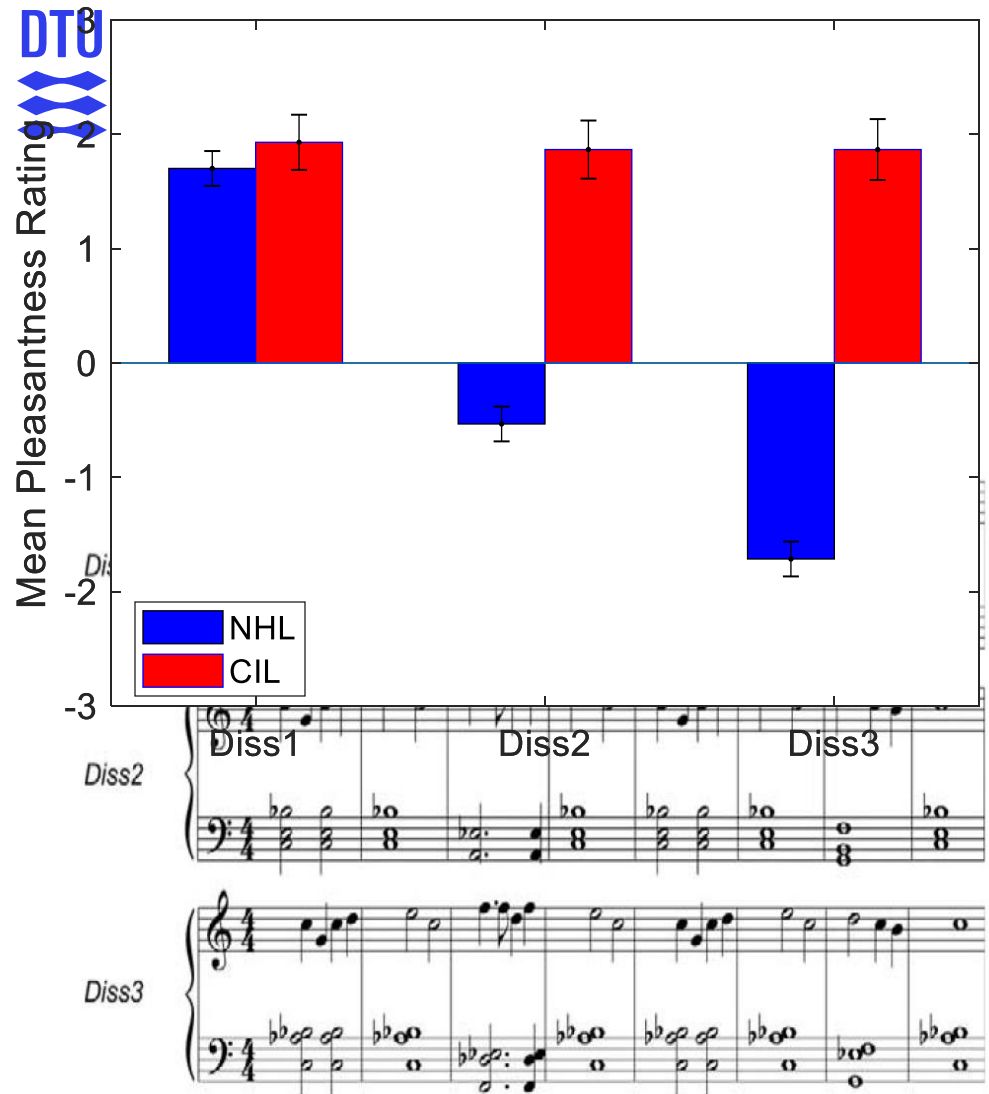


Difficulty in recognizing a melody

From Gfeller, K., et al. (2002). Cochlear Implants International, 3(1), 29-53.

Melody title	NHL % Correct	CIL % Correct
Here Comes the Bride	97.22	52.75
Frere Jacques*	97.22	25.00
Star Spangled Banner	96.23	27.91
Rock-a-Bye Baby	94.45	0.78
Row, Row, Row	92.45	31.01
Twinkle, Twinkle*	91.96	16.13
Happy Birthday	88.89	30.68
Yankee Doodle*	88.68	5.60
America*	77.36	23.85
On Top of Old Smoke	71.70	1.55
Jolly Good Fellow	66.67	5.56
Down in the Valley*	36.11	4.30





Data from Caldwell, et al. (2016). "Impaired Perception of Sensory Consonance and Dissonance in Cochlear Implant Users," Otology & Neurology.



Limitations of the Cochlear Implant

Difficulty in Timbre Identification



People with normal hearing recognise the instruments 87% of the time

Limitations of the Cochlear Implant

Difficulty in Timbre Identification



People with Cochlear Implant recognise the instruments 45% of the time

Difficulty in hearing melodic line separately.

Adagio

Joseph Haydn: Adagio
Editor: Christopher Hogwood

Flauto

Violino I

Violino II

Viola

Violoncello

Fortepiano

7

12

^{*) See / Vgl. Critical Commentary.}




Enjoyment of Music Among CI recipients (n=53)

Migirov et al (2009) Annals of Oto. Rhino & Laryn.

27% Never listen to music



43% Listen to music regularly



30% Listen and play music





CIL have problems to perceive pitch, melody and harmony.

-> So why do they still enjoy listening to music?

- Hypothesis 1: Super Power!





International Journal of Audiology 2013; 52: 424–432

informa
healthcare

Clinical Note

A cochlear implant user with exceptional musical hearing ability

Mohammad Maarefvand^{*,†}, Jeremy Marozeau^{*} & Peter J. Blamey^{*,†}

^{}Bionics Institute, East Melbourne, Victoria, Australia, and [†]Department of Audiology and Speech Pathology, The University of Melbourne, Parkville, Victoria, Australia*

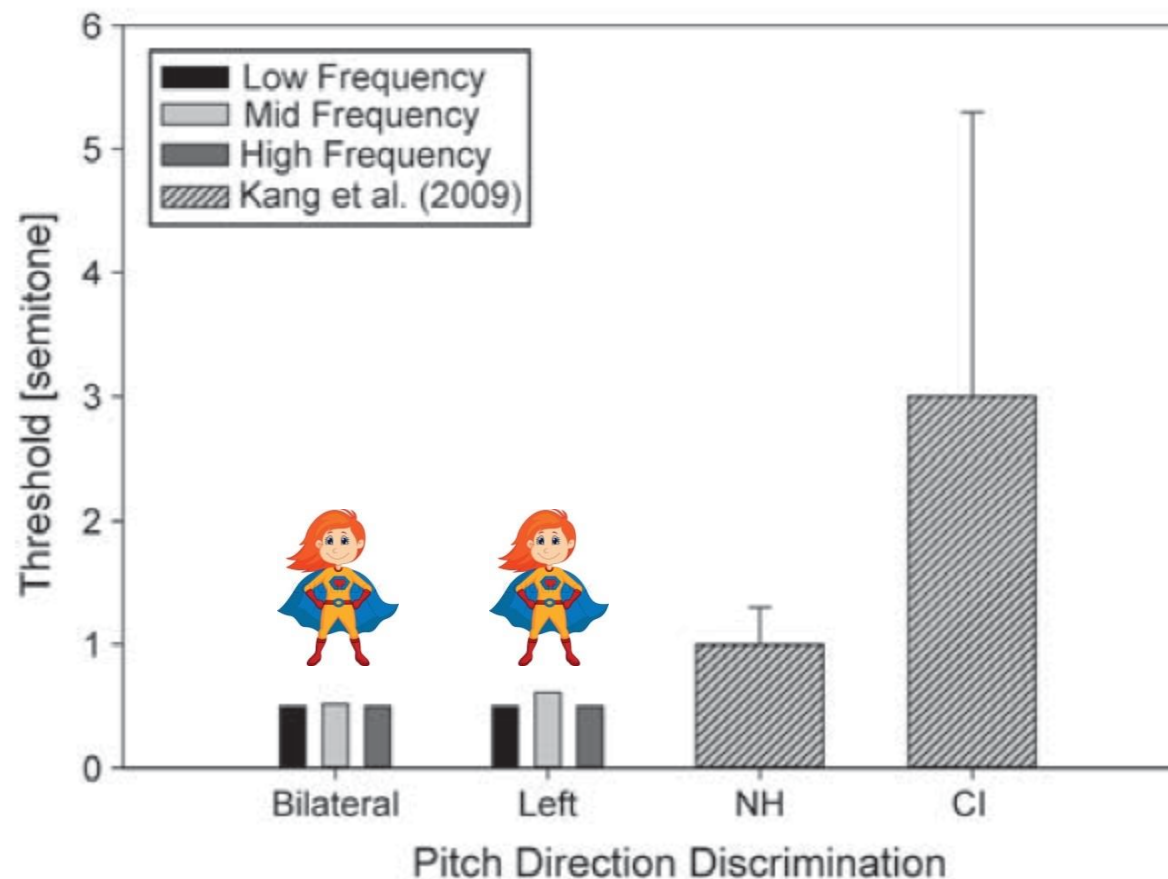


Figure 1. Mean semitones of pitch direction discrimination test for SP in three frequency ranges (low-, mid- and high-frequency) is highlighted by different colors in two conditions (Left and Bilateral). The results of the cochlear implant users (CI) and normally-hearing listeners (NH) in mid-frequency was derived from Kang et al (2009). The means expressed as thresholds with the unit of semitones.

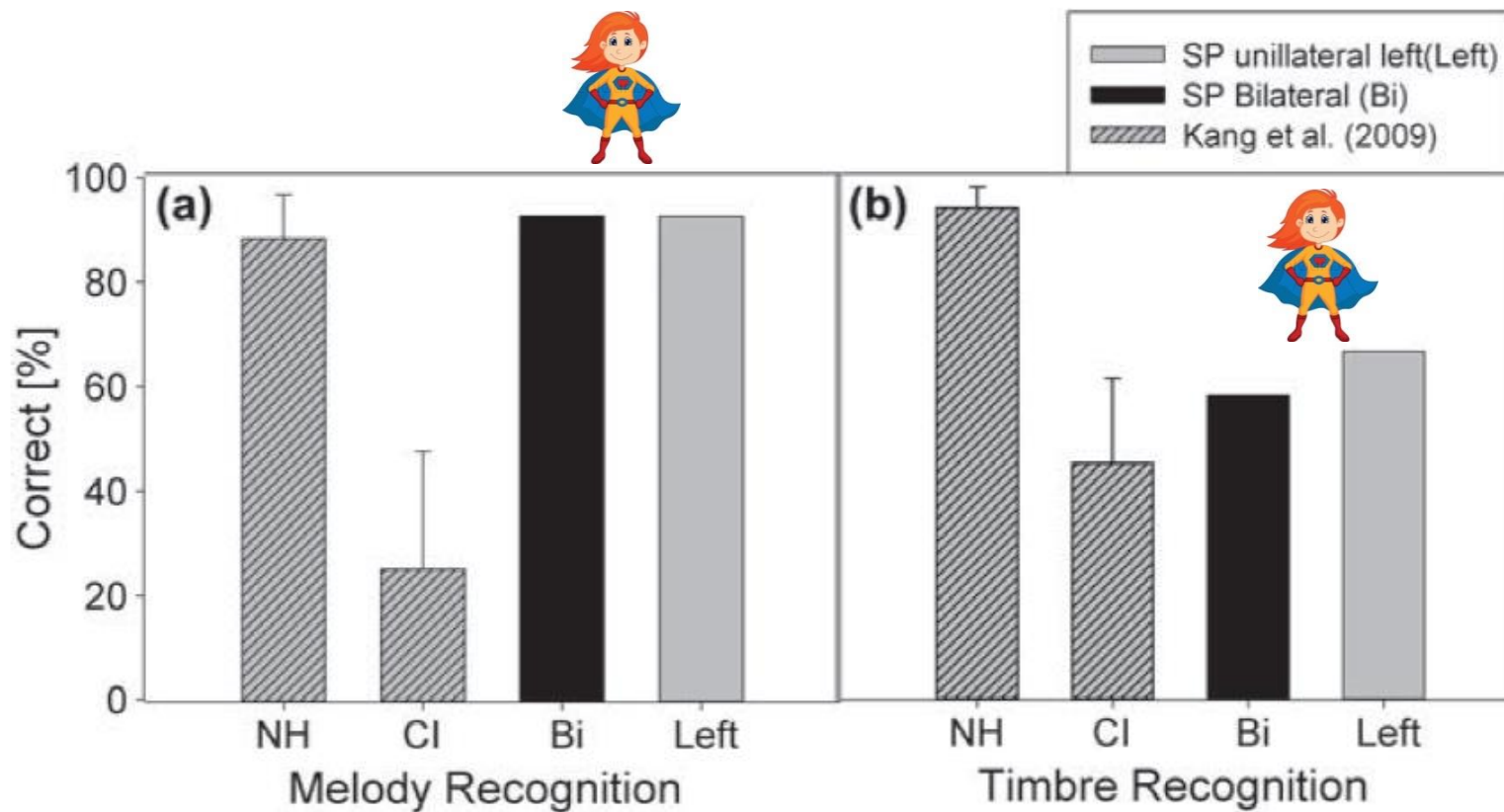


Figure 2. SP's results in two conditions of monaural left (Left) and bilateral (Bi) in (a) CAMP melody recognition, and (b) CAMP timbre recognition, were compared with the results of the normally-hearing listeners (NH) and cochlear implant users of Kang et al (2009). The correct selections are expressed in percentage.

- Hypothesis 2 : CI users perceive music in another way.



Dichotic Listening Can Improve Perceived Clarity of Music in Cochlear Implant Users

Nicolas Vannson^{1,2,3}, Hamish Innes-Brown⁴, and Jeremy Marozeau⁵

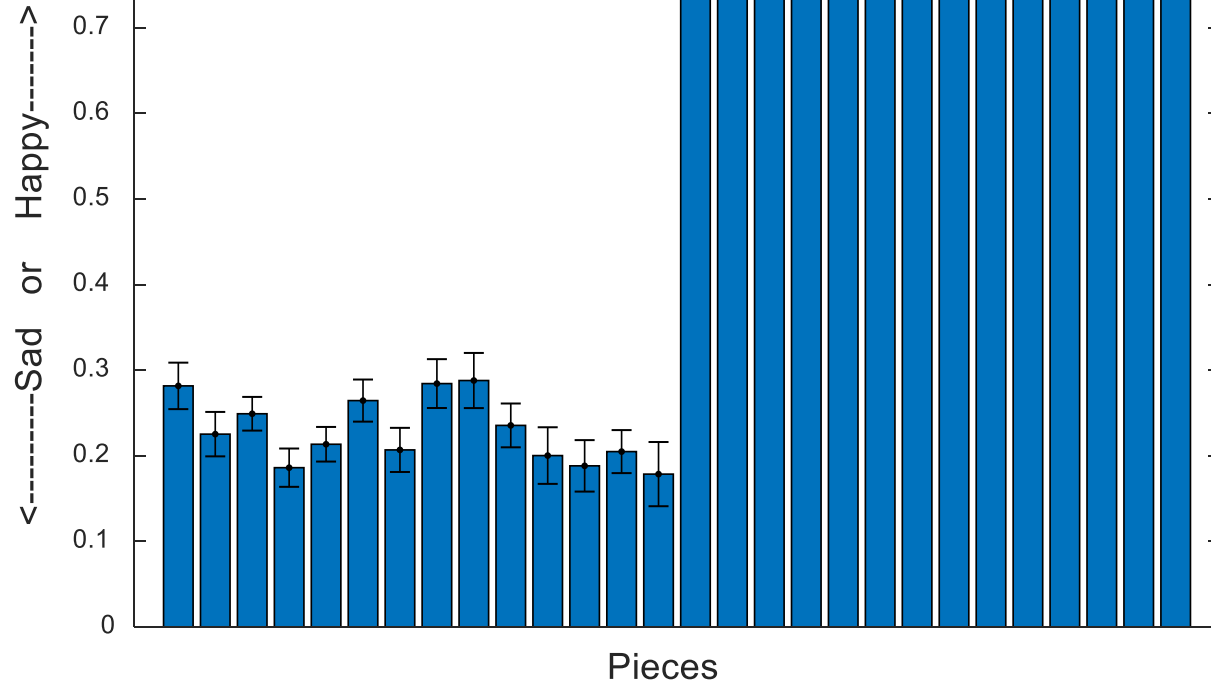
Trends in Hearing
2015, Vol. 19: 1–10
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DOI: 10.1177/2331216515598971
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- **Participants:** 11 NHL (19-31 yo)
19 CI (35 -77 yo)
- **Stimuli:** 28 unknown piano pieces composed to induce specific and well-defined emotions (Vieillard et al. 2008); 14 happy and 14 sad.
- **Task:**

Happy Sad





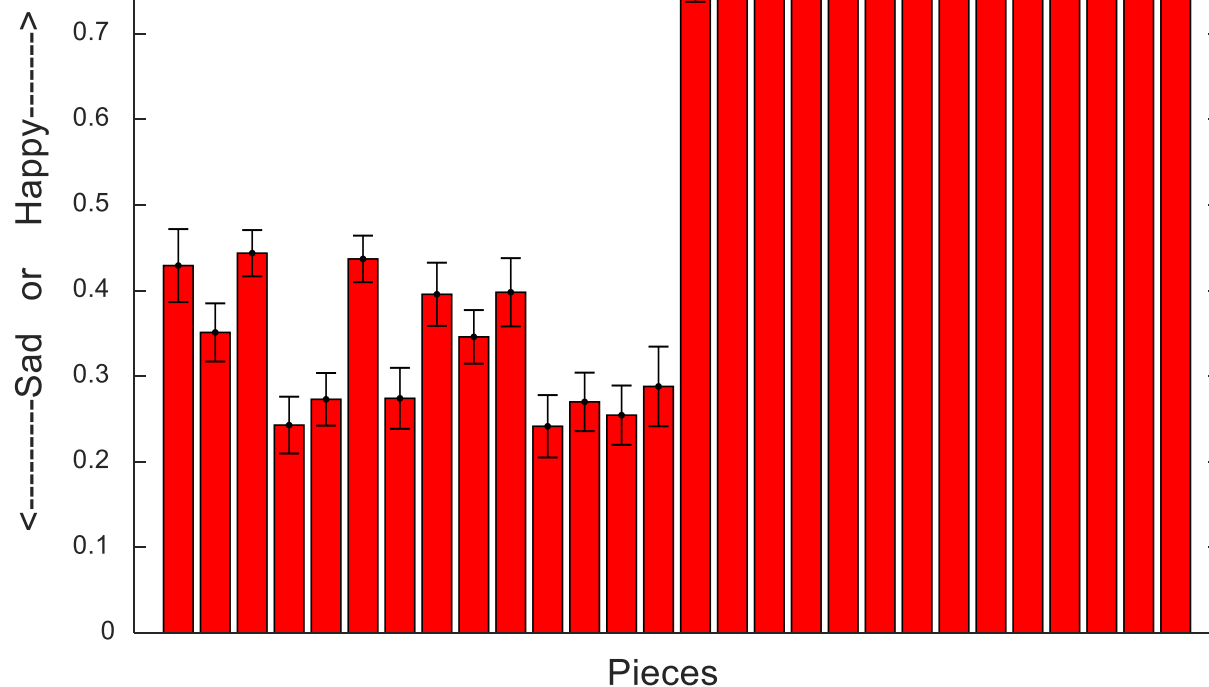
Listeners



- NHL can easily identify the intended emotion of a piece based on the mode.

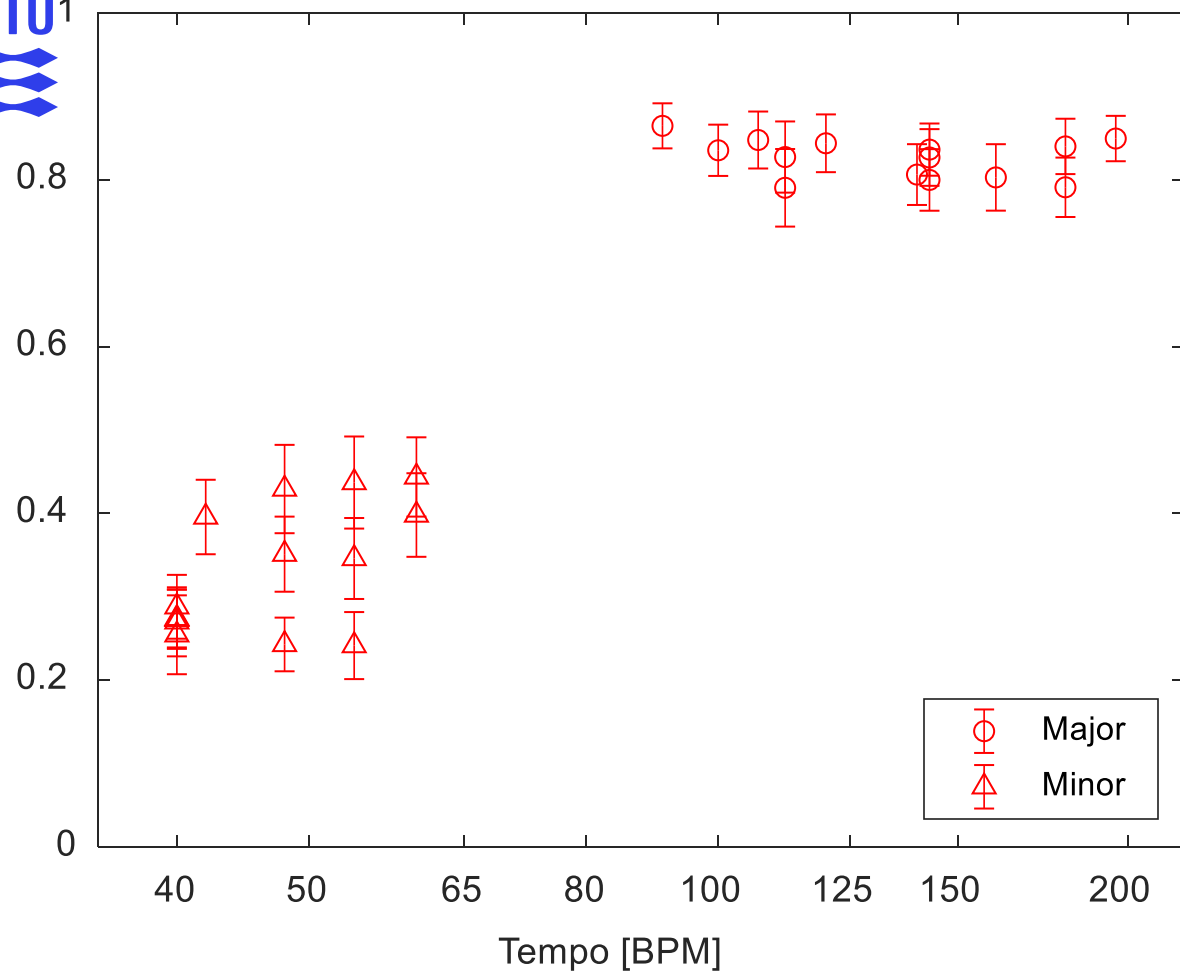


Results for Cochlear Implant Listeners



- CIL can also identify the intended emotion of a piece.
- All the major pieces were classified as happy.
- Some variability is observed for the pieces in minor.

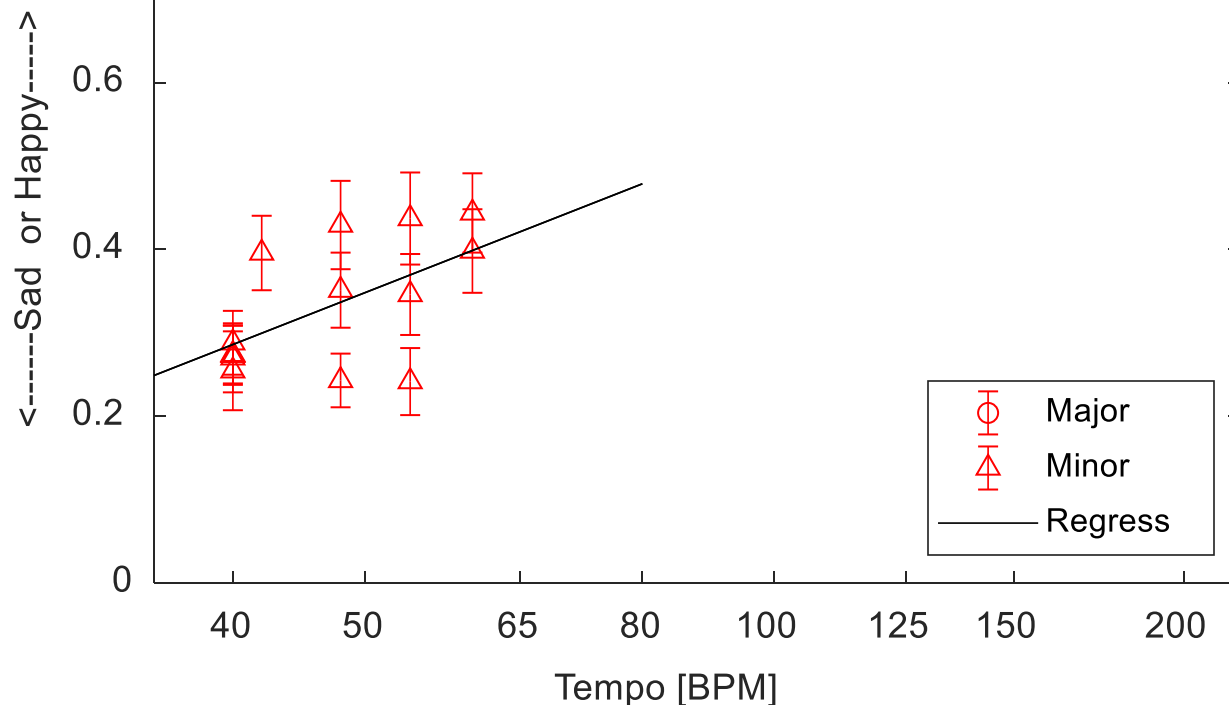
- Music emotion in NHL can be predicted by the mode and the tempo.**
- CI cannot transmit the signal needed to extract mode and harmony.**
- Can CI listeners based their judgement only on tempo?**



nt Listeners



Results for Cochlear Implant Listeners



- CIL can judgement is highly correlated with the log of the tempo.
 $r=0.93$ $p<0.0001$
- Minor pieces were only weakly correlated with tempo ($r=0.57$, $p=0.038$).
- Major pieces were not correlated with tempo.

- Can CI listeners have used tonal information to judge the emotion of the pieces?**
- Or is temporal information enough?**

Master project of Tanmayee Uday Pathre



- **Participants:** 10 NHL (19-31 yo)
- **Stimuli:** congas version of the piano pieces.
- **Task:**



Results for Normal Hearing Listeners with drums

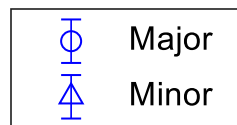


<-----Sad or Happy----->

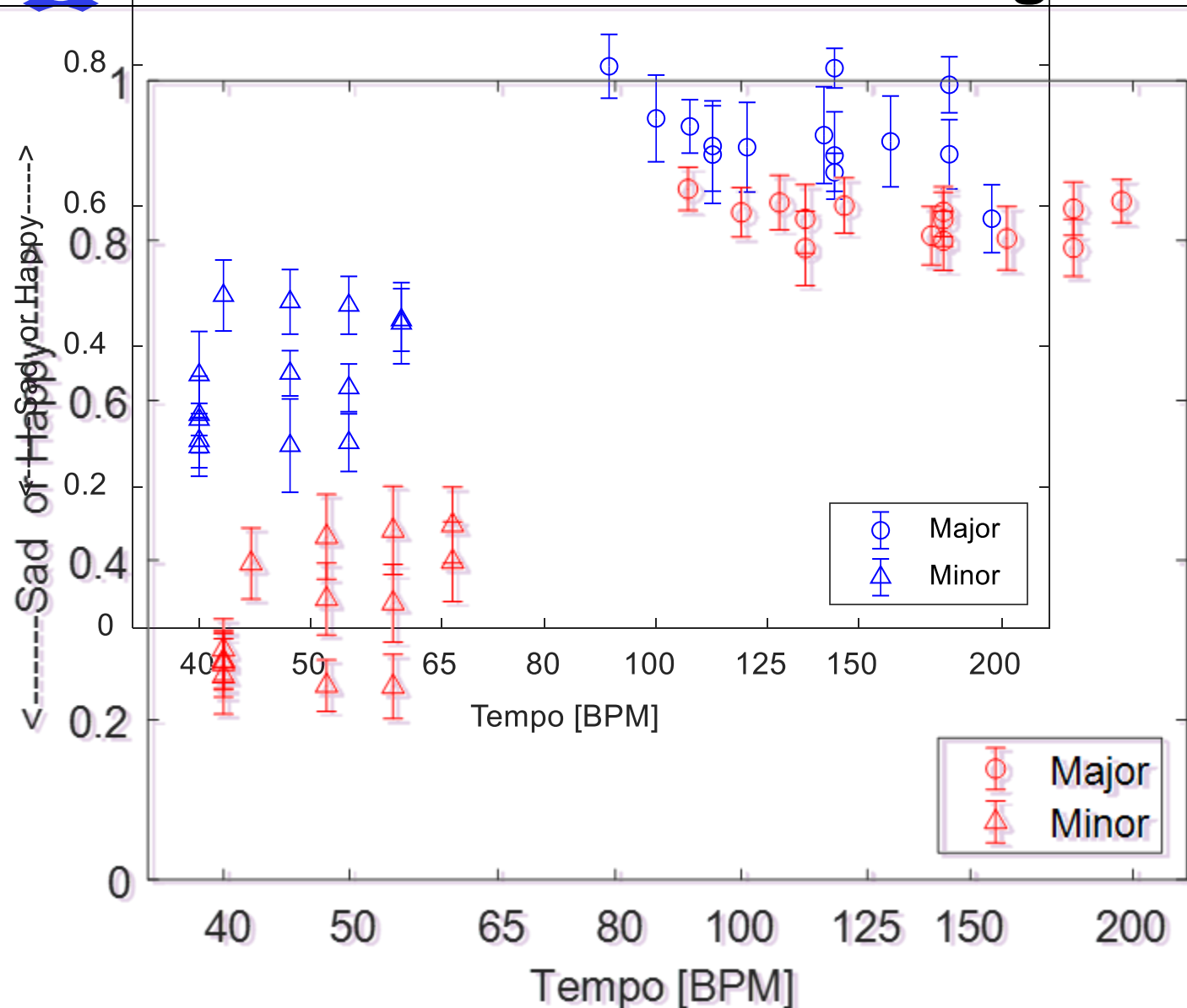
0.8
0.6
0.4
0.2
0

40 50 65 80 100 125 150 200

Tempo [BPM]



Results for Normal Hearing Listeners with drums



- NHL judgment of drums version of the piece is very similar to judgment of CIL with piano.
- > CIL could have used purely temporal cue to form their judgment.

Results for Normal Hearing Listeners with drums



<-----Sad or Happy----->

0.8

0.6

0.4

0.2

0

40

50

65

80

100

125

150

200

Tempo [BPM]

Major

Minor

Regress

- Minor pieces were not correlated with tempo. ($r = 0.43$, $p = 0.125$)
- Same as Major pieces ($r = -0.39$, $p = 0.163$)

Dichotic Listening Can Improve Perceived Clarity of Music in Cochlear Implant Users

Nicolas Vannson^{1,2,3}, Hamish Innes-Brown⁴, and Jeremy Marozeau⁵

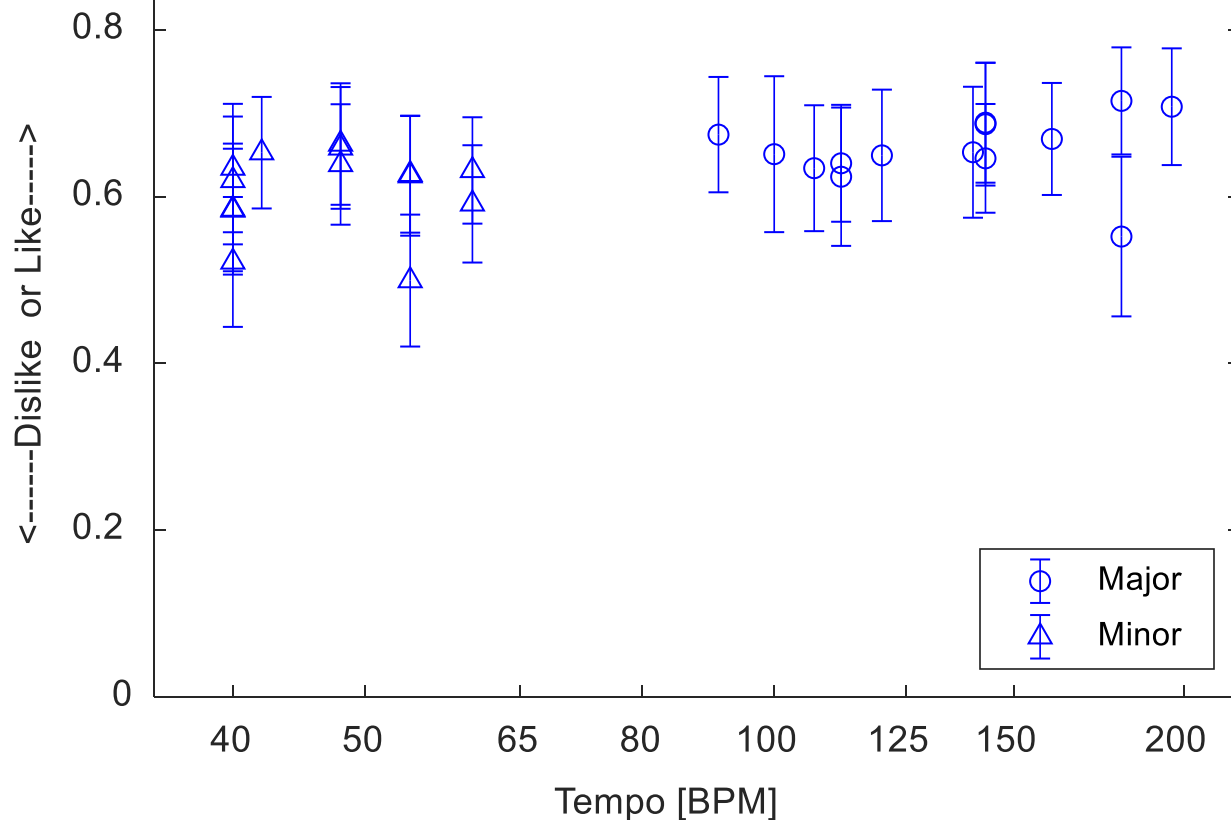
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SAGE

- **Participants:** 11 NHL (19-31 yo)
19 CI (35 -77 yo)
- **Stimuli:** 28 unknown piano pieces composed to induce specific and well-defined emotions (Vieillard et al. 2008); 14 happy and 14 sad.

- **Task:**

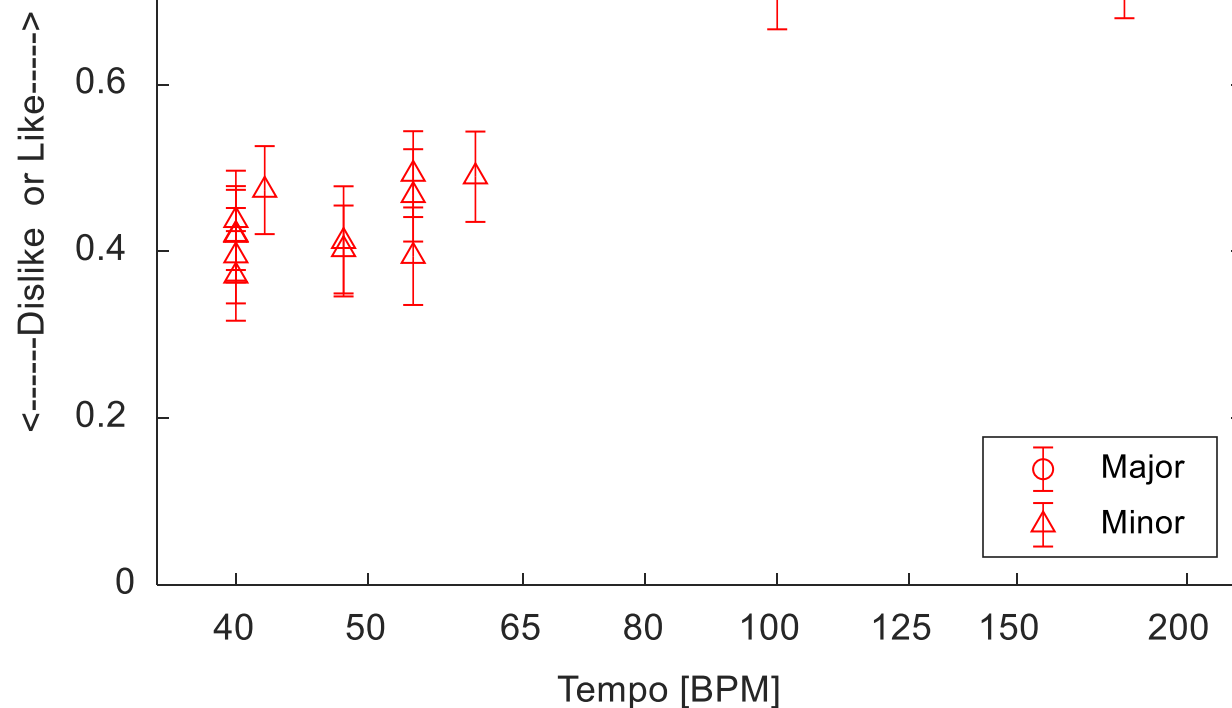


Results for Normal Hearing Listeners with piano



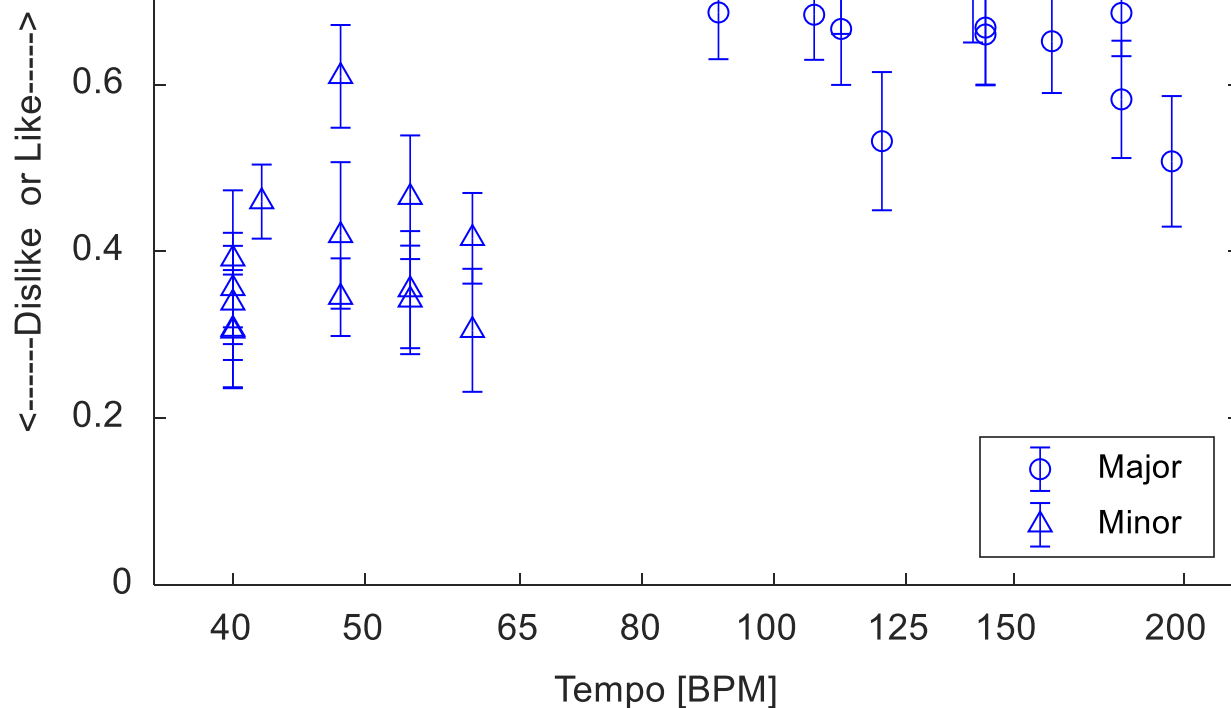
- Minor and major pieces were not correlated with like/dislike judgment.
- Tempo neither...

Results for Cochlear Implant Listeners with piano



- Mode seems to have an effect on the like/dislike judgment.
- CIL seems to like the major pieces more.

Results for Normal Hearing Listeners with congas



- Mode seems to have an effect on the like/dislike judgment.
- NHL seems to like the major pieces more.



Measuring Musical Tension

- **Participants:** 10 NH and 9 CI Listeners.
- **Task:** Evaluate in real time the musical tension of a piece of music.
- **Stimuli:** Sonata 282 of Mozart recorded on an acoustic piano equipped with midi sensors to allow modifications.



2 (30)

SONATE N° 4

für das Pianoforte
von

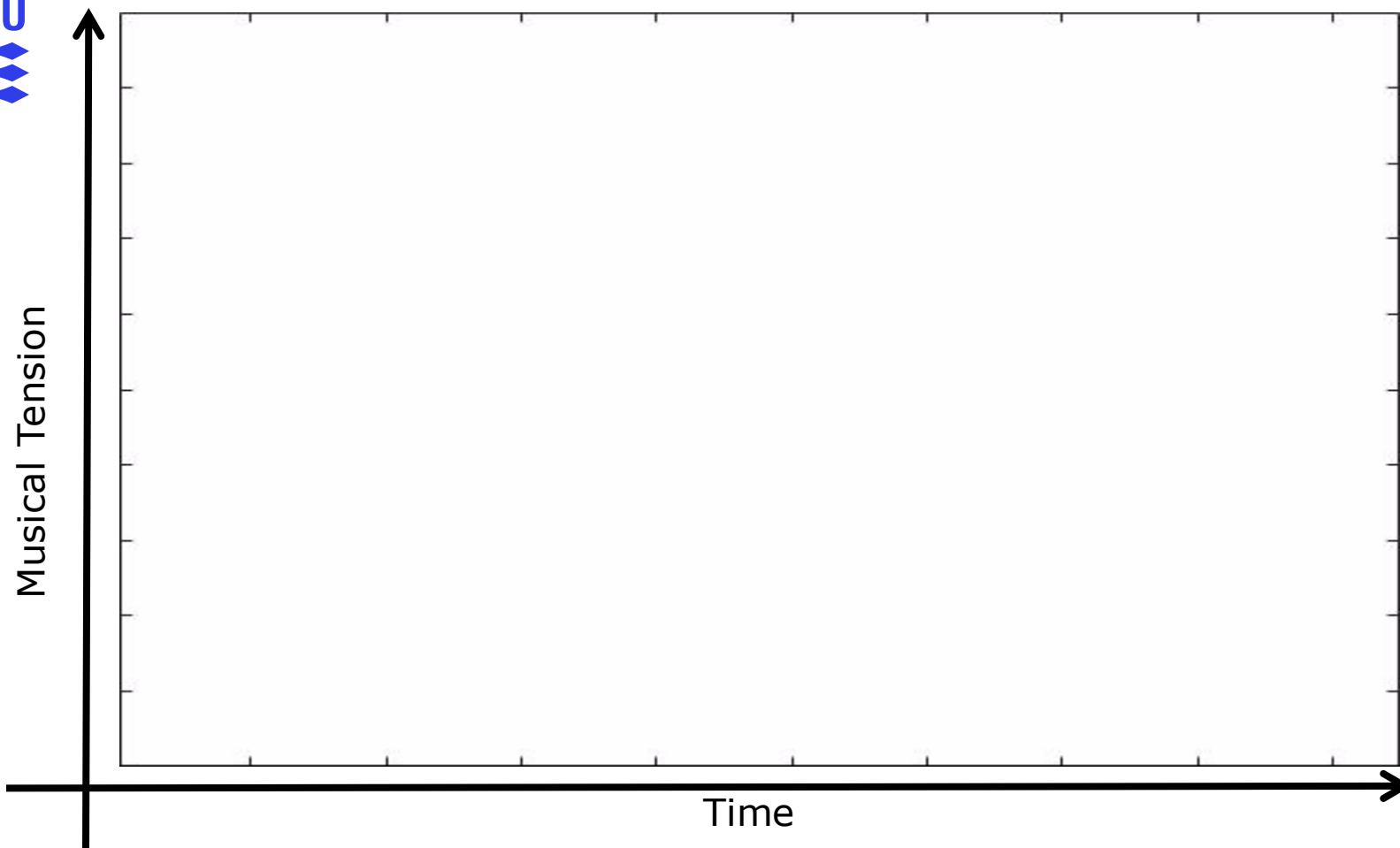
Mozarts Werke.

W. A. MOZART.

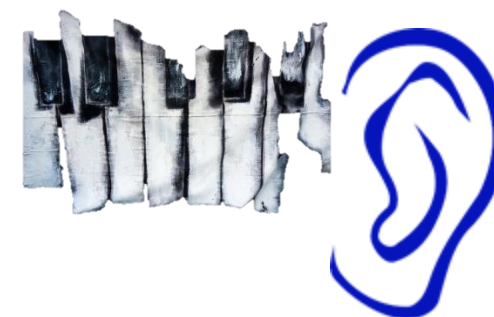
Serie 20. N° 4.

Köch. Verz. N° 282.

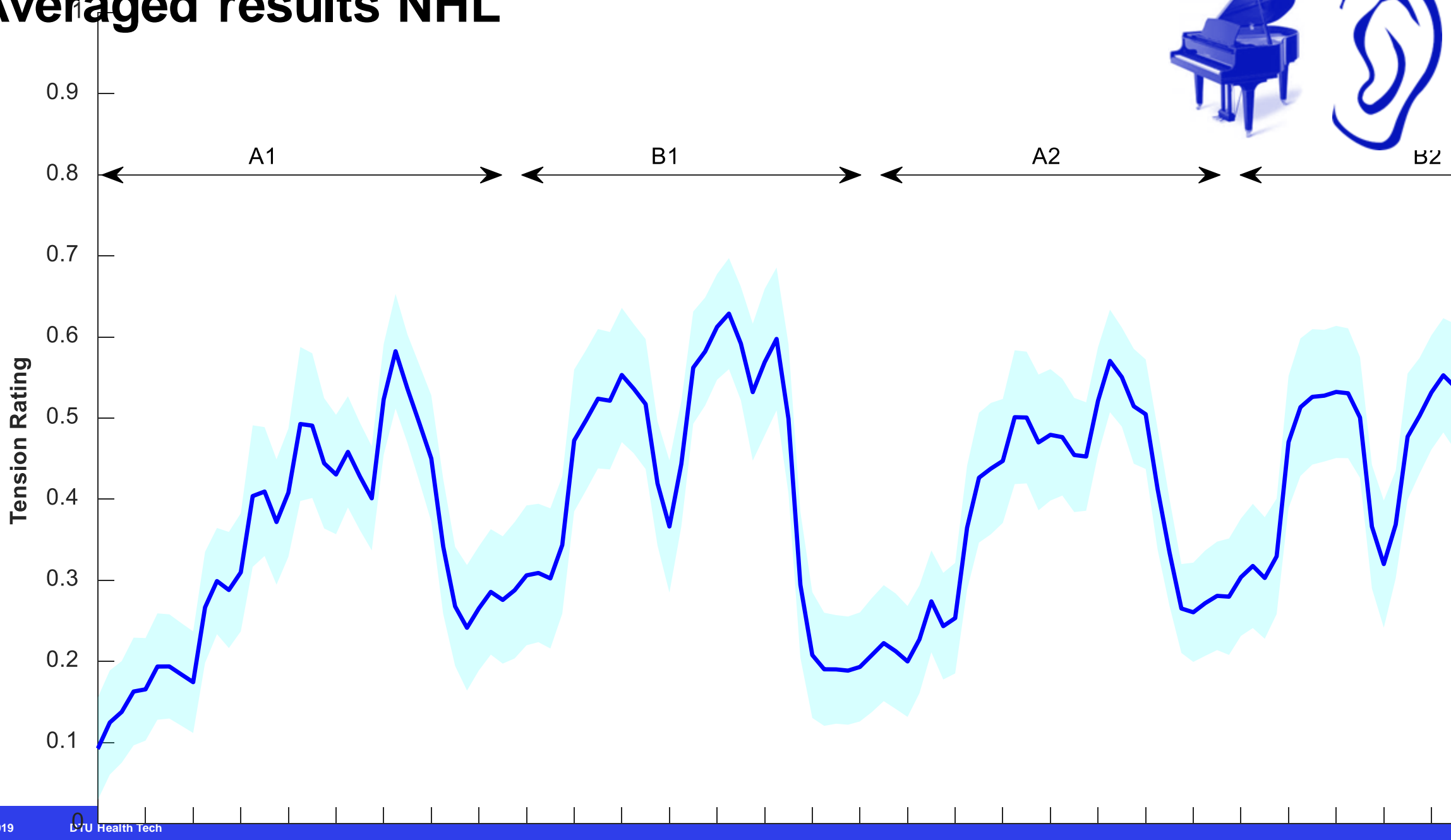




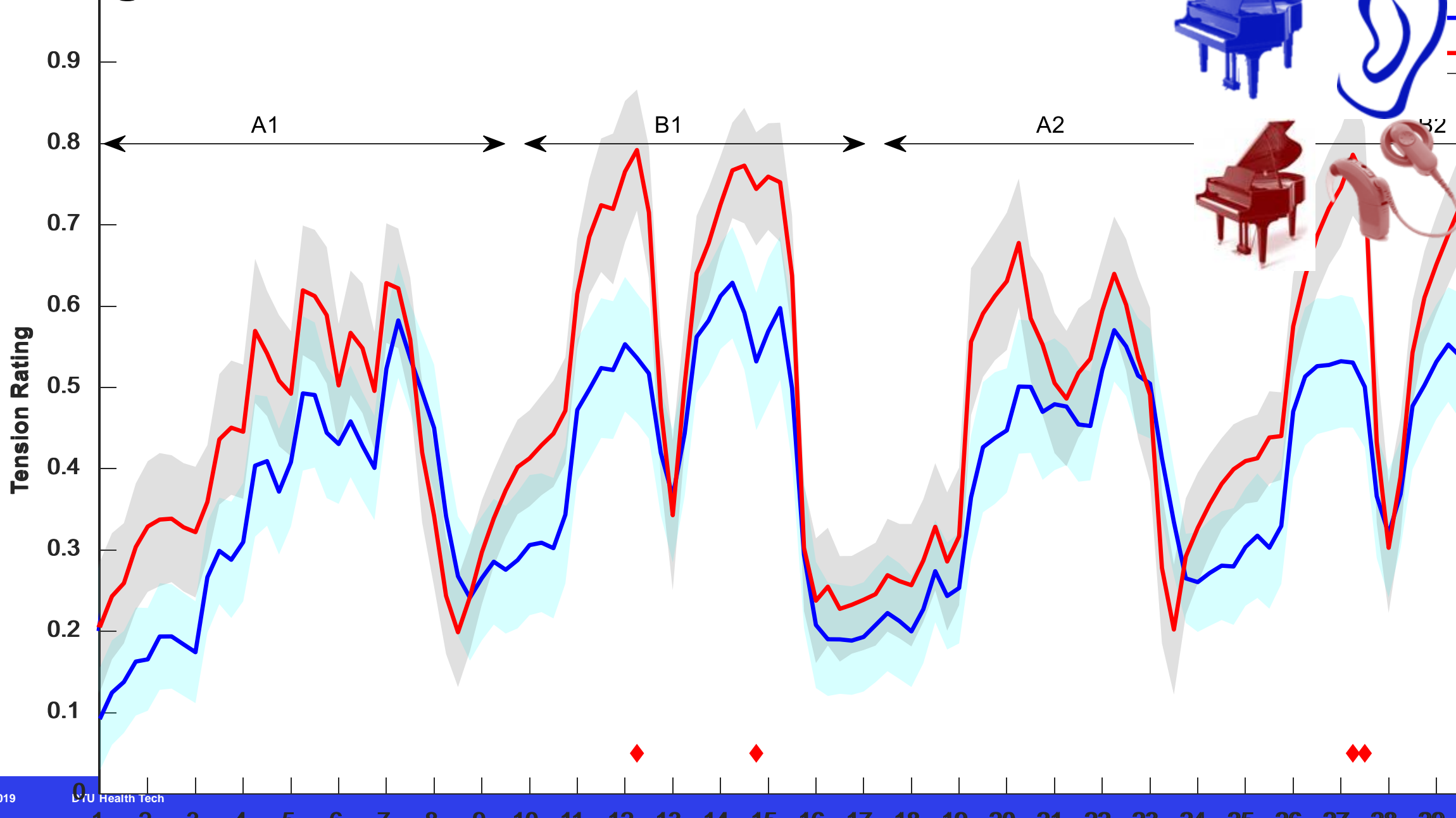
Three conditions



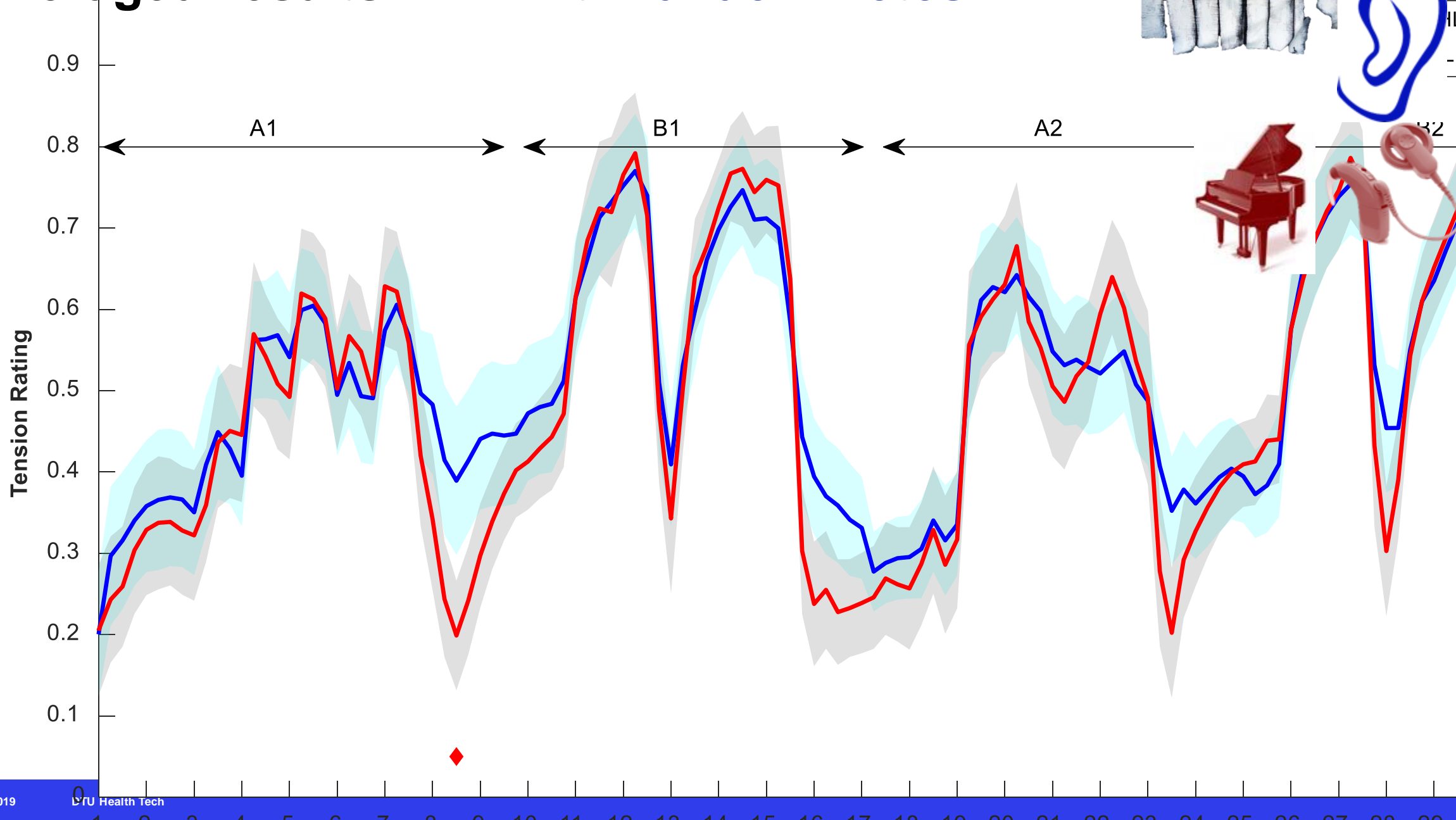
Averaged results NHL

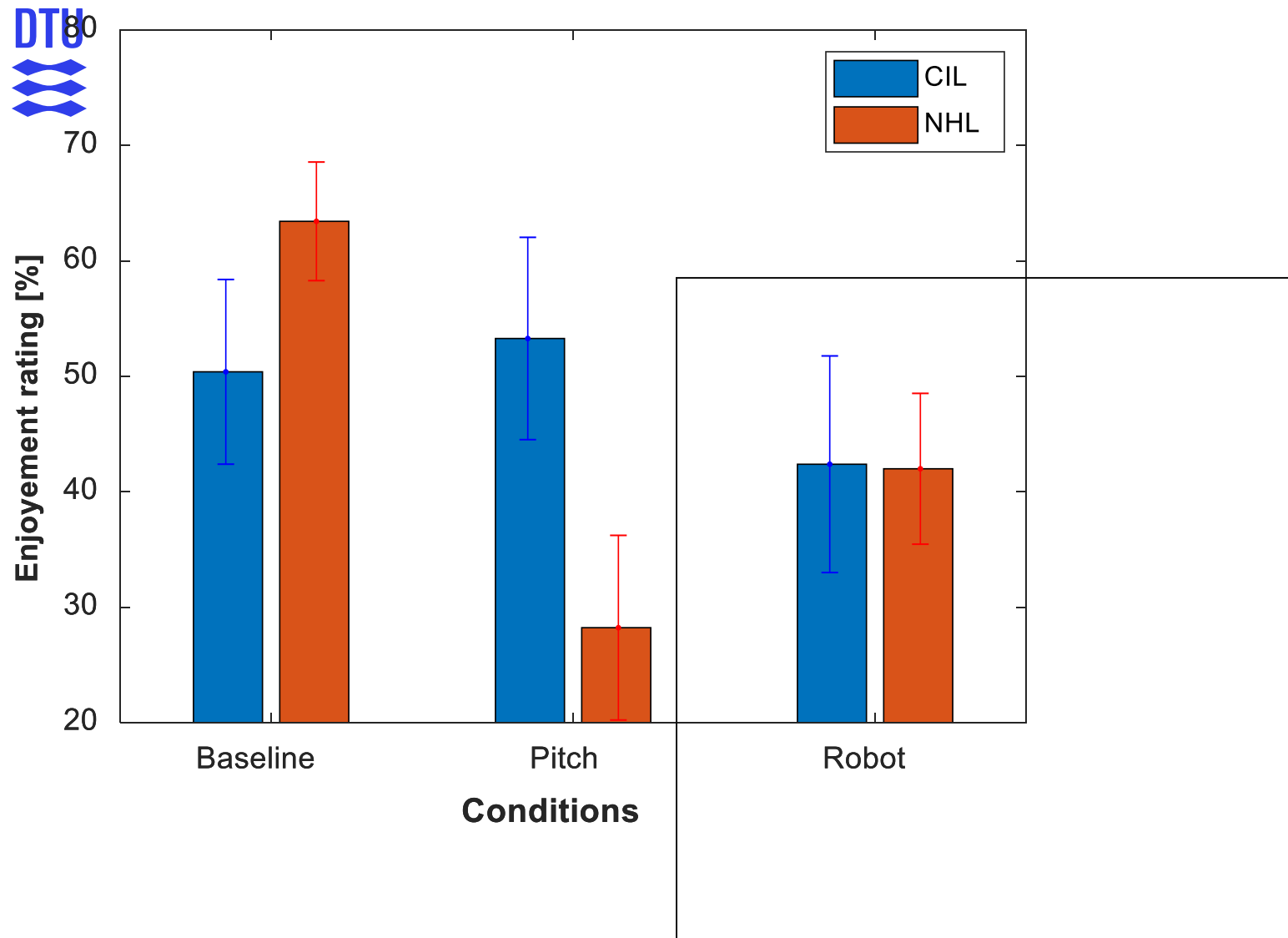


Averaged results NHL and CIL



Averaged results NHL with random notes





Overall Conclusions

- **Despite difficulties in perceiving pitch, CI users love music because, they can subtle cues to extract emotional information.**
- **Using non-tonal version of musical pieces in NHL can be a good model to study the perception of music in CIL.**
- **More experiment is needed....**

Thank you for your attention

This is
my
thank you
dance!



jemaro@dtu.dk