


(( AUDIOexplorers ))

# Sound Mapping in New York City!

By Audio Explorers



**oticon**  
PEOPLE FIRST



## Learnings and travelogue from the Audio Explorers expedition to New York 2016

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## I have followed the Audio Explorers project with great interest.

It is a good way of showing a new generation of bright engineers the big difference our products do for people with a hearing loss. During the study trip, the participants gain insight into the technologies it takes to create state-of-the-art hearing solutions. This makes it clear how they can use their own theoretical skills in the highly innovative task of developing the hearing healthcare products of tomorrow. Hopefully this will spark their interest for our business and form a good platform for ongoing dialogue – and hopefully – fruitful corporations in the future”

— Finn Möhring, VP, Oticon R&D

## Audio Explorers go to New York

In the spring of 2016, Oticon launched a big competition aimed at all Engineering students in Denmark. The students were encouraged to team up and solve 1 out of 3 challenges within the following categories; mechanical-, software-, or electrical development. In order to test the level of creativity, the students could freely choose how to hand in the solutions. Some chose reports, others video clips and posters while we also received a great deal of 3D printed items and mock-ups. A team of six Engineers from Oticon went through all the solutions and picked the 25 winners who were to embark on an action packed journey to NYC with five engineers from Oticon in August 2016.

Besides networking with the students and telling them about the technologies and R&D efforts that go into creating hearing aids, the goal of the trip was also to do a data collection of the sound levels in NYC. This in order to get an idea of the sounds of the urban space – and to investigate if a regular tourist encounter sound pressures high enough to damage the hearing.

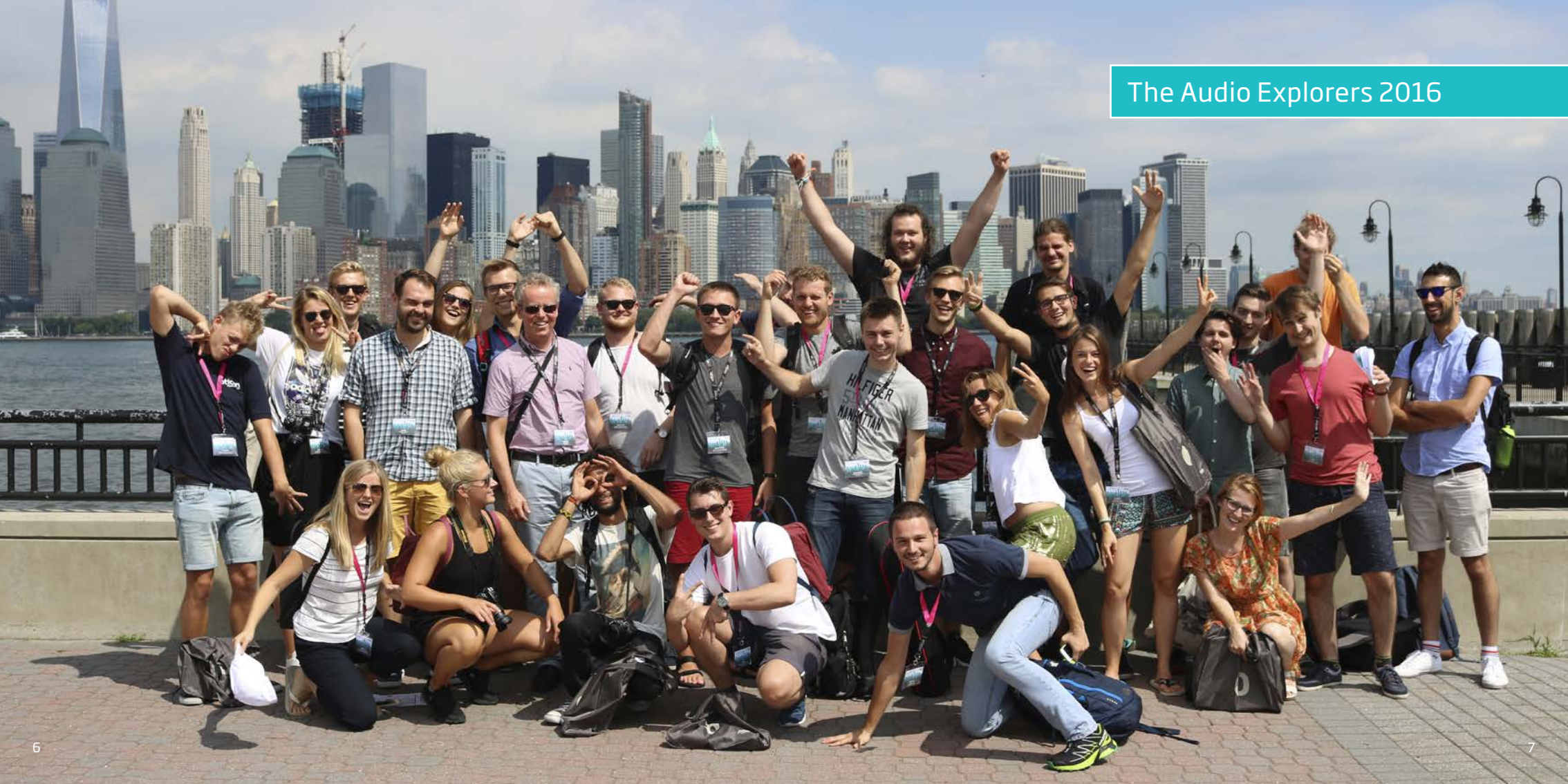
This small booklet is a ‘pocket version’ travelogue with our diary and main findings from the trip.

In case you want to know more about Audio Explorers or want to join next year's challenge yourself, go to the ‘Audio Explorers sign-up’ section.





## The Audio Explorers 2016



# Collecting the sounds of the city

Prior to leaving for New York, Oticon teamed up with three engineering students from Aalborg University. Their job was to prepare and structure the data collection in New York, and subsequently do the data processing and analysis by best scientific practices<sup>1</sup>.

## The equipment/tools/technology

Throughout the trip, the entire Audio Explorers team was equipped with a small Sound Activity Meter (SAM) and a GPS tracker. The SAM - a modified Oticon Vigo hearing aid (see below) - automatically collected sound from the surroundings thereby creating a complete "soundscape" depicting the environment we travelled in.



Carsten Borg, one of the Engineers who participated in the project, describes the data collection:

“**Sound pressure levels were measured during flights to and from New York as well as all days while in NYC using Oticon Vigo BTE hearing aids with modified firmware. A group of 31 people wore diffuse field calibrated hearing aids during 3 days in the city of New York. The instruments logged equivalent levels every 10 seconds (LAeq10), for 24 hours giving a total of approximately 8640 data points per day.**”

Carsten Borg, System Engineer

The GPS trackers were matching the sound measurements with geo-coordinates connecting the sounds to specific locations. The data was collected from the SAMs every evening in order to create an 'on the fly' idea of the sound image of the places we had visited during the day.

e treat the data from the 2016 expedition as a starting point. As we collect more data throughout the next Audio Explorers trips, we expect to be able to expand our learnings. Both by means of new technology development within hearing aids and by means of a bigger data pools.

We only show the main findings from the 2016 data set in this booklet - if you want to know more about the details, feel free to contact us on mith@dgs.com.



A SAM, developed by Oticon. A hearing aid, where we have replaced the traditional hearing aid technology, with sound measuring technology. It automatically collects sound data from the surroundings. Photo by Sebastian Aagaard Andersen.



# Understanding sound levels and hearing loss

In order to understand what a hearing loss is – and what causes it – we want to start out by explaining a bit about the different kinds of hearing loss. We also want to give some examples of the noise levels you may encounter in the city, your household or when travelling by plane.

The most common causes of hearing loss are age or overexposure to loud noise. But hearing loss can also be caused by infection, a head injury, cancer treatments, or taking certain medications.

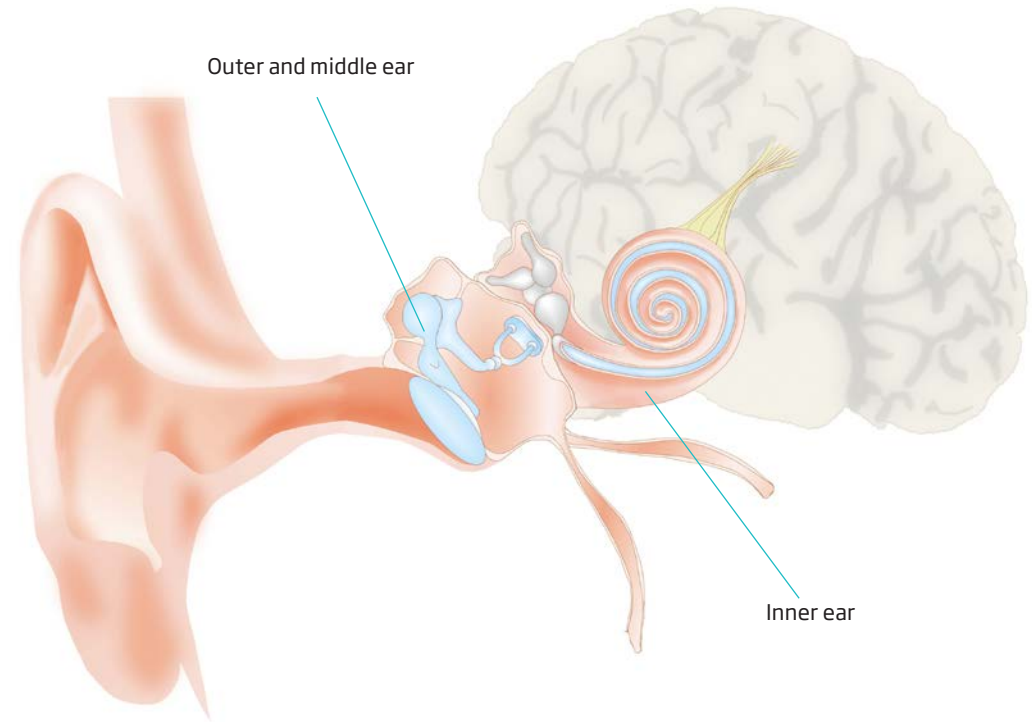
Hearing loss can be caused by problems in the outer and middle ear or by damaged cells or fibres in the inner ear. Alternatively, it can be a combination of both.

## Outer and middle ear hearing loss (Conductive)

Conductive hearing loss is caused by problems in the outer and middle ear, which can prevent sounds getting through to the inner ear. The most common cause can be a build-up of wax in the ear canal, perforated eardrums, fluid in the middle ear, or damaged or defective middle ear bones.

## Inner ear hearing loss (Sensorineural)

This type of hearing loss happens when the delicate nerve fibres in the inner ear get damaged. This stops them transmitting sound properly. *It can be caused by excessive exposure to noise*, but the most common causes of sensorineural hearing loss are the natural processes of ageing. For some the sensory cells wear out already at the age of 50 whereas others have only negligible hearing loss even at the age of 80. This condition is permanent in most cases.



Hearing loss is measured in decibels (dB HL) and the chart below to the left gives some perspective on what a normal to profound hearing loss means. The chart to the right shows examples of noise sources and how many decibels (dB SPL) they generate. This table can be used as a benchmark for our own measurements.

Degree of hearing loss	Hearing loss range (dB HL)
Normal	-10 to 15
Slight	16 to 25
Mild	26 to 40
Moderate	41 to 55
Moderately severe	56 to 70
Severe	71 to 90
Profound	91 +

dB  
(decibels)

140

120

## How loud is too loud?

### Extremely loud

Concerts, nightclubs

### Very loud

Stereo or MP3 player at full volume, motorbike

### Loud

Passing traffic, lawnmower, vacuum cleaner

### Moderate

Everyday conversation, washing machine

### Soft

Whispered conversation, quiet office

### Quiet

Bedroom, slow breeze



**At this level** there is a risk of **permanent hearing loss**. Ear protection should be worn.



Keep in mind that individual noise exposure may vary depending on your distance from the noise source, individual characteristics of the noise source and the length of exposure.

## Day 1: Visiting Oticon Inc. and learning about audiology

Going to New York as an Audio Explorer requires a good portion of knowledge about audiology, so the first day on our trip was dedicated to learning more about hearing and how Oticon's technologies help counteract the challenges a hearing loss impose. We had two lectures with PhD Donald J. Schum, Vice President, Audiology & Professional Relations at Oticon, Inc. The lectures "Why is hearing loss so difficult to solve?" and "The Oticon Approach to Solutions" gave all participants a good foundation to

understand both hearing loss and how we approach the area with new state-of-the-art solutions.

Afterwards we enjoyed a full tour of the production site and were explained in detail about the technologies that go into the hearing aids. Summed up the activities at Oticon Inc. were in scope with the purpose of the trip and provided a solid foundation for the activities on the rest of the trip as well as the overall educational outcome.



Audiology lecture by Donald J. Schum, PhD Vice President, Audiology & Professional Relations at Oticon, Inc.



At Somerset, we went on a 1½ hour long factory tour in the ITE (In The Ear) production.



There are many things to consider when choosing a hearing aid and Oticon is a full range supplier. At Oticon Inc. ITE - or "in the ear" devices - are manufactured. They are not a "standard" aid worn behind the ear instrument, but a custom-made solution made to fit - and disappear into - the individual user's hearing canal.



## Day 2: Microsoft Technology Center and Columbia University.

On second day in New York, the Audio Explorers were ready to take on a new day in the name of hearing technology.



**Camilla Ljungberg Daoust** ▶ Audio Explorers by Oticon

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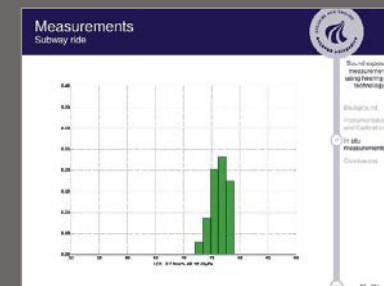
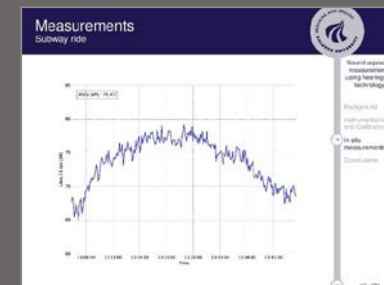
After an inspiring lecture on innovation regarding cochlear implant surgery, we don't want to leave! The uniforms are even good to go 😊  
#audioexplorers16 #columbiauniversity — with Alexander Skov Andersen at 📍 Columbia University.

First stop in the program was Microsoft's Technology Center (MTC). Microsoft demonstrated the latest trends and technologies within the digital technological field with special focus on the Internet of Things.

With Oticon's latest product release in mind - the internet connected "Opn" - the link was created to brainstorm over the potential for new hearing aid functionalities using this technology to the benefit of the hearing impaired.

Finishing up at MTC, we took the subway and headed towards Columbia University. Looking into the data from our subway ride, we can see that taking the subway in New York is an extremely noise experience:

The figure shows that the maximum Level of Exposure is 78.7 dB over 42 minutes, corresponding to 2% of recommended daily noise dose. If we look at the minimum Level of Exposure it is 72.3 dB over 42 min, corresponding to 0.47% of recommended daily noise dose.





Clinical Audiologist at Oticon, Andreea Mircula sums up the result from the subway:

“**In general, it does not affect your hearing to go on a subway ride, which, as the data shows, is considered a noisy environment. If you spend a lot of time in the subway, I would however recommend taking a ‘hearing break’ in a quiet place to rest the hearing, since being exposed to high noise levels for a long time can cause headaches and tiredness which can affect a big city holiday**”

Andreea Mircula, Clinical Audiologist at Oticon

Arriving at Columbia University, we had lined up an exclusive lecture at the Department of Mechanical Engineering. Professor Dr. Jeffrey W. Kysar, took us through his research on measuring, analysing and predicting the mechanical behaviour of materials and objects in relation to the development of tools for cochlear implant surgery.

Afterwards, the Audio Explorers engaged in a lively Q&A session with Dr. Kysar resulting in loads of interesting engineering related talks.

After a full day of educational activities, we joined a guided tour of the university campus site.

## Day 3: Lecture in Central Park and data collection

The final day in New York began in Central Park. An array of educational activities had been prepared displaying how the new technologies in Oticon Opn bring a new dimension of hearing to the end user. The morning started with lectures by our Oticon’s Engineers, Virtual Reality demos of

the Opn experience, and last but not least, a practical demonstration of how the directionality in a traditional hearing aid works – exemplified by playing penguin soccer with the students.



**Christoffer Rue** ▸ Audio Explorers by Oticon

20 August 2016 · Edited · 🌐

Get the Opn experience with virtual reality.  
#audioexplorers16 #oticonopn #oticon #newyork

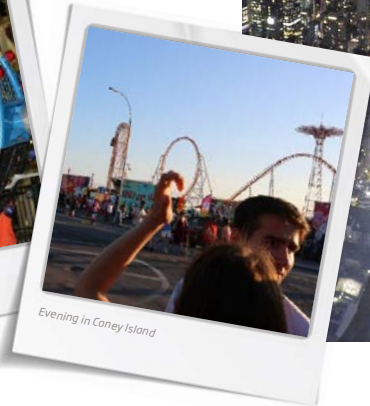
Next, it was time to explore the city and the noise levels. Geared up with our SAMs we teamed up and went out to sights like the Intrpid Air and Space Museum, MoMa and record shops in Williamsburg.

In the evening we met up for 'the final evening in town' at the amusement parks on Coney Island! Still being equipped with our SAMs, we explored the noise levels of the venues. Restaurants, rollercoasters, various shows and amusements of all sorts. Everything was explored!

Even though an entire evening in an amusement park is a great way of spending time, our data actually shows that it can be potentially damaging for your hearing if you visit the park several days in a row.



All the noise levels of Coney Island were explored!



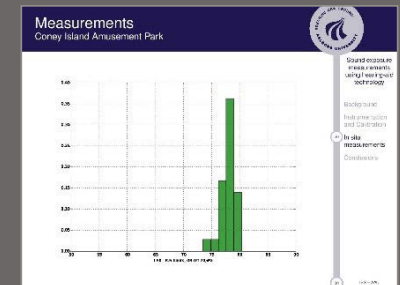
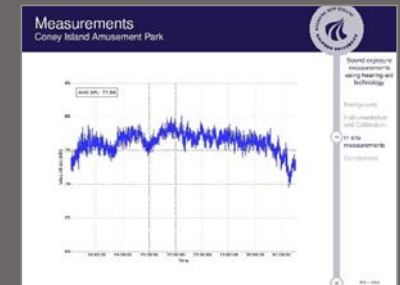
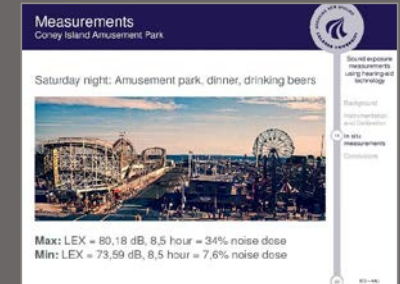
Evening in Coney Island

The figure shows that the maximum Level of Exposure is 80.18 dB over 8.5 hours, corresponding to 34% of recommended daily noise dose which is a lot. The minimum Level of Exposure is 73.59 dB over 8.5 hours, corresponding to 7.6% of recommended daily noise dose.

Andreea Mircula, Clinical Audiologist at Oticon, explains:

“ Spending one evening in Coney Island should be OK. One may experience headache, or worst case a temporal tinnitus. Whether any damage will be caused to the hair cells in the inner ear, depends on how long you are exposed to increased noise levels ”

Andreea Mircula, Clinical Audiologist at Oticon

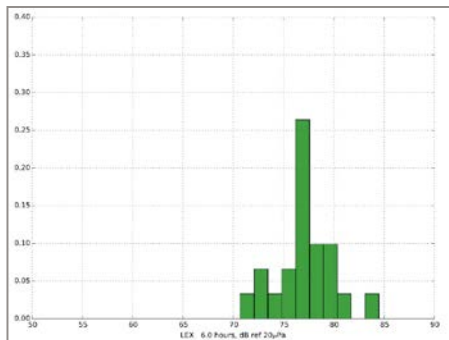




## Learnings from the data on the plane home

The very last data collection took place on the flight back to Europe. All Audio Explorers were equipped with their SAMs one final time. From the data, we can see that the noise levels are constant; however, there is one big spike, which we interpret as a signifier of takeoff and landing.

According to Clinical Audiologist at Oticon, Andreea Mircula, a long flight can cause tiredness due to the constant exposure of noise.



The figure shows that the maximum level of exposure is 83.84 dB over 6 hours, corresponding to 57% of recommended daily noise dose.

From the figure it can be seen that the Minimum Level of Exposure is 71.65 dB over 6 hours, corresponding to 3.43% of recommended daily noise dose.



## Scientific conclusions from the data collection

Carsten Borg, Systems Engineer and responsible for the data collection in Audio Explorers, sums up the findings of the 2017 trip:

“

**The data collected from Audio Explorers 2016 can be used for risk assessment with regards to noise exposure and corresponding hearing damages. The measurements, however, show that the measurement subjects at no time during the trip were exposed to sound pressure levels that would result in exceeding the recommended daily noise dose.”**

Carsten Borg, System Engineer

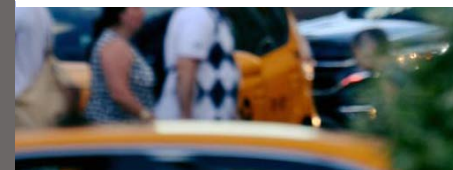
This is good news for the urban adventurer who wants to explore the treats of the city first hand. However, the data also shows that the sound levels can indeed create fatigue and call for pit stops at “sound free” surroundings to let the hair cells in the inner ear heal.



**Riziki Paul Martin Graversgaard Nielsen** ▶ Audio Explorers by Oticon

19 August 2016 · 📍

Sense the city. #audioexplorers16 #newyork — i  
📍 New York, New York.








 **Alexander Skov Andersen** ▶ Audio Explorers by Oticon  
21 August 2016 · 📍

Capturing the last data. Thank you for an amazing New York experience Oticon. #newyorkinmotion #audioexplorers16



 **Przemysław Mikulski** ▶ Audio Explorers by Oticon  
18 August 2016 · 📍

Evening at Time's Square with Oticon  
#audioexplorers16 #Oticon #FunAllTheTime — with Filip Magic and Zuzka Jeřícová at 📍 Times Square



 **Stanley Ondruš** ▶ Audio Explorers by Oticon  
19 August 2016 · 📍

On the edge of liberty 😊 #audioexplorers16 — with Daniel Mountizen, Kristian Revsbech and Zuzka Jeřícová at 📍 Statue of Liberty National Monument



 **Rasmus Lundgård Christensen** ▶ Audio Explorers by Oticon  
19 August 2016 · 📍

Feel the freedom of the Open #oticon  
#audioexplorers16 #newyork — with Joanna Nathan Jensen and Camilla Dusterdich Hansen in 📍 New York, New York



 **Christian A Bertram** ▶ Audio Explorers by Oticon  
19 August 2016 · 📍

What describes a tour to The Big Apple with focus on sound, better than a guitar playing naked cowboy on Times Square... Nothing



**Do you want to see all of the places we got to experience? In New York, we invited the Audio Explorers to join in on a Facebook photo contest about the many activities we did on our trip. And who could be better at telling the story than the Audio Explorers themselves?**

Do you want to see them all, then go to the Audio Explorers Facebook page and have a look.

[www.facebook.com/audioexplorers/?fref=ts](https://www.facebook.com/audioexplorers/?fref=ts)

# Want to join the Audio Explorers competition next year?

We hope that you have enjoyed reading this little booklet and that you are motivated to take good care of your hearing when travelling in the big cities.

Sign up for The Audio Explorers championship opens up at the beginning of the year. Want to join?



Read more about on our website  
and be sure to follow us on Facebook  
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Questions?  
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