# Want to find out more?

For lots more links to the work we do, visit our webpage; http://www.langsci.ucl.ac.uk/projects/noisyworld

For more information on the Diapix project go to www.tiny.cc/diapix_project and see our demo on Youtube: www.youtube.com/watch?v=80512hO_6pA

For more information on noise reduction go to www.clear-labs.com


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# The science behind...

# NOISY WORLD

UCL

## Speech Communication can be difficult in our noisy world.

UCL scientists have been investigating how different types of noise affect our ability to communicate with each other.

We have been using exciting experimental techniques to investigate;

- how noise changes the way we talk
- how noise makes it harder for us to listen
- how noise affects the brain.

Read more about our work in this leaflet and follow the links on the back page if you'd like to find out more.

# The science behind...

### the Noisy Dog Experiment

**What are we trying to find out?**
The brain uses certain clues to help you hear in noise;

*Clue 1*: Comparing what's being heard by both ears tells you where a sound is located
*Clue 2*: Attention! Paying attention helps you focus on what the sound is
*Clue 3*: Recognising patterns in the noise makes it easier to hear a sound

We want to find out how the brain uses these clues, and in particular, whether we need to use all of the clues at the same time.

**Why is this important?**
Much of our day-to-day communication takes place in background noise, but some people with hearing difficulties find it difficult to listen in these places, possibly because they may not be able to use all of these clues. By understanding which clues these listeners are able to use we might be able to help them communicate more effectively, e.g., by designing better hearing aids and cochlear implants.

**How did we design our study?**
We used EEG (electroencephalography) to record brain activity to sounds.

*Sensors are placed on the scalp to record electrical activity in the brain. We can analyze the changes in electrical activity to infer how a listener is processing the stimuli we present.*

In our experiment we played 3 types of sound:

- noise on its own (played most of the time)
- noise with a quiet 'dog' (played occasionally)
- noise with a loud 'dog' (played occasionally)

**What did we find?**
The louder the 'dog' is in noise, the greater the change in brain activity. This is very useful for scientists and clinicians. For instance, by just recording the brain activity to such sound-in-noise tests, we can see how well young children with hearing difficulties are able to listen in noise with their hearing aids or cochlear implants.

# The science behind...

## telling a dog about colours!

**What are we trying to find out?**
Our studies are aimed at understanding why children can have problems when listening in background noise, and what kinds of noises might be most disturbing.

*Understanding speech in noisy backgrounds can be difficult for us all, but children seem to be even more affected by background noise than adults. Furthermore, different kinds of background noises seem to interfere in different ways, and it is likely that the abilities that allow us to function well in background noise mature at different rates through childhood.*

**Why is this important?**
Children are often faced with noise in a classroom, so understanding these effects is an important consideration in the way classrooms are designed and operated. Also, certain children appear to have greater difficulty than others in understanding speech when there is noise in the background, so having a way to diagnose a listening problem like this would be really useful.

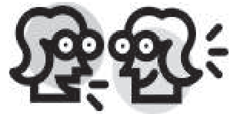
**How did we design our study?**
We have created a child-friendly computer game in which the listener hears a woman saying a sentence like ‘Show the dog where the red 9 is’ and has to say what colour has been heard. The level of a background noise is then adjusted on the basis of how well the listener is doing to find a level of noise that makes the listener get about 70% correct. The more noise someone can tolerate in comparison to the sentence they are trying to listen to, the better they are doing. We make this measurement for two different kinds of ‘noises’. One of these is not very interesting (a noisy cafeteria). But the other can be very confusing because it is a man saying a very similar sentence (‘Show the pig where the blue 4 is’).

**What did we find?**
Adults usually do better when there is another talker in the background, but children do the opposite, being less affected by uninteresting noises.

*In fact, even children at the beginning of primary school are only a little bit worse than adults with such noises but are far, far worse than adults when another talker is in the background. Strikingly, they do not seem to exhibit the adult pattern of performance even at the end of primary school, age 11. So the abilities that let adults ignore another talker in the background are very slow to develop.*



# The science behind...



## the Diapix demonstration

**What are we trying to find out?**
How people adapt their speech to make communication easier when speaking to someone who cannot hear them well.

*Some aspects of our speech are determined by biological factors like the size of our vocal tract, but we can still control many aspects of the way we speak, e.g., the speed or pitch we use. We want to see whether people are able to adapt the way they clarify their speech to improve how well they are understood in a specific difficult listening environment, e.g. talking to someone in background noise, who has a hearing loss or is not a native speaker.*

**Why is this important?**
If we understand better what makes speech clearer in different situations, this could help make better artificial speech systems and help train people to communicate better with people who have a hearing loss.

**How did we design our study?**
We analysed the speech of pairs of people doing the Diapix task while one person had to communicate via a ‘communication barrier’, and compared this to the speech produced when the two people heard each other normally.

*Because the task involves interaction between two people, it allows us to record conversations between two people in different contexts, e.g., background noise, hearing impairment. We can then measure acoustic characteristics of speech including: pitch, speaking rate, loudness and vowel articulation, and see how these measures change in the different conditions.*

**What did we find?**
Speakers tend to adjust the clarity of their speech according to the different difficult conditions.

*For example, when trying to speak clearly to someone hearing via a simulated cochlear implant, we don’t change our pitch very much; this makes sense as the simulated cochlear implant doesn’t transmit pitch information very well. But we make our pitch higher and more varied when speaker to someone hearing us in background noise, which makes the speech stand out from the noise.*

# The science behind…

## understanding different accents in noise

**What are we trying to find out?**
Communicating in a noisy environment is difficult, especially when the talker and the listener don't share the same first language and accent. We want to find out how listeners with different accents and first languages cope in these conditions.

**Why is this important?**

London is a multicultural society and many people don't share the same first language or accent. This can make communication difficult, especially in noisy environments. We're trying to understand how people cope with different accents, why some are able to cope whilst others can't, and why some accents are more intelligible than others. By understanding how people process accented speech in noise we can help listeners improve their communication skills in many different environments, e.g., in a noisy multi-cultural classroom.

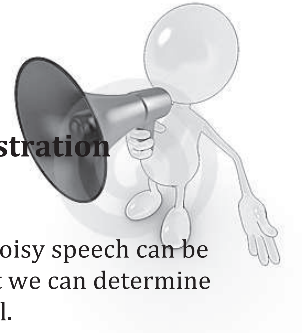
**How did we design our study?**
People from different backgrounds, e.g., native English speakers from the south of England, and French listeners who had just started learning English, listened to English sentences in different accents that were mixed with noise. We measured the words that they identified in each sentence. We also recorded them producing some of these sentences so that we could make acoustic measurements of their speech to compare with their scores in the listening experiment.

**What did we find?**
We are tuned up to listen to our own accent, though experience is also a big factor in our ability to understand an unfamiliar accent.

*Native listeners performed better with their own accent. For non-native listeners, experience also played a large role; the French listeners who had the most experience with English performed better with native English sentences than with French-accented speech, but for the least experienced French speakers, the French-accented English speech was the easiest to understand. We also found a link between speech production and intelligibility; the closer a talker's accent is to a listener's, the better they are able to communicate in noise.*



## the Noise Reduction Demonstration



**What are we trying to find out?**
We want to understand whether the intelligibility of noisy speech can be improved by computer processing and whether or not we can determine automatically the best way of processing a noisy signal.

**Why is this important?**
Noise reduction processing is used in telephones, hearing aids, and in the forensic analysis of audio recordings.

*A model that accurately predicts the impact of audio processing on intelligibility could be used to make sure these techniques are used to their best advantage, as well as to develop better techniques.*

**How did we design our study?**
Specially designed sentences are recorded and then corrupted with noise, before being processed through a range of noise reduction techniques and played to listeners to determine their intelligibility. We then study how processing changes the audio signals and build a model which predicts the impact of each technique on intelligibility.

**What did we find?**
You might have thought that noise reduction would improve intelligibility, but in fact most processing does the opposite: the processing involved in removing the noise often distorts the speech information itself.

*Traditional models of speech intelligibility cannot explain this result. We have developed a better model which allows us to predict the impact of noise reduction.*