

Impact Objectives

- Assess the impact of ageing on the way in which we produce speech when communicating with others
- Assess the impact that hearing loss can have on speech communication for older adults in different listening environments
- Examine the effectiveness of speech adaptations used by older adults in challenging listening environments

Balancing hearing and speaking

Professor Valerie Hazan and Dr Outi Tuomainen have new evidence on how speech communication changes across the lifespan. Here they discuss their projects, explaining what these changes can sound like and what they mean



Valerie Hazan



Outi Tuomainen

What are the inherent challenges involved in studying speech and communication?

How does your approach differ from traditional methods, and how does it achieve meaningful results?

VH: Our work, which is focused on the acoustic aspects of speech, is novel in a number of ways. It focuses on speech that is produced with the intent to communicate a message to an interlocutor. Although it would seem obvious to take this approach in studies of speech acoustics, generally the speech that is analysed is recorded while a participant reads words or sentences alone in a sound booth and is therefore devoid of communicative intent. The way in which we speak is actually very dynamic – it changes according to how well we're being understood – and all of that is lost if we're just listening to someone read out a sentence. Speech has to be looked at as communication. An experiment we use to obtain speech recordings for both young people and older adults, for example, has pairs of participants doing a problem-solving task together (a 'spot the difference' picture task). They are seated in separate rooms and have to communicate with each

other to work out what the 12 differences are in the pictures they've been given. In that time, they're multitasking, they're speaking but at the same time trying to figure out what the differences are. They're not primarily thinking about speaking; they're communicating.

Can you explain why you are studying the spoken communication of older adults?

VH: A lot of my research in speech communication has been concerned with speech development in children, trying to answer the question of when their speech truly becomes 'adult-like'. However, I've become increasingly convinced that the speech that we produce changes throughout our lives, and that 'adult-like' is not a single steady state. We therefore need to take much more of a lifespan approach to the research than we do, rather than just compare children to young adults. Changes in speech communication across the lifespan are in part due to physical changes in our vocal and hearing apparatus as we age, but they are also due to changes in our language experience throughout our lifetime.

What are some of the additional, less immediately obvious differences in the way older and younger adults communicate in a more realistic scenario, such as the one used in your experiments?

OT: We found that there are age-related differences in speech produced by older adults in good listening conditions that are

mostly linked with the physiological changes associated with advancing age, such as changes in lung capacity, vocal tract and vocal fold size. This was the case irrespective of the hearing status of the talker. For example, older adults speak more slowly on average than younger adults, and have less energy in their voice. However, in difficult listening conditions, while older adults with normal hearing were more similar to young adults, in terms of the adaptations that they made, older adults with age-related hearing loss showed some differences in their adaptations, which were consistent with an increase in vocal effort (similar to shouting). We also found that the speech of older adults, when presented in background noise, was not typically as easy to understand as that of younger adults, for both young and older listeners.

VH: Much communication happens in listening conditions that are less than ideal: with background noise, or in large rooms, or competing conversations. In a conversation between two older adults, both interlocutors may have some hearing loss. If their voice is weaker and if they are not as flexible as younger adults in adapting their speech in a way that counters the effect of this background interference, then their speech will be even harder to understand. Ultimately, if older adults find that conversation is too effortful, communication may break down altogether.

Communication across the lifespan

A new project, *Speech Communication in Older Adults: An Acoustic and Perceptual Investigation*, studies factors that can lead to changes in the speech of older adults, creating a new understanding of the communication barriers that may be faced in old age

Many of us will be familiar with everyday communication problems – a noisy restaurant, the distracting presence of the TV or radio, the conversation partner who can't quite hear you either, the throat tickling from the effort... sooner or later, we just give up, and verbal communication fails. It's a common scenario: one of the key impacts of hearing loss is that speech becomes much more difficult to understand in real life communication situations. As people age and their hearing is less effective, often their ability to interact within society thus deteriorates. The assumption tends to be that this is simply the result of age-related hearing loss.

In a recently completed project undertaken by Professor Valerie Hazan and Dr Outi Tuomainen at University College London (UCL), UK, the researchers have expanded this understanding by broadening the approach. Instead of focusing exclusively on hearing loss, they look at how ageing affects an individual's ability to speak in a way that is readily understood, and the impact this can have on their ability to communicate effectively. As Hazan notes: 'The effect of ageing on hearing is quite well-known by the general public, but there is probably a lower degree of public awareness on the effects of ageing on the ability to produce speech clearly, especially in challenging situations.' Age-related hearing loss is progressive and widespread in the older population, affecting at least half of all adults by the age of 75.

Along with projected demographics, this makes this research more vital than ever.

The primary objective of the study was to assess whether older adults, with and without hearing loss, are as able as younger adults to adapt the way they speak, according to the prevailing listening conditions, to ensure they can be easily understood. Hazan and Tuomainen wanted to know whether typical and clear speech produced by adults is as intelligible as that produced by young adults, while at the same time assessing whether hearing loss influenced this.

ASSESSING SPEECH COMMUNICATION

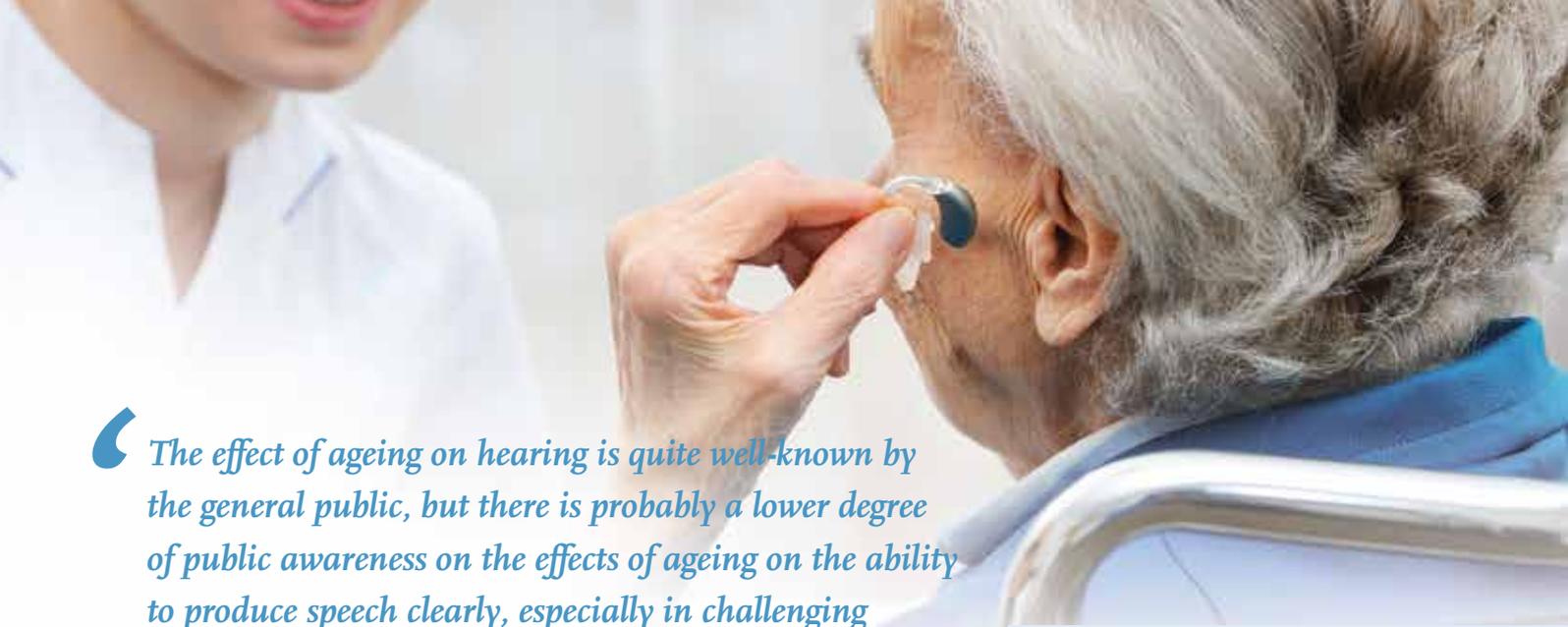
Hazan and Tuomainen specifically focused on speech that is produced with the intent to communicate a message to an interlocutor, in this case, in solving a problem together in simulated listening conditions that varied in difficulty. Older adults with and without hearing loss, and younger people with normal hearing, were partnered with a young person. After the speech of a range of participants in these realistic scenarios were recorded for 10 minutes, the recordings were used to make extensive acoustic analyses. Then, the second part of the study examined the effectiveness of these adaptations to counter difficulties in communication by extracting short snippets from the conversations they recorded, embedding them in noise and presenting them to younger and older listeners with and without hearing loss, who then had to repeat what they heard.

As well as discovering that older adults are less able to adapt their speech to poor communicative conditions, they discovered in the listening study, that the normal everyday speech of older adults was generally more difficult to understand in background noise than the speech of younger adults. This seems to be due to the fact that their voices are weaker.

The different strategies used by older adults with mild hearing loss when they tried to speak clearly, compared with older adults with normal hearing, were unexpected. The participants in the study were active and engaged older people who did not wear hearing aids, and yet some of the results from the communication scenarios are more similar to what the team might expect from older adults with a greater established degree of hearing difficulties.

VERBAL/NON-VERBAL ASPECTS

Hazan and her team's experiments brought some physiological factors involved in speech communication into sharp relief. For example, some of the adaptations to poor communication conditions were consistent with an increase in vocal effort, but this result was not seen in older adults with normal hearing or in younger adults. Increasing vocal effort – which, as Tuomainen points out, can sound like shouting – is sometimes effective



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but, in time, is likely to lead to vocal strain or fatigue. This strain, the researchers note, was clearly audible in some of the recordings.

The non-verbal aspects of communication also formed part of this holistic study, as the researchers analysed how often participants looked at their interlocutor while doing the task. This revealed that older adults with normal hearing looked less frequently and for shorter periods of time at their conversational partners compared to younger adults. 'This may be due to a decline in older adults' attention to cues which signal how well a conversation is progressing,' Hazan suggests. However, older adults with a mild hearing loss looked more frequently and for longer than their peers with normal hearing, as they have a greater need for the information provided by visual cues.

IMPROVING SPEECH COMMUNICATION

Overall, the research shows that in some respects, the communication difficulties faced by older people are greater than previously thought, and that even hearing loss too mild to require the use of hearing aids has a significant effect on communication strategies. Fortunately however, it also highlights practical ways forward. If there is an increased understanding of communication strategies that are effective at making speech clearer in certain environments, older people may be able to employ these to help them remain active in conversations. For example, it can be suggested that slowing down their speech and introducing pauses is preferable to shouting, which can lead to vocal strain. Useful strategies also include looking at the conversational partner to pick up verbal and non-verbal cues about their level of understanding.

This study also showed that the amount of energy in your voice has a big effect on how well you can be understood in noisy conditions; this depends to a great extent on how strongly and regularly your vocal chords are vibrating when you speak. Individuals can maintain the health of their voice by not smoking, keeping well hydrated and avoiding shouting. Voices could also be boosted artificially using speech technology to improve how well voice-activated devices work for older adults. Another vital aspect of easing communication difficulties is what the researchers call 'backchannelling', for example, using verbal cues like 'right' or 'OK', in order to briefly confirm understanding. The results, which are perhaps unexpected, highlight the importance of conducting studies into dynamic communications.

Going forward, the researchers leading the project see their work benefiting a number of areas including speech and language therapy, adult social care and charity sectors, developers of speech technology and also the wider public. This project could extend the understanding of the wider implications of hearing loss in older adults, and lead to developments in communication technologies that will help to address their needs.



Younger and older adults being recorded while carrying out a 'spot the difference' task

Project Insights

FUNDING

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Valerie Hazan is a Professor of Speech Sciences in the department of Speech, Hearing and Phonetic Sciences at UCL. Her research interests are in speaker-listener interaction in speech communication, in speaker variability and in speech development in typical and atypical populations. She is a Fellow of the Acoustical Society of America.

Outi Tuomainen, Research Associate, is based at the department of Speech, Hearing and Phonetic Sciences at UCL. Her work focuses on age-related changes (across the lifespan) in speech and language processing in typically and atypically developing individuals. She is particularly interested in bridging the gap between laboratory experiments and real life.

