



Mark Hickton discusses audio-visual interactions and their relevance to ophthalmic practice and audiology

“I can hear better with my glasses on”

Across the UK there are optical practices, both large chain and independent, that are choosing to diversify to support hearing care provision as well as eyecare.

Whilst the general healthcare link is obvious, and the dual provision would appear to be commercially advantageous¹, some would see the two aspects of vision and hearing as being quite separate. However, the studies in visual and audio interaction examined in this article show that the two sensory modes are not independent of each other, but instead combine to help form our perception of the world.

A phrase heard from time to time in optical practice is, “I need to put my glasses on to hear you better”. It is suggested that this improvement in hearing with corrected vision can be attributed to the fact that the patient will be able to identify lip movements², and therefore be able to make assumptions about the words being spoken. However, there is a far more profound link between our visual and audio senses in the processing of our perception: the auditory and visual senses will often enhance the perception of the world when working together.

CROSS-MODAL FUNCTIONALITY

As we age, our hearing performance deteriorates, especially in relation to the high-frequency range³. Studies³⁻⁷ have found that this reduction in auditory performance can be compensated by our visual system and the monitoring of a speaker’s visual cues, such as lip movement, gestures, etc.

This combined audio-visual input can improve social interactions for patients with high-frequency hearing loss, with Erber³ suggesting that everyday conversational

disruption is minimal when visual support is present. Ostrand *et al*⁸ support this by citing studies which indicate that the perception of speech is altered by the observation of lip movements, implying what we see can affect what we hear⁹⁻¹¹.

The interconnected relationship between the audio and visual modes can be observed at a physiological level; plasticity changes within the brain can occur with hearing loss patients, resulting in auditory regions of the brain changing their functionality to process visual information⁵.

This plasticity can also manifest through increased peripheral-field visual performance in hearing loss patients^{12,13}, to compensate for the loss of auditory spatial awareness. It should be noted, however, that although peripheral visual awareness can be heightened in hearing loss patients, their overall visual acuity and thresholds are not improved⁵.

When the sensory information from both modes of the audio-visual system are combined, there is often a more effective awareness of the world. However, there are also interesting phenomena that can arise when there is a conflict between what is seen and what is heard.

In such cases, where there is a clash between the visual and the audio input, one sensory mode can dominate the other¹⁴, resulting in your vision altering what you hear, and vice-versa.

As mentioned previously, studies have indicated that hearing can be altered by visual stimulus, and this can be effectively demonstrated experimentally in what is now commonly referred to as the McGurk effect¹⁵. This effect involves showing a subject a conflicting audio-visual stimulus, such as the sound ‘bah’ in conjunction with a visual display of lips mouthing the sound ‘fah’.

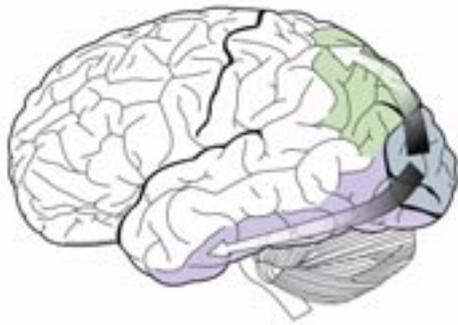


Is combining eyecare with audiology services the way forward?

In the majority of cases, the subject will perceive the sound ‘fah’, despite the fact that the subject has only been exposed to the ‘bah’ audio stimulus. The McGurk effect shows how the visual sensory system can dominate the auditory system when such conflicts arise between the sensory modes. This effect is so encoded into our visual/audio systems that the illusion still presents itself even when the participant knows about the effect⁶.

Studies have found that this visual dominance over the auditory input is more prevalent in the adult population compared to the child population¹⁶, with some suggesting that experiential learning will dictate how different sensory modes develop together^{17,18}.

There are many other situations in which cross-modal sensory information can either reinforce our perception, or create conflict which alters our perception. Work by Shams *et al*¹⁹ demonstrates some cases of



Much of the human cerebral cortex is involved in vision. The ventral pathway (shown in purple) is important for visual processing, as well as for processing auditory information. The visual dorsal system is shown in green

audio dominance, in which there can be visual perception changes based on the influence of audio stimulus. These studies involved experiments that presented participants with a single flash of light accompanied by a number of quick audible beeps.

Results from these experiments indicated that patients perceived the illusion of multiple light flashes during the process, despite only one visible light flash being presented as a visual stimulus. The findings again show a cross-modal functioning of the visual-audio system, with the audio stimulus altering the visual percept in this case.

Hötting and Röder¹⁸ also reveal that it is not just the visual-auditory processing that impacts on one's perception; with a similar methodology to Shams *et al*¹⁹, discussed above, the visual flash of light was replaced by a single tactile stimulus presented in conjunction with multiple auditory stimuli. Participants in this study reported perceiving more than a single touch when hearing multiple auditory beeps in quick succession, thus demonstrating that tactile perception can also be altered by audio stimulus.

DUAL-SENSORY CARE APPROACH

With all these studies demonstrating the symbiotic relationship between the senses, the combining of eyecare and audiology services in healthcare seems more justified. As well as the actual healthcare screening and testing of these senses, consideration should be given to the devices used to support patients with hearing loss or vision loss. Work in this area has suggested that hearing devices should employ cameras to provide visual stimulus as well as auditory²⁰, to help both perceptive modes to reinforce each other.

When ophthalmic and audiology services are delivered by the same practice, the services should complement one another, rather than being run as separate businesses. Studies propose that

audiologists should consider any visual impairment in hearing loss patients to enhance patient care and support^{3,4}. Likewise, optometrists should consider the importance of hearing support in relation to patients with vision loss. This dual-sensory care approach could also be considered for dyslexic patients, in which the visual and auditory systems may not collaborate effectively²⁰.

The Office for National Statistics²¹ cites projections suggesting that there will be a significant increase in the elderly population over the next few decades, and this increase is likely to place greater demand on the healthcare services that deal with age-related sensory decline.

With more optical practices diversifying into audiology¹, it is apparent that cross-department co-ordination and training should be applied to improve the healthcare service offered, and this collaboration between the two fields of optometry and audiology has been recommended as promoting best practice to improve patient support⁴.

Professional training of audiologists, optometrists and dispensing opticians could be enhanced by inclusion of the audio-visual cross-modal issues raised in these studies, especially in the areas of hearing loss and low vision.

Finally, it is important to raise public awareness of the importance of regular sight tests and hearing tests, and the benefits of attending both appointments. The complexity of the brain and the processing of information continually promotes research in this area, and it is becoming clearer that how we perceive the world is an amalgamation of many sensory and experiential influences.

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Growth in elderly population will put pressure on health service

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Watch a BBC2 Horizon clip on YouTube, showing a demonstration of the McGurk effect, at <https://youtu.be/G-IN8vWm3m0>

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