**Lip-reading abilities in a subject with congenital prosopagnosia**

*J. Wathour¹, M. Decat² F. Vander Linden¹ and N. Deggouj²*

¹Centre of Audio-Phonology, Catholic University of Louvain, University Hospital Saint-Luc, Av hippocrate 10, 1200 Brussels, Belgium; ²ENT department, Catholic University of Louvain, University Hospital Saint-Luc, Av hippocrate 10, 1200 Brussels, Belgium

**Key-words.** Congenital prosopagnosia; lip-reading; McGurk; facial dynamic; fine dynamic

**Abstract.** Lip-reading abilities in a subject with congenital prosopagnosia. We present the case of an individual with congenital prosopagnosia or “face blindness”, a disorder where the ability to recognize faces is impaired. We studied the lip-reading ability and audiovisual perception of this subject using a DVD with four conditions (audiovisual congruent, auditory, visual, and audiovisual incongruent) and compared results with a normal patient cohort. The patient had no correct responses in the visual lip-reading task; whereas, he improved in the audiovisual congruent task. In the audiovisual incongruent task, the patient provided one response; thus, he was able to lip-read. (He was able to use lip-reading/to use labial informations) This patient perceived only global dynamic facial movements, not the fine ones. He had a sufficient complementary use of lip-reading in audiovisual tasks, but not visual ones. These data are consistent with abnormal development of the pathways used for visual speech perception and associated with second-order face processing disorders and normal development of the audiovisual network for speech perception.

**Introduction**

In otorhinolaryngology, the study of face recognition is mainly applied to adults who have developed a hearing impairment and whose auditory abilities no longer allow them to fully follow a conversation. Lip-reading becomes very useful in such cases, whether this skill has developed spontaneously or through speech-language reeducation. Prosopagnosia, or “face blindness”, is the inability to recognize familiar faces, such as those of celebrities, family members, friends, and even one’s own face in the mirror. The condition can be congenital or acquired. The acquired form occurs more frequently and may develop after a head injury, cerebrovascular accident, or inflammation caused by infection (e.g., meningoencephalitis) has led to a uni- or bilateral lesion in the right hemisphere. On the other hand, congenital prosopagnosia, which is also known as developmental prosopagnosia, is very rare.¹ It may affect 2.5% of the population, without being associated with any obvious brain lesion.² Its origin is genetic, with dominant inheritance and variable expression.³ Prosopagnosics are often not identified because they are unaware of their disorder; therefore, prosopagnosia is under-diagnosed.

Face recognition requires first-order processing of the face’s constitutive features (two eyes, a nose, and a mouth), then perception and holistic processing (secondary or second-order detection) so that there can be recognition. The combination of steps allows us not only to recognize a face, but also to determine gender, age, ethnic origin, and facial expressions of familiar and unfamiliar people. It’s the holistic processing that is disrupted in prosopagnosics. First-order processing (primary detection) is unaffected.³ We hypothesized that lip-reading, part of secondary detection, would be disrupted in congenital prosopagnosics. Lip-reading is based on perceiving the movements of different parts of the face, in particular the lips. Lip-reading uses the neural circuits involved in holistic face perception; thus, prosopagnosics’ lip-reading abilities should be severely disrupted. To our knowledge, the lip-reading abilities of congenital prosopagnosics have not yet been described. This article presents the evaluation of lip-reading abilities in a congenital prosopagnosic and compares results with those of a normal subject population.
Case report

The Patient

MA, a 63-year-old pediatrician, realized at the age of 20 years that he had congenital prosopagnosia. He did not have any obstetric, medical, or surgical antecedents or any cognitive disorders (cognitive evaluation in 2007). MA exhibited good hearing and normal vision when wearing glasses (presbyopia). As a child, he had always been seen as timid, even autistic. He reported that he was a converted left-hander (he was forced to write with his right hand) and dyslexic. MA was incapable of recognizing faces; although, he was aware of details like hair, colors, glasses, as well as the shape of the features. He used features such as haircuts, movements, and voices to recognize his family and friends.

He could not correctly distinguish the expressions of sadness, anger, or joy on faces, but he could imitate them. He believed he had difficulty hearing in noisy environments and when learning a second language. His mother and two of his four children were also prosopagnostic. It should be noted that MA had previously undergone a neuropsychological evaluation regarding face recognition, which had uncovered a deficit specific to the processing of faces in terms of “individuating” and the “holistic processing of faces”. MA was compared with a control group of 12 subjects, six men and six women, aged between 61 and 70 (average age = 64.25) years. The selection criteria were: native French speaker with good hearing (no hearing aid).

Tests

It was necessary to design a test to objectively measure lip-reading abilities. This test is currently in the process of being published (DEWA). For the test, three lists of 60 words (a, b, and c), were made and read out by a man. The main criterion was lip-readability, as a word can be easy or difficult to lip-read. The lists were phonetically balanced (proportion of phonemes in the French language) in terms of length (between two and nine phonemes) and the frequency of the words. The test was carried out with audiovisual material in the form of a DVD.

The lists were presented audiovisually (DVD) under four conditions:

1. Auditory condition (A): the words were presented acoustically, and the subject had to repeat the words he heard.
2. Congruent audiovisual condition (CAV): the words were presented both acoustically and visually, in a congruent manner. The subject had to repeat the words he heard and saw.
3. Visual condition (V): the words were presented visually, and the subject had to repeat the words he lip-read.
4. Incongruent audiovisual condition (IAV): the words presented acoustically did not match those presented visually. The subject had to repeat the word he lip-read, while disregarding the incongruent words he heard.

The visual-only condition tested unimodal lip-reading abilities. The subject detects facial movements and attributes a linguistic meaning to them. The congruent audiovisual condition tested whether the subject could use lip-reading to clarify or improve his perception of the words presented acoustically. The incongruent audiovisual condition evaluated the subject’s ability to integrate discordant auditory and visual signals to form a perception of: the words said (complete [whole word] or partial [part of the word] auditory capture), of the words seen (complete or partial visual capture), of words formed by combining parts of the words said and seen (fusion), and of words formed that bore no relation to the words said or seen (illusion). It was an adaptation of the McGurk effect.

Test results

Neuropsychological evaluation

This evaluation showed no inversion effect, no composite face effect, and no whole-part advantage in face processing. These three tests revealed that MA had a deficit specific to face processing (holistic processing in face individualization).

Lip-reading and audiovisual integration test

MA’s performances in the auditory and congruent audiovisual conditions were normal, his scores matched those obtained by a control group of 12 normal-hearing subjects (Figure 1). Receiving both auditory and visual signals allowed MA to identify two extra words, as we can see from the difference in scores obtained in the congruent audiovisual condition (Figure 1a) and the auditory condition...
Lip-reading in congenital prosopagnosia

The subject tested had prosopagnosia that affected the holistic and second-order processing of facial features. MA’s scores in the visual condition suggest that he has not developed effective lip-reading abilities, even though he stated he had difficulty understanding in noisy environments. However, he correctly detected the number of syllables in 90% of the words presented visually (data not shown on the graph). In the incongruent audiovisual condition, MA did not provide any answer for 59 of the 60 words presented. The only answer given (neveu) was wrong. It was a fusion of the word presented visually (vœux) and the one presented acoustically (nœud). However, he clearly detected that the sound and image were discordant.

MA was compared with a male control subject of the same age (62). This normal-hearing subject only correctly identified one word visually. However, unlike MA, he gave 25 inexact answers, which were complete and partial auditory and audiovisual captures.

Discussion

The subject tested had prosopagnosia that affected the holistic and second-order processing of facial features. MA’s scores in the visual condition suggest that he has not developed effective lip-reading abilities, even though he stated he had difficulty understanding in noisy environments.
He was not able to use or transform the dynamic information of facial features into phonemic information. However, he detected the general dynamic aspect of articulatory movements well, since he was able to recognize the number of syllables. The detection of broad facial movements may be part of first-order processing, which is unaffected by congenital prosopagnosia; whereas, the detection of subtle movements may be part of second-order processing, which is disrupted in this pathology.

In the congruent audiovisual condition, MA’s perception of the words presented acoustically improved when these words were also simultaneously presented visually. This improvement may be explained by different hypotheses. The ability to detect subtle dynamic facial information may not be necessary for improved speech perception in the congruent audiovisual condition; thus, broad dynamic facial information may suffice. Lip-reading may permit improved speech perception even when the features of the face are not clearly identified or well lit.10 Another hypothesis is that lip-reading may involve two networks: one may integrate audiovisual information and determine the meaning; while, the other non-integrated network may directly determine the meaning. This dual perception may also be involved in the recognition of facial expressions. This integrated perception may enable facial expressions to be imitated; whereas, the direct perception may enable facial expressions to be recognized. This dual perception was found in MA as well as the subject studied by Campbell,10 who found that his patient was incapable of recognizing facial expressions but could imitate them well. Campbell also studied his subject’s lip-reading. The subject lip-read well and displayed the McGurk effect, an audiovisual interaction that occurs when there is incongruence between the auditory and visual information. Two things may explain these different observations: the tests used and the acquired or genetic nature of the pathology. Campbell10 did not use open lists of words; instead, he used a simpler test based on the recognition of some phonemes and numbers. His patient developed prosopagnosia at an adult age; thus, he may not have developed the necessary pathways for using dynamic facial information linguistically. In congenital prosopagnosia, children avoid looking at faces, which are unknown and therefore disturbing. They may exhibit autistic-like behavior with fleeing eye-contact and excessive timidity, impeding the development of the neural circuits needed to process lip-reading. MA’s poor lip-reading performance explained why he had difficulty understanding in noisy environments. Indeed, lip-reading is a natural compensation that dramatically improves the signal-to-noise ratio and, therefore, speech perception in noisy environments.11

In the incongruent audiovisual condition, MA displayed abnormal audiovisual integration capabilities. He did not form any new perception (except for one word) or focus his perception on auditory or visual capture. He responded with non-answers. He knew there was discordance, but could not overcome it. He did not form any illusory perception when presented with two incongruent signals. One explanation is that the non-congruent activation of the integrated audiovisual pathway did not permit activation of the auditory or visual pathways or the integration site that produces illusions. The only option left was a non-answer.

Conclusion

This case report presents, for the first time, the ability of a congenital prosopagnosic to lip-read and use audiovisual integration. The results support the hypothesis that this pathology is linked to an absence of secondary holistic detection. The patient had good congruent audiovisual integration; however, he had poor lip-reading abilities. In the incongruent audiovisual condition, his perception only permitted him to give non-answers, which showed that auditory and visual captures were blocked.

References


Prof Naïma Deggouj
Cliniques Universitaires UCL Saint-Luc
10, avenue Hippocrate
1200 Brussels
Belgium
Tel.: +32 2 764 19 45
Fax: +32 2 764 90 42
E-mail: naima.deggouj@uclouvain.be