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# The Influence of Age on the Frequency of the McGurk Effect

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## ABSTRACT

Generally, people use more than one sense simultaneously to receive information from the environment. This information is organized in the brain by a process called multisensory integration. The McGurk Effect (ME), which happens when the information received from the eyes does not correspond to the information received from the ears, is considered to be a classic example of multisensory integration. When this conflict happens, the eye dominates the brain. There are several factors that influence whether or not the ME is observed; this research examined how age affects the frequency of displaying the ME. Participants between the ages of 15 to 71 watched 10 videos containing auditory and visual stimuli. One video contained congruent stimuli and the other nine contained incongruent stimuli. After each video, participants were asked what syllable they heard. There was a positive correlation between age and the frequency of displaying the ME ($P = 0.0008$). This may be due to an age-related decrease in hearing acuity, which makes older people rely more on visual stimuli.

## Introduction

Sense is defined as a biological system used by living organisms to receive information from the environment. Of the twenty senses that humans have, five of them, also known as special senses, are the most important for us. These five senses are vision, hearing, taste, smell, and touch. Each sense has specialized sense organs that can receive sensory information and later change the information into nerve impulses that go to the brain. The organs that correspond to vision are the eyes. The ears are the special sensory organs that give rise to hearing. The sensory organs for taste are the taste buds on the tongue. The nasal cavity provides the ability to smell. Lastly, the skin is a significant sensory organ for touch. All these special senses provide humans with the ability to sense and communicate with the environment.

Most of the time people don’t use just one sensory modality to receive information from the environment. People will receive information from all different sensory modalities and that information is integrated in the brain. This is called multisensory integration, and it allows humans to perceive a world of complex sensory information (Stein et al., 2009). Multisensory integration is very common in daily life and people may not even be aware that it is happening. One example of multisensory integration is eating. When people eat food, they use the senses of both taste and smell. Sensory inputs from these two senses are integrated by the brain, making the eating experience more complete. Another example of sensory integration is watching television. When people use their eyes to receive information from the screen, their ears also receive the information simultaneously.

Speech perception is inherently multimodal, which means that more than one sense is involved in this process. Visual speech, or lip-reading, is usually combined with auditory speech simultaneously (Pathway, 2022). Furthermore, recent research suggests that the brain treats auditory and visual speech similarly (Ochsner & Kosslyn, 2013). However, when the auditory and visual stimuli are similar, a phenomenon called the McGurk Effect can occur (McGurk & MacDonald, 1976). The McGurk Effect is considered to be a classic example of multisensory integration and happens when the information received from the eyes does not correspond to the information received from the ears (Tiippana, 2014). When this conflict happens, the eyes have a greater effect on the brain than the ears which means the eye dominates the brain. For instance, if you hear bah while the lip of the speaker silently speaks the word fah, your brain makes you think you hear fah although you actually don't.

There are many different factors that influence whether or not one experiences the McGurk effect. Two, in particular, are the distance from an individual to the speaker and the nature of the stimuli itself. When an individual is far away from a speaker on a monitor, it's more likely that the individual would need to rely on the auditory information they receive considering they may not have a clear view of the visual information. In this case, the McGurk Effect is less likely to be displayed. Closer proximity to the monitor will likely enable an individual to receive clear visual information. In this case, the McGurk Effect could be displayed (Jordan, 2000). The nature of the stimuli received from the eyes and ears will also affect whether or not the McGurk Effect appears. The McGurk Effect usually appears when the visual stimulus and the auditory stimulus are similar in some way. If the individual can easily tell the difference between a visual stimulus and an auditory stimulus, the McGurk Effect is less likely to be displayed (Stein et al., 2009).

Some have investigated whether age might also determine whether the McGurk Effect is displayed. Sekiyama, et al. 2014 found that compared to adults aged 19-21, older people aged 60-65 rely more on visual speech (Sekiyama, 2014). This is likely to be associated with an aging-related delay in auditory processing. Meanwhile, Hirst, et al. 2018 found that the McGurk Effect is more likely to occur in adults aged 20-35 than in children who are aged 3-9 (Hirst, 2018). Young children need more auditory noise, and less visual noise, than adults to show McGurk responses. This implies that young children rely more on auditory stimuli. However, more research needs to be done comparing the frequency of the McGurk Effect in different age groups, particularly adolescents. Therefore, my study will examine the frequency of the McGurk Effect in adolescents as young as 13 and adults up to 60. My hypothesis is that as age increases, the frequency of the McGurk Effect increases.

## Method

The procedures for the study were approved by Shattuck-St. Mary's School's Ethics Review Board. A total of 146 subjects were recruited from students and faculty at Shattuck-St. Mary's School. Their ages ranged from 15 to 71. To recruit participants, an email that included a simple description of the study was sent out to all students and faculty. People interested in participating clicked on the link attached to the email. This link brought them to the experiment survey. The first page of the survey was the informed-consent form which explained the purpose, procedures, and any possible risks of the study. If the student or faculty member wanted to participate, they clicked agree which then led them to the second page. The second page asked participants to put on their headphones, then click on an instruction video on the third page. The instruction video explained to the participants that they will watch a series of videos and that they need to type what they hear. The instruction video provided an example: a video played auditory bah, and at the same time showed the word "bah" on the screen, so the participant understood what they needed to write. After the instruction video, they went to the fourth page of the survey which contained 10 videos. One video contained congruent auditory and visual stimuli. The other 9 videos, show up in random order, all had incongruent stimuli. After they watched all the videos and typed what they heard, a final question was asked: What is your age in years? Then, they submitted their survey.

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**Table 1. Visual and Auditory stimuli used in the survey:** *The congruent and incongruent stimuli used in the survey. One video (video 5) contains congruent stimuli, bah. The other eight videos are all incongruent stimuli.*

| Video number | Visual stimuli | Auditory stimuli |
|---|---|---|
| 4 | Bah | Gah |
| 5 | Bah | Bah |
| 6 | Kah | Dah |
| 7 | Kah | Pah |
| 8 | Tah | Bah |
| 9 | Tah | Kah |
| 10 | Tah | Pah |
| 11 | Dah | Bah |
| 12 | Gah | Bah |
| 13 | Dah | Pah |

## Results

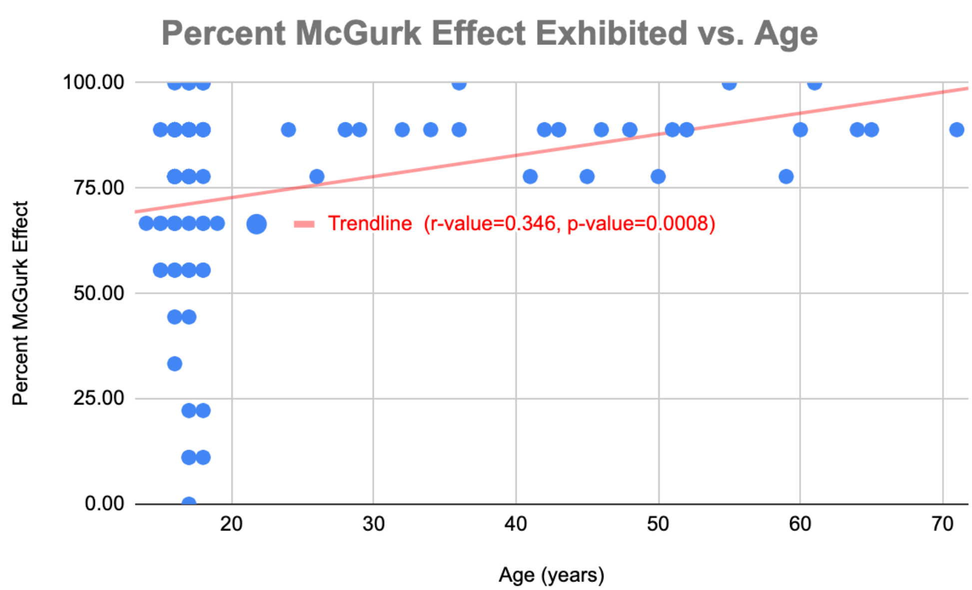


**Figure 1: Percent McGurk Effect Exhibited VS. Age:** *This graph shows the participant's age and the percentage of the McGurk Effect. Each blue dot represents data of a certain age and incidence of the McGurk effect. The percentage is calculated by using the number of videos that the participant displayed the McGurk Effect in, divided by the total number of incongruent stimuli videos (9 videos).*

There were 154 responses in total. After excluding the incomplete response and the response that didn't pass the control test, there were 92 responses left. A Pearson correlation coefficient calculator was used to calculate the relationship between the age and the frequency of the McGurk effect of the 92 responses. As observed in Figure 1, there is a trend line that shows the relationship between the frequency of displaying the McGurk effect and age. The trendline indicates that there is a positive correlation between the two variables. The R-value is 0.346 which means the correlation is not very strong. But the p-value of 0.0008 shows that the correlation is statistically significant.

## Discussion

This data shows that the frequency of the McGurk Effect was greater in older versus younger people. As age increased, the frequency of observing the McGurk Effect increased. This data is similar to Sekiyama 2014, who reported a greater frequency of the McGurk effect in older participants (60 to 65 years old) compared to younger participants (19 to 21 years old). Subjects in this study were exposed to three types of stimuli: both auditory and visual stimuli (AV), auditory-only stimuli (AO), and visual-only stimuli (VO). Participants' reaction time and accuracy were assessed when given a syllable (ba/da/ga) to identify in each condition. All participants experienced the AV stimuli first. Within the AV stimuli, half of the stimuli were congruent, and the other half were incongruent in order to see if the McGurk Effect would be observed. Then, participants were exposed to AO and VO stimuli in random order. Sekiyama observed that the older group showed a greater reliance on visual cues compared to the younger group, demonstrating a greater frequency of the McGurk Effect. In addition, the older group was less accurate in the AO condition compared to the younger group. There was no significant difference in VO accuracy between the two groups.

To determine whether the increase in the frequency of the McGurk Effect was due to an increase in reliance on visual influence with age, a second experiment was done where they controlled for hearing by setting up 4 specific signal-to-noise ratios (SNR), which provided equivalent auditory intelligibility in both the older and younger age groups. A significant effect of age group appeared for the visual influence score in AV speech perception. It showed that the older group was more strongly affected by visual information, particularly in the high SNR condition. This supports the visual priming hypothesis, which means that visual information has a bigger influence on multisensory integration as people age.

In a different study examining the ME, participants were divided into two groups by age: one group consisted of kids ages 3-12 years old, and another group consisted of people ages 20-35 years old (Hirst, 2018). Participants watched a video showing a person saying different syllables on a screen. After the video, an on-screen message appeared, asking the participant what they heard. Adults made more fusion responses (responses different from either the visual or auditory stimulus presented) than 3–6-year-olds ($p = 0.045$) and 7–9-year-olds ($p = 0.022$) Moreover, the older group displayed a significant correlation between the frequency of the McGurk effect and the unisensory response time difference. This indicates that the greater frequency of displaying the McGurk effect is associated with more delayed AO perception. These results are similar to both Sekiyama's results and the results of this study. In conclusion, the results from three studies all suggest that as age increases, people are more likely to display the McGurk effect because they rely on visuals more due to a decrease in hearing acuity. Another possible reason is younger people have a poor ability to read lips compared to older people. A third possibility is that there is simply less reliance on auditory input when older people process sensory stimuli compared to younger people.

## Conclusion

In conclusion, there was a correlation between age and frequency of the McGurk Effect. As age increases, there is a larger frequency of displaying the McGurk Effect. This may be due to an age-related decrease in hearing acuity. However, there are some possible limitations to this study. One is that almost 80% of the participants were adolescents, and only about 20% were over 20 years old. Despite this, the data still showed a significant difference due to age.

Besides this unevenly distributed age, those participants who were aged approximately 30 showed a higher frequency of displaying the McGurk Effect compared to participants that were aged approximately 20. No statistical analysis was done between those two age groups. But hearing acuity doesn't usually start to decrease around 30, which makes the reason that causes this difference unclear. In the study, only 9 incongruent stimuli were chosen to put in the survey. This limited number may not show a true difference between older people and young adults in displaying the McGurk Effect clearly. There was also no test for hearing and vision ability before the experiment, nor was there a question in the survey that asked about their hearing and vision ability. Future research should include a larger number of older participants, as well as standardize their hearing and visual ability.

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