INVESTIGATION OF THE EFFECT OF AGE ON SPEECH PERCEPTION BETWEEN AUDITION AND VISION (McGurk Effect)

Extended Essay (Biology)
Name of the Student: Ezgi Göksoy
Name of the Supervisor: Hatice Özmen
Word Count: 3905

Contents

Abstract

In case of an unnatural mismatch between the voice and mouth shapes of a speaker in a video, viewer perceives the sound based on mouth moves. By this way, perception of a voice different than the real one, occurs. This phenomenon, known as McGurk Effect, is one of the most well-known and distinctive illusions of human brain. Despite many investigations intended to, no research have clearly explained its mechanism.

There are two possibilities on how McGurk Effect develops and works: Either it is a secondary effect appearing as a result of a present function, or a result of a defect of human brain. In this investigation, it is aimed to determine which of these possibilities is valid. For this purpose, effect of age on speech perception between audition and vision (McGurk Effect) is investigated.

To determine the level of McGurk Effect a special video is prepared with digital montage. The mouth shapes of the speaker display “be-be”, whereas it has “de-de” sound. Later, the video was blurized in 10 steps. This final video was watched by 75 people from 5 different age groups. Each respondent was first shown the video with highest blur and was asked what he/she saw. Later, less blurized videos kept being shown until McGurk Effect appeared on the respondent. Blur level of video at which McGurk Effect occurred was accepted as the McGurk Level for the respondent.

As a result, as age increased, McGurk Effect occurred at less blurized videos. These findings were also statistically meaningful. It is interpreted that, McGurk Effect weakened with aging. To conclude, McGurk Illusion is a secondary effect of a mental function, rather than a flaw and declines with increasing age like other metabolic functions.

Introduction

I started thinking about preparing my extended essay on McGurk Effect first when I saw a documentary[1] about illusions and functions of brain on TV, at National Geographic channel. With the audiovisual they prepared by combining vision of an actress saying “ga” and voice of her saying “ba”, I was able to try it myself. As a result, I saw how interesting it is that you can hear the same words different when they are combined with different visions. The documentary explained it; “Our brain trusts what our eyes see and alters our other senses to accommodate.”

I found this quite interesting and made a research on it; McGurk Effect was first discovered by Harry McGurk and John MacDonald in 1976 and was explained on the report[2] they prepared as “…on being shown a film of a young woman's talking head, in which repeated utterances of the syllable [ba] had been dubbed on to lip movements for [ga], normal adults reported hearing [da]…”.

My further researches revealed that; acquiring knowledge has four steps: Reception, which takes place in receptor cells, delivers the stimuli as an action potential to sense organs where Sensation takes place. These information are later carried to brain where multiple sense organs interact and thus, illusions occur and this is called Perception phase. Cognition is high function of association of brain which compares gained knowledge with memory. While interpreting the information acquired from outside, our brain examines the sensations from sense organs and considers visual information to have more significance on our understanding than auditory information. Thus, voices we hear depend more on the vision of the speaker.

Despite there are many studies on McGurk Effect and how mental disorders affect it, there is neither certain idea on how age affects occurrence of this speech perception, nor a concluded investigation and an accepted thesis about this issue. This leaves me a big and empty area to work on.

One of the most important elements of a working McGurk Effect video is the syllables used. As far as known, a consonant followed by a distinctive vowel such as ‘a’ or ‘e’ is required to create the effect. Throughout the process of preparation of this extended essay, I will prepare

[1] National Geographic Series: Test Your Brain, Episode 2 – Perception (2011)

[2] McGurk, H., MacDonald J. (1976). Nature. Hearing Lips and Seeing Voices

a McGurk effect video of mine consisting of words of my language; for example “be-be”, “de-de” or “ne-ne”.[3] Then I will show the audiovisuals which are montaged to contain non-matching voice and vision, to people from different age groups and will see how much the effect of the illusion changes between age groups. As a result, my essay will mainly focus on this research question:

“How does McGurk Effect, which is observed in speech perception between audition and vision, alter with increasing age of humans?”

and explain the experimental process carried out and final data acquired, analyze and evaluate the results from the respondents (test subjects) and connect the outcomes to a conclusion and have a certain judgment on the effect of age.

[3] bebe (*bebek*): baby; dede: grandfather; nene (*nine*): grandmother in Turkish according to Turkish Language Association.

Hypothesis

McGurk Effect is observed when an audio of a syllable consisting of a consonant followed by a vowel is combined with the vision of another syllable being vocalized. The sound is heard as the one which is seen rather than heard; this situation can be explained by visual sensations having more priority than acoustic in the process of perception.

There are variable possibilities for the assumption of age's influence on this phenomenon;

- If McGurk Effect is a function or result of a secondary function of human brain, its operation rate will decrease with increasing age like other body mechanisms.
- If McGurk Effect is the proof of an error or defect on human brain which is an undesired circumstance, its abundance will increase or stay constant with increasing age.

As age increases, people's life experience increases; for example watching more dubbed films, thus getting used to ignoring the visual information acquired from the mouths of speakers, decreases the chances of being affected by McGurk Effect[4]. Or, as a result of sight problems developing with age, brain might be giving auditory senses more priority. In addition, it is a well-known fact that our brain chooses to trust our eyes when it needs to make a preference between sense organs. So, it wouldn't be wrong to assume McGurk Effect as a result of a function of brain which intrinsically aims to help the person to perceive more accurate. Thus, it can be hypothesized that as age increases, observation of McGurk Effect decreases.

[4] Boersma, P. (2006). A Constraint Based Explanation of the McGurk Effect

Method Development & Planning

A delicate work was needed on planning the most suitable method for experimental process to acquire some answers to given research question “How does McGurk Effect, which is observed in speech perception between audition and vision, alter with increasing age of humans?” and prove or refute the hypothesis, which was proposed. Preparation of a new McGurk Effect video was the most difficult part which needed the hardest and neatest work.

My mother C.G. is a middle-aged teacher. She has no abnormality in her face, her voice is microphonic and she has smooth intonation. Also, she is willing to contribute this study. Therefore, she was chosen as the video figure and voice source. 100 different videos of her, saying “be-be”, “de-de” and “ne-ne” was recorded. Among all, one appropriate video of each sound was chosen according to the criteria; optimum lighting, optimum distance, having no blinks or any other distractive components on speaker’s face -which might take respondent’s attention-, starting and finishing with closed lips –so that video can be repeated by joining from one’s end to other’s beginning- and correct stresses on each syllable.

After choosing and shaping videos into desired forms, next step was replacing sounds of different combinations of visions. After (2x3) 6 different combinations of audiovisuals being applied and tried (by combining the audio of one and video of the other with the help of computer programmes, following the same procedure explained more detailedly in Method part) following actions were taken; both the sound and vision of “ne-ne” videos were eliminated since shape of mouth while creating “ne” sound was very similar to “de”s and it was nearly impossible to recognize the distinction which resulted with McGurk Effect not occurring. On the other hand, it was sure that the sound of “be-be” was going to be used instead of “de-de”s, because sound “de” was so dominant that it was preventing visual of “be-be” being seen and not letting McGurk Effect occur. Finally the best couple is decided to be “de” vision with “be” sound.

When videos were all done, next question was how to perform the experimental process. First of all, changing resolution or definition of the images on the video and seeing at which level each age group could experience McGurk Effect was decided to be the easiest way to examine. Later, putting different numbers / patterns / thicknesses of obscure glasses in front of the screen on which the experiment will be performed was considered. Then, it turned out that it will cost more, might be distracting for the viewer and levels of sharpness would not

always be linearly distributed. Finally, it was concluded with the idea of adding blur via computer softwares would give the best results.

Another further problem was how to present the videos to the viewers. Preparing separate videos with different blur degrees was an alternative but was not practical, time-wasting and might cause boredom or distraction on respondents. Thus a video starting with “be-be” sound+vision and continuing with 10 “be-be” sound + “de-de” vision ranking between 100% and 0% blurred was prepared. So that, as soon as the vision gets clear enough to let McGurk Effect occur, video could be stopped which would save a lot of time for both respondent and researcher.

Furthermore, separation between two different videos are made to be 3 seconds to let respondents empty their minds or to get ready for the next video. Each piece of audiovisual is repeated 3 times in series to let them examine their hearings better.

For the experimental process, humans will be used as test subjects but it will not be illegal or against Human Rights since they will only be involved in watching a video and answering a single question of what they hear. For more accurate results and an easier researching process, it is decided to work with no respondents older than 70 years old since they may have hearing or sight problems. Also, as performing experiments on children (younger than 15) is unethical, our range has a lower limit of 16 years old.

To provide some standards, all respondents were made to read an informative writing beforehand. It was also important that, the new respondents were not informed about the content of experimental process by older contributors, while choosing them. Conditions for watching video were also tried to be kept constant. Intensity (bright enough to see but no direct light falling on the screen) and angle (from the top) of lighting was kept constant. Video was shown from a 10.1 inch monitor and distance between the monitor and respondent’s eye was standardized at optimum watching distance (50 cm) and it was made sure that respondents were comfortably seated. Resolution and brightness level of the monitor was kept constant throughout all the experiment. All respondents were asked to continue using glasses or contact lenses to correct their refractive errors if they were using them in daily life. All respondents used same headphones to listen the sounds at constant volume.

For the processes of video recording, editing and montage stated above, professional assistance and guidance was received from the Biophysics Department of Gülhane Military Medical Academy, Ankara, Turkey.

In case of wishing to watch the video which has been talked about, the link *https://www.youtube.com/watch?v=3vHoOmGT5yc* can be visited.

Material & Method

Materials & Devices:

1. Full HD Video Camera (1920x1080 pixels)
2. Tripod (with feet 1.5 m)
3. Portable PC (Windows Media Player installed) with 10.1 inch LCD monitor
4. PC with Intel® Core™ i5 operator (capable of running high-performance demanding programmes such as Ulead Media Studio Pro 8.0 and TMPGEnc Xpress 4.7)
5. Stereo Headphones

Recording Audiovisual Material:

After preparation of an area of homogenous lighting, an HD video camera was positioned on a 1.5 m length tripod, to record the image of the face and voice of C.G. who was sitting comfortably 50 cm away in front of the camera (Figure.1). C.G. was initially asked to repeatedly say “be-be” and 100 “be-be” videos were recorded. Later, the same process was repeated for “de-de”. The main reason for repeating each syllable separately 100 times was being able to acquire completely matched be-be and de-de videos.

Figure.1 sample moment at video recording.

Montaging & Editing Audiovisual Material:

Next step was to examine, edit and montage captured videos. For this purpose, Ulead Media Studio Pro 8.0 and TMPGEnc Xpress 4.7 softwares were utilized. First, the two videos matching each other the most was seeked among 100 be-be and 100 de-de recordings. 3 numerical criteria were determined and evaluated such as, duration of first be and de

syllables, time at which the second be and de syllable starts and duration of second be and de syllables. The 4th criterion was rather visual; initial position of model's lips at first syllable, being the same of the final position of them at the end of second syllable. 4th criterion especially had an importance at protection of natural qualities when videos would be montaged one after other. With the examination made taking these criteria into consideration, 46th be-be and 73rd de-de were found to be almost completely matching. Later, the extracted audio of be-be video is replaced with the original sound of de-de video. Two different videos both having 3 seconds duration are obtained at the end of editing and montage processes:

1st video (original be-be): be-be video having number 46. Mouth shapes and sound are matched.

2nd video (modified de-de): synthetic video obtained by combining image of 73rd de-de video with sound of 46th be-be video. Mouth shapes and sound are not matched.

As a part of the pre research made, the modified de-de video has been watched by 25 people each of different age groups and all respondents reported to hearing de-de when looking at the video and be-be when not looking. Succeeding in pre research was concluded that, the video prepared was quite efficient at creating a McGurk Effect.

Video prepared after the last step of editing contained 12 pieces some of which were blurized. (Blur algorithm was quite easy as Ulead Media Studio Pro 8.0 had a simple blur setting, in which only pattern [standard pattern in which the whole screen is blurized evenly and no variation is present, was used] and percentage of applied blur is set according to needs) This final video was used in data collection. Its fragments are explained below:

1st part: The aim of this piece of video is to inform the contributors about contents of the experiment before starting. It only contains original (unmontaged) be-be video. To strengthen the perception, video is repeated 3 times consecutively. With the help of 4th criteria stated above, a delusion occurs, making it look like the figure is repeating the phrase 3 times.

2nd part: Modified de-de video is blurized 100% (Figure.2) and repeated 3 times consecutively. Before and after this part, number 10 is seen on a black screen for a second to inform the researcher about at which blur level they are. With a 100% blurized image, it is aimed that none of the mouth movements of model being apparent, thus none of the respondents experiencing McGurk Effect.

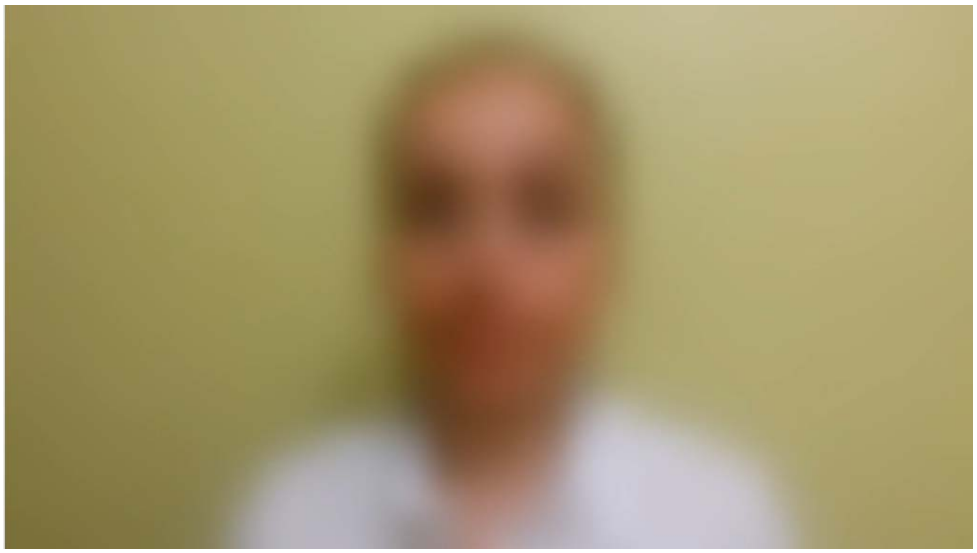


Figure.2 sample moment from 100% blurized video part.

Parts which are not explained individually here, distribute evenly with blur percentages decreasing 10 by 10 and numbers on the screen decreasing one by one. However, each screen can be viewed with explanations in **Appendix-I**.

11th part: Modified de-de video is blurized 10% (Figure.4) and repeated 3 times consecutively. Before and after this part, number 1 is seen on a black screen for a second.

Figure.4 sample moment from 10% blurized video part.

12th part: Modified de-de video which is not blurized. It is repeated 3 times consecutively. Before and after this part, number 00 is seen on a black screen for a second. Aim of this piece of video is to make all mouth moves of the model look clear without any blur, thus McGurk Effect to work on everybody.

Each part is (3 x 3) 9 seconds long. 1 second of black screen was put at transitions between parts. Finally, to provide more professional appearance, instead of the transition scenes appearing suddenly, transition effects were applied. As a result, a video of 3 minutes 34 seconds was obtained.

Data Collection:

The investigation was planned to be performed on voluntary test subjects. Age groups were determined considering statistical assessments which will be carried out after data collection. 1st group consisted of 10-19, 2nd of 20-29, 3rd of 30-39, 4th of 40-49 and 5th of people of above 50 years old. As they will be leaving childhood and entering adolescence, it is decided that first age group would exclude children below 16. Experiment was applied to 75 people in total (15 of each age group).

An informative writing in Turkish was prepared to be read by volunteers accepting to contribute the research. The Turkish to English translation of this writing can be seen at **Appendix-II**. To make sure every respondent had the same initial knowledge, all respondents are made to read that paper. After reading, video was shown to ones who decided to contribute the research.

The video consisting of 12 pieces, whose preparation was explained above, was shown to respondent on a 10.1 inches LCD monitor, from a 50 cm distance, under bright light not directly falling on screen. After watching each part, video was paused and he/she was asked what he/she was hearing. If he/she stated hearing be-be, video kept being shown and later paused again to ask what was heard this time. If transition answers such as “de-be” or “be-de” were acquired, process was continued to next steps until the respondent expresses hearing de-de. At this point video was stopped and the level at which McGurk Effect occurred (1-9) was denoted with personal information (name, age, gender).

Results

Table 1. Raw Data Table Illustrating All Respondents' Names, Ages, Genders and Level in Video at Which McGurk Effect was Observed

	RESPONDENT'S																			
	10-19				20-29				30-39				40-49				50+			
Number	Name*	Gender	Age	Result**	Name	Gender	Age	Result	Name	Gender	Age	Result	Name	Gender	Age	Result	Name	Gender	Age	Result
1	B.S.	F	17	5	N.S.	F	24	3	K.D.	M	32	3	K.A.	M	45	3	T.Ç.	M	53	2
2	Z.S.	F	17	5	G.E.	F	29	5	B.K.	F	31	5	Ş.K.	F	41	3	Z.O.	M	54	3
3	İ.Ü.	F	17	5	Ö.K.	F	29	6	B.C.	F	33	5	C.Ö.	F	41	5	R.A.	M	54	3
4	N.E.B.	M	17	5	Ç.O.	F	27	5	E.G.U.	F	37	2	S.D.	M	49	4	Y.Ş.	F	50	2
5	E.N.G.	F	17	5	S.K.	M	25	5	D.T.	F	38	5	M.Y.	M	49	5	S.K.	M	55	2
6	G.A.	F	17	6	Y.N.	M	26	4	M.G.Ş.	F	37	6	S.D.	M	49	4	O.A.	F	55	5
7	S.T.	F	17	5	H.S.	M	24	4	S.Ç.	F	37	4	B.Ö.	F	48	3	F.U.	F	53	3
8	İ.M.A.	M	16	5	C.K.	M	26	5	S.G.	F	36	3	M.C.	M	46	4	A.V.	M	56	3
9	C.T.	F	17	5	R.S.	M	29	3	M.K.	M	39	3	M.S.	M	44	2	H.K.	M	57	4
10	Y.E.	F	17	4	S.M.A.	M	21	4	T.M.	M	37	3	S.S.K.	M	40	3	N.Ş.	M	54	3
11	S.E.	F	17	6	Ç.C.	M	24	4	G.Ö.Ö.	M	37	3	F.F.	F	48	3	S.T.	M	51	3
12	İ.G.	F	17	7	U.Ö.	M	27	5	S.K.	M	35	5	İ.Z.	M	42	4	S.Y.A.	M	54	2
13	İ.A.	F	17	4	Ş.A.	M	29	4	G.K.	M	34	4	G.A.	F	45	4	K.S.	M	52	2
14	G.Ö.	F	17	7	C.D.	M	21	4	A.M.A.	M	32	5	H.D.	M	43	5	Ş.K.S.	M	57	2
15	İ.G.	F	16	5	S.M.	M	24	3	U.S.T.	M	36	3	Y.Ö.	M	46	2	S.C.	M	51	3

** . The initials of name and surname of participants are given to maintain their privacies.*

***. By 'result', the part of the video at which McGurk Effect is observed is meant and it will be referred as McGurk Level from now on.*

The respondents M.T. and N.K. who stated they were hearing be-be even at 12th part (with no blur) of the video were accepted as not experiencing McGurk Effect and excluded from the data.

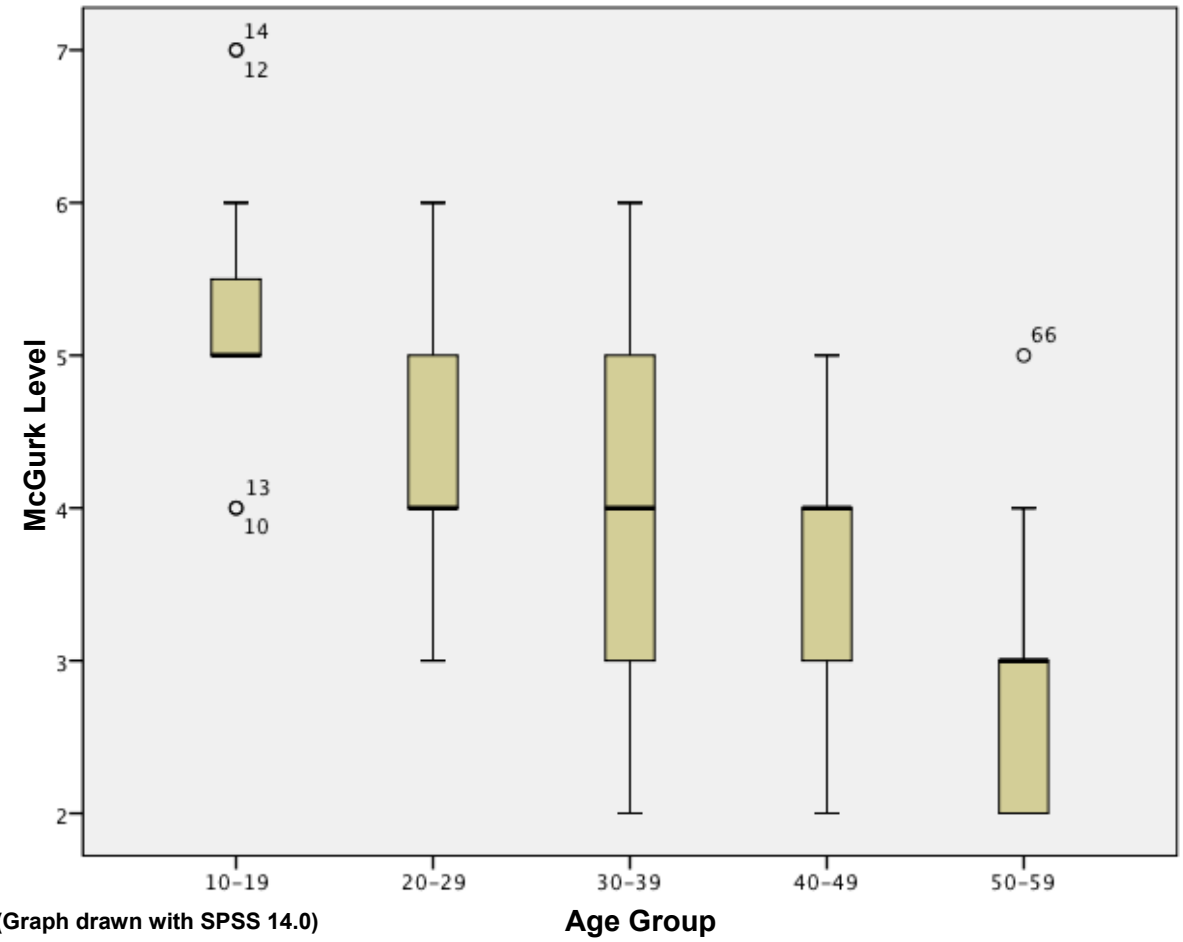
As McGurk level values are not mathematically continuous variables, the experimental results are expressed in form of median and min-max instead of arithmetical mean.

Data Analysis

Table 2. Processed Data Table Illustrating Averages Of Level In Video At Which McGurk Effect Was Observed At Each Age Group

		Averages Of McGurk Level		
		Median	**Minimum Value**	**Maximum Value**
Age Group	**10-19**	5	4	7
	20-29	4	3	6
	30-39	4	2	6
	40-49	4	2	5
	50+	3	2	5

Graph 1. Box and Whiskers Plot Showing The Distribution* Of McGurk Level Values Around Median



(Graph drawn with SPSS 14.0)

**. edge values which are excluded at the graph are marked with circles.*

To perform successful statistical evaluations, 15 in each age group and (15x5) 75 in total respondents was found to be adequate. It is determined to use ANOVA Test via the program SPSS 14.0 for statistical comparisons between age groups.

When the McGurk level values acquired from 5 different age groups were compared with the ANOVA Test, there is found to be a statistically significant difference between age groups as the p value was smaller than 0.05.
($F=13.27$, $p<0.001$).

To determine between which groups this difference is the most evident, post-hoc Least Significant Difference Test was performed. According to it, the McGurk Level values obtained from 10-19 age group significantly varies from each of the other groups. It is also the same for 50-59 age group; it is significantly different than all the other groups. The differences between the McGurk levels of 20-29, 30-39, 40-49 age groups are found to be statistically insignificant.

Table 3. Statistics Table Showing Anova Results Of Variables

	ANOVA				
	Sum of Squares	Degrees of Freedom (df)	Mean Square	F Distribution	Significance
Between Groups	49.147	4	12.287	13.273	<.001
Within Groups	64.800	70	.926		
Total	113.947	74			

When evaluated generally with the help of statistical results, outputs of the research can be summed up that; a decrease occurs when going from 10-19 to 20-29 age group, for the 3 following decades McGurk level value is in a condition of plateau and when passing to 50-59 age group it against shows a decreasing pattern.

Table 4. Statistics Table Showing the Significances of the Differences Between All Combinations of Two Age Groups, the Lower and Upper Bounds of Confidence Interval Showing the Reliability of Estimates and Mean Differences

Multiple Comparisons

				95% Confidence Interval (CI)	
Group I	**vs. Group J**	**Significance (p)**	**Mean Difference (I-J)**	**Lower Bound**	**Upper Bound**
10-19	20-29	.006	1.000*	.30	1.70
	30-39	<.001	1.333*	.63	2.03
	40-49	<.001	1.667*	.97	2.37
	50-59	<.001	2.467*	1.77	3.17
20-29	10-19	.006	-1.000*	-1.70	-.30
	30-39	.346	.333	-.37	1.03
	40-49	.062	.667	-.03	1.37
	50-59	<.001	1.467*	.77	2.17
30-39	10-19	<.001	-1.333*	-2.03	-.63
	20-29	.346	-.333	-1.03	.37
	40-49	.346	.333	-.37	1.03
	50-59	.002	1.133*	.43	1.83
40-49	10-19	<.001	-1.667*	-2.37	-.97
	20-29	.062	-.667	-1.37	.03
	30-39	.346	-.333	-1.03	.37
	50-59	.026	.800*	.10	1.50
50-59	10-19	<.001	-2.467*	-3.17	-1.77
	20-29	<.001	-1.467*	-2.17	-.77
	30-39	.002	-1.133*	-1.83	-.43
	40-49	.026	-.800*	-1.50	-.10

**. The mean difference is significant at the 0.05 level.*

For further information on mathematical relationship of McGurk Level with age groups and the distribution of results within and between groups, see the detailed table of case summaries of statistical calculations at **Appendix-III**.

Evaluation

In this neurophysiologic research, at which some answers to research question “How does McGurk Effect, which is observed in speech perception between audition and vision, alter with increasing age of humans?” was seeked. Finally, the hypothesis; as age increases, rate of experiencing McGurk Effect decreases, was proven to be true.

Data acquired for level of McGurk Effect being experienced shows a decreasing pattern with increasing age. When plotted, the McGurk Level vs. age group graph has the pattern of decreasing-pausing-decreasing again. The graph having no shape of increase is also an evidence for the consistency of experimental results. Statistical procedures carried out also demonstrate that, youngest and oldest age groups tested ([10-19] and [50-59] respectively) are significantly different when compared with each of the other groups (as $p<0.005$).

On the other hand, it is impossible to claim that age groups formed at this study and distribution of individuals that the groups consist of are sophisticated enough. For this reason, despite there was found to be a significant decrease when passing from 10-19 age group to the higher decades, there is no chance of reliably examining it having a plateau phase and later decreasing again. However, it is still possible to make generalizations relying on the findings of this study: McGurk Effect’s occurrence decreases with age.

It is clear that the result that will be acquired, would be more trustworthy if the study was carried out again with narrower age groups in which individuals show a homogenous distribution. This might also help to determine the possible changes occurring at 3 consecutive decades which formed plateau in the current study. Additionally, applying the same procedure to developing children (after gathering the required ethical approval), may help acquiring further knowledge on developmental processes of human brain.

Furthermore, there were some other factors which were causing errors and was difficult to eliminate. First of all, application of an experimental process had a great impact on respondents. As they were expecting some kind of illusion to take place, McGurk Effect experiencing rates also increased greatly[5]. This factor was almost impossible to eliminate as the respondents had to be conscious to contribute to the study. However, as all age groups

[5] Mindmann, S. (2004). Journal of Memory and Language. Effects Of Sentence Context And Expectation On The McGurk Illusion

would have some expectance, it may not have an impact on the comparison between age groups.

Secondly, it is known that McGurk Effect's efficiency depends on listener's mother tongue[6] and whether he/she is bilingual[7]. As school, where the most of the experiment took place, consists of many people with knowledge of multiple languages, it was impossible to seek unilinguals. Excluding only the people who were born into multiple languages was found to be enough.

Respondent's familiarity to the speaker on the video results with a decrease in strength of McGurk Effect[8]. Since most of the respondents was chosen from my acquaintances, it was made sure that none of them knew my mother C.G. before.

Although females are more susceptible to McGurk Effect than males are[9], the role that gender plays at its observation was neglected to create a more diverse research group.

If all these factors were controlled more delicately, results acquired would have been more accurate.

[6] Sekiyama, K., Tohkura, Y. (1991). Journal of Acoustical Society of America. McGurk Effect In Non-English Listeners

[7] Sekiyama, K., Burnham, D. (2008). Developmental Science. Impact of Language On Development Of Auditory-Visual Speech Perception.

[8] Walker, S., Bruce, V., O'Malley, C. (1995). Perception and Psychophysics. Facial Identity and Facial Speech Processing: Familiar Faces and Voices In The McGurk Effect

[9] Irwin, J.R, Whalen, D.H., Fowler, C.A. (2006). Perception and Psychophysics. A Sex Difference In Visual Influence On Heard Speech

Conclusion

My reason for choosing this subject to work on is, our brain is full of interesting illusions and functions most of which haven't been discovered yet. And this endless universe of capabilities offers researchers a wide area to study on. My investigation was on McGurk Effect, which is one of these properties of human brain.

The occurrence of McGurk Effect at higher blur levels, shows an increase in the level at which the McGurk Effect observed. So, McGurk level value and the activity of McGurk Effect on an individual is directly proportional. The result can be generalized that, activity of McGurk Effect decreases with increasing age.

A possible anti-thesis could also be proposed: With increasing age, loss of visionary functions occurs anyhow. And this might cause a decrease in McGurk Level at this investigation. But this condition does not seem to be valid; as cataract, which is the most possible visionary problem to cause any difference in McGurk Level, form after age 60 and becomes evident after 70. According to literature, there is no significant difference in the visionary functions between test subjects of this experiment.

So, what does the decrease of activity of McGurk Effect with increasing age mean? It is a well-known fact that brain functions start to regress from the beginning of 20s. In this condition, there rises a chance to express McGurk Effect as a secondary result of a mental function. As stated in the hypothesis, as these functions regress, McGurk activity also weaken.

The results present indicate that McGurk Effect is actually the outcome of some brain function. Which function can be responsible for McGurk Effect? Although there are several hypothesis in medical literature aiming to explain McGurk Effect, none of them have truly clarified the main mechanism.[10] However, it is almost sure that McGurk Effect is caused by connections responsible for communication and interaction between different locations of brain.[11/12] The signals originated from visionary sense, omit the ones from auditory sense at perception process.

[10] Nath A.R., Beauchamp M.S. (2012). Neuroimage. A Neural Basis For Interindividual Differences In The McGurk Effect, A Multisensory Speech Illusion

[11] Szycik G.R., Stadler J., Tempelmann C., Münte T.F. (2012). Frontiers In Human Neuroscience. Examining The McGurk Illusion Using High-Field 7 Tesla Functional MRI

Connections responsible for communication and interaction between different centers of human brain are called “intermodal (cross-modal) pathways”.[13] Although they might cause inhibition or excitation on aimed region, most of them show inhibitory characteristics. This means, an activation sourced at a region can travel along with intermodal pathways and cause an inhibition at another region. It is highly possible that, an intermodal pathway constructed to carry signals from visionary to auditory sense is responsible for McGurk Effect.

As McGurk Effect is the result of a function rather than defect, it is expected to have a mission. In daily life, adaptation to sounds that are considered as noise is developed and they are omitted by the brain. An animal concentrated at its prey or a possible danger, is expected to omit any irrelevant sound, in wild life. Similarly, a person concentrated on something is mostly isolated from other inputs. Considering that brain has the ability of perceiving sounds that are not likely to be originated from the object at which it is concentrated; it is not surprising that it omits, even corrects a sound which is irrelevant to the mouth moves of a speaker, that it is focused on.

As a conclusion, based on the findings of this study, it is possible to claim that: The mechanism which helps to omit noises when in a condition of visionary concentration, might be causing McGurk Effect by neglecting a noise not adjusted with the mouth moves of a carefully watched speaker. As age increases, this inhibitory mechanism also gets weaker along with the whole brain. Thus, McGurk Effect strength decreases.

As stated, there are numerous new study opportunities on brain. Blur algorithm used on the method could be considered as a visual distracter. Another study about auditory distracters could be carried out. A research about the influence of irrelevant noises’ presence or variation of sound’s intensity, on McGurk Effect susceptibility at different age groups would also be quite interesting.

---

[12] Beauchamp M.S., Nath A.R., Pasalar S. (2010). The Journal of Neuroscience. fMRI-Guided Transcranial Magnetic Stimulation Reveals That The Superior Temporal Sulcus Is a Cortical Locus of The McGurk Effect

[13] Gontier E., Hasuo E., Mitsudo T., Grondin S. (2013). PLoS One. EEG Investigations of Duration Discrimination: The Intermodal Effect Is Induced By An Attentional Bias.

Appendix-I

The middle steps which were skipped at the Material & Method are given here with brief explanations and sample images.

3rd part: Modified de-de video is blurized 90% (Figure.5) and repeated 3 times consecutively. Before and after this part, number 9 is seen on a black screen for a second.

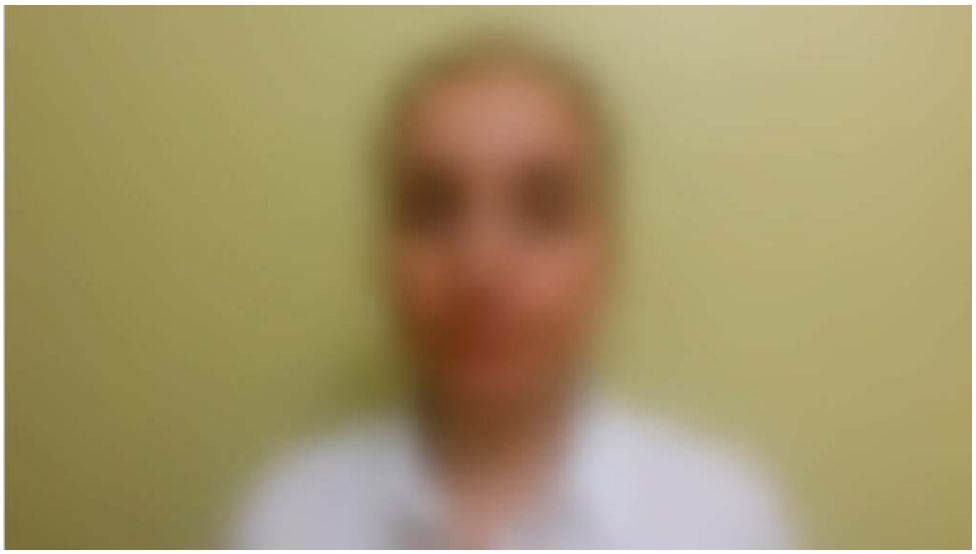


Figure.5 sample moment from 90% blurized video part.

4th part: Modified de-de video is blurized 80% (Figure.6) and repeated 3 times consecutively. Before and after this part, number 8 is seen on a black screen for a second.

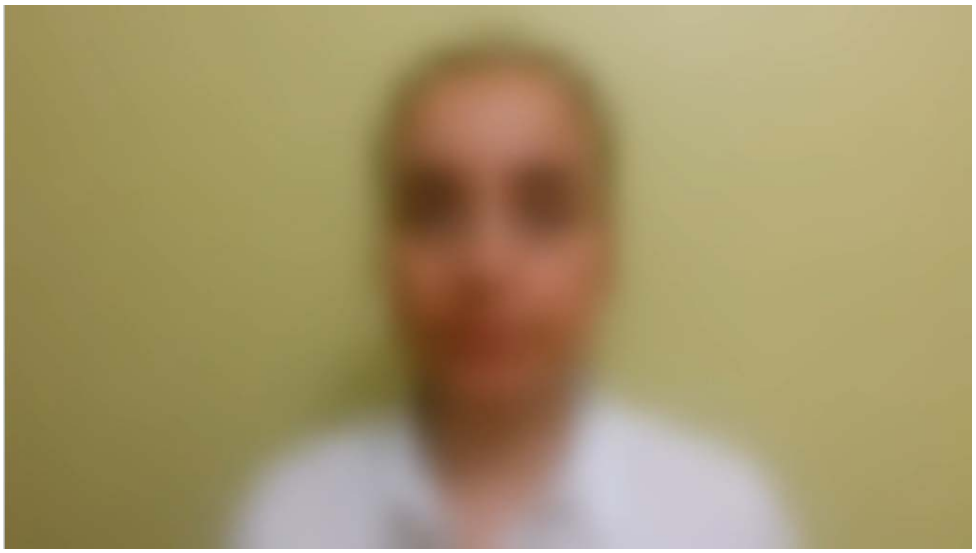


Figure.6 sample moment from 80% blurized video part.

5th part: Modified de-de video is blurized 70% (Figure.7) and repeated 3 times consecutively. Before and after this part, number 7 is seen on a black screen for a second.

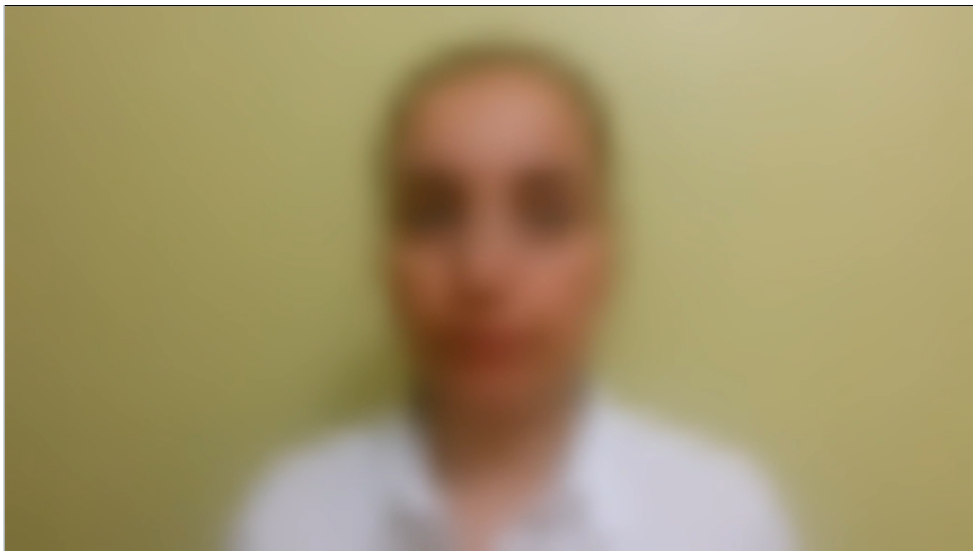


Figure.7 sample moment from 70% blurized video part.

6th part: Modified de-de video is blurized 60% (Figure.8) and repeated 3 times consecutively. Before and after this part, number 6 is seen on a black screen for a second.

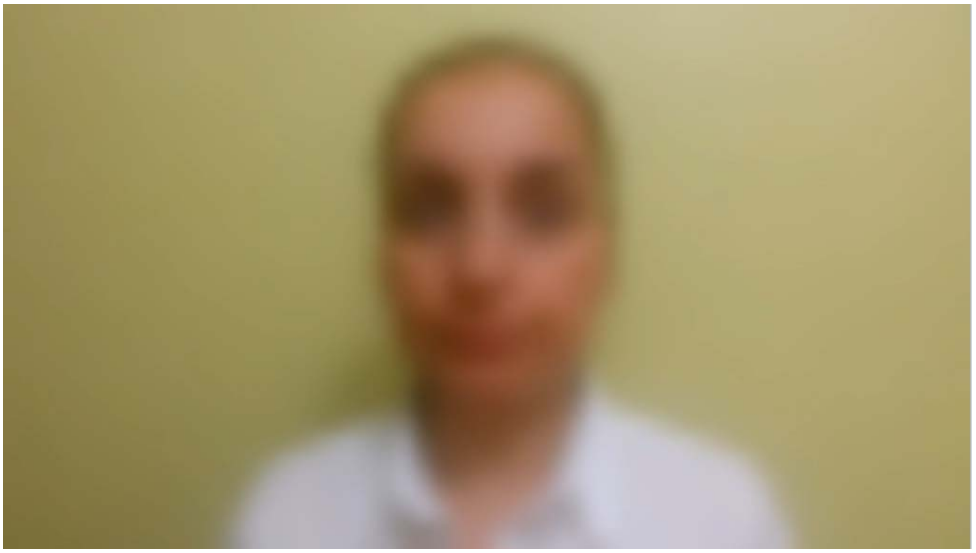


Figure.8 sample moment from 60% blurized video part.

7th part: Modified de-de video is blurized 50% (Figure.9) and repeated 3 times consecutively. Before and after this part, number 5 is seen on a black screen for a second.

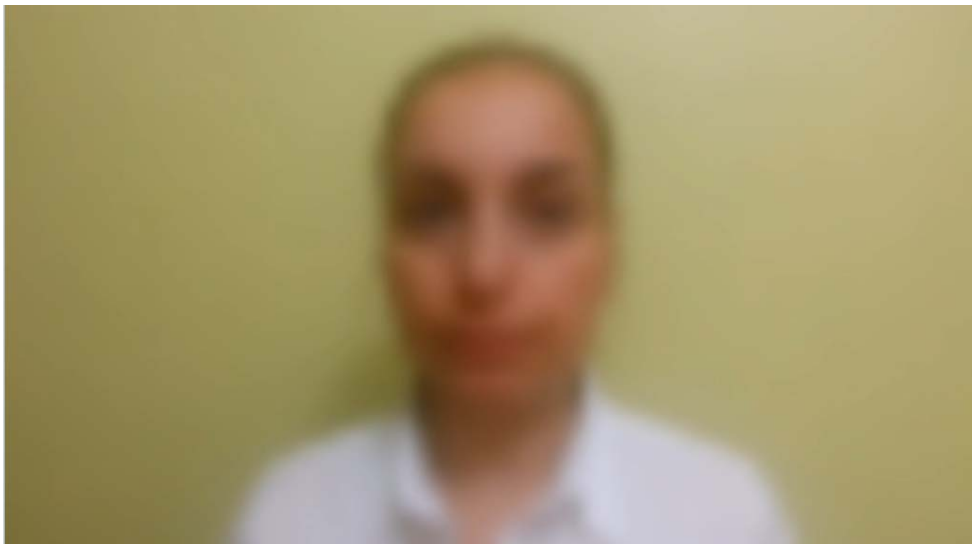


Figure.9 sample moment from 50% blurized video part.

8th part: Modified de-de video is blurized 40% (Figure.10) and repeated 3 times consecutively. Before and after this part, number 4 is seen on a black screen for a second.

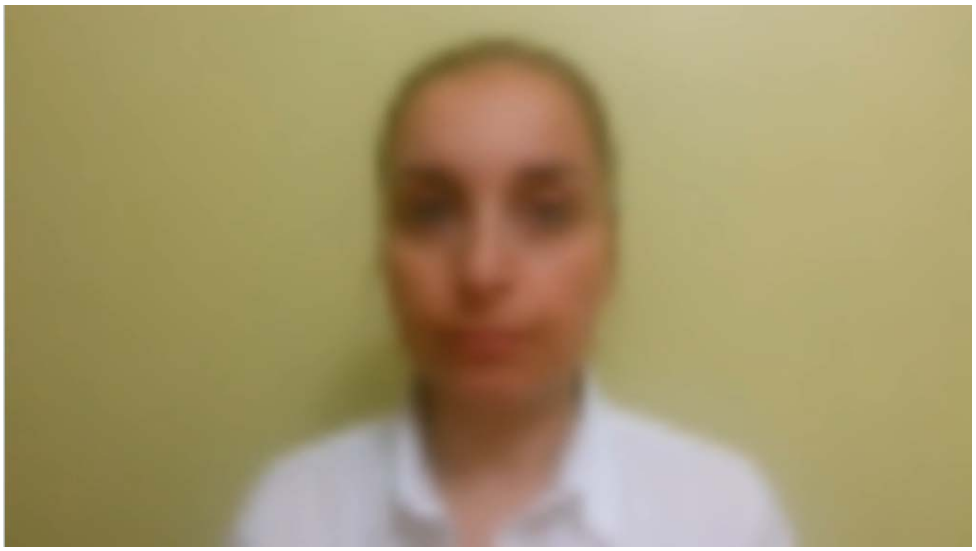


Figure.10 sample moment from 40% blurized video part.

9th part: Modified de-de video is blurized 30% (Figure.11) and repeated 3 times consecutively. Before and after this part, number 3 is seen on a black screen for a second.

Figure.11 sample moment from 30% blurized video part.

10th part: Modified de-de video is blurized 20% (Figure.12) and repeated 3 times consecutively. Before and after this part, number 2 is seen on a black screen for a second.

Figure.12 sample moment from 20% blurized video part.

Appendix-II

The informative writing in Turkish which is read by volunteers accepting to contribute the research. It is aimed to help the respondents acknowledge the conditions of the experimental process. The Turkish to English translation of this writing is given in the following:

Dear Participant,

With this research, to which you can contribute, the activity of visionary sense in hearing a voice is investigated. For this purpose, you will be shown a video. The experimental process consist of only watching this auditory video and responding to questions which you are asked. The video which is going to be shown, contains nothing other than an image of a human face vocalizing some simple syllables and has no disturbing content. No other application or request is going to be made after that. Even if you decide to contribute the research, you will still have the right to drop the experiment. After the process, only your name-surname, age and gender is going to be asked, no other demographic information is going to be demanded.

The video, which is going to be shown if you accept to contribute the research, consists of 12 short video pieces, each having 10 seconds duration. In each part, the same syllable is going to be repeated 3 times. At the end of each part, the video is going to be paused and you will be asked of your hearings.

As expressed in the beginning, in the process of perception of a voice heard, audition and vision work together and even artificial changes made on the vision causes changes to occur in the properties of perceived sound. Thus, in the perception of especially human voices, mouth moves have such big significance. To contribute this investigation with maximum efficiency, it is very important to pay attention to both mouth moves and sound.

Thanks in advice for your attention and contribution.

Ezgi GÖKSOY

Appendix-III

Table 5. Table Illustrating Further Statistical Calculations Based on the Findings of the Experiment

Age Group	Case Summaries*		McGurk Level
10-19	1		5
	2		5
	3		5
	4		5
	5		5
	6		6
	7		5
	8		5
	9		5
	10		4
	11		6
	12		7
	13		4
	14		7
	15		5
	Total	Mean	5.27
		Median	5.00
		Std. Error of Mean	.228
		Minimum	4
		Maximum	7
		Std. Deviation	.884

Age Group	Case Summaries*		McGurk Level
20-29	1		3
	2		5
	3		6
	4		5
	5		5
	6		4
	7		4
	8		5
	9		3
	10		4
	11		4
	12		5
	13		4
	14		4
	15		3
	Total	Mean	4.27
		Median	4.00
		Std. Error of Mean	.228
		Minimum	3
		Maximum	6
		Std. Deviation	.884

Age Group	Case Summaries*		McGurk Level
30-39	1		3
	2		5
	3		5
	4		2
	5		5
	6		6
	7		4
	8		3
	9		3
	10		3
	11		3
	12		5
	13		4
	14		5
	15		3
	Total	Mean	3.93
		Median	4.00
		Std. Error of Mean	.300
		Minimum	2
		Maximum	6
		Std. Deviation	1.163

Age Group	Case Summaries*		McGurk Level
40-49	1		3
	2		3
	3		5
	4		4
	5		5
	6		4
	7		3
	8		4
	9		2
	10		3
	11		3
	12		4
	13		4
	14		5
	15		2
	Total	Mean	3.60
		Median	4.00
		Std. Error of Mean	.254
		Minimum	2
		Maximum	5
		Std. Deviation	.986

Age Group	Case Summaries*		McGurk Level
50-59	1		2
	2		3
	3		3
	4		2
	5		2
	6		5
	7		3
	8		3
	9		4
	10		3
	11		3
	12		2
	13		2
	14		2
	15		3
	Total	Mean	2.80
		Median	3.00
		Std. Error of Mean	.223
		Minimum	2
		Maximum	5
		Std. Deviation	.862

	Case Summaries*	McGurk Level
Total	Mean	3.97
	Median	4.00
	Std. Error of Mean	.143
	Minimum	2
	Maximum	7
	Std. Deviation	1.241

**. Limited to first 100 cases.*

Bibliography

McGurk, H., MacDonald J. (1976). “Hearing Lips and Seeing Voices.” *Nature.* Vol.264, p:746-748.

Boersma, P. (2006). “A Constraint Based Explanation of the McGurk Effect.”

Mindmann, S. (2004). “Effects Of Sentence Context And Expectation On The McGurk Illusion.” *Journal of Memory and Language.* Vol.50(2), p:212-230.

Sekiyama, K., Tohkura, Y. (1991). “McGurk Effect In Non-English Listeners.” *Journal of Acoustical Society of America.* Vol.90(1), p:1797-1805.

Sekiyama, K., Burnham, D. (2008). “Impact of Language On Development Of Auditory-Visual Speech Perception.” *Developmental Science.* Vol.11(2), p:306-320.

Walker, S., Bruce, V., O’Malley, C. (1995). “Facial Identity and Facial Speech Processing: “Familiar Faces and Voices In The McGurk Effect.” *Perception and Psychophysics*. Vol.57(8), p: 1124-1133.

Irwin, J.R, Whalen, D.H., Fowler, C.A. (2006). “A Sex Difference In Visual Influence On Heard Speech.” *Perception and Psychophysics*. Vol.68(4), p: 582-592.

Nath A.R., Beauchamp M.S. (2012). “A Neural Basis For Interindividual Differences In The McGurk Effect, A Multisensory Speech Illusion.” *Neuroimage.* Vol.59(1), p:781-787.

Szycik G.R., Stadler J., Tempelmann C., Münte T.F. (2012). **“**Examining The McGurk Illusion Using High-Field 7 Tesla Functional MRI.” *Frontiers In Human Neuroscience.* Vol.6, No.95. (eCollection)

Beauchamp M.S., Nath A.R., Pasalar S. (2010). “fMRI-Guided Transcranial Magnetic Stimulation Reveals That The Superior Temporal Sulcus Is a Cortical Locus of The McGurk Effect.” *The Journal of Neuroscience*. Vol.30(7), p:2414-2417.

Gontier E., Hasuo E., Mitsudo T., Grondin S. (2013). “EEG Investigations of Duration Discrimination: The Intermodal Effect Is Induced By An Attentional Bias.” *PLoS One*. Vol.8(8):e74073. (published electronically)