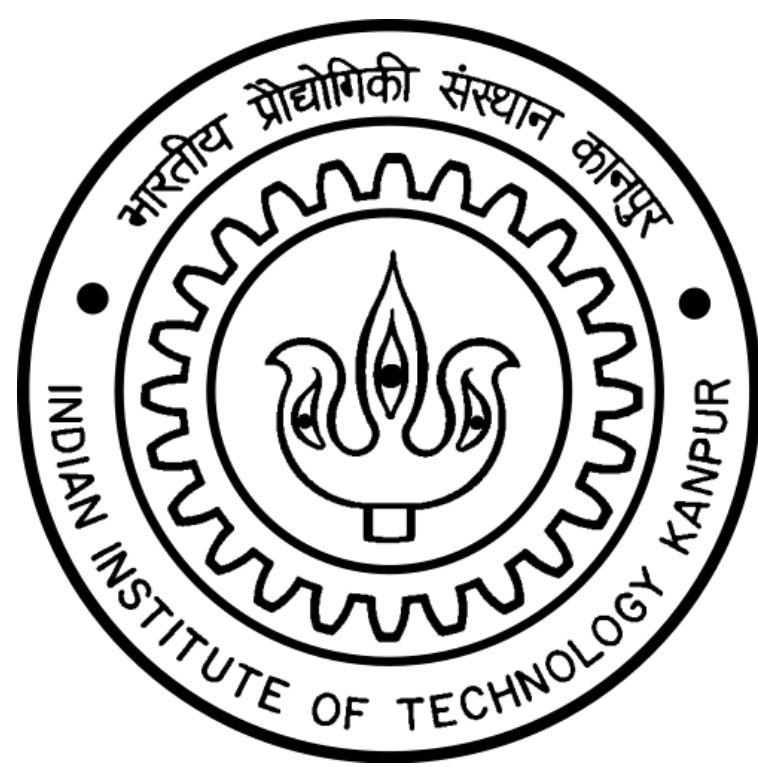




# Phonotactic Constraints in McGurk Effect

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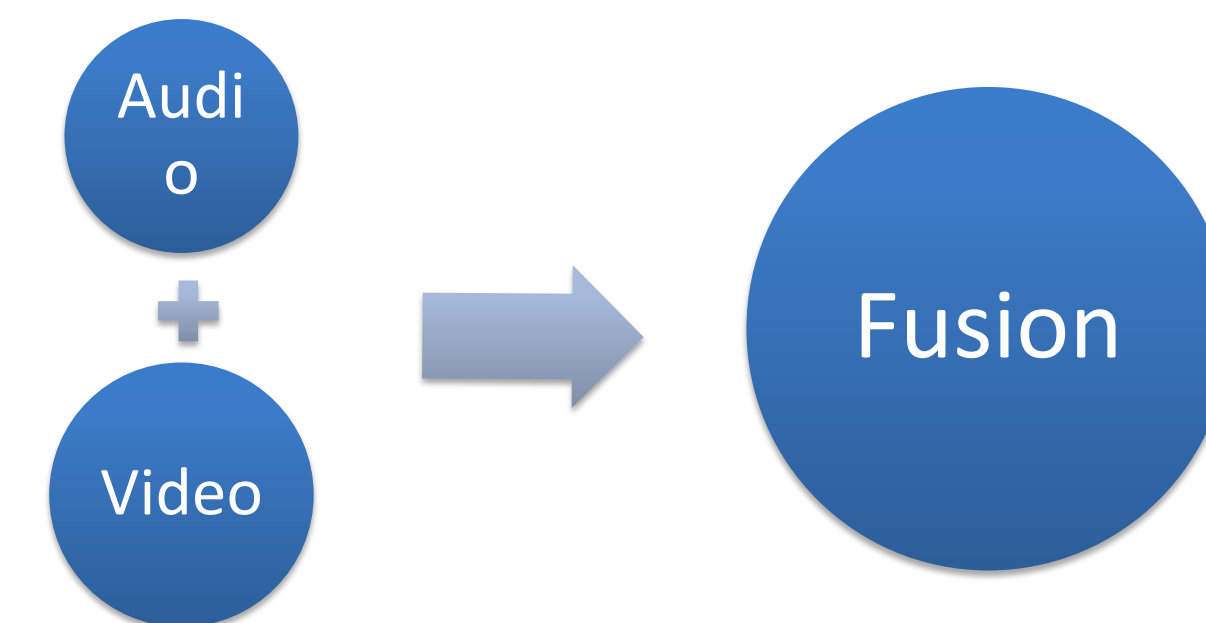
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## ABSTRACT

McGurk Effect demonstrates an interaction between audio and visual sensory inputs and how an incongruency between the two can lead to a completely new percept. Since this audio-visual fusion takes place unconsciously, we use it to verify how Phonotactics is unconsciously used during speech processing. An experiment was carried out, where the subjects were presented with meaningless words containing McGurk effect. Phonotactic constraints in English language were used to classify the effect as either legal or illegal depending upon the resultant fusion. Results show that the strength of McGurk effect was significantly influenced by these constraints. While there was a strong effect in words where the fusion was legal, the effect was significantly suppressed in cases where the fusion was illegal. This also proves that McGurk Effect is not completely autonomous and is altered by cognitive intervention

## INTRODUCTION

McGurk effect was discovered by McGurk and Macdonald in 1976<sup>[1]</sup>. The effect occurs when the auditory component of one sound is paired with the visual component of another sound, leading to the perception of a third sound. This establishes that speech perception is not at all an auditory phenomenon but an audio-visual phenomenon.



Experiments have been conducted to study the influence of other cognitive processes. Windmann discovered that sentence context affected the McGurk illusion in German language<sup>[2]</sup>. Azra N. Ali gave similar results for sentences in English<sup>[3]</sup>.

Through this work, we study the influence of Phonotactic constraints on McGurk effect. Phonotactics is the branch of phonology that deals with restrictions on the permissible combinations of phonemes. For our work, we use the constraints in English language.

In the present study, an experiment is carried out where an English speaking subject is presented with meaningless words. Phonotactic constraints are used to classify the effect as either legal or illegal depending upon the resultant fusion. If the results show a marked difference in the strength of the effect, it would suggest that fusion is not robust to cognitive intervention. It will further verify the fact that humans unconsciously use phonotactic constraints during speech perception, even though they pertain to meaningless units<sup>[4]</sup>.

## METHOD

### STIMULI

Audio-video stimuli consisted of English syllables /pa/ and /ka/ respectively, embedded in arbitrary words. All these words were meaningless.



Similar results were expected when they were embedded in different words.



A speaker producing the required audio and video stimuli was filmed using an HD camera. The audio tracks were then dubbed with the required video tracks to introduce the McGurk effect.

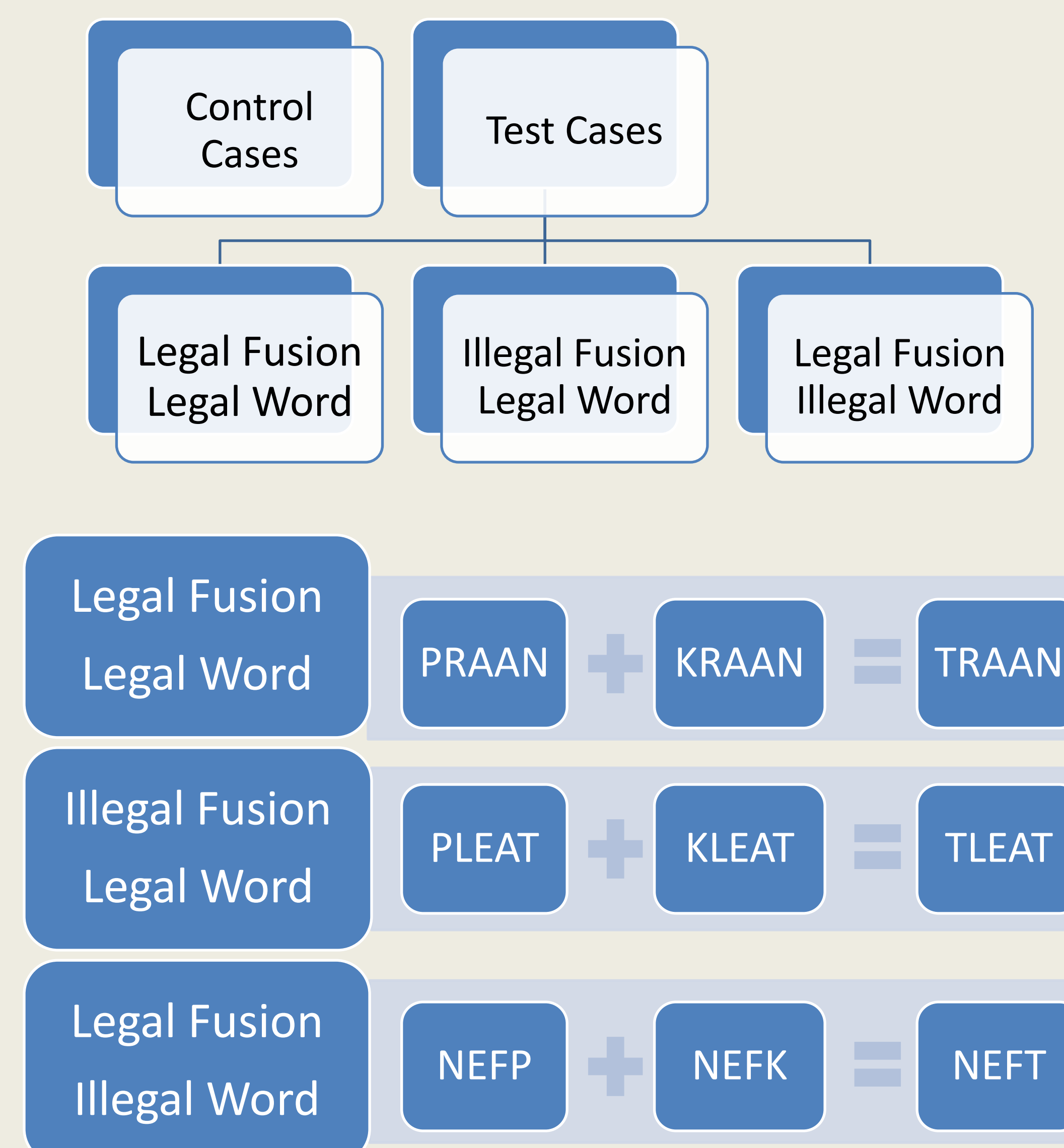
### PROCEDURE

The experiment involved 30 English speaking subjects with normal hearing and vision. The subjects were tested individually. They were made to watch a video sequence of about 50 sec duration and instructed to report the word immediately after they heard it.

The video was of high quality, with a frame size of 1920\*1080 played on a standard Laptop screen with external speakers

## DESIGN

21 words were created at random to introduce the McGurk effect. Out of these 21 words, 6 words were coherent; i.e. the audio and the video stimuli corresponded to the same utterance. These constituted the control cases. These words did not have any McGurk effect and were included to ensure that the subject was reporting the accurate perception. Rest of the words were the test cases where the stimuli was incoherent; i.e. different audio and video tracks were dubbed together to introduce the effect.



## RESULTS

The probability of McGurk effect was determined by counting the relative number of times that subjects gave the expected fusion response. This probability was then normalized by the probability with which subjects reported the correct word in the control cases. This probability was calculated for the three test cases.

Results show that a strong McGurk effect exists in the chosen words, with a probability of **80.4%**.

**Table 1** presents the difference between the mean values of the probability of the effect in the three test cases.

| Cases                      | Mean  | Standard Deviation |
|----------------------------|-------|--------------------|
| Legal Fusion Legal Words   | 0.804 | 0.09               |
| Legal Fusion Illegal Words | 0.850 | 0.10               |
| Illegal Fusion Legal Words | 0.428 | 0.24               |

## DISCUSSION

The data suggests that there is no marked difference in the strength of the McGurk effect, when the spoken words are illegal compared to the neutral case, where all the words are legal. However there is a marked difference in the case when the fused word is illegal as the McGurk effect gets significantly suppressed. On computing the one way ANOVA of the three test cases, we get **F(2,57) = 42.48; p<0.001**. This again indicates a marked difference between the three test cases. Therefore the results show that Phonotactic constraints can significantly alter the strength of the McGurk Effect; especially suppressing it when the fused word is illegal.

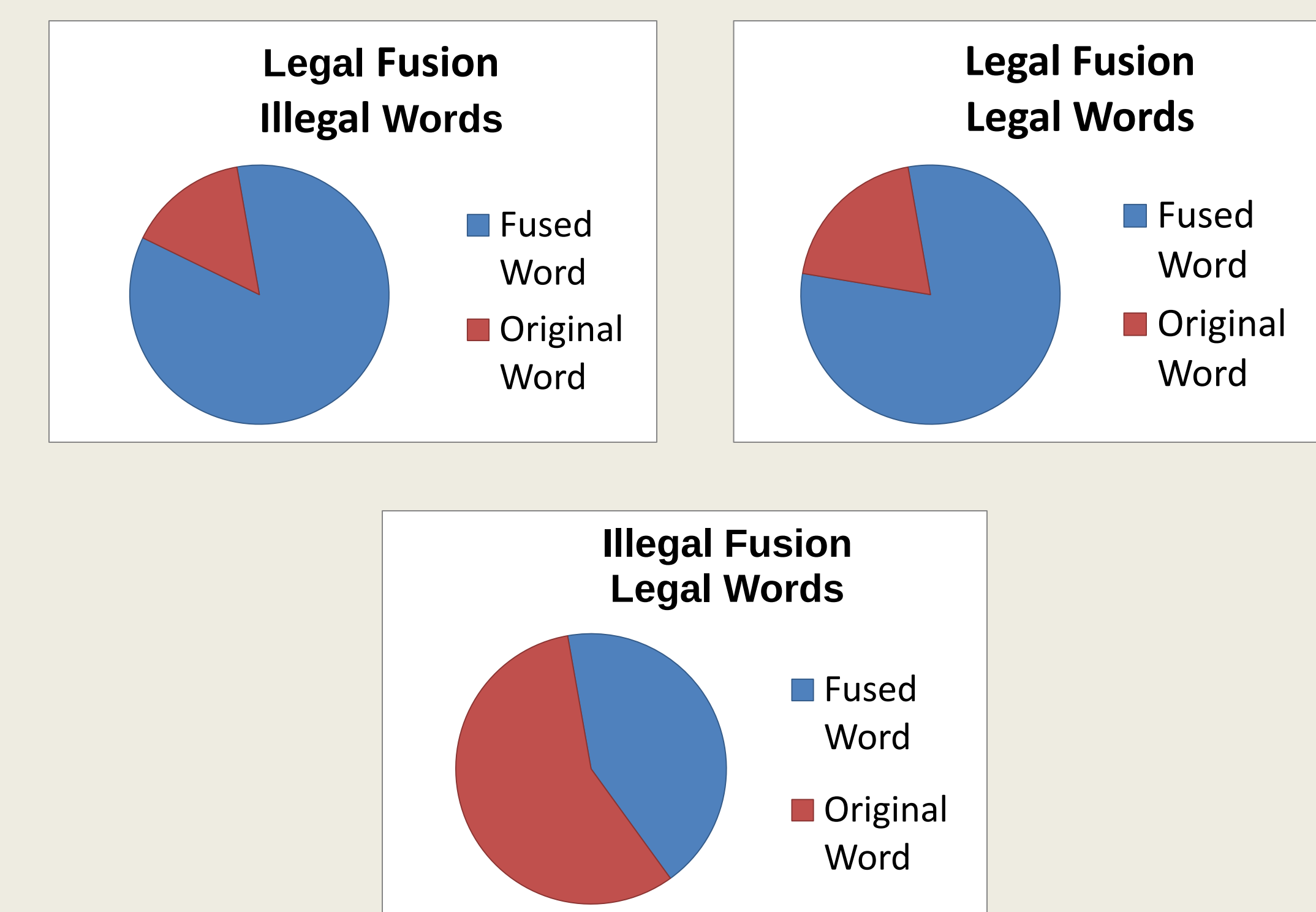


Figure 1. Individual statistics for the three cases

## CONCLUSIONS

From the results, we can clearly see that phonotactic constraints influence the speech perception in McGurk effect. This also verifies the fact that phonotactics is actively used by humans during online speech processing

## ACKNOWLEDGEMENT

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