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TRABAJO DE FIN DE GRADO

**SUPRASEGMENTAL INSCRIPTION OF EMOTIONS: AROUSAL, POLARITY AND DURATION**

Ana Esteban Puebla

Tutor: Enrique Cámara Arenas

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**Abstract**

This study aims to ascertain whether there is a correlation between the emotion associated with a verbal expression and its duration. In particular, it focuses on the effect that two factors associated with emotions have on the variability of duration. These are: polarity, i.e. the positivity or negativity of emotions; and the arousal or state of physical activation that emotions entail.

An experiment was carried out, in which native English speakers were asked to pronounce a series of sentences that were associated with different emotions. The average of the durations per emotion was collected and statistically analyzed through an ANOVA test. The results reveal that the influence of polarity and arousal cannot be observed individually, as they work in conjunction. This is because the effect that the arousal produces in the duration depends on the polarity of the emotion that the sentence carries.

**Resumen**

El objetivo de este estudio es averiguar si existe una correlación entre la emoción asociada a una expresión verbal y su duración. En particular, se centra en el efecto que dos factores asociados con las emociones tienen sobre la variabilidad de la duración. Estos son: la polaridad, es decir, la positividad o negatividad de las emociones; y el arousal o estado de activación física que las emociones implican.

Se realizó un experimento en el que se pidió a hablantes nativos de inglés que pronunciaran una serie de frases asociadas a diferentes emociones. Se recogió el promedio de las duraciones por emoción y se analizó estadísticamente a través de un test ANOVA. Los resultados revelan que la influencia de la polaridad y el arousal no se puede observar de forma individual, ya que trabajan de forma conjunta. Esto se debe a que el efecto que el arousal produce en la duración depende de la polaridad de la emoción que la frase lleva.

Keywords: *phonetics, prosody, emotions, arousal, polarity, duration.*

Palabras clave: *fonética, prosodia, emociones, arousal, polaridad, duración.*

Universidad de Valladolid                                            Ana Esteban Puebla

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## 1. Introduction

Human speech is one of the most important systems of communication between individuals since it is the characteristic that differentiates us as a species. Our speech carries linguistic information, that is basic for our communication, but remaining with this single image would be a rather poor vision of all that our speech is capable of accommodating. When we speak, we reflect our attitude, our feelings and emotions. These elements leave an imprint on the suprasegmental level of our speech, through which listeners are able to make assumptions and infer the emotional state of the speaker. Many scholars have investigated this process of inference (Banse & Scherer, 1996, Mozzinocacci, 1998, Scherer, 1981, etc.) and have shown that individuals are capable of recognizing emotions behind someone's utterances (Gustafson-Capková 1).

When a person is speaking we usually realize when the tone is rising or falling, or when specific phonemes are remarked in order to catch the listeners' attention. All of these aspects get inscribed in the acoustic and suprasegmental level of speech, and they give essential nuances to the meaning of words and sentences. Besides, this suprasegmental level has been specifically studied in connection with emotions and their expression through speech. Traditionally, emotions have been classified depending on their polarity, which is defined as a binary classification into positive or negative. However, these emotions are usually accompanied by a physical state, as agitation appears with anger. This may also suggest that there is some sort of physical activation or arousal, affecting our expression of emotions, as we tend to speak differently when we are excited and when we are not. These aspects are also reflected in some way in the prosodic level of speech, and they make possible the recognition of emotions. This capability to identify different emotions through someone's speech suggests that the vocal expression of emotions is patterned (Banse & Scherer 615). Therefore, does this mean that we know, for example, when someone is happy because of her or his fast speech? Do we really tend to speak faster when we are happy? Or slower when we are sad? Or does it have to do with how physically activated we are?

There is extensive research on how prosodic features of speech represent or are affected by emotional states, mostly regarding intonation. The feature of duration has not been studied as much, and so we hardly find any studies specifically dedicated to it. This

study focuses on duration in connection with the inscription of emotions in the suprasegmental level of speech. The importance of this study is not only that it focuses on a feature that has not received proper attention, but also that it investigates the effect of two characteristics of emotions that have not been studied together. These are polarity and arousal. For this purpose, an experiment was carried out, in which native English speakers were asked to pronounce a number of sentences associated with different emotions.

In previous research on the expression of emotions through speech, it has been observed that emotions such as happiness often lead to fast speech, while emotions such as sadness lead to the opposite. Considering those results, two starting hypotheses were assumed. The first is that duration correlates with the polarity of emotions, more specifically short duration correlates with positive polarity. That is to say that positive emotions are delivered faster and because of that the duration of the speech is short. The second hypothesis is that duration correlates with arousal. In particular, short duration correlates with high arousal. The greater the arousal, the faster the speech and the shorter the duration.

## 2. Theoretical Framework

Phonetics and phonology distinguish between two dimensions or levels of speech, which are the segmental and the suprasegmental. The segmental level includes small units or segments, such as phonemes and syllables, that can be analyzed in their own or combined to form longer sequences of sound. A segment, also referred to as a phoneme (Sawaengmongkon 571), is the smallest linguistic unit that cannot be divided into smaller units and that produces sound. When the effect produced by certain characteristics does not apply to only one phoneme but extends over more than one segment (Richard et al. 281), we are referring to the suprasegmental level. It is in this dimension that we find prosodic features like intonation, tone, pitch and duration, which are typically studied in whole sentences and long phrases, since their effects cannot be observed in minimal time windows as it happens with acoustic features (Polzin and Waibel 2).

Peter Roach stated that there is no fully valid and satisfactory definition of intonation (119). However, there is a central element that contributes to the production of intonation, and that is the pitch. 'Pitch refers to the auditory sensation experienced by a listener' (Roach 119), which means that when someone is speaking, we as listeners are able to detect changes in the sound of the speech. These changes happen when the pitch rises or falls, producing tone. It could be said then that intonation refers to the movement of pitch from higher to lower, and vice versa, in an utterance (Dobrovolsky 37). Another suprasegmental feature, and the one which will be specifically studied in this investigation, is duration. As Cahn defines it, duration "is the component of prosody described by speech rate and stress placement, and whose effects are perceived as timing and rhythm" (31). Speech rate refers to the speed at which a person speaks, and this speed is usually measured in syllables per minute. This feature will directly affect the duration of an utterance, because a fast speech rate will result in a short duration, and vice versa. Stress placement refers to how frequently pitch-accented words occur and the regularity of space between them (Cahn 31), which will also affect duration. This is because, for instance, more spacing between spoken words will mean longer duration. The combination of these features will produce rhythm. However, the feature of duration should not be mistaken with length. Length refers to the time of articulation of vowels and consonants (Dobrovolsky 41).

All of these prosodic features affect both the perception and production of speech, and they have been connected to the expression of emotions through speech. Psychologists, psycholinguists and phoneticians interested in the paralinguistic level have studied the relationship between emotions and speech, "in an attempt to determine which acoustic and prosodic features encode the emotional state of a speaker" (Polzin and Waibel 1). In order to understand this relationship, it is necessary to state firstly what is understood by emotion.

The definition of emotion is still a problematic issue, since there is no consensus on a general definition to be widely accepted by scholars. Throughout the years many theories on emotions have appeared and with them many attempts of definitions, sometimes even including notions of attitudes or feelings. The present study will follow Scherer definition of emotion, which states that an emotion is usually produced by a stimulus that activates our organism and produces a response once it has been evaluated its significance (700).

This response will usually be observed through a physiological and behavioral state, like crying when we are sad or being positive and animated when we are happy. In fact, a different physical and behavioral state will accompany each emotion. As Izard et al. explain, "emotions are considered to be complex phenomena with biological, social, and personal components" (cited in Mozziconacci 3), which implies that the differences in responding to a stimulus will depend on the person expressing it, as well as on many other factors, like the environment or situation of the moment. Overall, what is clear is that emotions involve a process that requires a number of common elements for any individual, regardless of other personal or environmental characteristics. Firstly, there must be a stimulus capable of producing a response or reaction; secondly, an individual that is able to detect such stimulus; and thirdly, an evaluation of the stimulus, carried out by the individual, in order to understand what is happening and respond adequately.

Emotions have been classified in various ways throughout the years of study in the field of psychology, but for this research the focus will be primarily on two: the classification according to their polarity and the classification according to the physical activation associated with them, also called arousal. The first classification is the most common, and the traditional one, which was first proposed by Plutchik in 1980 (cited in Scherer and Ekman 200). As the Oxford dictionary defines it, polarity 'is the state of having two opposite or contradictory tendencies, opinions, or aspects'. This means that the classification of emotions in terms of their polarity consists basically on differentiating between emotions that are positive or negative, also referred as pleasant or unpleasant. This, for example, would classify anger as a negative emotion, and happiness as a positive one.

On the other hand, there is a classification of emotions as highly arousing or less arousing. According to Schachter and Singer's theory of emotions, physical activation or arousal is connected with emotions, in the sense that it is this activation what prompts a person to look for an explanation on what is happening and subsequently associate their feelings with an emotion (381). Due to this connection with the state of physical activation, this classification of emotions does not contemplate polarity but rather the level of arousal. Then, it can be observed how emotions such as happiness or anger, which are usually classified as opposites regarding polarity, are included in the active sphere because they tend to correlate with high physical activation. However, others like sadness

and contentment are considered passive since the physical activation associated is lower (see fig. 1). In this classification we see how active (arousing) and passive (less arousing) spheres embrace both pleasant and unpleasant emotions.

Figure 1. Classification of emotions depending on Arousal.



Source: Jirayucharoensak, Suwicha et al. "EEG-Based Emotion Recognition Using Deep Learning Network with Principal Component Based Covariate Shift Adaptation". *The Scientific World Journal*, vol 2014, 2014, p. 2. *Researchgate*, doi:10.1155/2014/627892. Accessed 7 May 2019.

It should be mentioned that for the present investigation there were four specific emotions tested, which were happiness, sadness, anger and satisfaction. This choice was made so that the present investigation could deal with emotions that, being opposite in terms of polarity, could fit into the same category of physical activation. That is to say, anger and happiness were selected because they are incompatible emotions in terms of polarity, but both are associated with great physical activation so they would fall into the category of arousing. Sadness and satisfaction are also very different emotions with opposing polarities, but both of them can be included within the category of less arousing, since the physical activation associated with these is lower.

Having clarified these concepts of emotion, polarity and arousal, the topic on the expression of emotions through speech needs to be addressed. It is common knowledge that one of the basic means for expressing emotions is language. As such, people tend to think that emotions influence, in some way, how we speak. For example, in the case of a happy person speaking about something, one would normally imagine that this person's speech is going to have some specific features, such as loudness and fast speed. In fact, it would be that loudness and speed what, together with other elements like facial expressions, would make listeners believe that this person is happy, since it is not the way he or she would normally speak. This means that people know when an emotion is being expressed because something in the person's speech changes. It is reasonable to believe that each type of emotion tends to imprint a different recognizable mark in prosodic features such as the intensity or volume of the voice, the speed of delivery, the average tone, timber related aspects and the articulatory precision. And this is going to be perceived by the listeners.

These prosodic features as Mozziconacci and Hermes outline, play an important role in our speech, as they can add important information to the purely linguistic content (154). That is why they have been the main focus of attention in attempts to prove the existence of a connection between the expression of emotions and our speech. One of the most studied characteristics of prosody has been intonation, which allows us to express attitudes, and helps us to focus on specific lexical items or syllables, among many other functions (Roach 146). Some other features like rhythm or speech rate have also been studied.

As already mentioned above, the relationship between the state of physical activation and the different emotions is undeniable. The higher or lower level of physical activation seems to produce a change in our speech when expressing diverse emotions. For us to be able to speak, many of our muscles need to activate and work in conjunction. Emotions can produce changes in our physical state, such as in our muscle tension, and these changes may affect the acoustic characteristics of our vocalizations (Mozziconacci 4). In emotions with a high level of arousal, we tend to observe how speed and loudness are increased, resulting in fast vocalizations with a high pitch (Cahn 22). However, when a speaker is extremely aroused, he or she may produce errors that will decelerate the speed and in turn features like duration will be affected. On the contrary, emotions with a low

level of arousal result in speech productions that are slowly delivered and low pitched (Cahn 117). This suggests that there might be a pattern in the oral expression of our emotions. The results of different studies such as that of Williams and Stevens on *'Emotions and speech: some acoustical correlates'* or that of Cosmides on *'Invariances in the Acoustic Expression of Emotion During Speech'*, note that, although there are no unique patterns for the expression of every emotion, 'different individuals adhere to reasonably specific acoustic patterns in expressing different emotions' (Cosmides 878).

## 3. Methodology

The following experiment was conducted with the aim of finding out whether there is a relationship between duration and emotions; this means whether duration, as a suprasegmental feature that accommodates abstract and extra-linguistic aspects of speech, is somehow marked depending on the different emotions that are being expressed. And more specifically, this experiment was intended to find a relationship between duration and the arousal and polarity aspects of emotions. For that purpose, a group of native speakers of English was asked to pronounce four sets of five sentences that carried different emotions.

In order to explain how this investigation was carried out, all the materials that played a role in this process and the conduction of the experiment will be presented. It is important to bear in mind all the theoretical information explained before since it is the basis for the development of the research.

### 3.1 Ethical Considerations

The following investigation was carried out under the approval of the experiment participants. In order to have such authorization, the participants were given an Informed Consent (See Appendix), which was obtained from a Spanish version created for linguistic research, and which was translated and adapted to fit with the present research (Consentimiento Informado, Scribd.com). They were guaranteed anonymity and the possibility of withdrawing from the experiment at any time.

## 3.2 Participants

Thirteen individuals, between twenty and twenty-two years old, participated in this experiment. Since the purpose was to study the possibility of emotion affecting the duration of the speech, the experiment needed participants of native competence in English to avoid possible variables that, without having to do with emotion, would affect the duration of the speech. If the task was performed by non-native speakers, they could speak more slowly or more rapidly due to many variables that are difficult to anticipate rather than because of the effect of the emotion itself. An instance would be struggling with the pronunciation of some words, which could result in a pause or a decrease in the speed of delivery, thus affecting the overall duration of speech. To avoid such issues, all of the participants came from the United States. The majority of them were from Pennsylvania and Wisconsin, although no distinction was made on the basis of places of origin and accents since the focus of this study was on minimal variations in duration. They all studied Spanish in their university degree as well as in the Languages Centre of the University of Valladolid. The following table presents a summary of their characteristics.

Table 1

Participant's information

| Participant | Age | Country | State | Occupation |
|---|---|---|---|---|
| 1 | 20 | USA | Pennsylvania | [1]SPFL Student |
| 2 | 21 | USA | Pennsylvania | SPFL Student |
| 3 | 22 | USA | Pennsylvania | SPFL and Business Student |
| 4 | 21 | USA | Pennsylvania | SPFL Student |
| 5 | 22 | USA | Pennsylvania | SPFL Student |
| 6 | 21 | USA | Lancaster | SPFL Student |
| 7 | 20 | USA | Pennsylvania | SPFL and Criminology Student |
| 8 | 21 | USA | Pennsylvania | SPFL Student |
| 9 | 20 | USA | Wisconsin | SPFL Student |
| 10 | 20 | USA | Minnesota | SPFL and English Literature Student |
| 11 | 20 | USA | Wisconsin | SPFL Student |
| 12 | 22 | USA | Wisconsin | SPFL and Business Student |
| 13 | 20 | USA | Wisconsin | SPFL, Int. Business Student |

[1] Student of Spanish as a Foreign Language

### 3.3 Materials

Before starting with the experiment, the participants were given a brief description of it, together with a set of questions to gather some basic information about them (See Appendix). This brief description was a summary of their task in the experiment, and it described how the process would develop. No details on the topic of emotions were revealed in an attempt to achieve naturalness.

Twenty different sentences were designed for the experiment. They were very similar in length, and they were arranged in four different groups depending on the emotion with which they were associated. The emotions were at the same time under two classifications, depending on their polarity and level of arousal. This means that: happiness was classified under high arousal (+Ar) and positive polarity (+Pol); anger was classified under high arousal (+Ar) but negative polarity (-Pol); sadness under low arousal (-Ar) and negative polarity (-Pol), and satisfaction under low arousal(-Ar), but positive polarity (+Pol). However, the participants did not see these classifications. They were given a paper with the sentences all numbered and following each other. Each sentence had a very exact description to put the participants into context. For example, the sentence 'my girlfriend has found out she is pregnant', was included in the set of emotions dealing with happiness. It had the following context: 'For a very long time you have wanted to become a father, but your girlfriend has been struggling to get pregnant. You have recently discovered that you are finally going to have a baby and you can't be more euphoric'. This way it was ensured that the participant was well aware that the situation was not simply a happy one but also one in which you are highly aroused.

The sheet with the sentences of the experiment included six more that were completely unrelated to the subject of emotions and speech. These were inserted in between the sentences that carried emotions. The aim of this was to conceal the study's intentions and avoid possible tendencies to accommodate to the researcher's objectives. Since emotions are very present in the daily life, we have associated with them certain attitudes and ways of expression. If participants realized about the emotion being studied, it could be possible that they started producing stereotyped responses rather than natural ones, and this would bias the possible results.

All the sentences were individually recorded with a computer, and a handheld recorder was used to record the whole process. The individual recordings were processed through Cool Edit Pro, which is a program designed for the recording and editing of audio. The measures acquired thanks to Cool Edit were managed by Excel, and later on it was used SPSS, which is a computer program created for the statistical analysis of data.

## 3.4 Procedure

The experiment took place in the Languages Centre at the Campus Miguel Delibes, since it is where most of the participants had Spanish lessons, and it was held on three different days. The thirteen participants were asked to pronounce the sentences. Prior to that, they were given two copies of the Informed Consent so they could keep a copy, and the brief description of the experiment. Each participant came individually to a classroom, where the recording would take place. The following process was carefully explained to them: for each sentence, the contextualization would be read and explained by the researcher, then they would have some seconds to read the sentence, and they would pronounce it out loud while being recorded. Each participant was assigned a number that would be used to name their recordings in order to identify them later on. It was emphasized that they had to pronounce the sentences following the contextualization offered. The aim was to ensure that each sentence was pronounced with the right emotion.

Once the recording stage was completed with every participant, the audio files were processed. Cool Edit Pro was used to analyze de audios and measure the exact duration of each spoken sentence. The only treatment applied to the audios was a noise filter in order to facilitate the location of the beginning and end of each realization. All of the durations obtained were gathered in an Excel table and transferred to the SPSS application. In order to verify the existence of significant differences between the averages of the durations the parametric test of repeated measures, ANOVA, would be performed. This statistical test was used because the 4 variables to be compared came from the same subjects, and it is one of the most powerful tests for obtaining reliable

results. However, a requisite for performing this test is to have [2]normality in the values to be studied. In the case of the ANOVA, the values to check are the [3]residuals. When we verify this normality, it is demonstrated that it cannot be assumed for all measures. For a clearer vision of the problem, the data was transferred into a boxplot (see figure 2), in which we can appreciate an atypical value in the four emotions, produced by the last participant of the experiment. Finally, the values of this participant were discarded in order to have normality and continue with the ANOVA.

Figure 2. Boxplot with atypical value



Average Duration Box-Plot
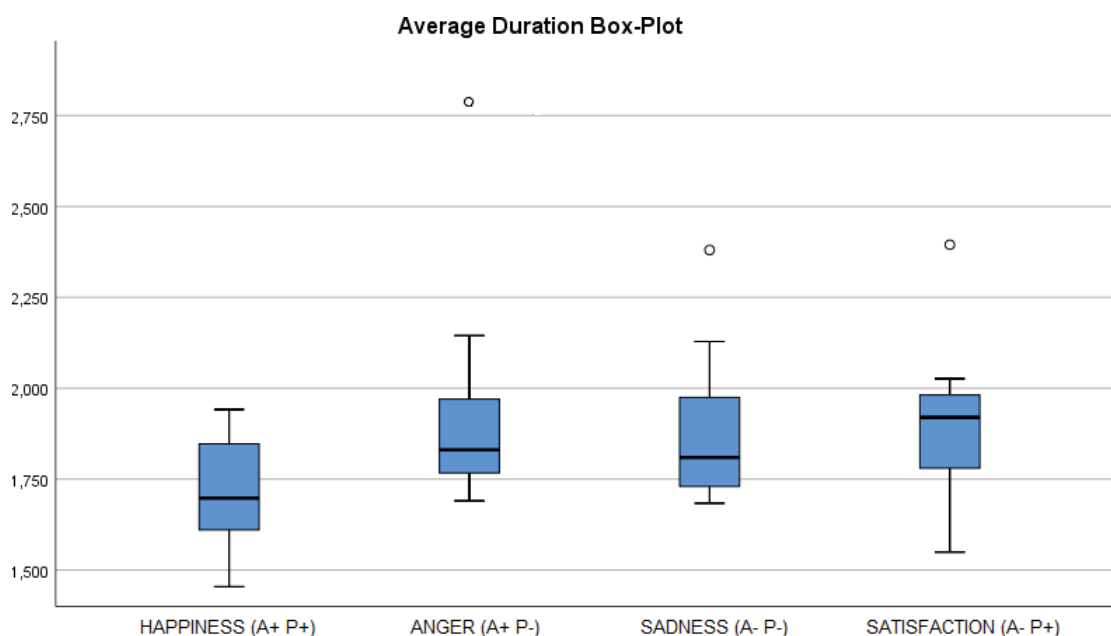
[2] Normality means that when representing these values in a graphic it can be appreciated how there is symmetry in their distribution, and how the total average, the median and the mode coincide in the same point.

[3] Residuals are the values obtained from calculating the difference between each individual value of the variable and the average value.

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## 4. Results

A total of 240 durations were gathered in an Excel table (see appendix), in which they were classified by sentence, emotion and participant. The average duration of the 5 sentences per emotion was calculated for each participant, as it would be the 4 resulting average values per person that we would need for the subsequent statistical test (see table 2). These durations were measured in milliseconds, which means that the investigation was working with a continuous quantitative variable. Those durations of the unrelated sentences were not included since they did not entail any value for the study.

Table 2

Average duration of the 5 sentences per emotion and participant

| Participant | Average Dur. Happiness | Average Dur. Anger | Average Dur. Sadness | Average Dur. Satisfaction |
|---|---|---|---|---|
| 1 | 1,625 | 2,068 | 1,730 | 1,971 |
| 2 | 1,698 | 1,810 | 1,853 | 1,920 |
| 3 | 1,849 | 1,806 | 1,810 | 1,679 |
| 4 | 1,504 | 1,759 | 1,684 | 1,656 |
| 5 | 1,454 | 1,691 | 1,796 | 1,549 |
| 6 | 1,603 | 1,767 | 1,706 | 1,780 |
| 7 | 1,671 | 1,970 | 1,702 | 1,808 |
| 8 | 1,611 | 1,903 | 1,975 | 1,960 |
| 9 | 1,807 | 1,742 | 1,990 | 1,879 |
| 10 | 1,754 | 1,831 | 1,850 | 2,027 |
| 11 | 1,847 | 2,145 | 2,128 | 1,982 |
| 12 | 1,942 | 1,905 | 1,769 | 1,990 |

The ANOVA test performed with this data verified the existence of statistically significant differences between the variable. The results obtained revealed that the emotion of Happiness has an evident shorter duration in comparison with the other three emotions (see table 3). To investigate this variability in depth, paired comparisons of happiness with the rest of the emotions were performed. It was appreciated that happiness was 0,169 seconds shorter than anger; 0,153 seconds shorter than satisfaction; and 0,136 seconds shorter than sadness. No other statistically significant differences were found between other emotions.

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Table 3

Average duration per emotion obtained through the ANOVA test.

| Emotions | Averages |
|---|---|
| Happiness (A+ P+) | 1,69710 |
| Anger (A+ P-) | 1,86643 |
| Sadness (A- P-) | 1,83268 |
| Satisfaction (A- P+) | 1,84993 |

## 5. Discussion

In table 3 it can be observed how there is no significant variability for three of the four emotions. Anger (A+ P-), sadness (A- P-) and satisfaction (A- P+) present very similar durations, as none of them goes below 1,8 milliseconds or above 1,9, being the three of them around 1,85 milliseconds. However, the duration obtained for happiness (A+ P+) stands out, resulting to be the shortest. Looking at the individual durations obtained per participant (see appendix), it can be observed from a closer perspective how each of them would produce really short durations for every sentence included in the set of happiness, while emotions like satisfaction obtained more variable values. The expression of emotions is something very subjective and personal, and these results prove the truth of that statement. It can be appreciated how two different people pronouncing exactly the same sentence produced very different durations, which could demonstrate that even though the sentences were the same for all of the participants, each of them would perform them in their own specific way. A very clear instance is participant number thirteen, the one who was finally left out of the ANOVA test. His way of expressing was completely different from that of the rest of the participants, and all of his durations were distinctively long. This is why he produced such atypical values (see number 13 in appendix). However, his particular way of speaking was seen every time he spoke, and not only for the sentences of the experiment. This could mean that the expression of emotions through speech is somehow modulated by the way you normally speak. If you normally speak slowly, it seems logical to think that you will do so when you are expressing emotions too.

There are two findings to be commented regarding the idea of arousal affecting the speech produced with different emotions. In the first place, happiness is an emotion that entails a high level of physical activation or arousal, as it is the case with the emotion of anger. However, their polarity is very different. While for happiness there is positive polarity, for anger we encounter a negative polarity. Taking this into account, does arousal affect them in the same way independently of their polarity? Looking at the results obtained in the average duration of happiness (see table 3), it can be observed how in the case of an emotion with a positive polarity, the arousal is producing an increase in the speed of speech that translates into a short duration. However, anger, an emotion with a negative polarity and a high level of arousal, presents a much longer duration than happiness. What can be deduced from these results is that arousal does not function in the same way for all emotions. Even though the level of activation is the same for some emotions, the polarity of these will determine the final result. That is to say, with a high level of arousal for a pleasant emotion as happiness it can be seen that the duration of the speech is short. While for an unpleasant emotion such as anger, even if it has the same level of arousal than happiness, the resulting speech duration is much longer. Although the results for anger do not reach the level of statistical significance, it is clearly observable how there is a deceleration with respect to happiness

The sentences classified under the emotion of anger had strong messages that stated the unpleasantness of such emotion. In fact, among the five sentences of anger, there were some with especially strong messages. For example, the sentence 'Do not dare to touch her once again' implied that someone was being hurt. Besides, in the contextualization offered for such sentence, it was explained that a girl was being physically hurt by her partner. This idea caused speakers to be particularly careful to pronounce certain parts of the sentence such as 'do not dare' or 'touch', in order to make them very clear. In addition, they produced many pauses between words in an attempt to maintain composure. This is proving that the unpleasant message, which implies negative polarity, also shapes the way of speaking. The fact that most of the sentences dealing with anger had messages that could be considered disagreeable but delicate, demands greater self-control in its expression. This flood of negativity with a high level of physical activation hinders the speaker's self-control, who, by making an extra effort to keep it, produces a deceleration of speech. Also, highly aroused speakers produce errors sometimes, like omissions,

repetitions or hesitations. All of these facts were probably the cause for the resulting longer average duration.

In contrast to anger and happiness, satisfaction and sadness are emotions that do not have high arousal. The level of physical activation in both of them is low, and their polarities are opposite as it is the case in anger and happiness. The lack of arousal here clearly produces a similarity in the duration of the two emotions, even though they have opposite polarities. Speech produced with these emotions has a normal average speed. This results in a much longer duration than that of happiness, but shorter than the duration of anger.

## 6. Conclusions

The traditional classification and study of emotions according to their polarity has been somehow sidelined with the emergence of psychological theories such as that of arousal. The study of the expression of these emotions through speech has been carried out analyzing the suprasegmental features, and how they are affected by the different emotions. The purpose of this study was to determine the influence of emotions, their polarity and their level of physical activation or arousal on the duration of speech, which is one of the suprasegmental features most neglected in past studies.

According to the results obtained, the following conclusions have been reached. First, the study has evidenced that the expression of emotions is intently linked to the personality of the individual, so there is no absolute common pattern for all individuals. The duration of speech highly depends on the particular way of speaking of every individual. This means that there are individuals whose speech is usually fast and active, while others speak slowly and in a relaxed way. It seems obvious to believe then that this will be reflected in their expression of emotions too. And, in fact, the individual results obtained per participant are proof of it.

Secondly, it has been demonstrated that the polarity and arousal of emotions correlate with duration. However, neither polarity nor arousal are elements whose effects can be evaluated on their own. As we have already seen, the effects of the arousal will depend on the polarity of the emotion. And thirdly, what this investigation can conclude from the

results is that high arousal is an essential determinant of the speed of speech, and therefore will affect the total duration of the sentences. This high arousal produces an overflow in the physical activation that, when associated with positive emotions, produces an increase of speed, and therefore results in a shorter duration of the speech. Nevertheless, when that overflow may involve a social threat or risk, self-control mechanisms are set in motion that produce a speech deceleration, and consequently a longer duration of speech. This could be the case with a negative emotion such as anger. Although in the case of anger there is no statistical backing, since the result remains within the normal levels of standard deviation, it can be observed how high arousal in negative emotions produces a deceleration. Likewise, it has been proven that arousal produces a change in speech, since in happiness it is clearly observed how high arousal combined with positive polarity results in a really short duration of speech.

Future investigations could further study this effect of high arousal on emotions that have opposite polarities. Perhaps, investigating this matter with a bigger number of participants could statistically support the suggested idea of deceleration of speech in emotions such as anger, and maybe shed some light into the effect of other emotions too.

## 7. Works cited

Banse, Rainer, and Klaus R. Scherer. "Acoustic Profiles In Vocal Emotion Expression.". *Journal Of Personality And Social Psychology*, vol 70, no. 3, 1996, pp. 614-636. *American Psychological Association (APA)*, doi:10.1037/0022-3514.70.3.614. Accessed 28 Apr 2019.

Cahn, Janet E. "Generating Expression in Synthesized Speech." 1989, *Semantic Scholar*, www.semanticscholar.org/paper/Generating-expression-in-synthesized-speech-Cahn/2a778385293b638d0fd6cb724bd4463e53ec922e.

Cahn, Janet E. "Generating Expression in Synthesized Speech." 1998, *Semantic Scholar*, www.semanticscholar.org/paper/Generating-expression-in-synthesized-speech-Cahn/2a778385293b638d0fd6cb724bd4463e53ec922e.

Carlos, Xoan. "20080524-Consentimiento Informado.doc." *Scribd*, 23 Oct. 2014, es.scribd.com/doc/244093371/20080524-Consentimiento-Informado-doc.

Clark, J., Yallop, C. and Fletcher, J. (2007). An Introduction to Phonetics and Phonology (3rd ed). Victoria: Blackwell.

Cosmides, Leda. "Invariances in the Acoustic Expression of Emotion during Speech." *Journal of Experimental Psychology: Human Perception and Performance*, vol. 9, no. 6, 1983, pp. 864–881. *Semantic Scholar*, doi:10.1037/0096-1523.9.6.864.

Dobrovolsky, M. "Phonetics: The Sounds of Language." *Contemporary Linguistics*, edited by O'Grady, W. et al. Bedford/St. Martin's, 2001 (pp.63-130).

Gustafson-Capková, Sofia. "Emotions in Speech: Tagset and Acoustic Correlates." *Semantic Scholar*, 2002, www.semanticscholar.org/paper/Emotions-in-Speech-:-Tagset-and-Acoustic-Correlates-Gustafson Capková/9fac4a635c7cb012ef2390eb60cf30454b988346.

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Mozziconacci, Sylvie J. L., and Dik J. Hermes. "Role of Intonation Patterns in Conveying Emotion in Speech." 1 Jan. 1999, *Semantic Scholar*, www.semanticscholar.org/paper/Role-of-intonation-patterns-in-conveying-emotion-in-Mozziconacci-Hermes/b629d70f57f9b51efcc530ad22fe642f44566ca5.

Mozziconacci, Sylvie J. L. *Speech Variability And Emotion: production and perception*. Technische Universiteit Eindhoven, 1998.

"Polarity." *English Oxford Living Dictionaries*, Oxford University Press, www.en.oxforddictionaries.com/definition/polarity.

Polzin, Thomas, and Alexander Waibel. "Detecting Emotions In Speech". *Semanticscholar.Org*, 1998, www.semanticscholar.org/paper/Detecting-Emotions-in-Speech-Polzin-Waibel/3bd8661f53291b927f341e3daaba6768275c430f. Accessed 25 Feb 2019.

Richard, J., et al. Longman Dictionary of Applied Linguistics.4th ed., Essex, Longman House, 1985.

Roach, P. English Phonetics and Phonology (4 th ed). Cambridge, Cambridge, 2010.

Sawaengmongkon, Chapanit. "Teaching Suprasegmental Features Of Spoken English Through Films To Develop Listening Achievement Of Learners". *Litu.Tu.Ac.Th*, (570-577) www.litu.tu.ac.th/journal/FLLTCP/Proceeding/570.pdf. Accesed 13 Mar 2019.

Schachter, Stanley, and Jerome Singer. "Cognitive, Social, And Physiological Determinants Of Emotional State." 1962, *Semantic scholar* www.semanticscholar.org/paper/Cognitive%2C-social%2C-and-physiological-determinants-Schachter-Singer/ee7f1f02a86dfaf38ca4493a4f8c4a061dfc36aa.

Scherer, Klaus R. "What Are Emotions? And How Can They Be Measured?". *Social Science Information*, vol 44, no. 4, 2005, pp. 695-729. *SAGE Publications*, doi:10.1177/0539018405058216. Accessed 28 Apr 2019.

Scherer, Klaus R., and Paul Ekman. *Approaches To Emotion*. Psychology Press, 2009.

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## 8. Appendix

## 8.1 Consent

**Informed Consent for Research Participants**

The purpose of this consent form is to provide participants in this research with a clear explanation of the nature of the research, as well as their role in it as participants.

This research is conducted by Ana Esteban Puebla, student of the University of Valladolid. The aim of this study is to carry out an investigation on pronunciation for an end-of-grade project.

If you agree to participate in this study, you will be asked to pronounce 26 sentences. This will take approximately 15 minutes of your time. What we discuss during these sessions will be recorded so that the researcher can then work with the material.

Participation in this study is strictly voluntary. The information collected will be confidential and will not be used for any purpose other than those of this research. Your recordings will be encrypted using an identification number and will therefore be anonymous. Once the research is completed, the cassettes with the recordings will be destroyed.

If you have any questions about this project, you can ask at any time during your participation in it. You may also withdraw from the project at any time without being aggrieved in any way. If you find any of the statements during the recording uncomfortable, you have the right to let the researcher know or not pronounce them.

Thank you in advance for your participation.

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I agree to participate voluntarily in this investigation, conducted by Ana Esteban Puebla. I have been informed that the goal of this study is to carry out an investigation on pronunciation for an end-of-grade project.

I have also been told that I will have to pronounce a few sentences during the process, which will take approximately 15 minutes.

I acknowledge that the information I provide in the course of this research is strictly confidential and will not be used for any purpose other than those of this study without my consent. I have been informed that I may ask questions about the project at any time and that I may withdraw from the project at any time without any prejudice to myself.

I understand that a copy of this consent form will be given to me, and that I may request information about the results of this study when it is completed. For this, I can contact the researcher at anaestebanpuebla@gmail.com

-------------------------------------------------------------------------------------------------------------------

Name of the Participant          Signature of the Participant          Date

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**8.2 Sentences for the participants of the experiment**

1. I have received the prize for my movie.

[You have been awarded for a movie you produced, and now you have been given a prize of a million of dollars for it. You are telling your family and you are extremely happy and filled with energy.]

2. My girlfriend has found out she is pregnant.

[For a very long time you have wanted to become a father, but your girlfriend has been struggling to get pregnant. You have recently discovered you are finally going to have a baby and you can't be more euphoric.]

3. I will be able to run again.

[Two years ago you got injured and had to give up athletics, your favorite sport. Today your doctor has determined you are perfectly healed and you can start running again. You are so happy and motivated.]

13. You always do whatever you want!

[Your brother is once again in trouble for something you advised him not to do. You are so sick of the situation and he is getting you on your nerves.]

14. I had to say goodbye to my mother.

[Your mom is having a really dangerous heart surgery and the chances of survival are very few, you knew this day would come so you remain calm while you say this to your friends, but you are really sad on the inside.]

15. My boyfriend is leaving for nine months.

[You are not going to see the person you love for nine months, you know it is a big opportunity for him so you want to be ok with it, but you still feel a bit like crying.]

16. I have a plan and I want you to listen to me.

[You want everyone's attention for what you are about to tell, but your listeners are distracted and talking to each other, so you need to impose yourself and act bossy.]

4. You have to go down the street and turn right.

[You are giving directions to a foreigner so you need to articulate a lot and go really slow so she can understand what you are saying.]

5. I will see my favorite group in April.

[Seven years you have waited for seeing your favorite group live. Finally, the time has come and you got the last tickets. You are jumping of joy.]

6. My father is coming home today.

[During the last six months you have been sad and missing your father, who is in the army. But today he is finally coming home. You are feeling a strong tingling of happiness in your stomach and can't stop telling everybody.]

7. You promised me you would keep the secret.

[A close friend of yours, someone you have always trusted, has revealed a really important secret to you. You are so

17. I am feeling a little isolated.

[You are starting to see that you are being left apart by your friends and they don't include you in their plans anymore, so you feel a bit down.]

18. I have just missed the plane to go home.

[After four months you are finally going home to see your family, but you arrive late at the airport and miss you flight. Now you will have to wait another day and you are unhappy about it.]

19. I had studied a lot for this exam.

[You have failed the test although you studied all week for it, so you feel a bit depressed.]

20. I am going to be by your side no matter what.
[Your best friend is going through a complicated situation and you want to show him support. You will never abandon him, and you want him to know he is not alone.]

disappointed and would like to punch him in the face.]

8. You are the cutest thing I have ever seen.

[Your friend has had a baby and you are talking to her. She is tiny and beautiful, and you are fascinated with her.]

9. Do not dare to touch her once again.

[You have seen the partner of a beloved friend slapping her, and you are so furious you have to control yourself.]

10. I said get out of my sight right now.

[This person that has been really mean to you tries to talk to you, but you remember how you have suffered because of her fault and your blood is boiling.]

11. You have been such a horrible friend!

[A person you thought that was your friend has been saying bad things about you and inventing numerous lies. You are really really mad at him.]

21. I have finally finished my project.

[After two years working hard you have completed your project, and it looks great. You feel relieved and satisfied with your work.]

22. My boss has said I am his best worker.

[You feel like you are finally getting recognition for your work and you are content.]

23. I have lost 3 kilos in a month.

[You feel so gratified by your consistence on losing weight, but you know there is still a long way to go]

24. I have to confess you were my first love.

[You are telling this for the first time to the first person you fell in love with. You are feeling so embarrassed even though it was many years ago.]

25. I got a ten on my last exam.

[You studied a lot for your exam and you feel proud of your work.]

| | |
|---|---|
| 12. If you need anything just tell me, my dear.<br><br>[An old friend you haven't seen in years is staying at your house for a few days. It feels a bit strange because of how much time has passed, but you are trying to be as nice as possible.] | 26. She has finally got what she deserved.<br><br>[The girl who was being a bully has been expelled from school, and you feel pleased about it. You can finally relax.] |

**8.3 Experiment Presentation Sheet**

## EXPERIMENT PRESENTATION

The present experiment will deal with the pronunciation of 26 sentences in English. Each of them will have a precise description on how to be produced, this will be read by the researcher, but you can take your time to reread it afterwards. Then, imagine yourself in the situation presented in the description, take a few seconds to think about the sentence, and say it out loud. The researcher will ask you if you are ready so she can start recording.

After the recording of each sentence, the researcher will take a few seconds to give the audio an identification number so they are anonymous.

However, before beginning with the process you will be asked to complete a few questions. These will be for the researcher as purely informative data, and if used it would be anonymously too.

| |
|---|
| 1. What is your name? |
| 2. Where are you from? Country and city |
| 3. How old are you? |
| 4. You are: <br> Studying ☐ Working ☐ Both ☐ None ☐ |
| 5. What do you study or work in? |

Thank you very much for your time participating in this experiment.

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## 8.4 Individual durations

| Participant | Happiness | | | | | Anger | | | | | Sadness | | | | | Satisfaction | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sent. 1 | Sent. 2 | Sent. 3 | Sent. 4 | Sent. 5 | Sent. 6 | Sent. 7 | Sent. 8 | Sent. 9 | Sent. 10 | Sent. 11 | Sent. 12 | Sent. 13 | Sent. 14 | Sent. 15 | Sent. 16 | Sent. 17 | Sent. 18 | Sent. 19 | Sent. 20 |
| 1 | 2,173 | 1,623 | 1,162 | 1,816 | 1,350 | 1,602 | 2,891 | 1,864 | 1,969 | 2,012 | 1,631 | 1,838 | 1,469 | 1,720 | 1,992 | 2,296 | 2,313 | 1,862 | 1,661 | 1,722 |
| 2 | 1,843 | 1,894 | 1,467 | 1,728 | 1,558 | 1,728 | 2,386 | 1,903 | 1,647 | 1,384 | 1,644 | 1,987 | 1,703 | 1,947 | 1,984 | 1,772 | 2,289 | 2,056 | 1,765 | 1,717 |
| 3 | 2,061 | 2,236 | 1,370 | 1,881 | 1,699 | 1,994 | 2,215 | 1,758 | 1,604 | 1,459 | 1,674 | 1,918 | 1,727 | 1,956 | 1,774 | 1,683 | 1,911 | 1,555 | 1,602 | 1,644 |
| 4 | 1,727 | 1,679 | 1,144 | 1,573 | 1,397 | 1,815 | 1,512 | 2,244 | 1,591 | 1,635 | 1,553 | 1,651 | 1,601 | 1,718 | 1,896 | 1,413 | 1,749 | 1,735 | 1,777 | 1,604 |
| 5 | 1,634 | 1,550 | 1,045 | 1,748 | 1,295 | 1,642 | 1,633 | 1,833 | 1,797 | 1,549 | 1,643 | 2,049 | 1,494 | 1,642 | 2,153 | 1,647 | 1,528 | 1,410 | 1,665 | 1,496 |
| 6 | 1,786 | 1,807 | 1,251 | 1,686 | 1,486 | 1,913 | 1,912 | 1,644 | 1,703 | 1,665 | 1,572 | 1,811 | 1,584 | 1,835 | 1,726 | 1,724 | 2,048 | 1,716 | 1,680 | 1,734 |
| 7 | 1,923 | 1,956 | 1,318 | 1,690 | 1,467 | 2,129 | 2,243 | 2,269 | 1,778 | 1,432 | 1,466 | 1,909 | 1,333 | 1,740 | 2,060 | 1,770 | 2,068 | 1,707 | 1,734 | 1,759 |
| 8 | 1,730 | 1,873 | 1,197 | 1,778 | 1,475 | 2,127 | 1,892 | 2,020 | 1,781 | 1,696 | 1,757 | 2,088 | 1,419 | 2,363 | 2,247 | 1,976 | 2,329 | 1,855 | 1,841 | 1,797 |
| 9 | 2,279 | 2,028 | 1,315 | 1,817 | 1,598 | 2,359 | 1,738 | 1,535 | 1,654 | 1,424 | 2,009 | 2,211 | 1,709 | 2,041 | 1,978 | 1,897 | 2,008 | 1,961 | 1,818 | 1,709 |
| 10 | 1,788 | 1,722 | 1,412 | 2,024 | 1,823 | 1,826 | 1,753 | 2,315 | 1,754 | 1,506 | 1,664 | 2,624 | 1,613 | 1,681 | 1,668 | 1,908 | 2,580 | 2,014 | 2,035 | 1,596 |
| 11 | 1,959 | 2,093 | 1,143 | 2,426 | 1,615 | 2,158 | 2,283 | 2,053 | 2,148 | 2,084 | 1,674 | 2,366 | 1,838 | 2,408 | 2,356 | 1,980 | 2,160 | 1,921 | 1,701 | 2,146 |
| 12 | 1,938 | 2,686 | 1,419 | 1,984 | 1,681 | 2,336 | 2,001 | 2,387 | 1,611 | 1,190 | 1,568 | 1,825 | 1,527 | 2,034 | 1,893 | 2,095 | 2,054 | 1,938 | 1,746 | 2,119 |
| 13 | 1,935 | 2,291 | 1,569 | 2,001 | 1,704 | 3,026 | 2,942 | 2,951 | 3,084 | 1,925 | 2,427 | 2,514 | 2,207 | 2,782 | 1,971 | 2,498 | 2,873 | 2,141 | 2,142 | 2,320 |

Ana Esteban Puebla