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Correlation between personality traits and acoustic patterns in the speech of spanish speaking individuals in the river plate

Correlación entre rasgos de personalidad y mediciones acústicas en el habla de individuos hispanoparlantes del río de la plata

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Abstract

The background of this study is presented in three sections: a) Motivation Theories and their relationship with brain structures, b) Psychometric studies of Primary Personality Factors (PPF) and c) The role of brain structures in the production of prosodic aspects of language. Its objective is to evaluate the combination of parameters and acoustic characteristics found in the speech of normal individuals (n = 23), previously grouped according to a psychometric study of their personality in order to sort out Primary Personality Factors (PPF) and improve our knowledge on Human Temperaments. Acoustic parameters under study were: fundamental frequency (F0), total maximum energy and total duration, normal constituents of prosodic information. A three-syllable same phrase was analyzed in all the cases. The subject´s emissions were registered on a Sony (WM – 6 × 320) recorder and the phrase studied for each individual (N = 22) was processed with the Anagraf speech acoustic analysis program. The acoustic characteristics more useful to discriminate between PPF groups are: a) F0 rank and b) energy differences between stressed syllables and those not stressed. Acoustic studies can complement psychometric ones in order to differentiate each PPF group.

Keywords: Temperament; speech rhythms; pitch; energy; duration

Resumen

El fundamento de este estudio se presenta en 3 secciones: a) Teorías de la Motivación y su relación con estructuras cerebrales, b) estudios psicométricos para determinar Factores Primarios de la Personalidad (FPP) y c) el rol de las estructuras cerebrales en la producción de los aspectos prosódicos del lenguaje. Su objetivo es evaluar la combinación de parámetros y características acústicas encontradas en el habla de individuos normales (n = 23), previamente agrupados en base a estudios psicométricos de la personalidad y aumentar el conocimiento acerca de los temperamentos humanos. Los parámetros acústicos estudiados incluyeron: frecuencia fundamental, energía total y duración, constituyentes normales de la información prosódica. Una misma frase de tres sílabas fue analizada en todos los casos. Las emisiones vocales se registraron en un grabador Sony (WM – 6 × 320) y la frase estudiada en cada individuo (N = 22) fue procesada con Anagraf, programa de análisis acústico del habla. El análisis de las varianzas en los resultados obtenidos mostró que las características acústicas que más probablemente pueden discriminar cada uno de los grupos de FPP son dos: a) el rango de la frecuencia fundamental, y b) la energía individual usada en las sílabas acentuadas respecto de aquellas que no lo son. Los estudios acústicos pueden complementar a los psicométricos para diferenciar los individuos que corresponden a cada grupo según los FPP.

Palabras clave: Temperamento; ritmos del habla; tono; energía; duración

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Introduction

The background of this study is presented in three sections:

1. Neuropsychological Theories of Motivation and its relationship to brain structures.
2. Psychometric studies of Primary Personality Factors, and:
3. The role of brain structures in the production of prosodic aspects of language.

Neuropsychological Theories of Motivation and its relationship to brain structures

Motivation explains behavior, as long as it happens in extremely simple behavior as occurs in monosynaptic reflexes.

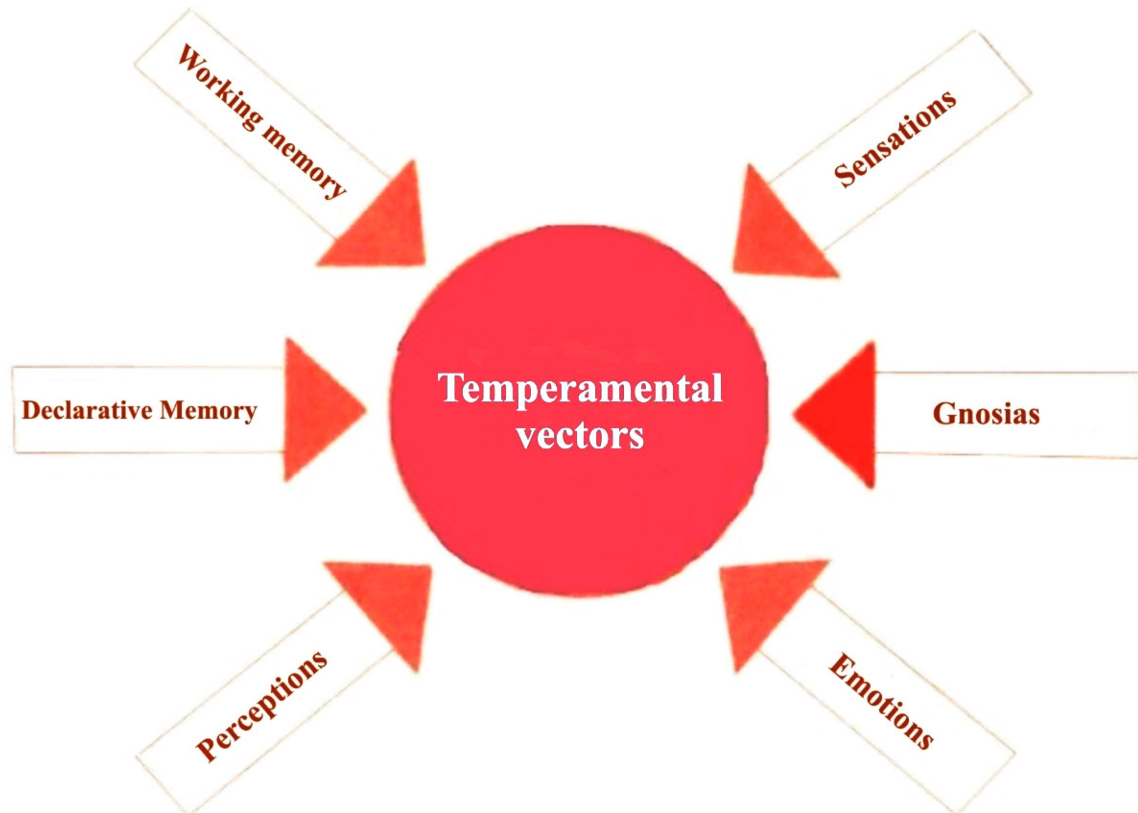
According to Madsen (1973), motivation is a generic term that includes different variables, such as: a) The Central Activation processes governed by the Brainstem Reticular Formation; b) The motivational baseline depending on subcortical processes (E Catell component, energy) (Catell, 1957); c) Sensibilizing processes depending on the Hypothalamus and the Limbic Circuit (P Catell component) (Catell, 1957); d) Cortical-Subcortical learning circuits induced proceses; e) Variable motivational disposition depending on the individual´s constitutional nerve centers (temperament) (Tolman, 1932) or; f) Acquired inducing stimuli; g) Induced impulses, leading to G Cattel component, gratification (Catell, 1957); and h) Cognitive processing of information, both cortical and sensory.

Cattel (1957) classifies Inducement Theories as: 1) *Homeostatic*: emphasizing the role of hypothalamus, particularly in hunger and thirst; 2) *Limbic*: originating wrath, fear aggression, pleasure and sexual drive; and 3) *Cognitive*: generating curiosity, among others, mainly of cortical origin.

Halgren and Chauvel (1993) review these theories concluding that emotion originates from various substrates, those based in the brain stem are responsible for somatic or visceral automatic behavior. On the other hand, telencephalic behavior is responsible for more subtle and developed behavior.

By mean of intracranial implanted electrodes for electrical brain stimulation Halgren and Chauvel (1993) describe emotional experiences as signals from subconcious to conscious neural networks in the human brain. The same authors connect emotions located in the Limbic System (a), with other five areas in the associative multimodal cortex. Other five vectors are: b) sensations, in their basic components arising at the primary sensorial cerebral cortex; c) topographic knowledge at the perceptive unimodal cortex; d) associated sensations from gnosic associative cortex; e) working memory: conscious information for immediate use from the prefrontodorsolateral cortex; and f) declarative memory at the temporal lobe as a free flow of conscious contents. Possibly different configurations emerge according the influence or intensity of the activity of each of the six described vectors, underlying the basic concept of temperaments or in other words, primary personality factors (Figure 1).

FIGURE 1. *Theoretical model regarding the integrative structure of temperament.*



Source: Modified from Halgren and Chauvel (1993).

Primary Personality Factors (PPF)

These traits may be biologically based and their distribution follows the traditional concept of Temperament, though this is still under discussion. In Reyburn and Raath´s (1950) original study, 160 subjects were evaluated by 83 observers, two subjects each observer. Reliability between observers was 0.80. The population was balanced regarding gender and education. Patients were evaluated using a 5 point scale, including 45 well defined personality traits. The data was analyzed by oblique rotation resulting in six predominant factors.

Resulting PPF were: stability, spontaneity, persistence, sensitivity, inferiority feelings and security. They could be charactherized as follows (Romano & Capurro, 1989):

1. *Stability*: Unemotional, unexpressive, self-sufficient, calm, focused and systematic.
2. *Spontaneous*: Optimistic, excitable, emotionally expressive, sociable, easily influenceable and adaptable.
3. *Persistence*: Overcomes difficulties, unemotional, confident, not excitable, not Subject to external influence, and calm.

4. *Sensitivity*: Responsive to emotions or actions of others, excitable, emotional, Susceptible and conciliating.
5. *Inferiority feelings*: Feeling of personal inadequacy often resulting in the belief that one is in some way deficient or inferior to others, weak, quick to take offence and suggestible.
6. *Security*: Confident, generally ready to defend personal viewpoints when challenged, tendency to lead or dominate, aggressive, influential but not easily influenced and self-sufficient.

Using blood typing, french psychologist Bourdel (1964), linked the results of psychological tests searching PPF with groups a, b, o, & ab. She found four different temperament dispositions called: harmonic, rhythmic, melodic, and complexes. In the rhythmic types, personal projection superimpose adaptation to environmental guidelines. Melodic types present inversion of those characteristics, adaptation over projection. Harmonic subjects seem to be a balanced combination of both types. In complexes subjects rhythmic and melodic traits alternate randomly.

The role of brain structures in the production of prosodic aspects of language

Prosody is the systematic organization of different linguistic components in an emission involving the spoken word. It encompasses segmental and suprasegmental rhythms of speech, on the purpose of emitting not only linguistic utterances but also paralinguistic and non-linguistic information represented by discreet symbols and rules that describe its combinations. In this way, the linguistic information is discreet and firm.

Paralinguistic information is defined as the information that has no consequence on its written counterpart, being deliberately added by the speaker to modify or supplement the linguistic information. A sentence may be issued in different ways, in order to express different intentions, attitudes, and styles of speech, that are under the conscious control of the speaker. In this way, information can be discreet and continuous.

Non-linguistic information is related to factors such as age, gender, idiosyncrasy, etc. These factors are not controlled by the speaker and do not relate to the linguistic or paralinguistic information. Non-linguisitc information may be discreet or continuous, to certain degrees it may be a common cultural characteristic in a variety of speakers.

In psycho-acoustic terms: accent, intonation and the rhythm of speech, are the basic attributes of prosody. In its physical aspect, prosody is a phenomenon manifest through fundamental frequency, energy and duration (Ure et al. 1996).

Most investigations derived from neurological clinic relate prosody to biological structures based on studies carried out on patients with brain damage. Tucker et al. (1977) found that patients wounded in the right parietal lobe fail in the comprehension of emotional signals included in spoken language´s intonation, as well as in the case of repetition of phrases that must be said with a certain emotional intonation. Lesions on right thalamus and posterior arm of the internal capsule causing sensory aprosodia were reported in another communication (Wolfe & Ross, 1987).

According to Ross and Mesulam (1979) the minor hemisphere (right one) is dominant for the motor organization of emotional components in the spoken word; this function being surely cortical, although they do not dismiss the participation of subcortical mechanisms. Following these ideas, Ross (1981) reported that the organization of emotional language in the right hemisphere is similar to the propositional language on the left one, and classifies aprosodies resembling aphasias as motor, global, conductive, sensorial, and transcortical sensorial (Gorelick & Ross, 1987). Shapiro and Danly (1985) published a study of right and left acoustically damaged brains with diverse focalization damages discovering that the right damage in pre and post central regions present reduction in the variety of F0, and restricted intonation in all the dominions of emotional and non-emotional expression. Conversely damage in the posterior right cortex showed an increase in the variation of F0, and in the pitch of intonation on both domains. The damages on the left side did not show any of these alterations.

George et al. (1996) studying 13 normal subjects with PET testing in response to slogans depending on intonation, found that only right prefrontal cortex was activated in response to the emotional prosody. The Supplementary Motor Area (SMA) is used for discovery speech wording as well as facilitation of language. These mechanisms involve: a) control of speech rhythm; b) control of articulation mechanism; and c) phonation control. According to Jonas (1981), the left SMA is predominant over the right SMA on these functions, right SMA importance being restricted to cases of inverted hemispheric dominance of speech. Probably, while SMA sustains the rhythm of propositive language, the anterior gyrus cinguli may be crucial in the initiation of emotional speech (Ure et al., 1998).

Regarding subcortical mechanisms of initiation and maintenance of the rhythm of speech is valuable to take in mind subcortical anarthria (Ure et al., 2001). Vos and Troost (1989) link time passage perception to the comprehension of compass in music and speech. Disturbances in the understanding of rhythm in speech and music have been described also in individuals with traumas in the left hemisphere (Oepen & Berthold, 1983).

Objectives

The objective of this study is to evaluate the combination of parameters and acoustic characteristics found in the speech of normal individuals, previously grouped according to a psychometric study of their personality in order to sort out Primary Personality Factors (PPF).

Hypothesis

Through the studies previously commented, the following conclusions transpire:

1. Human speech has a temporal organization of its emission, segmental and supra-segmental. This function depending mainly on frontosubcortical circuits located in the dominant hemisphere for speech, usually on the left side.
2. Speech has a prosodic accent or intonation, in which variations of the fundamental frequency in time (contour) and energy variations (accentuation) are the vehicle for messages from the emotional world. Expression and perception of these messages are functions of the non-dominant hemisphere for language, usually the right one, in regions that have been speculated to mirror the control of spoken propositional language in the left hemisphere.
3. Emotional expression of speech follows acoustic patterns similar in different individuals according to the emotion currently expressed.
4. According to Reyburn and Raath (1950) normal subjects interviewed showed six different primary factors in their personality (PPF). Acoustic studies may complete the psychometric ones in order to differentiate individuals belonging to each one of these six groups.

Material and Methods

Determination of the primary personality factors (PPF)

The measurement of PPF required the elaboration of an indirect-structured autoadministered questionnaire of 67 questions, derived from the original direct-observational questionnaire (Reyburn & Raath, 1950). The questionnaire could be administered to 24 adult subjects of both sexes who know how to write and read fluently so that they can interpret the content of the items in relation to themselves. Subjects must not have auditory and speech and/or emotional psychiatric alterations that may hinder the performance. The test was presented by means of a booklet with the corresponding instructions, questions and assessment scales. Validity scales have been developed, which include: a) the total number of unanswered items, and b) the number of items answered in both directions (yes-no) in the same situation. It has been considered that the answers to the protocol are not valid when there are more than three questions (5%) unresolved, and if an item is answered in two opposite directions. The clinical scales were built according to the factorial analysis of the work of Reyburn and Raath (1950), which endorse the validity of the questionnaire.

The PPF test was applied to a group of voluntary subjects, females between 20 and 30 years of age, without disturbances in the vocal apparatus, tertiary and/or university level, from Buenos Aires, Río de la Plata speakers, except in two cases, one from Cordoba and one from Entre Ríos, who had lived in the Capital since their second childhood. Then the test subjects uttered a short sentence. '*bueno sí*' twice. Same phrase was in two lists of very short phrases that the interviewed had to repeat.

The results obtained allowed us to recognize six factors, distributed among the subjects, as follows: '*persistent*' (Per) 4, '*affective*' (Af) 8, '*sensitive*' (Sen) 4, '*security*' (Sec) 1, '*stable*' (St) 3, and "feelings of inferiority" (If) 4. As the sample obtained was subject to the interest of the people in participate this factor contributed in a certain way to outline the psychological profile of the people who voluntarily collaborated in the research. For the acoustic study, the '*security*' category will be discarded because it has only one speaker and the '*affective*' category of eight subjects was divided according to the second factor into two groups: "affective/sensitive" (Af/s) and '*affective/self-secure*' (Af/ss) with four subjects each group.

Acoustic Study

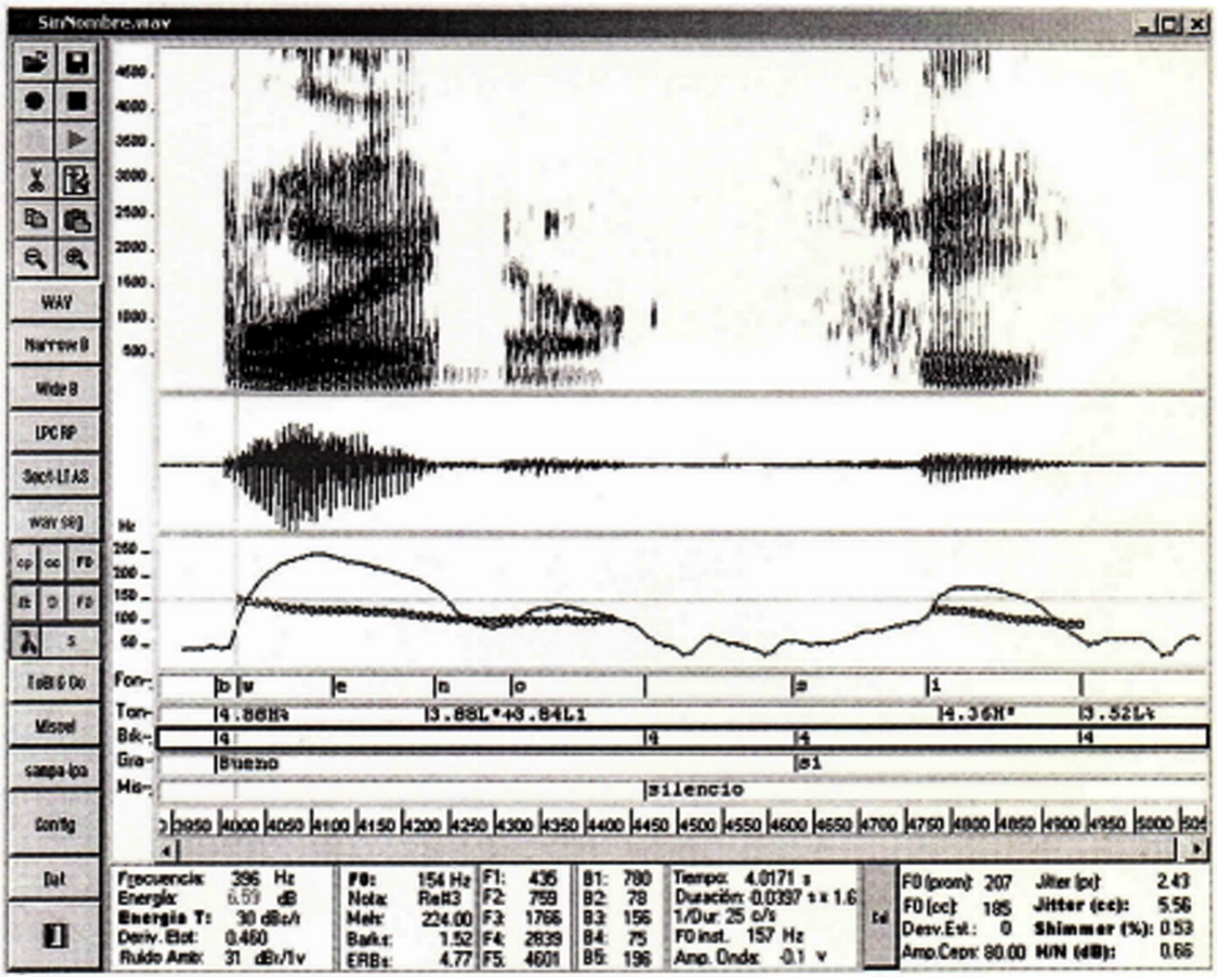
In this study, the incidence of relevant acoustic patterns that occur in the verbal emission of a simple text was explored experimentally. The cases studied were female subjects with a normal voice who repeated a declarative sentence with one or two intonation groups where the lexical accents coincide with the tonal accents of the intonation group. The pitch accents together with the joining tones at the ends of the phrase determine the intonation contour.

The subjects that carried out the Reyburn Raath test were required to say the phrase '*well yes*' twice and this phrase was included respectively in two lists of short phrases that the subject was supposed to repeat. The studied sequence is transcribed as bwe-no-si. In Argentinean Spanish, the phoneme /b/ in initial position is transmitted as a stop, optionally presenting a temporal segment with low-frequency sonority without higher formants. For the purposes of measuring the duration, this initial segment was discarded to avoid the occurrence of a segment that randomly depends on the speaker's phonetic habits.

The realization of the phoneme /u/ in diphthong with /e/ occurs as the semivowel /w/ of short duration and less intensity than a vowel. The vowel /e/ with its formant structure delimits the first syllable with precision. Furthermore, the transition to the following nasal is abrupt and clearly differentiated by the oral-nasal interface, visible on the spectrogram (Figure 2). The acoustic interface between the syllables /no/ and /si/ is also easy to determine, given the voiced/voiceless characteristics of the phonemes /o/ and /s/ respectively. The analysis of the final portion of /i/ presented the greatest number of variants. These variants are determined by a final elongation with low amplitude, or by a phonation with a noisy breath of air or with snoring, with cuts in the F0.

The subject´s emissions were registered on a Sony (WM-6x320) recorder and the phrase studied for each individual was processed with the Anagraf speech acoustic analysis system (Gurlekian, 1997). Data was digitized at 16 bits, and 16k samples/sec, and the calculation of the fundamental frequencies was done by two different

Figure 2. *Spectrographic representation of the phrase "well yes".*



Spectrographic representation of the phrase "well yes". In the upper part the spectrogram is observed, in the middle the amplitude of the waveform and in the lower part, the contours of total energy in dB (solid lines) and fundamental frequency in Hz (circles), all as a function of time. Below, the phonetic, tonal, pause, graphemic and miscellany transcription. At the base, the numerical values of the different acoustic parameters of speech obtained through the Anagraf system.

methods: autocorrelation with dynamic programming and spectrum analyzer. The acoustic parameters measured were vibratory frequency of vocal chords (fundamental or F0), total energy and duration.

Acoustic parameters

1. Fundamental frequency (F0) maximum (F0M) and minimum (F0m) of all the emissions and of each syllable (F0 /we/, F0 /no/ and F0 /sí/). F0 is estimated with the ESPS algorithm within an implementation of the Snack library in ANAGRAF (the speech analysis system).

2. Total energy of each syllable, measured in dB related to the level of environmental noise.

3. Total Duration of Emission (TD) and of each syllable.

The following combination of characteristics was taken from these direct measurements:

Acoustic Characteristics

a. F0 pitch, obtained as the difference between maximum and minimum of the entire emission. It provides information on the degree of modulation of the tonal groups.

b. F0 rank for all emission and average F0 pitch obtained as the difference between the maximum and minimum of each syllable and the mean for each expression.

c. F0 pitch of each syllable, obtained as the difference between maximum and minimum of F0 in each syllable. It provides information on the tone accents.

d. Maximum total energy (TME) and relative energy of the first syllable /we/ (tone, accent) relative to the second /no/ (E1/E2) and the third syllable /sí/ (tone, accent), relative to the second /no/ (E3/E2). Relative energy normalized the differences in intensity due to factors external to the individual, such as microphone to mouth distance, or environmental noise. These characteristics are associated to lexical accent. TME is the RMS (root mean square) overall energy calculated for each window analysis.

e. Duration of the syllables relative to total duration. Pauses between words allow for the definition of tonal groups. Duration of the last syllable was normalized relative to the total duration of its emissions.

Results

The results of those parameters that were significant for the differentiation of at least one pair of groups are presented using the LSD method that determines a significant value when the p is less than 0.05 and in such a case the value is written in bold (Tables 1 a 12).

Fundamental Frequency (F0)

Correlations were found between the values of F0 minimum and maximum, for all subjects in each syllable: r › 0.85, p ‹ 0.000. Variations were noted for the different groups of FPP , evaluated by the analysis of their variations. F0 max is a differentiation parameter of groups of PPF, F(1.138) - 12.7, p ‹ 0.000. Similarly for F0 min: F(1.138) – 7.866, p ‹ 0.000. An analysis was performed on the minimum significant differences, (LSD, with p ‹ 0.05), rendering differences between groups depicted in Table 1 and Table 2, marked in bold type.

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Table 1. *p values (LSD test) for F0 Max (F0M).*

F0M	Af/ss	Sen	Af/s	If	St
Per	0.019	0.001	0.001	0.000	0.000
Af/ss	-	0.000	0.000	0.000	0.000
Sen	-	-	0.961	0.234	0.741
Af/s	-	-	-	0.228	0.763
If	-	-	-	-	0.439

Suggestive ones have been marked in bold characters.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Table 2. *p values (LSD test) for F0 mín (F0m).*

F0m	Af/ss	Sen	Af/s	If	St
Per	0.011	0.010	0.127	0.002	0.122
Af/ss	-	0.011	0.000	0.000	0.000
Sen	-	-	0.218	0.581	0.380
Af/s	-	-	-	0.071	0.829
If	-	-	-	-	0.166

Suggestive ones have been marked in bold characters.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Derived from these measures, the pitch of F0 was evaluated, shown as the difference between minimum and maximum values of F0 for all emissions (Table 3; Table 4).

Table 3. *p values (LSD test) for pitch of F0 (RF0).*

R.F0	Af/ss	Sen	Af/s	If	St
Per	0.86	0.02	0.007	0.003	0.008
Af/ss	-	0.05	0.02	0.01	0.01
Sen	-	-	0.71	0.43	0.52
Af/s	-	-	-	0.65	0.75
If	-	-	-	-	0.93

Suggestive ones have been marked in bold characters.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Table 4. *p values (LSD test) for average pitch of F0 (AP.F0).*

AP.F0	Af/ss	Sen	Af/s	If	St
Per	0.577	0.039	0.000	0.001	0.001
Af/ss	-	0.015	0.000	0.001	0.000
Sen	-	-	0.09	0.197	0.094
Af/s	-	-	-	0.725	0.844
If	-	-	-	-	0.619

Suggestive ones are marked by bold characters.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

The pitch of F0 revealed a capacity to distinguish PPF groups : F(1.46) = 3.65, p ‹ 008, and average pitch of F0: F(1.46) = 7.136, p ‹ 000. The probabilities obtained (p ‹ 005) are shown in Table 3 and Table 4. These two F0 pitch evaluations became equivalent. A clear grouping of persistent and affective / self-secure was noted, being clearly discernible from the rest of the groups. The statistical analysis of F0 average pitch coincides with the results for pitch of F0, F(1.46) = 7.136, p ‹ 000.

Table 5. *p values (LSD test) for the syllable/we/ (RF0/we/).*

RF0/we/	Af/ss	Sen	Af/s	If	St
Per	0.910	0.143	0.000	0.000	0.000
Af/ss	-	0.142	0.000	0.000	0.001
Sen	-	-	0.017	0.011	0.022
Af/s	-	-	-	0.636	0.984
If	-	-	-	-	0.664

Probable suggestive ones, in bold characters.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Table 6. *p values (LSD test) For the syllable/no/ (RF0/no/).*

RF0/no/	Af/ss	Sen	Af/s	If	St
Per	0.000	0.555	0.530	0.975	0.427
Af/ss	-	0.002	0.000	0.001	0.000
Sen	-	-	0.215	0.606	0.170
Af/s	-	-	-	0.542	0.833
If	-	-	-	-	0.443

Probable suggestive ones, in bold characters.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

The results of a test for the syllable/we/F(1.46) = 7.635, p ‹ 000, for the syllable and, at lesser extent for syllable/sí/ F(1.46) = 2.803. F0 in the last accentuated syllable, defines the nuclear accent of the phrase, and due to this the syllable/si/ is a segment where a relevant prosodic information load of linguistic and non-linguistic is included, this explains the less differentiable load.

Table 7. *p values (LSD test) for the syllable/sí/(RF0/sí/).*

RF0/sí/	Af/ss	Sen	Af/s	If	St
Per	0.128	0.006	0.004	0.004	0.040
Af/ss	-	0.271	0.242	0.172	0.686
Sen	-	-	0.984	0.712	0.448
Af/s	-	-	-	0.713	0.413
If	-	-	-	-	0.286

Probable suggestive ones, in bold characters.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Table 8. *Total Maximum Energy (TME). p values (LSD test) for TME.*

TME	Af/ss	Sen	Af/s	If	St
Per	0.158	0.257	0.771	0.000	0.000
Af/ss	-	0.015	0.082	0.003	0.000
Sen	-	-	0.365	0.000	0.000
Af/s	-	-	-	0.000	0.000
If	-	-	-	-	0.19

In bold: probably suggestive one have been marked.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Energy

The total maximum energy in the dB (decibels) of accentuated syllables, E1 and E3 have been presented relative to a non-accentuated syllable E2 for all PPF categories. For the relation between E1/ E2 , the results have been analysed in Table 9, F(1.46), - 5.140, p ‹ 001. The results showing the relation between E3/E/2 ares shown in Table 10. F(1.46) = 7.594, p ‹ 000.

Table 9. *p values (LSD test) for the relative Energy of the first syllable bwe/ with respect to the 2nd. /no/ (E1 / E2).*

E1/E2	Af/ss	Sen	Af/s	If	St
Per	0.473	0.796	0.002	0.001	0.011
Af/ss	-	0.632	0.023	0.014	0.078
Sen	-	-	0.03	0.02	0.020
Af/s	-	-	-	0.716	0.738
If	-	-	-	-	0.523

In bold, probably suggestive ones.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Table 10. *p values (LSD test) for the relative Energy of the third syllable /sí/ with respect to the 2nd. /no/ (E3 / E2).*

E3/E2	Af/ss	Sen	Af/s	S. Inf	Est
Per	0.010	0.02	0.000	0.000	0.000
Af/ss	-	0.697	0.166	0.021	0.109
Sen	-	-	0.283	0.036	0.181
Af/s	-	-	-	0.238	0.673
S.Inf	-	-	-	-	0.522

In bold, probably suggestive ones.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Duration

The analysis of duration (TD) is one that shows the least differences. Differences between normalized duration to total duration, noted for each syllable, turned out to be insignificant. For example, for the last syllable that shows a major number of variations, due to it´s place in the phrase, the analysis of the variation, showed the absence of suggestive differences between the groups, $F(1.46) = 1.013$, $p < .423$. Nevertheless, the analysis of variations in $F(1.46) = 3.258$, $p < 0.015$, for the total duration are explored in Table 11.

Table 11. *p Values (LSD test) for Total Duration (TD).*

TD	Af/ss	Sen	Af/s	If	St
Per	0.915	0.036	0.056	0.887	0.004
Af/ss	-	0.065	0.097	0.979	0.009
Sen	-	-	0.755	0.050	0.311
Af/s	-	-	-	0.077	0.181
If	-	-	-	-	0.006

In bold probably suggestive ones.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

The analysis of probabilities obtained, allows the construction of patterns, of distinctive acoustic characteristics that categorize the different groups classified by PPF (Table 12).

Table 12. *Differencial acoustic parameters in each group.*

	Af/ss	Sen	Af/s	If	St
Per	F0M F0m RF0 /no/ E3/E2	F0M F0m Rank F0 RF0 /sí/ E3/E2 TD	F0M Rank F0 RF0 /we/ RF0 /sí/ E1/E2, E3/E2	F0M F0m Rank F0 RF0 /we/ RF0 /sí/ TME E1/E2, E3/E2	F0M Rank F0 RF0 /we/ RF0 /sí/ TME E1/E2, E3/E2 TD
Af/ss	-	F0M F0m Rank F0 RF0/no/ TME	F0M F0m Rank F0 RF0 /we/ RF0 /no/ E1/E2	F0M F0m Rank F0 RF0 /we/ RF0 /no/ TME E1/E2, E3/E2	F0M F0m Rank F0 RF0 /we/ RF0 /no/ TME TD
Sen	-	-	E1/E2 RF0 /we/	TME E1/E2, E3/E2 RF0 /we/ TD	TME E1/E2 RF0 /we/
Af/s	-	-	-	TME	TME
If	-	-	-	-	TD

E1/E2: relative energy mbetween the first and second syllable /we/ and /no/. E3/E2: relative energy between the third and second syllable /sí/ and /no/.F0M: fundamental frequency maximum. F0m: fundamental frequency minimum. RF0: fundamental frequency rank. RF0 /we/, RF0 /no/, RF0 /sí/: pitch of F0 as averaged by syllables. TME: total maximum energy, TD: total duration.
P: persistent, Af/ss: affective/self-secure, Sen: sensitivity,
Af/s: Affective/sensitivity If: inferiority feeling, St: stability.
Source: Author.

Discussion

Lehiste (1970) pointed out fundamental frequency, energy and duration as three acoustic parameters related to speech, intertwined through segments and sequences of segments (suprasegmental) responding to a previous brain programme. The suprasegmental characteristics are temporal patterns manifest as phonologic units of diverse duration. Finally she informs about having no doubts regarding the fact that speech has a rhythmic structure (Lehiste, 1970).

She also defines the rhythmic structure as an accentuated syllable followed by a variable number of non-accentuated variable number of syllables connected to the first one. Henderson et al. (1966) added that rhythmic units also include the pauses during speech. Allen (1973) introduces a model that describes precisely how the duration of segments of speech are controlled during speech and calls the neural underlying mechanism, the 'segmental clock'.

Strangert points out speech, rhythm is manifested in the temporal structure of the accentuated and non-accentuated syllables. This structure differs in several languages, and seems to be the basis of perceived rhythmic differences. In parallel, there is evidence that regular temporal adjustments are independent whichever language is being spoken (Strangert, 1987). Studies on the rhythm of speech in Spanish have been added by latinoamerican authors (Borzone & Signorini, 1983; Toledo 1985a; 1985b).

Kramer (1963) proposed a programme to be developed, regarding the study of the acoustics of the human voice, as a tool to categorize interindividual differences, through inferences from emotional language characteristics taken from its non-verbal aspects, both in speakers and listeners, useful as well for psychopathological states. Huttar (1968) described the degree of emotional perception increases in parallel to the pitch of f_o of the speakers as well as the major pitch of intensity. Williams and Stevens (1972) attempt to correlate emotions such as anger, sadness and fear with acoustic parameters of speech, arriving at the conclusion that the contour of F0 in time is the most useful measure for guidance.

Cosmides (1983) carried out an experiment in which 11 subjects read 10 passages with different emotional meanings, finding that acoustic expressions were extremely similar for the different subjects, relative to the defined text being read, concluding that different subjects produced standard acoustic configurations to express their emotions.

For Gérard and Clement (1998), joy produces the most acute intonation change, with a major deviation in the pitch of F0. The control of all parameters related to the emotional expression is completed at the age of 5 years old. Recent descriptions of the intonation have permitted a phonologic inventory for the intonation groups and tonal units typical of Spanish as spoken in Argentina (Gurlekian et al, 2001; Colantoni & Gurlekian, 2004).

The analysis of the acoustic results could separate the six groups under study according to different parameters. Nevertheless, it is noted that a greater number of cases will be need in order to more clearly differentiate the PPF factors or temperaments by mean of acoustic studies.

In Table 12 we summarized individual patterns of each group taking into account only the significative differential parameters. '*Persistent*' group (rhythmic in older classification) and '*Affective/ self-secure*' are shown, having the larger quantity of different characteristics that clearly stands out from the rest. Between them, there was significative differencies in R.F0 /no/ (Table 6). The energy relationship between the first stressed syllable (bwe) and the second unstressed (no) (E1/E2) can differentiate the PPF '*Sensitivity*' in respect of the other three groups (Table 9).

Regarding the discriminating capacity of RF0, RF0/we/, and F0max, allowed the definition of three groups but do not solve the distinction between '*Affective/ Sensitive*', '*Stable*', and '*Feelings of Inferiority*'. '*Affective/sensitive*' group differs from '*Stable*" and '*Feelings of Inferiority*' by only the low Total Maximum Energy parameter (Table 8). The characteristics obtained from energy: E1/E2, E3/E2, and TME, define five factors, but do not effectively distinguish between Stable and Feelings of Inferiority but. Total Duration (TD) could distinguish on these two factors (Table 11).

Spoken acts of a longer length should be considered, where the rhythmic aspects might be better studied. Besides, future study of the acoustic determination of parameters in the psychometric group '*Security*' may be required.

Below, further applications of this type of study, besides those mentioned as complementary to the psychometric tests:

1. *Neuro and Psychopathologic speech*. The description of the acoustic parameters of a community of normal individuals, classed according to the PPFs may allow the analysis of patients with language pathologies, with a more specific reference to psychyatric patients, not included in the present paper.

2. *Artificial Intelligence* (IA). Generating an artificial voice requires the utmost quality and lifelikeness, where factors due to personal characteristics could be required to carry out a successful communication.

3. *Forensic*. The determination of the identity of a speaker during forensic tests, may also, consider prototypical non-linguistic characteristics of speech.

Conclusions

Acoustic studies can complete the psychometric ones in order to differentiate the individuals corresponding to each of six PPF, since the acoustic measurement systems are easy to implement on a personal computer. The analysis of the acoustic results could separate the six groups under study according to different parameters. Nevertheless, it is noted that a greater number of cases will be need in order to more clearly differentiate the PPF factors or temperaments by mean of acoustic studies. The most determining characteristics of the fundamental frequency were: its maximum values (a), total range values (b) and the range of the first syllable of the intonation phrase (c). The most distinctive energy characteristics are: the maximum value of the entire utterance (d), and the maximum energy values of the stressed syllables with respect to the unstressed ones that surround them (e, f).

The total duration of the emission has shown some capacity for differentiation (g), however the parameters related to the temporal factor must be explored in greater depth.

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