Expressivity resources used by a university professor

Recursos de expressividade utilizados por um professor universitário

Recursos expresividad utilizado por una profesora universitaria

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Abstract

Introduction: The voice is the main tool of the teacher's work and it is closely related to a good professional performance. Several vocal and body resources are used in classroom by teachers in order to arouse the interest of the student, to facilitate memorization and to enhance their learning. **Purpose:** To study the communication performance of a professor through an auditory perceptual and acoustic analysis of voice and speech, and through the analysis of gestures, to verify the association of these resources as strategies of expressivity. **Material and Method:** We video-recorded some classes of a professor well evaluated by her students. After, we performed an auditory perceptual and acoustic analysis of the prosodic aspects of her voice and her speech, and a visual analysis of the video to classify the gestures enacted by her. **Results:** We noted the employment of six vocal expressive resources: frequency, intensity and speech rate variation, silent pause, extension of segments and exaggerated articulation. Regarding to gestures we observed the use of four gestural resources: a combined deictic and action gesture, modal, depiction and deictic. Furthermore, the association of gestures with speech was observed. **Conclusions:** In speech, the expressivity manifested through the frequency (variation of melodic curve) and vocal intensity increase, variation of speech

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Conflict of interests: *No*

Authors' contributions: *LLA project management, methodology development, analysis of data, orientation graduate, writing, final review. PMC analysis of the data, formatting of figures, writing. EFM project management, group coordination of researchers, writing, final review. ALB writing, final review. EFS writing, final review. LM analysis of gestures, writing, final revision, revision of translation into english. RRP writing, data collection, final review.*

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Received: *16/04/2014;* **Accepted:** *31/08/2014*

rate, exaggerated articulation; extension of segments and silent pauses. In the gestures, the expressivity manifested predominantly by combined deictic and action gestures. In most cases, the gestures were associated with speech.

Keywords: voice; speech acoustics; gestures; faculty; learning; nonverbal communication.

Resumo

Introdução: *A voz é a principal ferramenta de trabalho do professor e está intimamente relacionada ao seu bom desempenho profissional. Diversos recursos vocais e corporais são empregados pelo professor durante a aula para despertar o interesse do aluno, facilitar a memorização e potencializar seu aprendizado.* ***Objetivo:*** *Estudar o desempenho comunicativo de uma professora universitária, por meio da análise perceptivo-auditiva e acústica de aspectos prosódicos da voz e da fala, e da análise dos gestos, investigando a interação desses recursos como estratégias de expressividade.* ***Material e Método:*** *Foram gravadas em vídeo, aulas de uma professora universitária. Posteriormente, foi realizada análise perceptivo-auditiva e acústica dos aspectos prosódicos da voz e da fala, e análise visual do vídeo para classificar os gestos utilizados.* ***Resultados:*** *Observou-se o emprego de seis recursos vocais expressivos: variação da frequência, da intensidade e da velocidade de fala; pausa silenciosa; prolongamento de segmentos; e articulação exagerada. Quanto aos gestos, observou-se o uso de quatro tipos: dêitico combinado com representacional de ação, pragmático de modo, representacional de descrição figurativa e dêitico.* ***Conclusões:*** *na fala, a expressividade se manifestou por meio da variação da frequência (variação da curva melódica), da intensidade vocal e da velocidade de fala; da articulação exagerada; do prolongamento de segmentos; e de pausas silenciosas. Observamos o predomínio do uso de gestos dêiticos combinados com representacionais de ação. No episódio analisado os gestos estavam associados à fala.*

Palavras-chave: *voz; acústica da fala; gestos; docentes; aprendizagem; comunicação não verbal.*

Resumen

Introducción: *La voz es la herramienta principal de trabajo del profesor y está estrechamente relacionada con su buen desempeño profesional. Diversos recursos vocales y corporales son empleados por el profesor durante la lección para despertar el interés de los estudiantes, facilitar la memorización y mejorar su aprendizaje.* ***Objetivo:*** *Estudiar el desempeño comunicativo de una profesora universitaria, a través del análisis perceptivo-auditivo y acústico de aspectos prosódicos de la voz y del habla y del análisis de los gestos, investigando la interacción de estos recursos como estrategias de expresividad.* ***Material y método:*** *Fueron grabados en video lecciones de una profesora universitaria. Posteriormente, se realizó un análisis perceptivo auditivo y acústico de los aspectos prosódicos del habla y el análisis visual del vídeo para clasificar los gestos utilizados.* ***Resultados:*** *Se observó el empleo de seis recursos expresivos vocales: variación de la frecuencia, de la intensidad y de la velocidad del habla; pausa silenciosa, prolongación de segmentos y articulación exagerada. En cuanto a los gestos se observó el uso de cuatro tipos: deíctico combinado con representante de acción, pragmático de modo, representante de descripción figurativa y deíctico.* ***Conclusiones:*** *en el habla, la expresividad se manifiesto mediante la variación de la frecuencia (variación de la curva melódica), de la intensidad vocal y de la velocidad del habla vocal de la articulación exagerada, de la prolongación de los segmentos y de las pausas silenciosas. Se observó el predominio del uso de gestos deícticos combinados con representantes de la acción. En el episodio analizaron los gestos estaban asociadas con el habla.*

Palabras clave: *intervención precoz; fonoaudiología; desarrollo infantil.*

Introduction

The last years have seen an increased interest in the study of communication, mainly in individuals who depend on it for their work, such as voice professionals, among whom professors stand out. To have good communication performance a professor needs to have a healthy voice, which is also pleasant to his listeners[1].

For professors, the voice is closely related to a good performance in the class room[2]. The professors' success in the classroom depends on their communication profile. Communicating in the classroom involves features such as speech, body and voice and essentially depends on the way the content is conveyed. To this end, various vocal and body resources are used during classes to raise student interest, facilitate memorization and potentiate learning. Prosody, articulatory and gestural features and voice speed must also be taken into account, as they influence how effectively the message is delivered. Regarding professor communication profiles, we can state that voice changes and an imbalance in communication resources may hinder the professor performance[1,3].

There is extensive literature on voice alterations and vocal complaints in professors; however, the literature on professor communication performance is still scarce.

Prosody is fundamental in communication; it plays a decisive role in speech organization and conveys information that goes beyond the verbal content. The meaning of an utterance can be modified by changes in syntax structure, lexicon, context or simply prosody. The same utterance can be produced using various melodies, intensities and time organizations to convey different meanings.

In turn, gestures can indicate objects, represent actions, illustrate or strengthen elements of the speech and even convey meaning by itself when repeated many times in the same situation[4] and thus make understanding easier and favoring further learning.

Professor communication in the classroom occurs in a multimodal way: through written and spoken words, gestures, drawings and other means. A study on gesture proposed that gestures are rhythmically coordinated with the utterances they are associated with[5].

The classroom is a complex social environment where professors seek to interact with students to convey a certain point of view. It is a socially constituted space to favor the making of meaning. The professor's task is also complex, as the professor must manage the class space/time, in addition to the velocity of production of knowledge, new information technologies and communication, support the students in the making of knowledge and development of ethical, political and other values, regardless of the social medium they are within, impart knowledge taking into account the social context and expanding the limits between disciplines, develop the students' individual awareness, and favor the internalization of knowledge, among other activities[6-7].

Although undergraduate level classes are of great importance to university, they have not been systematically and thoroughly investigated[7-8]. The disregard for university professors' didactic skills may be associated with one of the gaps in higher education professor training: the lack of knowledge of the importance of professor performance in teaching[9]. One of the skills expected from professors is related to the professors' communicative action that favors professor-student interactions and contributes directly to the teaching and learning process. Discourse intentions are at the core of the making of new meanings by the students[10]. Despite the importance of discourse and classroom interaction features, relatively little is known about these interactions and how the different types of discourse can contribute to student learning, particularly regarding university professors. However, there is a growing interest in the meaning-making process in the classroom. Researchers have sought to answer how meanings are made and developed through language and other forms of communication[6,10].

The goal of the present study was to investigate the communicative performance of a university professor who is well evaluated by the students. Voice and speech prosodic features were evaluated through perceptual, auditory and acoustic analysis and gestures were evaluated through the analysis of the interaction between voice, speech and gestures as expressivity resources.

Material and Method

This study was approved by the Research Ethics Committee of the Federal University of Minas Gerais (UFMG), Opinion No. 0121.0.203.000-10. The participants gave their written informed consent of participation in the study.

A female professor aged 44 who is well evaluated by Chemistry undergraduate students from UFMG was chosen. The evaluation of the professor was based on an institutional instrument in which the students evaluate their professors and classes at the end of each term. Our initial hypothesis was that a well evaluated professor might present a better interaction of expressivity resources. The professor

is a native speaker of Brazilian Portuguese and the video recorded class was taught in this language.

A sequence of classes was recorded with a video camera (Sony, HVR-A1U C-MOS 1080i HDV) with directional microphone (coupled ECM-NV1). Class episodes in which gestures were extensively associated with the speech were selected from the collected material.

The analysis episode was converted from *.wmv* to *.wav* file format with the VideoConverterXLite software for later acoustic analysis of voice and speech using Praat 4.6.40 software.

For ease of analysis, the episode was divided into the following fragments:

1: "Dois, duas observações: por que essa reação é lenta?"; 2: "Porque para que a reação ocorra o cloro tem que estar antiperiplanar ao hidrogênio."; 3: "E, essa condição só ocorre na conformação mais instável."; 4: "Ou seja, a molécula tem que mudar de conformação e isso demanda uma energia de ativação grande para reação poder ocorrer."; 5: "A gente sabe que o equilíbrio está todo deslocado pra cá."; 6: "Mas um pouquinho que forma desse aqui, dessa conformação, a base enxerga, ataca e forma o produto."; 7: "Aí o equilíbrio vai deslocando."; 8: "Então a reação é lenta porque a molécula precisa mudar de conformação, e ir para uma conformação mais instável."

1:"Two, two observations: why is the reaction slow?", 2: "Because for the reaction to occur, chlorine has to be in position antiperiplanar to the hydrogen.", 3: "And this condition occurs only in a more unstable conformation.", 4: "That is, the molecule conformation has to change and this requires a great activation energy for the reaction to occur.", 5: "We know that the equilibrium is moving here., 6: "But the little [product] that is formed here, in this conformation, the base sees and attacks it and forms the product.", 7: "Then the equilibrium gradually moves.", 8: "Then, the reaction is slow because the molecule conformation needs to change to a more unstable conformation."

Some prosodic parameters were measured in the acoustic analysis and perceptual-auditory evaluation. This analysis was performed by one of the authors, the one who is a voice therapist with over 10-years' experience in the area.

The acoustic analysis shows a variation in frequency (maximum - minimum frequency, in Hz), melodic curve characterization (rising or falling), pause duration (in s), prolongation duration (in s), melodic variation velocity rate (frequency variation divided by the duration, in Hz/ms).

The perceptual-auditory evaluation was divided in two parts. The first part was the global evaluation of the voice: voice quality, degree of voice alteration (if any), articulation, resonance, voice projection, pneumophonic and phonodeglutition coordination, pitch and intensity fall, vocal breaks (frequency and/or sonority), pitch, loudness, usual vocal range, tension, posture, voice psychodynamics and type of respiration. The second involved the evaluation of speech prosodic elements: pitch variation, loudness variation, duration and types of pauses (silent or filled), duration of prolongations and speech velocity.

The selected episode was also visually analyzed for classification of the gestures used and analysis of the gesture-speech interaction. This analysis followed the classification proposed by Kendon[5].

In this classification, we considered three reference gestures that represent one aspect of the utterance content: (a) action gesture, in which the body parts used in gesturing present an action pattern similar to that referred to in speech, (b) depiction gesture, when the speaker sculpts and/or sketches the shape of the object being described, that is, "creates" the object in the air, c) deictic gesture, when the speaker points to the object, either concrete, virtual or abstract, mentioned in the speech. In addition, there is pragmatic gesture, which is related to the meaning of the utterance which is neither part of the referential meaning nor the propositional meaning. In the present study, the professor used pragmatic gesture with intensifying function.

As the recording was performed in classroom, a relatively noisy environment, signal interference prevented acoustic analysis with a broadband spectrogram. The speech signal was better observed in a narrowband spectrogram.

Results

The global perceptual-auditory analysis of the professor's voice revealed: voice quality, articulation and normal usual tone range, balanced resonance, adequate vocal projection and pneumophonic and phonodeglutition coordination, absence of pitch and intensity fall of voice breaks, sharp pitch, increased loudness, absence of tension, adequate posture and psychodynamics (for sex, age, profession and context) and upper costal breathing.

The perceptual-auditory and acoustic findings are described next, in relation to the gestures that stood out in the development of the professor's good communicative performance.

In fragment 2, when the professor uttered *"Porque para que a reação ocorra"* the vowels /o/ and /e/ in the word *"porque"* were prolonged, 0.23 s and 0.24 s, followed by a silent pause of 0.62 s, evidencing that an explanation would follow.

The prolongation of the first /a/ vowel in the word *"para"* (0.38 s) was simultaneously accompanied by a deictic gesture, combined with an action gesture, with an arc movement from one point on the board to another. This gesture was performed in synchronicity with the speech, that is, at the same velocity, to represent the chemical reaction. Additionally higher pitch and loudness were used in the first /a/ of *"para."* At the end of the utterance, on the word *"ocorra,"* the professor raised the pitch and loudness (rising melodic curve) and prolonged the utterance of the second /o/ (0.26 s) and of vowel /a/ (0.24 s) in this word. The professor held the gesture when she touched the board with her left pointing finger flexed while she uttered *"orra"* in the word *"ocorra."* This utterance was finished with a silent pause (0.64 s). The gesture and speech duration and velocity were associated. These data are illustrated in Figures 1 and 2.

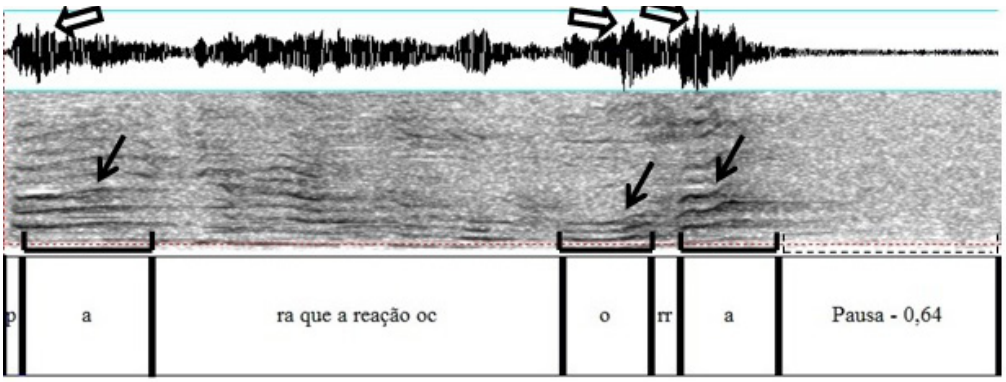


Figure 1 - Oscillogram and spectrogram of the segment *"... para que a reação..."*

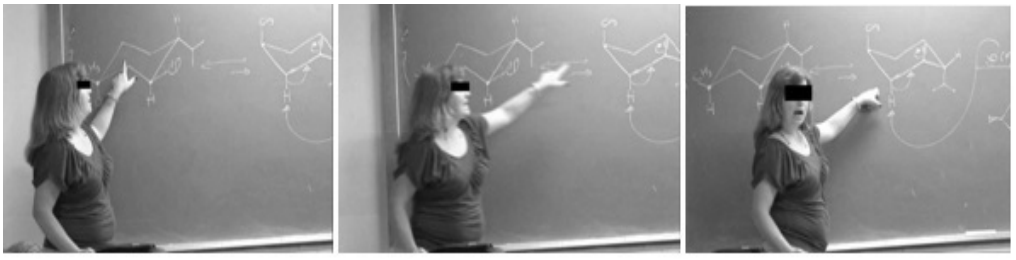
Key

Rising melodic curve

Pause

Prolongation

Increased intensity



para... ***que a reação*** ***ocorra...***

Figure 2 - Gestures used in the segment *"...para que a reação ocorra..."*

It is worth pointing out that in the perceptual--auditory analysis in the entire study, a higher pitch was always associated with a rising frequency curve and a lower pitch was always associated with a falling frequency curve in the spectrogram. Likewise, higher loudness in the perceptual-auditory analysis was always associated with a greater amplitude oscillation in the oscillogram, and lower loudness to smaller amplitude.

When the professor uttered the rest of the fragment "chlorine has to be in a position antiperiplanar to the hydrogen," she prolonged the first (0.27 s) and the last (0.27 s) /a/ vowels and the /e/ vowel (0.23 s) in *"antiperiplanar."* The perceptual-auditory analysis also showed higher loudness on this same vowel. The use of these prosodic resources, associated with the combined deictic and action gesture, clearly indicated the beginning, middle and end of the word *"antiperiplanar"* and made the students' understanding easier. The professor first pointed out the chlorine in the structural formula and then made a movement with her left pointing finger towards the hydrogen, which was lower, and further ahead the chlorine (anti), thus attributing meaning to the word *"antiperiplanar"* through speech and gesture.

The professor's speech velocity was generally high, with a mean of 5.28 syllables per second (syl/s). However, when she uttered: *"Porque, para que a reação ocorra, o cloro tem que estar antiperiplanar ao hidrogênio,"* she did it with a lower velocity (3.09 syl/s), adjusting the velocity of the gestures to the velocity of the speech to impart meaning to her explanation. She probably used a low speech and gesture velocity because she wanted to emphasize the velocity of the reaction. As previously described, she repeated the combined deictic and action gesture, holding her left pointing finger flexed in three moments: while she uttered *"orra"* in the word *"ocorra," "anti"* in the word *"antiperiplanar"* and *"gênio"* in the word *"hidrogênio."* The reduction of the speech and gesture velocity, the recurrence of the gesture and the segmentation of the utterance associated with the said gestures were used to facilitate the students' understanding of the chemical reaction.

In fragment 3 *"E, essa condição só ocorre na conformação mais instável,"* the professor used a different means to produce emphasis. When she uttered the vowel /e/ in the beginning of the segment, she varied the pitch and realized a rising--falling melodic curve with a melodic variation rate of 0.17 Hz/ms. She also prolonged this vowel (0.31 s), raised the loudness and made a long silent pause next (0.41 s). Together with the utterance of vowel /e/, she made a pragmatic gesture. After this pause following the /e/ vowel, the speech velocity decreased; this was the slowest utterance in the entire episode (2.86 s). This also was the resource the professor used to emphasize what she was saying.

In the utterance *"na conformação mais instável...",* the pitch varied from adequate to high (rising melodic curve) and the nasal /i/ vowel (0.24 s) of *"instável"* was prolonged. Simultaneously to the utterance of this vowel, she started a downward movement with the left hand from the top to the bottom of the board. The movement was finished when she touched the bottom of the board with her finger, the moment she uttered the vowel /a/ of the same word at a higher degree of loudness. The professor made a recurrent combined gesture – deictic and action gesture, which in this context indicated *"antiperiplanar."* In this way she indicated that the most stable conformation was the antiperiplanar conformation through speech and gesture, simultaneously. This fragment shows the complementarity of these two modes. Once more, the professor segmented the utterance with a combined gesture for emphasis.

In Fragment 4, *"Ou seja, a molécula tem que mudar de conformação e isso demanda uma energia de ativação grande para reação poder ocorrer,"* the professor uttered the syllable /dar/ of *"mudar"* in a higher pitch (rising melodic curve) and loudness and prolonging the vowel /a/ (0.22 s). She simultaneously performed a recurrent combined gesture – deictic and action gesture – to indicate the chemical reaction. The higher pitch and loudness of this segment and the duration of the utterance associated with the amplitude of the gesture placed emphasis on the word *"mudar."*

In the segment *"...e isso demanda uma energia..."* of this same fragment, the melodic curve was rising-falling-type. Simultaneously to the utterance of this segment, the professor made a depiction gesture by drawing the activation energy

graph with a rising-falling hand movement in the air, following the same direction of the voice frequency curve, also rising-falling. The first /a/ vowel in *"demanda"* (0.18 s) and of the vowel /i/ in *"energia"* (0.21 s) were also prolonged. The loudness of the same vowels was also increased and the duration, loudness and pitch were associated with the gesture type and amplitude. These data are illustrated in Figures 3 and 4.

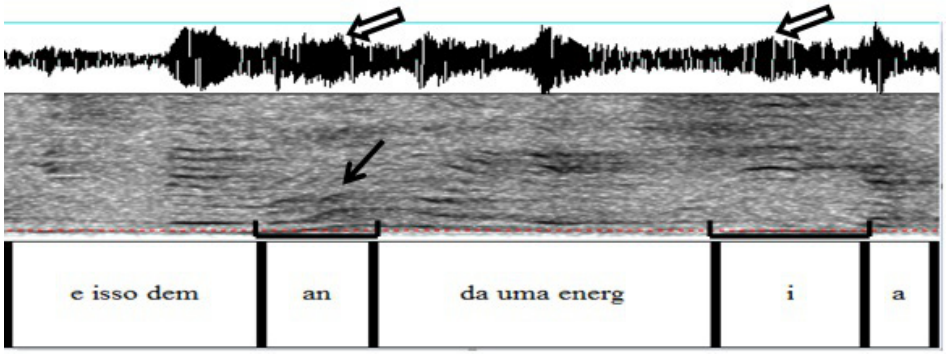


Figure 3 - Oscillogram and spectrogram of the segment "*...e isso demanda uma energia...*"

Key

Rising-falling melodic curve

Prolongation

Increased intensity

...demanda... ***... ener...*** ***... gia...***

Figure 4 - Gestures performed with words utterances "*... e isso demanda uma energia...*"

On finalizing the segment *"para reação poder ocorrer,"* the professor held the pitch high. She simultaneously made a combined deictic and action gesture with an arc movement from one point of the board to another to represent the chemical reaction. At the end of the fragment, when the professor uttered the word "ocorrer," she made a falling frequency curve by making the pitch lower and simultaneously touched the board (finishing the gesture) to close the reasoning.

In Fragment 5, *"A gente sabe que o equilíbrio está todo deslocado para cá,"* when she uttered the word *"equilíbrio",* she made a combined deictic and action gesture following the direction of the arrows that indicated the direction of reaction. She prolonged the utterance of the segment *"está todo deslocado para cá"* (0.13 s) and the melodic curve rose (made the pitch higher) in the first /o/ vowel in *"todo"* accompanying the speech velocity with a combined deictic and action gesture to indicate the shift in equilibrium. This also is a recurrent gesture that indicates chemical reaction. To finish the fragment, the professor used a falling melodic curve (made the pitch lower) and ended with the associated gesture. It is important to point out that the gestures were performed fast, agreeing with the increased speech velocity (7.63 syl/s). This was the fastest utterance of the analyzed episode. The speech velocity and gesture increased at the exact moment that she mentioned the increase in the reaction velocity.

In fragment 6, *"Mas um pouquinho"* she varied the pitch with a rising melodic curve (using a higher pitch) when she uttered the word *"um"* and the vowel /i/ in *"pouquinho"* and with a falling--rising melodic curve (pitch variation from low to high) and the prolongation of the last /o/ vowel in *"pouquinho."* We also observed the use of higher loudness in the two /o/ vowels of the same word.

In continuation, in the segment *"que forma desse aqui, dessa conformação,"* the professor made a deictic gesture while pointing to the conformation that she was referring to at the same time that she looked towards the students and then to the board. Next, she made a silent pause (0.48 s) and continued with a series of gestures: the first gesture was deictic and made with her pointing finger and the second and third gestures were combined - deictic and action gestures (the first with her thumb and the second with her pointing finger) simultaneously to the utterance of the segment *"a base enxerga, ataca e forma o produto."* These gestures were made during short silent pauses of 0.05 s between the utterances of the word *"base"* and *"enxerga"* 0.06 s, after the utterance of *"ataca"* and 0.05 s, after the utterance of *"forma o produto."*

In fragment 7, *"Aí o equilíbrio vai deslocando,"* the utterance was accompanied by a combined deictic and action gesture to demonstrate the shift of the equilibrium and the chemical reaction. The gestures were marked on the second /i/ vowel of *"equilíbrio"* and in the nasal vowel /a/ of *"deslocando."* These vowels were marked by higher loudness. The word "deslocando" also had a falling melodic curve (lower pitch) on the vowel /a/.

Fragment 8, *"Então a reação é lenta" was accompanied by a pragmatic gesture, prolongation of nasal vowel /e/ in "lenta"* (0.27 s), thus characterizing slowness, and with a falling-rising melodic curve on the same vowel.

The segment *"porque a molécula precisa mudar"* was uttered in a higher speech velocity (5.61 syl/s). In the visual analysis of the gestures associated with the speech, the combined gestures (Figure 5) performed in this segment were synchronized with the speech, that is, had the same velocity. The professor used a higher tone of voice in this segment and closed the fragment with a pragmatic gesture, moving her hand in the air downward while uttering *"e ir para uma conformação mais instável."* The utterance of the word *"instável"* was prolonged (0.21 s) on the vowel /a/ and its loudness was stronger. The word was also articulated in an exaggerated way for emphasis, which was expressed both in the speech and with a gesture. The emphasis was predominantly made through a higher pitch and loudness, as well as by prolongation of the segments and pauses. The emphasis through gestures was made mainly with the combined gestures that accompanied the speech. The professor's facial expression was reduced, despite the extensive use of gestures. Her look went to and fro between the students and the board all the time, as if she were driving the students' attention

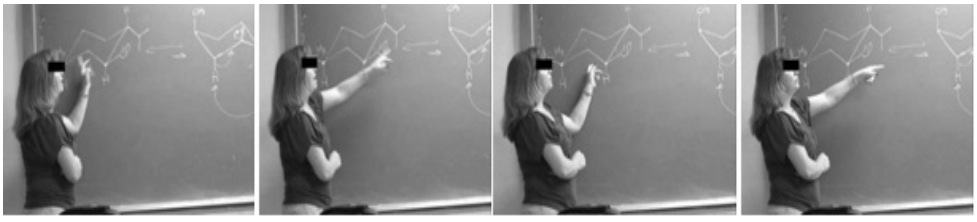


Figure 5 - Gestures performed with segment *"...porque a molécula precisa mudar..."*

to the reaction equation written on the board. She moved from one side of the board to the other slowly, following the direction of the reaction that she described with her body, mainly with her left hand, as she explained the reaction, thus imparting dynamism to her explanation.

In the analyzed episode, the professor used six voice expressive resources: frequency variation (22.82%) – with 50.02% being rising melodic curve, 21.42% falling melodic curve, 14.28% rising-falling melodic curve and 14.28% falling--rising melodic curve; silent pause (12.28%), filled pause not used; segment prolongation (29.82%); increase in intensity (28.07%); speech velocity variation (5.26%) – being 50% increasing speech velocity and 50% decreasing speech velocity and exaggerated articulation (1.75%). The professor used four gestural resources to impart expressivity to the communication: combined deictic and action gesture (64.72%), pragmatic gesture (17.64%), depiction gesture (5.88%) and deictic gesture (11.76%).

Segment prolongation and speech velocity reduction were used to refer to "slow chemical reactions" and the velocity of the combined gesture was reduced simultaneously, which confirmed the synchronicity of the gesture and speech association. When the professor referred to "fast chemical reactions," she increased the velocity of both the speech and the combined gesture simultaneously.

The gesture always ended simultaneously with the speech. Pause with communicative intention was also used in various fragments to divide words or segments.

The pitch of the fragments varied and the duration of some segments was prolonged and vowel loudness was increased in stronger words. Simultaneously to these vocal resources, a gesture indicated the beginning, middle and end of these words. In other situations, the separation of words or segments was determined by pauses with the syllable before the pause uttered at the same time that the gesture was produced and both finished at the same time.

Loudness variation was directly related to gesture amplitude. In segments with higher loudness, the gestures were broader and vice versa.

In most of the analyzed fragments, the gesture direction followed the melodic curve. In a rising--falling melodic curve, the professor simultaneously made a rising-falling movement with the hand, in the same direction of the voice frequency curve.

Another determinant of hand movement was the direction of the chemical reaction. Many times the professor moved her body in the same direction as the reaction.

Discussion

A limitation of the present study was the relatively noisy recording environment, a classroom, which is not considered ideal for recording material for acoustic analysis. There was noise interference with the signal that made it impossible to carry out the acoustic analysis by broadband spectrogram normally used for speech analysis. The solution found was to employ narrowband spectrogram in this study, which allowed a better visualization of the speech signal and did not interfere negatively on the analyzed prosodic features. It is worth pointing out that the recording was performed in the classroom because it is closely related to the objective of the study and data obtained in any other environment would be pointless.

The analysis of the class video recording showed:

1. The importance of the role played by the association of speech and gesture in the efficiency of communication in the classroom and in the maximization of expressivity.

This is corroborated by various studies in the literature. A study on the use of gestures proposed that gestures are rhythmically coordinated to the speech that they are associated with[5]. In a study on academic efficiency, the most highly recommended professors were those that communicated more and better with their students, which shows that a professor's competence is evaluated through communication competence[11]. However, this study only cited other studies and did not define what "good communication" is. Another study on gestural behavior investigated communication as one of the "skills" the professor has to develop to be able to share knowledge and experiences with colleagues and students[12].

A study on gestural behavior of good and bad speakers concluded that good speakers use more gestures that contribute to speech effectiveness than poor speakers. It also concluded that the more frequent the gestures, the more enthusiastic, extroverted, persuasive and verbally fluent the speakers[12].

There exists a synchronism between body gestures and speech. When we observe someone speaking in any language in various circumstances, we can see arm and head movements associated with the speech. Body and voice gestures occur simultaneously because they are controlled by the same hemisphere of the brain (right). They develop together since birth and are influenced by culture, society and context[13].

In this study, speech and gesture explained each other reciprocally in the construction of meaning, expanding meanings and complementing each other. Gestures complement and expand the speech, in a classic example of cooperation between oral and gestural modes. In other situations, gestures only place emphasis and strengthen words. The gesture-speech association played an important role in professor-students interactions.

The association of gestures to speech could be observed in the variation of intensity, for example, being directly related to gesture amplitude. Additionally, when the speech velocity varied, the gesture velocity also varied at the same time to accompany the speech. The professor used increased speech velocity most of the time; sometimes she reduced the speech velocity associated with a reduction in gesture velocity. Increased speech velocity imparted dynamism to the class and occasional reduction in velocity made understanding easier, mainly when it was associated with marked pauses.

It is worth pointing out that gesture direction followed the voice melodic curve in most of the analyzed episodes. Another determinant of gesture direction was the direction of the chemical reaction.

These findings corroborate the literature. According to a study[14], in adults, 90% of the body gestures with communicative function are produced during the speech. However, they are both coexpressive and cotemporal. Many researchers refuse to separate body movements and speech because they consider communication an interrelation act between communicative behaviors[15].

In this study, we observed the use of gestures together with speech associated with the intention of dividing words and segments to make the students' understanding easier. Segmentation was performed through short gestures and silent pauses.

2. in speech, expressivity was produced mainly through frequency and voice intensity variation, together with segment prolongation and pauses.

Various authors highlight the expressive and communicative functions of prosody, giving evidence that the production of an utterance with different tone patterns with a specific duration and intensity may produce different meanings and convey information on the speaker's attitudes and feelings[16-17].

Prosodic elements have various functions, such as: segmentation of speech flow, increasing intelligibility, facilitating speech comprehension, highlighting vocal production elements for prominence, expressing attitudes, emotions, physical conditions and state of mind.

We frequently use variations of prosodic parameters to express our emotions and attitudes. In social interactions, prosodic elements signal the speaker's attitude to the listener[16,18]. Even a monotonous speech is expressive, as it demonstrates that the speaker has some problem or may be sad or even sick[17].

The literature is consensual on the point that melodic variation is the most important characteristic of intonation[18]. In this study, frequency was constantly increased, together with variation in the melodic curve, as prosodic expressive resources. They were the most used by the professor.

Each utterance, word or syllable has a melody; there is no speech without melody[18]. When we choose the tone of a given utterance, this choice is followed by the intention to say something. A change in the direction of the melodic movement may change the meaning of an utterance; that is, the intonational meaning can change the lexical meaning of an utterance[18]. Intonation also has an identifying function. The melodic contour reveals individual characteristics of the speaker such as age, sex and psychological state.

In this study, the voice of the investigated professor is rapidly identified as a female voice because of the high pitch. Her active personality can also be perceived in the increased velocity and intensity of speech used in most of the class. The adequate use of intonation can also be perceived in the voice of the analyzed professor: falling melodic curve to finish sentences and thoughts, rising, rising-falling and falling-rising melodic curves were used in the middle of sentences for emphasis. The melodic curves, together with the gestures, agreed with the professor's speech and the content that she wanted to convey to the students.

Regarding prosodic parameter intensity, increased intensity was frequently used as an expressive prosody resource in this study.

The use of increased intensity in the discourse may express vitality and energy[19], or it may also reinforce a message[20]. The analyzed professor used this resource for emphasis, which agrees with the literature. A voice with low loudness does not reach the listeners and may demonstrate little experience in interpersonal relations, shyness, fear of reaction of others or inferiority complex[20]. It may also be used to pass the idea of greater proximity[21].

When used adequately, intensity demonstrates voice training and the mastering of one's voice[19]. Despite the predominant use of increased intensity for emphasis in the discourse, it was used accordingly by the professor.

Increased intensity is also observed when the frequency increases. However, these prosodic elements are normally studied separately. We presently observed the use of increased frequency with increased voice intensity.

Regarding prosodic parameter duration, we observed the constant use of segment prolongation for emphasis of specific parts of the text. This observation agrees with the result of the analysis of elementary teachers' speech, which used syllable prolongation as an emphasis resource[22].

Duration may indicate emphasis and hesitation. When there is hesitation, the duration of the last syllable is increased and is normally followed by a silent or filled pause. For emphasis, duration, which is normally increased, highlights some characteristic of the utterance[21]. In the present study, we did not observe the use of hesitations in the professor's discourse, even though she often used prolongation for emphasis, the prosodic resource that she used the most. Additionally, the professor used silent pauses with communicative intention to divide a segment of the speech, emphasize another or even finish one segment and start another, and to finish an idea.

Strategically used pauses are a very interesting resource that may raise the listener's expectation[23]. Pauses are important conversation organizers; they create a time of transition between turns. The investigated professor used pauses as a prosodic resource to divide words and segments and catch the students' attention. It is important to point out that the professor used only silent pause, without polluting the discourse.

In another study[22], another professor well evaluated by the students used syllable prolongation, pitch variation, high loudness and productive repetition of melodic patterns as emphasis resources. These resources contributed to the professor's way of expression being considered motivating, pleasant, capable of catching the students' attention and confident. The prosodic expressive resources used by the latter professor correspond to the main resources used by the professor investigated in this study: frequency variation (with predominant increase), increased intensity, segment prolongation and silent pauses.

3. Exaggerated articulation in some segments of the analyzed episode was another expressive resource that the professor used.

Accurate articulation conveys clearness of ideas and thought, granting credibility and expressivity to the discourse[19], while exaggerated articulation, with excess movements, wide opening of the mouth, causes the impression of affectedness

or lack of naturalness. In this study, exaggerated articulation was used to emphasize some words. Overall, the articulation was accurate and the discourse was natural and expressive.

4. In gestures, expressivity predominated mainly in combined deictic and action gestures.

In a comparison study of gestural behavior of good and bad speakers, the gestures most used by good speakers were performed mainly with their arms and hands following the speech flow and were closely related to the speech[12]. Bad speakers touched their own body and objects more often than good speakers. This study concluded that a speaker whose gestures accompany their speech can be classified as expressive, enthusiastic and persuasive.

In the present study, the professor used combined deictic and action gestures most of the time and they accompanied the speech flow and were closely related to it, corroborating the said study[12].

The analysis of the present findings point to new studies of professor expressivity. One possibility is the measurement of other prosodic features, facial expression and support resources used in the classroom, such as figures, objects, projection and others, to improve expressivity and consequently student learning.

However, we should point out that besides studies that analyze the communicative performance of professors, it is equally important to carry out prevention programs and training for complex performance in classroom, covering aspects from voice health and quality to expressivity.

Conclusions

The objective of this study was to analyze the communicative performance of a professor who was well evaluated by students through the perceptual-auditory and acoustic evaluation of prosodic speech features and gestures and the association between speech and gestures as expressivity resources. We observed the use of various prosodic resources associated with gesture, which was fundamental for an effective communication in the classroom.

Speech expressivity was observed through increased frequency, melodic curve variation, predomination of the rising-falling curve, increased voice intensity, speech velocity variation, exaggerated articulation, segment prolongation and silent pauses. Gesture expressivity was observed mainly in combined deictic and action gestures.

This study gave evidence of vocal, prosodic and gestural resources that are relevant to improve professor expressivity in the classroom. The association of these resources contributed to improve communication. A better knowledge of this subject may contribute significantly to the training of educators and other voice professionals.

Acknowledgments

Thanks go to the National Council for Scientific and technological Development (CNPq) for the support for this study.

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