Certainty and uncertainty in Brazilian Portuguese: methodology of spontaneous corpus collection and data analysis

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Abstract

This work presents a methodology used to collect some spontaneous social affect corpus and preliminary prosodic analysis of certainty and uncertainty in Brazilian Portuguese. The corpus was collected using a Wizard of Oz method (through EmOz platform). The scenario to induce certainty and uncertainty is based on the situation of a job interview, where a companion robot (Emox) is used as a trainer. The subjects were convinced to benefit from a free teaching of this "revolutionary" method to train to job interview. In this scenario the linguistic expressions are partially controlled, in order to focus the certainty/uncertainty expression mainly on paraphrasing and prosody. Data were preliminarily analyzed for audiovisual prosody: videos analysis were made regarding eyebrows, eyes, mouth and face/head movements, while audio analysis were made about acoustic prosody parameters of fundamental frequency and duration. The first results show that using EmOz within such a scenario is an efficient way to induct spontaneous but comparable speech production. Prosodic results show that fundamental frequency and duration measurements, as well as eyebrows, eyes, mouth and face/head movements are differently used in certainty and in uncertainty production in Brazilian Portuguese.

Index Terms: spontaneous attitudinal corpus acquisition, audiovisual prosody of (un)certainty, Brazilian Portuguese.

1. Introduction & theoretical background

As early noted by [1], one fundamental prosody's function is to express the speaker's affective states, such as emotions, attitudes or moods. More generally, in face to face communication the socio-affective states (intentions, attitudes, mental states) are the main cues of dialog efficiency. Here, the socio-affective prosodic expressions are assumed to be voluntary controlled and a part of the linguistic system, according to [2, 3, 4], differing in this way from emotions. In this paper we focused on two attitudes particularly relevant in dialog: *certainty* and *uncertainty*, specifically in Brazilian Portuguese (henceforth BP).

Since 15 years, many prosodic studies of BP have been focusing on the role of the prosody to express the speaker's attitudes or intentions [5, 6, 7, 8, 9]. Among the investigated attitudes in these prosodic studies we can find certainty and uncertainty, which were already studied in other languages.

Many studies held on several languages showed some similarities and differences between languages (confidence vs. doubt for French, English, Japanese, Vietnamese and Chinese [10]). More elicitated expressions were produced in some Dutch language studies [11, 12, 13, 14]: the audiovisual prosody was investigated to indicate the uncertainty degree in answers of factual questions. In these studies, the methodology for data acquisition was based on the answer to factual questions, as done in [15, 16]. The researchers (who do not show themselves to the participants at this moment) asked 40 questions to the subjects (students). Participants were recorded in audio and video (with a camera taking the participant's face). After this, the participants were asked if they would be able to recognize the answer to the same questions if they were in a multiple choice test. Subsequently, the same subjects answered the same questions in a multiple choice test. The authors' intention was to describe, through audiovisual prosody, the degree of uncertainty in each answer, measuring the Feeling of Knowing (FOK), defined as "people's ability to assess and monitor their own knowledge" [13].

Audiovisual prosodic differences between certainty and uncertainty in these studies include: i) concerning the verbal cues: the final boundary tone, where the High tone is associated to uncertainty, while the Low one is associated to certainty; the delay or the time to start the answer, longer times being linked to uncertainty; the presence of pauses, mainly filled ones (filled by 'uh', 'uhm' or 'mm'), is more frequent in uncertainty; ii) concerning the visual cues: gaze not focused and funny (marked) face, which are linked to uncertainty; presence of eyebrows movements or smiles, generally related to uncertainty [11, 12, 13, 14].

In BP, the prosody of certainty and uncertainty attitudes, as well as the prosody of other attitudes that are said to be related to them (like doubt, incredulity or obviousness) was mainly studied in acted speech. Most of these works investigate these attitudes in acted sentences, included or not in contextual situations [17, 18, 19, 20, 21]. The prosodic differences described in these attitudes concern fundamental frequency - F_0 (higher at the end of the sentence in uncertainty and doubt attitudes), intensity (stronger in certainty), duration (longer in uncertainty), and the presence of pauses and fillers (mainly in uncertainty).

For emotional prosody (involuntary production processing), some perceptive discriminations between acted and spontaneous speech were shown [22, 23]. The next step of this present study will be to compare acted and spontaneous expressions of certainty/uncertainty.

Thereby, we come to a paradox: how can we control the induction of spontaneous attitudes in order to get comparable data for several subjects, together with acted speech for the same subjects? In other words, how can we study real expressions of certainty and uncertainty attitudes on (quite) the same linguistic material? Using real interaction corpora can provide spontaneous speech, but we would not be sure that lexical items will be the same, as discussed in [24, 25]. In BP, the works investigating attitudes' prosody with spontaneous corpora [e. g. 8] had another problem: how to annotate the real productions, since even if the induction process is supposed to carry on certainty/uncertainty, it must be verified without influencing the annotation by the expected labels? To try to

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solve these problems and with the aim to study certainty and uncertainty in a spontaneous comparable corpus we decided to create a job interview scenario.

2. Material and methods

2.1. Corpus

(Un)certainty occurs in many contexts of verbal interactions. One context, perhaps easier to control, would be situations where answering questions is needed. For that reason it is the kind of protocol used the most to collect data to study (un)certainty. We can find many real situations where one has to answer questions: knowledge games, job interviews, giving information and so on. To have spontaneous answers in which (un)certainty can be expressed, we chose to create a job interview scenario (rather than doing a real job interview, due to ethical reasons), in which we could also use factual questions (which answers would be comparable due to lexicon similarities). This way we were able to use two kinds of question/answer interaction.

Many studies held by the Grenoble team are based on this methodological choice (a combination of a scenario conducted by Wizard of Oz method) to induct spontaneous affective speech [23, 24, 26, 27]. The advantages of this choice were discussed in [23], and among them we can highlight the possibility to induct attitudinal production in a controlled way.

To play this scenario, we chose to use EmOz, a Wizard of Oz platform, developed at LIG laboratory [28], which works with a companion robot Emox (developed by the Awabot Company <www.awabot.com>). This choice is based on three assumptions: the small robot, whose form is neither human nor animal, cannot perform humanoid gestures, that is the anthropomorphisation and interpretation of robot movements are reduced and then all the attention can be paid to the vocal productions; the recorded sentences said by the robot could be exactly repeated in each interaction with each different subject, in the same order, to have the same stimuli for each participant; the EmOz platform allows to control the robot remotely, while the subject thinks (s)he was interacting with a(n) (intelligent) machine.

About the EmOz platform, we use Excel files (scripts) associated to the robot Urbi system through a Java interface to program the robot's actions [28]. In these files it is possible to include the robot's actions like body or head movements, sounds or a combination of sounds and movements. The sentences the robot will say are prerecorded as wave files. The platform has a protocol and an improvisation mode. In the protocol mode we have a table with all the programmed robot's actions, in order, and we can follow the sequence by just clicking each table line. In the improvisation mode we have all the scripts and sounds as clickable buttons (and we can choose the scripts which will appear as buttons and drag and drop these buttons to organize them), and finally we have a recording button to record and play sounds on the spot (See figure 1).

The job interview scenario was organized as follow: first we recruited 9 Brazilian students at Grenoble University, two men and seven women, aged from 21 to 32 years, telling them they would do a job interview with a robot that could do and analyze job interviews. This way, the subjects thought they would evaluate the robot system while the robot would train them to do job interviews. Systems like this exist or are in development [29, 30, 31], which makes our scenario credible.

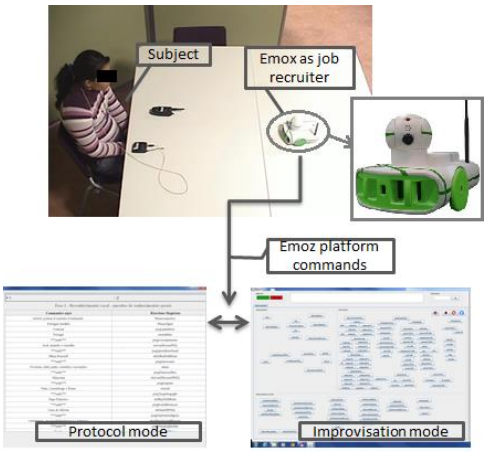


Figure 1: *Scheme to record the corpus*

When subjects arrive to do the job interview, we tell them there is a first interview phase in which the robot will make factual questions. This phase is justified by the need of voice recognition, i. e., the robot has to "learn" the subjects' voice, and the sequence of questions has this aim. In this context we placed a headset microphone on the subject, saying that this microphone would help with the voice recognition. The participants did not know they were being recorded. We also said this first phase was a pre-test used in some job interviews, in which the recruiter asks general knowledge questions. The factual questions were selected from a Brazilian factual questions collection, available in [32]. To ensure the production of answers with certainty and uncertainty we diversified easy and difficult questions. A group of 30 questions was evaluated by 10 Brazilian university students as easy, medium and difficult questions. After this evaluation, we saved 4 questions for each difficulty level (4 easy, 4 medium and 4 difficult), the four best within the judges agreement.

Along these questions we elaborated 12 mixed questions, which asked more than a thing at a time, and vary the level of difficulty among these asked items. For example, we asked which months of the year have less than 31 days. As February has 28 days, we expected subjects would easily remember February, but other months of the year that also have less than 31 days would take more time to remember. That's why in these questions, we expected to have productions in which subjects would deal with certainty and uncertainty at the same time, in the same answer. These 12 mixed questions were also evaluated by Brazilian students, and we saved the 8 in which judges agreed best in the classification. This way we saved 20 factual questions. These 20 factual questions were recorded by a Brazilian woman, with university education, who produced the questions with a standard Brazilian pronunciation. To start the experiment, the robot said it was ready to start. After each answer, there was a feedback from the robot saying it had heard the answer.

The job interview questions were taken from sites that list the main job interview questions in BP [e. g. 33 and 34]. We chose 12 of the most frequent questions in these sites. These questions were recorded by the same Brazilian woman who recorded the factual questions. To guarantee a real interaction with the subject in this phase of the experiment, the organization of the questions was made to make room to other questions, formulated at the moment of the interview, depending on the answers given by the subject. For example, one question asked was 'what are your strengths and your

weaknesses?'. If the subject answered that one of his(her) strengths was determination, we formulated a question like 'do you think your determination may help you in your work?'. These questions were included to make the robot look more intelligent, able to analyze a job interview, as we said, making our scenario more believable.

During the first (factual questions) and second (job interview) phases of our scenario we recorded the subjects, although they did not know, with two cameras: the first one directed to subjects' face and the second one taking the entire context. In Figure 1 we can see an image taken from the second camera, with the organization made for recording data.

In a debriefing phase, after the job interview, we asked the participants to evaluate the robot's system. After this, we told them that some participants evaluate as a strange situation to do a job interview with a little robot as a recruiter, so we told we would like to compare the manner to answer a robot to the manner to answer a person. With this pretext, we asked the subjects to answer again all the questions, this time asked by a human, thus we have one natural and one artificial production of the same linguistic material. Subsequently we told the subjects that we recorded all the experiment and we asked them if they could come back to watch their videos and to annotate how they felt during the experiment.

Three or four days after, subjects came back to watch their videos and freely annotate their feelings during the experiment. In this auto-annotation, the subjects could already remark they felt something related to (un)certainty. Nevertheless, to ensure this type of evaluation, we asked the participants to choose in a forced test if they felt certainty or uncertainty for each answer to factual questions.

At the end we revealed the real aim of the study: to find how we express (un)certainty in BP. According to this aim, we gave subjects their answers transcribed and we asked them to answer the questions twice again, firstly acting certainty and then acting uncertainty in each of their answers.

2.2. Audiovisual prosodic analysis

In this work, we will present only the analysis made on the answers of factual questions. With 20 answers from each of our 9 subjects, 180 answers were analyzed, and this number can vary due to the answers composed by more items.

The recorded videos were analyzed to verify the presence of eyebrows, eyes movements and funny face (considered as mouth movements), to watch gaze direction (if it was diverted or directed) and head movements (yes/no), while observing the attitude to which these factors were linked. Then we calculated the percentages of presence/absence of these factors.

Concerning audio, data were analyzed in Praat software [35], and fundamental frequency and duration measurements were made. Regarding fundamental frequency, initial, final, maximum and minimum F_0 values were taken for each sentence. After that, the final F_0 movement was measured, and its shape was observed. These values were taken in semitones, because different speakers produced the sentences and the relative semitones measurements can minimize interpersonal differences. However, results are presented separately for male and female subjects. Regarding duration, we measured the entire duration for the sentence and the number of pronounced syllables, and the ratio of these values generated the rate of articulation in syllables per second. We also took the duration of all pauses and noted if each pause was filled or not. The delay time before starting to answer was measured too.

3. Preliminary Results and Discussion

3.1. Video analysis

In table 1 we present the summary of the movements perceived in video analysis regarding answers with certainty and uncertainty. We added a third attitude, as described by subjects in their auto-annotations, when they were sure to not know the answer. In some questions (in which we asked more than a thing at the same time) they also annotated they were sure about some item(s), while they were not sure about other(s). Thus we analyzed 242 noted attitudes instead of 180.

Table 1. *Movements observed in the videos*

attitude	eyebrows movements	diverted gaze	Mouth movements	head movements
certainty (127)	7 (5.5%)	26 (20.5%)	2 (1.6%)	4 (3.1%)
cert. of not (56)	16 (28.6%)	29 (51.8%)	20 (35.7%)	17 (30.4%)
uncertainty (59)	21 (35.6%)	52 (88.1%)	25 (42.4%)	25 (42.4%)

As we can see in the first table, the percentages of movements are higher in attitudes that involve uncertainty or certainty of not knowing. In some certain answers we find movements (precisely in 25.2% of the answers classified by subjects as certain), that is mainly of the eyes. We believe these movements are not exactly the same they used to express uncertainty, but it can be related, in the case of the eyes, to a moment that the participant takes to remember a well-known answer. Regarding head movements, the times they appeared in certainty it was as a nodding movement, unlike the head movement in uncertainty, the head shake. The other movements found in certainty appearing at the end of the answer were related to the next answer item, which was not known by the subjects. Another interesting thing is that each subject has his own manner to express uncertainty by using gestures: while some of them use diverted gaze others prefer using eyebrows movements. In 97.8% of uncertain answers at least one of these gestures is used (often two or three gestures are used in the same answer). In the answers where the subjects are sure to not know the answer, 90.9% have at least one of these gestures.

In figure 2 we can see some examples of the movements found to express uncertainty, such as mouth, head and eyebrows movements or diverted gaze (on the right in each pair) in contrast with certainty (on the left in each pair) (it is important to observe that "neutral position" is to look down, with the face turned to the robot).

Figure 2: *Facial expressions in certainty (on the left in each pair) and in uncertainty (on the right in each pair).*

3.2. Audio analysis

The audio of the answers was analyzed regarding general characteristics such as the delay time, the filled pauses, the final F_0 movement (see table 2). We also analyzed the order

inversion or the presence of lexical items to say which attitudes were used (e.g. 'it can be...' or 'I think...').

Table 2- *General characteristics of the answers*

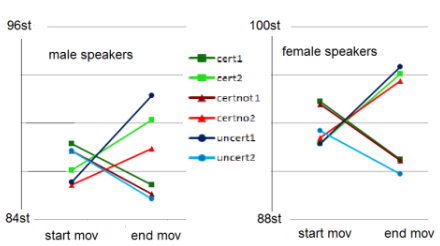
S	Delay (L-long or S-short)			Filled pauses (presence)			Final F_0 movement (A-ascending or D-descending)		
	C	CN	U	C	CN	U	C	CN	U
F	29L 84S	24L 14S	34L 13S	2	24	21	54A 59D	10A 28D	32A 15D
M	4L 10S	11L 7S	5L 7S	0	10	7	5A 9D	5A 13D	8A 4D
Tot (N)	**33L 94S (127)**	**35L 21S (56)**	**39L 20S (59)**	**2 (127)**	**34 (56)**	**28 (59)**	**59A 68D (127)**	**15A 41D (56)**	**40A 19D (59)**

Legend: F- Female subjects; M- Male subjects; C- certainty; CN- certainty of not knowing; U- uncertainty; N- number of occurrences

As can be seen in table 2, regarding the delay time, it was divided in short and long values, depending if they were longer or shorter than median value. The certainty attitude presents a tendency to have the smallest values of the delay time, while uncertainty and certainty of not knowing attitudes present the higher values. Regarding the presence of filled pauses, they were almost not found in certainty, but they could be commonly found in uncertainty and certainty of not knowing. Finally, regarding the final F_0 movement, despite some variation, we can state that mainly a descendent movement was used in certainty and certainty of not knowing attitudes, while an ascending one was used in uncertainty attitude. As we have different directions of the F_0 movements, if we compare the rising movement found in uncertainty with the falling one found in certainty and certainty of not knowing, the values found are significantly different ($p<0,05$, CI 95%).

The variations found in the F_0 movements were related to other characteristics of the attitudes' expression in our corpus: an ascending movement is expected in an uncertain answer, but if the speaker uses expressions like 'I think it is...' the uncertainty is already represented lexically, so the F_0 movement chosen was a descending one. We found ten uncertain answers with a descending movement that have these lexical expressions to express uncertainty in our data. In some answers we also found order inversion: the subject answered the most difficult item at the end of the sentence and, to indicate finality, the end of the sentence was descending. These reasons could explain why we found some uncertain answers with a falling F_0 movement. Concerning ascending movements, they were found in certainty and certainty of not knowing attitudes mainly in enumerations, in which the first items would be ascending to indicate continuousness; we have 8 questions which ask more than a thing at the same time, so we have 8 answers we expected to have an enumeration of some items.

Graphic 1 – *Final F_0 movement of the answers*



The two types of F_0 movement found in each attitude can be seen in detail in graphic 1. The darker colors represent the most recurrent movement for each attitude, while the lighter colors represent the other movement found. Comparing darker colors, we can see typical final F_0 movements: rising for uncertainty (dark blue) and falling for certainty and certainty of not knowing (dark red and dark green). In figure 3 we present a typical example of certainty and uncertainty answers.

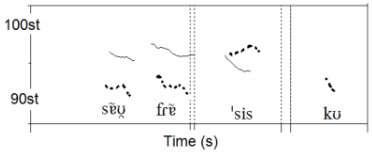


Figure 3: *F_0 contours of the answer "São Francisco"* (Saint Francisco*) with certainty (continuous line) and uncertainty (dotted ticked line), said by two women. Marked syllable is the tonic one, with a falling and a rising F_0 movement.*

Regarding duration measures, we compared results of the articulation rate (speech rate, in syllables per second) and duration of the last tonic syllable and its previous one (see table 3). The male speakers' speech rate varies, being used in a different way to express the attitudes: uncertainty is significantly different from the other attitudes, with a significantly higher value of speech rate. For female speakers no difference is statistically significant and the tendencies of higher values are different from men's tendencies. The duration of the final syllables, studied as an important cue to express uncertainty in BP previous works do not point out a clear tendency in our study; these values do not seem to play a role to express spontaneous (un)certainty attitudes in BP.

Table 3- *Speech rate and duration of the final syllables*

attitude	Male speakers			Female speakers		
	syl/s	tonic	pre-tonic	syl/s	tonic	pre-tonic
certainty	4.48	296.5	179.9	4.58	310.2	192.8
cert. of not	5.01	293.7	158.1	4.65	274.3	183.8
uncertainty	5.99	252.5	158.3	4.64	284.9	163.2

4. Conclusions

Collecting spontaneous speech data using a Wizard of Oz method within a scenario revealed to be an efficient way to induct spontaneous but comparable attitudinal speech utterances. Audiovisual prosodic results, such as F_0 and duration, eyebrows, eyes, mouth and head movements, showed personal behaviors but general tendencies used to express (un)certainty in BP. In further studies, we will compare spontaneous and acted utterances produced by the same subjects and we will also analyze other collected data with this method to study other (un)certainty characteristics in BP.

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