Collection and Annotation of a Corpus of Human-Human Multimodal Interactions: Emotion and Others Anthropomorphic Characteristics

Aurélie Zara[1,2], Valérie Maffiolo[1], Jean Claude Martin[2], and Laurence Devillers[2]

[1] France Telecom Orange Labs, 2 av. P. Marzin, 22300 Lannion, France
[2] LIMSI-CNRS, BP 133, 91403 Orsay cedex, France
{aurelie.zara,valerie.maffiolo}@orange-ftgroup.com,
{devil,martin}@limsi.fr

Abstract. In order to design affective interactive systems, experimental grounding is required for studying expressions of emotion during interaction. In this paper, we present the EmoTaboo protocol for the collection of multimodal emotional behaviours occurring during human-human interactions in a game context. First annotations revealed that the collected data contains various multimodal expressions of emotions and other mental states. In order to reduce the influence of language via a predetermined set of labels and to take into account differences between coders in their capacity to verbalize their perception, we introduce a new annotation methodology based on 1) a hierarchical taxonomy of emotion-related words, and 2) the design of the annotation interface. Future directions include the implementation of such an annotation tool and its evaluation for the annotation of multimodal interactive and emotional behaviours. We will also extend our first annotation scheme to several other characteristics interdependent of emotions.

Keywords: Corpus collection, annotation, multimodal behaviours, human-human interaction.

1 Introduction

Interacting with computers elicits emotion from users. People feel amused when they are playing a game [1,2], frustrated or angry when the machine doesn't come up to their expectation. Taking expressions of emotion into account in human machine interaction may not only improve the machine's performances in assisting users but might also enhance computers' ability to make decisions [3]. Consequently, interest in virtual embodied agents able to express emotions [4], to react to users' expression of emotion [5] or even to have emotion, has grown in the past decade. This raises several questions: Which emotions are elicited from users when they interact with computers? How are these emotions expressed? How much does that depend on the application at hand? Which emotions should express a virtual agent and how should these emotions be expressed (regarding the application in which the interaction is studied)?

There has been a lot of research on emotions and their non-verbal expressions in face [6], voice [7,8] and body movements [9]. Yet, these studies are mostly based on

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acted basic emotions. Recent audio-visual corpora enabled to collect more spontaneous « real-life » behaviours in TV interviews [7,10], in-lab situations [11], or multimodal behaviours during sophisticated acting protocols [12]. Although these corpora allow spontaneity and naturalness, they are either limited with respect to multimodality (they contain few gestures or few body movements), or with respect to interaction (the video corpus does not show the full multimodal behaviours of the two people who interact). Some of these studies have also enlarged their investigations with other mental states [11,13], mood or attitudes [14]. Indeed, it has been shown that emotions and their expressions are interdependent to other characteristics proper to the human being:

- Emotions are interdependent of other mental states such as beliefs or intention (e.g. conflict of mental states can elicit negative emotions from a person) [15].
- Emotions influence attitudes, judgment and strategic communications [16].
- For a given situation, emotions and their modes of expression vary from one person to another, in accordance with his/her history, culture, social background and personality [17].

Furthermore, these anthropomorphic characteristics involve the same set of modalities as the expressions of emotion:

- Face reveals personality [18] and mental states such as beliefs (e.g. doubt: raised eyebrow) or intention (e.g. to implore: head aside, inner eyebrow up) [19].
- Eyes reflect cognitive activity (e.g. thinking: look up sideways) [20] and communicates the nature of the interpersonal relationship [21].
- Speech also gives cues about personality, social membership, beliefs (e.g. doubt: hesitation in speech), cognitive process such as comprehension and so on [22].
- Gestures are physical-symbolic representation of intention, beliefs and so on [23].

Therefore, it is necessary to consider both emotions and others anthropomorphic characteristics in the analysis of the multimodal behaviour. Several researches on virtual embodied agents have argued in favour of giving importance to anthropomorphic characteristics to enhance the believability of a virtual agent. According to Thomas and Johnson [24], characters that appear to think, have emotions and act of their own, can be considered as believable because these characteristics confer drawings with an illusion of life. A minority of virtual agents is currently able to express some of these characteristics and they only use a few modalities. One of them is GRETA which has been designed to show information about location and properties of concrete or abstract objects or events, beliefs, intentions, affective states and metacognitives actions with facial expressions and gaze directions [4].

The long-term goal of our work is to model the non-verbal behaviour of an agent endowed with anthropomorphic characteristics. A Wizard-of-Oz will be carried out to evaluate the impact of the expression of these characteristics on the interaction with a human in a game context. The first step is the identification of the relevant anthropomorphic characteristics for the virtual agent and the specification of the corresponding multimodal behaviours. For that, we selected a corpus-based approach for studying face-to-face human-human interaction in a game. Moreover, this approach allows us to collect strategies of interaction useful for the specification of

Wizard-of-Oz experiment (e.g. for the virtual agent, adopting appropriate emotional responses to some human behaviours according to the other anthropomorphic characteristics (for example personality) assigned to the virtual agent). We chose a game for the reason that several researchers consider games as a relevant means for eliciting emotional behaviours, especially in laboratory, and riding subjects of their inhibitions [1,2].

EmoTaboo is the name of the protocol we have established to collect a corpus of multimodal expressions of emotion during human-human interaction. The procedure is presented in section 2. A first phase of annotation using a multi-level coding scheme including emotion labels, mental states, and communication acts was carried out and is described in section 2. In order to reduce the influence of language via the predefined set of labels, we propose in section 3 a new annotation methodology based on a hierarchical structure of emotion-related words. We also explain our plans for implementing the corresponding user interface to be used by the coders. Future directions include the implementation of such an annotation tool and its evaluation for the annotation of multimodal interactive and emotional behaviours. We will also extend our first approach to several other characteristics interdependent of emotions.

2 The EmoTaboo Protocol

2.1 Procedure

The goal of the EmoTaboo protocol was to collect emotionally rich multimodal and interactive. EmoTaboo is an adaptation of the game Taboo. Our procedure involves interactions between two players. One of them has to guess a word that the other player is describing using his own speech and gestures, without uttering five forbidden words. The word to guess and the five forbidden words are written on a card. Each person had to make guess three series of words alternating roles (mime and soothsayer). The two players did not know each other. One of them was a naïve subject whereas the other player was instructed. This confederate knew all the cards in advance, and for each card, indications were given on how to induce emotions in the naïve subject. We involved a confederate in the protocol because we wanted to be sure to collect enough emotional interactions and we supposed that it would enable us to have a better control over the emotion elicitation situations. To ensure the engagement of the subjects in the task, the results of previous teams were displayed on a board in the room during the game, and a gift token was promised to the winner team. We used strategies for eliciting emotions at three different levels in the procedure: in the course of the game, in the choice of cards, and in the directions given to the confederate.

Strategies connected to the course of the game. The mime had ten seconds to read the card on which was written the word to make guess and the five forbidden words. Then he/she had two minutes to make guess the word. Thirty seconds before the end of the prescribed time, the experimenter announced the remaining time in order to motivate the players and to elicit stress. After these two minutes, the experimenter takes stock of the penalties, if the secret word wasn't found or if the team transgressed the game rules (e.g. using a forbidden word, describing the word using charades).

Strategies connected to the choice of cards. Game cards were provided to the players in ascending order of difficulty. Regarding the type of this game, we supposed that the emotions induced by game cards would include embarrassment, shame, amusement and surprise. To ensure their elicitation, we played on the knowledge of the word, the easiness to guess the word, and its evocation. We chose cards containing very uncommon words (e.g. "palimpsest") supposed to arouse embarrassment or shame, words evoking disgusting things (e.g. "putrid") or words with sexual connotation (e.g. "aphrodisiac").

Strategies connected the directives given to the instructed subject. For each card, the confederate had directions such as "do not find the word on purpose", "propose words with no relation at all with what is said by the naïve player". For each card, a list of emotions to elicit from the naïve subject was suggested (e.g. "temptation": negative emotions as disappointment, frustration, stress or positive emotions as pride, satisfaction). For each emotion an illustrative list of possible strategies was proposed (e.g. to induce anger, criticize the naïve player).

At the end of the procedure, subjects had to answer to a questionnaire (cf. section 2.3) about emotions felt by the naïve subject and another questionnaire evaluating the personality in terms of extraversion, neurosis and sincerity [25].

Fig. 1. The collected data features four viewpoints. The naive subject is on the left side, the confederate is on the right side.

We recorded ten pairs of players, each pair involving twenty cards. Naïve subjects were university students (four women and six men), confederates were close relations of the experimenter or laboratory staff (three women, five men). We collected about eight hours of videos with four different viewpoints corresponding to face close-up and upper body of both players (Fig. 1).

2.2 Representation of Emotions

Several studies define emotions using continuous abstract dimensions: Activation-Valence [7] or Intensity-Valence [26]. But these three dimensions do not always enable to obtain a precise representation of emotion. For example, it is impossible to distinguish fear and anger. According to the appraisal theory [27], the perception and

the cognitive evaluation of an event determine the type and the intensity of the emotion felt by a person. Finally, the most widely used approach for the annotation of emotion is the discrete representation of emotion using verbal labels enabling to discriminate between different emotions categories. In most of these studies, the coders select one or several labels out of a set of emotion-related words. Some studies also propose a free text verbalization of emotions [28]. A few studies use taxonomy such as WordNet affect but in a language processing context [29,30].

In our experiment, we define two lists of emotion labels using a majority voting technique. A first list of labels was selected out of the fusion several lists of emotional labels defined within HUMAINE (European network on emotion http://emotion-research.net/). In a second step, several judges rated each emotion word of this list with respect to how much it sounded relevant for describing emotions induced by our EmoTaboo protocol. The most relevant words were used in a questionnaire used at the end of the game (cf. section 2.3). A similar approach was used to rate the relevance of each word of the merged list in the light of collected video data. We obtained the following twenty-one emotion labels that we used for manual annotation (cf. section 2.4): "Amusement", "Embarrassment", "Disappointment", "Excitement", "Impatience", "Frustration", "Annoyance", "Anxiety", "Effervescent happiness", "Nervousness", "Pride", "Satisfaction", "Stress", "Boredom", "Confidence", "Contentment", "Pleasure", "Surprise", "Cold Anger", "Sadness" and "Other".

2.3 Questionnaire Results: Reports by Naïve Subjects and Confederates

At the end of the game, each naïve subjects had to report emotions felt during the game, by recall, on a scale of intensity according to the twenty-one emotion labels. The confederate had to rate on the same scale the naïve subject's emotions he/she inferred. The goal of this questionnaire was to validate that subjects felt a great variety of emotions during the interaction and that these emotions were perceived by the confederate.

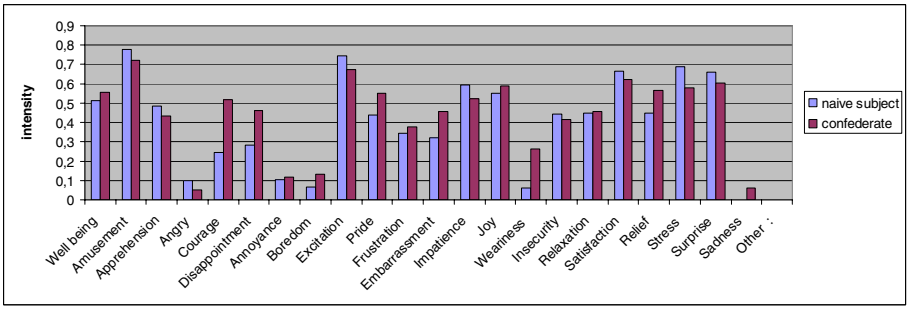

Fig. 2. Mean intensity of naïve subjects' emotion, reported by subjects themselves and confederates. Intensity is given in a scale 0-1.

Fig. 2 shows that emotions with highest intensity felt by the naïve subjects are "Amusement", "Excitation", "Satisfaction", "Surprise", "Stress" and "Impatience". For these emotions, the intensity inferred by the confederates is close but always lower.

We observe that confederates have significantly over-estimated the intensity of the naïve subjects' emotions "Courage", "Disappointment" and "Weariness". These differences are probably due to individual differences in the ability to categorize and verbalize felt or perceived emotional experiences [31]. It is also likely that subjects didn't evaluate emotions intensity but a combination of intensity and frequency of the emotion. Nevertheless, the analysis of the questionnaires highlights that subjects have felt emotions and these emotions have been perceived by the confederates. This suggests that our protocol EmoTaboo seems relevant for the collection of emotionally rich behaviours.

2.4 Corpus Analysis from the Viewpoints of Third Observers

In the eyes of the literature and first observations done of the corpus, we defined a first scheme to annotate emotion, cognitive states and processes (called mental states by Baron Cohen), strategic communication (including the strategies suggested in the instructions provided to the confederate and other strategies that we observed in the corpus such as "ironic") and contextual information (e.g. current card, current phase of the game). In order to represent complex emotion, the annotation procedure allowed the coders to choose at most five labels per segment [32]. For each emotion, we added two abstract dimensions: the intensity of the emotion and its valence [32]. Concerning cognitive states and processes, we selected an intermediate level in the taxonomy of Baron-Cohen [21]. These labels are: "Agreeing", "Concentrating", "Interested", "Disagreeing", "Thinking" and "Unsure". We also annotated speech acts, taken from DAMSL [33]. Videos were segmented in sequences of about 2 minutes corresponding to the guess of one word and annotated with the ANVIL software [34].

Table 1. Annotation of one sequence corresponding to the word palimpsest (body view)

Annotation Category (corresponding to a track in Anvil)	**Main results (% of the sequence annotated with a label of the corresponding category)**
Naïve subject's emotions	77% including: Amusement 29%; Stress 9%; Exasperation 7%, Embarrassment 7%.
Confederate's emotions	84% including: Embarrassment, 29%; Amusement, 21%; Stress, 11%; Satisfaction, 6%.
Naïve subject's cognitive states and processes	75% including: Uncertain 29%; Thinking 21%; Interested, 18%.
Confederate's cognitive states and processes	81% including: Interested, 41%; Thinking, 21%;
Strategic communication used by the naïve subjects	Joking, expressing self doubt, criticizing, sarcastic, encouraging, ironic, etc.
Strategic communication used by the confederates	Criticizing, disrespect, expressing doubt about partner, expressing self doubt, discouraging, etc.

First annotations, done by four coders on one sequence corresponding to the word "palimpsest", show the presence of emotional and cognitive states and processes in the corpus (cf. table 1). They suggest that the strategies used to elicit emotion (e.g. penalties, the choice of cards, the announcement of the remaining thirty seconds, some of directives given to the confederate) were effective and relevant for the specification of our future Wizard of Oz procedure because of their capacity to elicit emotions. A first analysis was also done on gesture and other modalities. It reveals that the corpus contains many and various multimodal behaviours [35].

2.5 Discussion

The corpus collected using the EmoTaboo protocol contains a great variety of emotions, felt and expressed by naïve subjects and confederates .Furthermore, these emotions can be considered as being emotions of everyday life and easily found in a human-machine interaction in close situations (e.g. frustration or irritation when the computer doesn't understand the user request). These emotions are expressed through various behaviours as well in categories (e.g. gestures categories) as in modalities (gesture, facial expressions, voice). Furthermore first annotations show that the expression of other characteristics such as cognitive states and processes are observed in the corpus.

Although the participation of a confederate appears to be effective to elicit emotions from the naïve player, it might constitute a bias in our experiment. Indeed, the use of strategies to elicit negative emotions from the naïve subject caused some embarrassment from the confederate. He was less spontaneous and natural and this is visible and annotated by the third observers (cf. Table 1). The study of the corpus cannot thus be done without taking into account this phenomenon.

First annotations have raised several questions. According to different coders, emotions-related words were not precise enough to capture the diversity of emotions expressed in the collected data. For example, some coders made distinctions between happiness and triumphant, and could not choose a label in adequacy with their perception because of the absence of such labels in the set of proposed ones. Consequently they annotated the emotion using the label with the closest meaning. We can assume that such annotations were low in accuracy. Our approach did not give the possibility to the coders to be as precise (or imprecise) as they wished in accordance with their level of certitude regarding their perception. A solution to this problem would be to allow the coder to propose a new label when there is no appropriate word in the defined list. But many emotional words are polysemic and we would not be able to discriminate the exact meaning used by the coder. Another solution would be to propose a larger list of emotion-related words, but this would increase the difficulty of annotation because of the length of the proposed list.

Moreover these first annotations have revealed that some emotion categories were missing and were not properly defined. For example, our initial list of strategic communications was a mix of cognitive states (e.g. self doubt, doubt about the partner), attitudes (e.g., offensive, perseverant), and communication strategies (e.g. criticizing, joking, ironic, sarcastic). Those considerations led us to revise our first annotation approach and to explore how people categorize and verbalize emotions and the influence of language on the perception of emotions.

3 Toward a New Approach for Annotating Emotions and Other Characteristics

3.1 "Emotional Granularity" and the Influence of the Language on the Perception of Emotion

When people report their emotional experiences in everyday life, some of them use discrete emotion labels such as "angry", "sad" etc. to represent the most general aspect of their feelings (typically pleasure and displeasure) whereas other people use more precise, differentiated terms, in a way that captures the distinctiveness in the words meaning [31]. Barrett called this phenomenon "*emotional granularity*". This is also observed when people describe their perception of others' emotions. Consequently people are not equal in categorizing and verbalizing their own emotions and their inferences of others' emotions. According to [37], the language also intrinsically shapes the inference of others' emotions from their behaviours. Through the results of three studies, the authors found that the accessibility in memory of emotion-related words influences participant's speed or accuracy in perceiving facial behaviours depicting emotion. Consequently coders with low "emotional granularity" might be slower in the processes of categorization of their perception and less accurate if they have to annotate with precise emotion-related words.

Moreover many studies on attention have shown that focalizing attention on a particular dimension (here some emotional terms) increases the capacity of discrimination of stimuli according to this dimension but also decreases this capacity on other dimensions. Tasks involving categorization processes are sensitive to this process [36]. We thus assume that presenting a restricted list of emotional-related words would encourage the coder to focalize his/her attention only on emotions for which related words are provided in the list.

3.2 On the Use of a Hierarchic Taxonomy for Manual Annotation

Our aim is to design a coding scheme which would allow coders to be as precise as they wish according to their confidence in their own judgment. In this way, we take for granted that people would be more accurate in the annotation task. Moreover, having precise information can be also useful for the specification of the virtual agent since it would enable to display a more appropriate behaviour according to a particular situation.

Ekman defined each emotion category (e.g. Surprise) as a family of emotion. He distinguishes four types of surprises depending on how the surprise is expressed using differently different parts of the face: questioning surprise (involving eyes and brows), astonished surprise (eyes and mouth), dazed or less interested surprise (brows and mouth) [8].

Many other studies have shown that emotion-related terms are organized in taxonomic structure which the form would be a circumplex shape [31,38,39,40]. According to Plutchik [39], a circumplex model enables to highlight continuous relations between emotion-related terms but also their discontinuity. In fact, terms can be grouped according to eight emotional concepts called primary emotions (fear, anger, joy, sadness, acceptance, disgust, anticipation, surprise) and seven concepts

can be grouped in terms of pleasure and displeasure, excepted surprise. This conceptual and linguistic form of organisation is proposed by Plutchik to support the existence of analogous structure that it is supposed to exist within the framework of the experience of emotion. This taxonomic structure seems to be dependent on the language. Galati [40] underlined the existence of differences between Neolatin languages and English. Taxonomies of emotions in French were defined in [30,40]. A selection of the taxonomy presented in [40] is given in Table 2.

Table 2. Part of the semantic structure of French emotions lexicon [40]

pleasure	joy	Satisfaction, amusement, relief, well being, happiness…
displeasure	sadness	Despair, dissatisfaction, confusion, annoyance …
	anger	Irritation, contempt, consternation, aversion…
	fear	Anxiety, apprehension, embarrassment, discouragement …

Despite the fact that there is no evidence of a universal taxonomic structure of emotions [31], we believe that using this type of structure for helping the annotation task can answer the problems occurring during the annotation of anthropomorphic characteristics discussed in the previous sections. Whereas our first approach was to use a flat list, the structure that we propose for manual annotation would be hierarchic tree-network taxonomy. The top of the structure would describe general concepts (e.g. emotion-related states, attitudes, cognitive states) and leafs would represent precise concepts (e.g. jubilation, triumph, scepticism).

We propose two alternatives to the coder. The first one would allow the coder to have a direct access to the taxonomy. He/she would be able to navigate from general concepts (e.g. emotion, pleasure/displeasure) to more precise ones (e.g. triumphant). The second solution would be a completion system. The coder would be able to propose a label characterizing his/her perception. In this way, he/she wouldn't be influenced or disturbed by the organisation of concepts and it would ensure the validity of the proposed label (e.g. its spelling). Once the label chosen, the definition(s) and a part of the taxonomy corresponding to the label would be displayed to avoid meaning confusions and to enable the coder to validate his/her choice. Instead the coder might also choose another label that he/she estimates to be more appropriate (e.g. more precise term, more general term, synonym), in accordance with his/her degree of confidence.

This raises issues with respect to the ergonomics of such an annotation tool. We will thus investigate visualisation techniques used to display dictionaries or ontologies. Moreover, the use of a large number of labels will require the adaptation of statistical and inter-judge agreement algorithms. A solution would consist in taking into account the semantic distance in the taxonomy between emotion-related words.

4 Conclusion and Future Directions

The specification of multimodal behaviours of a virtual agent endowed with anthropomorphic characteristics in the context of a game requires the study of the

human expressions of these characteristics in a closed context. In this framework, we presented the EmoTaboo protocol and explained how it enabled the collection of a corpus of dyadic interactions during a game. We illustrated the richness of the collected data with respect to expressions of emotions and other anthropomorphic characteristics. First experiments of annotation lead us to propose a new strategy of annotation. The new hierarchical approach of annotation would enable human judges to select labels at several possible levels of precision. We assume that this method is adapted to the annotation of any corpora requiring an interpretation from the judge.

To improve our first approach, we also suggest to reorganise categories and to add missing ones (we provide in brackets the general concepts associated to the category):

- Emotions (see for an example table 2) and their intensity (low, average, high).
- Cognitive states (e.g. interestedness, readiness, curiosity, certainty, doubt, preoccupation confusion) and cognitive processes (e.g. thinking, deciding, attention and inattention) adapted from [20,29].
- Attitudes (e.g. defensive, intolerance, paternalism) adapted from [27,29].
- Strategic communication (e.g. approval, disapproval, disrespect, Humour), corresponding to strategies used to elicit emotion, adapted from Wordnet (http://wordnet.princeton.edu/); and speech acts [33].
- Mood, adapted from [27,29,41].
- Personality [43] (e.g. Extraversion agreeableness, consciousness, neurosis, openness), adapted from theories of personality such as OCEAN [42].
- Contextual information such as (current card, game phase, etc.).

Future directions include the definition of a coding scheme for multimodal behaviours. This will enable us to compute relations between anthropomorphic characteristics and their multimodal expressions. From this corpus, a subject will be selected for his multimodal behaviour and his communication strategies as a model for the setting of the Wizard-Of-Oz, allowing the evaluation of the impact of the expression of anthropomorphic characteristics on a HMI in a game context.

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