

Multimodal Embodied Mimicry in Interaction

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Abstract. Nonverbal behavior plays an important role in human-human interaction. One particular kind of nonverbal behavior is mimicry. Behavioral mimicry supports harmonious relationships in social interaction through creating affiliation, rapport, and liking between partners. Affective computing that employs mimicry knowledge and that is able to predict how mimicry affects social situations and relations can find immediate application in human-computer interaction to improve interaction. In this short paper we survey and discuss mimicry issues that are important from that point of view: application in human-computer interaction. We designed experiments to collect mimicry data. Some preliminary analysis of the data is presented.

Keywords: Mimicry, affective computing, embodied agents, social robots.

1 Introduction

People come from different cultures and have different backgrounds while growing up. This is reflected in their verbal and nonverbal interaction behavior, speech and language use, attitudes, social norms and expectations. Sometimes a harmonious communication is difficult to establish or continue because of these different cultures and backgrounds. This is also true when people are from the same culture and have the same background, but differ in opinions or are in competition. In designing user interfaces for human-computer interaction, including social robots and artificial embodied agents, in designing tools for computer-mediated interaction, and in designing tools or environments for training and simulation where interaction is essential, we should be aware of this. These interfaces, tools and environments need to be socially intelligent, capable of sensing or detecting information relevant to social interaction.

Mimicry is often an automatic and unconscious process where, usually, the mimicker neither intends to mimic nor is consciously aware of doing so, but may tend to activate a desire to affiliate. For example, mimicking behaviors even occur among strangers when no affiliation goal is present. Certainly, mimicking strangers assumes unconscious mimicry. In other cases, people often mimic each other without realizing they want to create similarity. This also can be assumed to be unconscious mimicry. Conversational partners may or may not be consciously engaged in mimicry, but no doubt, one or both of the interactants take on the posture, mannerisms, and movements of the other during natural interaction [1].

Some instances of mimicry in daily life and factors that affect them are given below. People often mimic their bosses' behavior in a meeting or discussion. For example, repeat what the boss said because of a desire to affiliate even if there is no real agreement. As another example, meeting or discussion partners mimic each other to gain acceptance and agreement when they share or want to share an opinion in a discussion. Thus, it is worth nothing that interactants mimic each other because of directly activating goals though without consistent awareness.

Mimicry occurs in our daily life all the time, and in most of the cases mimicry behavior implicates or explicates the mimickee and mimicker's actual attitudes, beliefs, and affects, moreover, judging the current interaction situation as positive or negative. Nonconscious mimicry widely occurs in our daily life, for example, people unconsciously speak more softly when they are visiting a library. Mimicry is inherently sensitive to actual social context; in other words, automatic mimicry changes with changing goals according to the realistic social situation.

It is expected that human-computer interfaces that employ knowledge on mimicry can improve natural, human-like interaction behavior. It requires detection and generation of mimicry behavior. It allows the interface to adapt to its human partner and to create affiliation and rapport. This can in particular be true when mimicry behavior is added to human-like computer agents with which users communicate. One of the important goals for the future studies in embodied virtual agents and social robots is to use social strategies in order to make them more sociable and natural [2]. The sociable agent should have the capability of recognizing positive and negative situations and its communicative behavior should be appropriate in the current situation. Then it can achieve desirable interaction results such as creating affiliation and rapport, gaining acceptance, increasing belongingness, and, of course, better understanding of the conversational partner. Indeed, in recent research on humanoid agents the view that humans are "users" of a certain "tool" is shifting to that of a "partnership" with artificial, autonomous agents [3], [4].

Social agents need to have the capabilities to acquire various types of inputs from human users in verbal and non-verbal communication modalities. Also, social agents should have the capabilities of understanding the input signals to recognize a current situation, and then according to desired goals in the conversational setting to combine social strategies to determine what behavior is appropriate to express in response to the multimodal input information. Similarly, in the output phase, agents are expected to have the capabilities of mimicking users' facial expression, eye contact, postural or even verbal types to gain more closeness and natural communication.

2 Types of Mimicry

Various types of mimicry can be distinguished. They range from almost directly mimicking facial expressions and slight head movements to long term effects of interaction such as convergence in attitudes [2]. When we look at automatic detection and generation, we confine ourselves to the directly observable and developing mimicry behavior during interactions and what can be concluded from that. Therefore, below we distinguish mimicry in facial expressions, in speech, in body behavior (including gestures and head movements) and emotions.

2.1 Facial Expression Mimicry

Interactants may express similar facial expressions during face-to-face interactions. When one of two interactants facing each other takes on a certain facial action, the partner may take on a congruent action [5], [6]. For instance, if one is smiling, the other may also smile. From previous mimicry experiments it is known that when images of a facial expression displaying a particular emotion are presented, people display similar expressions, even if those images are just static expression [7], [8], [9].

2.2 Vocal Mimicry

Vocal behavior coordination occurs when people match the speech characteristics and patterns of their interaction partners [10]. They may neither intend to do so nor are they consciously aware of doing so. This can be observed even if they are not facing each other [11].

2.3 Postural Mimicry

Body behavioral coordination involves taking on the postures, mannerisms, gestures, and motor movements of other people such as rubbing the face, touching the hair, or moving the legs [12]. For instance, if one is crossing his legs with the right leg on top of the left, maybe the other also cross his legs with the left leg on top of the right leg or with the right leg on top of the right leg [13].

2.4 Emotional Mimicry

The perception of mimicry is not limited to the perception of behavioral expressions [14]. Emotional mimicry is another phenomenon that needs to be considered. It is more complicated and mostly based on personal feeling and perception. In [7] emotional mimicry is classified into positive mood mimicry, negative mood mimicry and counter-mimicry. In an actual social situation not all emotion expressions are mimicked equally. Normally people have a higher chance to mimic positive emotion than negative emotion. This seems to be because of a negative emotional mimicry being less relevant and costly [15]. Consider, for example, the situation where someone tells you a bad thing happened to him or her, and he or she consciously or unconsciously, displays a sad face. Mimicking his or her sadness expression means signaling understanding, and maybe also willingness to help. Hence, sadness mimicry only occurs between people who are close to each other rather than just a passing acquaintance [15]. In contrast, people mimic happiness regardless of the relationship with each other or the situational context because of mimicking positive emotion is with low risk and is low costly [14]. Usually in a competition condition such as debates or negotiations, counter-mimicry is evoked to express different attitudes or negative emotion in a polite and implicit way, which shows contrasting facial expressions, and postural or vocal cues, such as a smile when the expresser winces in pain [7].

3 Mimicry as a Nonconscious Tool to Enhance Communication

Individuals may consciously engage in more mimicry with each other in the case that they intend to affiliate during interaction. In contrast, they may also consciously engage in less mimicry since they prefer disaffiliation [16]. Hence, mimicry has the power to enhance social interaction and to express preferences.

This is not really different in the case of unconscious mimicry. Unconscious mimicry shows a merging of the minds such as creating more similar attitudes or share more viewpoints [12]. Moreover, in interpersonal interaction mimicry can be an unconsciously used 'tool' to create greater feelings of, e.g., rapport and affiliation [17]. Mimicry can be seen as an assessment of the current social interaction situation (e.g., positive environment and negative environment). The connection between mimicry and closeness of social interaction was shown by a study conducted by Jefferis, van Baaren and Chartrand [18].

To use mimicry as a tool to enrich social interaction, some important research issues are, first, to understand and explore how people experience and use mimicry, second, to examine the implications of explicit mimicry behaviors in terms of social perceptions of the mimickers, third, to analyze detected and classified mimicry behavior for cues about the characteristics of the interaction, and, finally, to examine to what extent mimicking should occur so that it enriches communication properly.

Embodied automatic mimicry can be used as a social strategy to achieve the desired level of affiliation or disaffiliation. The key is to obtain an optimal level of embodied mimicry [2], that is, mimicry should occur only to the proper degree so that such mimicry behavior serves the affiliation goal and is not costly and risky.

4 Measuring of Mimicry

Mimicry refers to the coordination of movement between individuals in both timing and form during interpersonal communication. These phenomena are observed in newborn infants [8], and it is reported that these phenomena are related to language acquisition [10] and, as mentioned before, rapport. Therefore, many researchers have been interested in investigating the nature of these phenomena and have introduced theories explaining these phenomena. Because of this broad range of theoretical applicability, interactional mimicry has been measured in many different ways [19]. These methodologies can be divided into two types: behavior coding and rating.

Some research has resulted in illustrating the similarities and differences between using a coding method and a rating method for measuring mimicry. Some researchers have been studying interpersonal communication using both methods. Recently, Reidsma et al. [20] presented a quantitative method for measuring the level of nonverbal synchrony during interaction. First the amount of movement of a person as a function of time is measured by image difference computations. Then, with the help of the cross-correlation between the movement functions of two conversational partners, taking into account possible time delays, it is determined if they move synchronously. In research on judging rapport and affiliation, studies examined how people use objective cues, as measured by a coding method, or subjective cues, as measured by a rating method, when they perceive interpersonal communication.

For automatic mimicry detection advanced learning techniques need to be employed to construct a model from both subjective knowledge and training data. Affect (e.g., disagreement/agreement) recognition is accomplished through probabilistic inference by systematically integrating mimicry measurements with mimicry behavior detection and a mimicry behavior organization model. In the model head movements, postural movements, and facial expressions can be explicitly modeled by different sub-modes in lower levels, while the higher level model represents the interaction between the modes. However, automatic selection of the sensory sources based on the information need is non-trivial; hence no operational systems exploit this. Individual sensors are integrated in sensor networks. Perceived data from single sensors need to be fused and integrated in the network. Moreover, the multimodal signals should be considered mutually dependent rather than be combined only at the end as is the case in decision-level fusion. And the same problem also appears in classifying features such as when and how to combine the features from various sensor models.

5 Collecting Data and Annotation

It is necessary to automatically detect mimicry and recognize affect based on mimicry analysis. To achieve the ultimate goal of automatically analyzing mimicry some sub goals need to be achieved. First, a multi-modal database of interactional mimicry in social interactions is necessary to be set up, and secondly, possible rules and algorithms of mimicry in interactions need to be explored based on experimental social psychology. The desire to set up a multimodal database of interactional mimicry in social interactions are to (1) understand and explore how people consciously and unconsciously employ and display mimicry behavior, (2) develop methods and design tools to automatically detect synchrony and mimicry in social interactions, (3) examine and annotate the implications of mimicry detection in terms of social perceptions and emotions of the mimickers, (4) develop social mimicry algorithms to be utilized by embodied conversational agents. In sum, the goal is to understand when and why mimicry behavior happens and what the exact types of those non-verbal behaviors are in human face-to-face communication by annotating, analyzing and modeling recorded data.

Recently we finished the process of collecting data from a large number of face-to-face interactions in an experimental setting. The recordings were done at Imperial College London in collaboration with the iBUG group of Imperial College. The setting and the interaction scenarios aimed at extracting natural multimodal mimicry information, and to explore the relationship between the occurrence of mimicry and human affect (see section 2). The corpus was recorded using a wide range of devices including face-to-face-talking and fixed microphones, individual and room-view video cameras from different views, all of which produced auditory and visual output signals that are synchronized with each other.

Two scenarios were followed in the experiments: a discussion on a political topic, and a role-playing game. More than 40 participants were recruited to participate. They also had to fill in questionnaires to report their felt experiences. The recordings and ratings are stored in a database. The interactions are being manually annotated for

many different phenomena, including dialogue acts, turn-taking, affect, and some head and hand gestures, body movement and facial expressions. Annotation includes annotating behavioural expressions for participants separately, annotating the meaning expressed by the behavioral expressions, and annotating mimicry episodes. Some preliminary results on automatic detection of mimicry episodes can be found in [21]. The corpus will be made available to the scientific community through a web-accessible database.

6 Conclusion

Embodied mimicry can provide important clues for investigations of human-human and human-agent interactions. Firstly, as an indicator of cooperativeness and empathy. Secondly, in its application as a means to enrich communication. The impact of a practical technology to mediate human interactions in real time would be enormous both for society and individuals as a whole (improving business relations, cultural understanding, communication relationship, etc). It would find immediate applications in areas such as adapting interactions to help people with less confidence, training people for improved social interactions, or in specific tools for tasks such as negotiation. This technology would also strongly influence science and technology (providing a powerful new class of research tools for social science and anthropology, for example). While the primary goal of such an effort would be to facilitate direct mediated communication between people, advances here would also facilitate interactions between humans and machines.

Moreover, given the huge advances in computer vision and algorithmic gesture detection, coupled with the propensity for more and more computers to utilize high-bandwidth connections and embedded video cameras, the potential for computer agents to detect, mimic, and implement human gestures and other behaviors is quite boundless and promising. Together with the early findings in [21] this suggests that mimicry can be added to computer agents to improve the user's experience unobtrusively, that is to say, without the user's notice. It is worth mentioning again that the first main issue in our research is to explore and later to analyze automatically in what situation and to what extend mimicking behaviors occur.

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