The Role of Emotional Congruence in Human-Robot Interaction

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Abstract— **The communication of emotion is a crucial part of daily life interaction. Therefore, we carried out a study to research which role emotional congruence plays in human-human and human-robot interaction. In our results there is no effect of emotional incongruence between verbal content and facial expression of human as well as robotic stimuli on the cognitive performance in a story comprehension task. But more importantly, results indicate, that participants' performance in a memorizing task is significantly better if the robot tells the story. Possible explanations will be discussed.**

IndexTerms— **Emotional Congruence, Emotional Conflict, Human-Robot Interaction, Story Comprehension Task**

I. INTRODUCTION

Social Communication between interlocutors is one of the most important, but also most complex aspects in daily life. It involves many processes to perceive, transmit and understand the communicated information. One of these processes deals with emotional information. These emotions can be expressed multi-modally, e.g. through face, voice or semantic meaning. To build robots, which can act in real life, we have to think about the influence of emotions in human-robot interactions. Therefore, it is important to explore the similarities and differences between emotional human-human and human-robot interactions.

During an interaction, emotions can play different roles and can influence for example the perception of our interaction partners, the perception of the communicated information or our cognitive processes [3]. Ruz and Tudela [8] for example report, that emotions displayed by another person affect our decision-making in social contexts. Also for human-robot interactions, there are many studies about the necessity of emotion perception and production to diversify the interaction and make it more natural and easy [7].

But what happens, if the communicated information is emotionally incongruent? Arai et al. [1] demonstrated with their study, that already 8-10 month old infants have a neural basis for the detection of emotional conflicts or incongruence of voice tone and facial expressions. According to their results and other studies (e.g. [5]), we assume that emotions are not only a natural part of communication but also that there is an important influence of congruency.

With our study, we want to investigate the interplay of emotional and cognitive aspects in human-robot compared to human-human interaction. We focus on the influence of emotionally conflicting robotic and human stimuli on cognitive aspects like memory and inference processes in a story comprehension task. Participants had to combine incoming linguistic information, their world knowledge and nonverbal communicative cues into a more and more complex discourse and situation model. A change or a development of the situation model occurs, when new information fail to overlap in one or more features for example like causality or intentionality [6].

II. METHOD

A. Participants

One hundred-four students from Bielefeld University (Mean Age: 28,3; SD: 9,51; 65 women) participated in this study for course credits or 15 € fee. All participants were German native speakers and had normal or corrected-to-normal vision and hearing. Participants were screened via self-report about previous or actual neurological and psychiatric diseases.

B. Material

Narratives

Stimuli consisted of two adapted video-screened versions of the story "Herbstgespräche im Blumenhimmel [Autumn talks in flowers' heaven]"[2]. In one condition, a professional male

actor narrates the story. In the second condition the story is told by the virtual version of the robot Flobi [4]. In both conditions, the story is told with a neutral prosody. Both stimulus sets are subdivided into twelve story parts to allow the user to time the subsequent parts, which do not differ in length, number of syllables or number of emotional words.

Emotional Faces

We recorded emotional facial expressions from the male professional actor as well as from the robotic system Flobi. Both acted the emotion expressions "sadness", "happiness" and "neutral". All video sequences had a length of four seconds. They started with a neutral face, followed by an expressed emotion or the neutral expression and changed back or stayed in a neutral position.

C. Procedure

Participants were seated in front of a computer monitor. The narrative stimulus was either presented by the robot Flobi (cond1) or the human actor (cond2). Each subpart was followed by a short video with a facial emotion expression acted by the same character (robot/actor). After the video, the participants had to perform a lexical decision task, followed by the next part of the story. The same procedure was repeated for twelve parts. Afterwards, participants had to retell the story. Then, the whole procedure was repeated with the only difference that participants had to tell a possible continuation of the story instead of retelling. Participants were randomly assigned to one of eight groups either interacting with a robot or a human. Four groups first listened to a congruent (or incongruent condition) and then to the neutral condition. The other four groups started with the neutral condition and then listened to the congruent (or incongruent) condition.

V RESULTS

We find an effect of agent (robot vs human) on cognitive performance (i.e. the memorizing task). If the robot tells the story, more flowers were named by participants (Mann-Whitney-U = 1009; Z = -2,097; p = .036).Correlation analyses with Spearmans´ Rho indicate, that there is no correlation between emotional congruence and the performance in the cognitive task ($p > 0.05$).

VI DISCUSSION

With our study, we investigated emotional communication as one of the most important aspects of human-robot interaction. We examined the influence of emotional congruence on cognitive performance by using a story comprehension task. Results suggest that emotional congruence has no effect on cognitive performance measures, as used in the present study. This is in contrast to literature, which show, that there are some effects of emotional conflicting stimuli on cognitive performance. While we analysed a conflict between semantic content and facial expression, most other studies created an emotional conflict between facial and prosodic features or semantic content and prosodic features. Therefore, our study adds important results to the question which modalities are relevant in emotional congruency. We assume that the channels, which create emotional conflict, differ in their importance. It is known, that facial expressions are very important for transporting emotional information in communication. It seems, that in our setting verbal expression (semantic content) is less dominant in creating an incongruent emotional message when combined with facial expressions. For emotional human-robot interaction we conclude, that for high cognitive performance it is less important to build a robot, which is able to produce an emotional congruence between semantic content and facial expressions, but to focus more on congruency between prosody and facial expression. Summing up, it is necessary to do more research, as our result might also be true for other channel combinations (like semantic content and prosody) in human-robot interaction.

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