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Great minds think alike. Experimentelle Studie zu lexikalischem Alignment in der Mensch-Agenten Interaktion

Great minds think alike. Experimental study on lexical alignment in human-agent interaction

virtual agent/embodied conversational agent_linguistic alignment_human-computer interaction_tutoring program

Zusammenfassung. Vor dem Hintergrund erster Ergebnisse zum lexikalischen Alignment gegenüber Computern, in denen gezeigt werden konnte, dass menschliche Nutzer sich in ihrer Wortwahl an die des Computers anpassen, wurde geprüft, ob es auch zu einer entsprechenden Anpassung an einen virtuellen Agenten im Rahmen eines Tutoring Systems kommt. In einem experimentellen between-subjects Design (N = 40) präsentierte eine virtuelle Agentin den TeilnehmerInnen unter Nutzung von entweder Laienausdrücken oder Fachbegriffen Informationen zu drei medizinischen Themen. Die Ergebnisse zeigen, dass die TeilnehmerInnen sich in beiden Bedingungen an die Wortwahl der Agentin anpassen, es kommt aber nicht zu unterschiedlichen Zuschreibungen hinsichtlich Kompetenz oder Sympathie.

Summary. Based on first results on lexical alignment towards computers demonstrating that human users adapt their word choice to that of a computer, it was tested whether participants will also adapt to a virtual agent within a tutoring setting. In an experimental between subjects design (N = 40) participants were presented with information on three medical topics by a virtual agent either using lay language or technical terms. Results show that participants aligned to the word choice of the agent in both conditions, while there were no effects for perceived competence and likeability.

1. Introduction

A large body of empirical evidence shows that people converge in interactions (see Giles & Coupland, 1991, for an overview) and it has also been shown that linguistic alignment occurs in human-computer interaction, sometimes to an even greater extent than in face-to-face dialogues (see Branigan et al., 2010, for an overview). An open question is, however, to what degree people converge with virtual agents which add a social component and a humanlike appearance to the interaction with computers. A widespread trend in learning software is the integration of pedagogical agents which are defined as animated virtual characters who shall support the learning process. Pedagogical agents in this respect serve as virtual tutors who make knowledge accessible to the user by adding a social component to the virtual learning situation. Integrating agents is motivated by the expectation that agents allow a more natural and individual learning situation by transferring the advantages of social interactions to human-computer interactions and thus will be more effective and beneficial than standard learning software. Factors which have been shown to be influential with regard to the effectiveness of pedagogical agents include appearance and dialog abilities, intelligence, nonverbal abilities and didactic abilities (Krämer, 2010). What has not been investigated so far is, how mechanisms of linguistic alignment could be exploited to support learning effects, e.g. extending vocabulary by lexical entrainment. Previous work on linguistic alignment with (traditional) computers has shown that people indeed converge linguistically with the (artificial) interlocutor, thus we assume that users will also align with virtual agents. With regard to the additional social component virtual agents add to HCI in learning environments it is also worthwhile to investigate whether alignment is influenced/mediated by the (person) perception of the virtual agent.

Against this background, the present study is aimed at providing a first preliminary test whether human users will also align to a virtual agent. This will allow for conclusions on the social effects of virtual agents and – with regard to applied aspects – on the effectiveness on tutoring systems to encourage the usage of specific words.

DOI 10.1524/icom.2013.0005

2. Theoretical background and related work

2.1 Language Accomodation and Linguistic Alignment in Human-Human Interaction

Numerous studies show that people converge in interactions, a phenomenon which has been described in the Communication Accommodation Theory (CAT) (see Giles & Coupland, 1991, for an overview). Here, convergence is defined as "a strategy whereby individuals adapt to each other's communicative behaviors in terms of a wide range of linguistic-prosodic-nonverbal features including speech rate, pausal phenomena and utterance length, phonological variants, smiling, gaze, and so on" (p. 35). CAT states that people accommodate on nonverbal and verbal microscopic levels (e.g. proximity, gaze, smiling, silences, response latency, utterance length) and on more macroscopic levels of behavior (helping, global intimacy, affect, resources) (Burgoon et al., 1993). With regard to the accommodation of verbal aspects of the conversation, the phenomenon has been termed linguistic alignment and has been described as the basis for successful communication (Pickering & Garrod, 2006). It was demonstrated that interlocutors for example converge concerning sentence structures (Branigan, Pickering & Cleland, 2000) as well as concerning word choice (Brennan & Clark, 1996) which is called lexical alignment.

Linguistic alignment has been described as automatic, unconscious process that is based on the necessity of the interlocutors to find a joint semantic concept (Garrod & Anderson, 1987). Therefore, a dialogue is seen as a joint process in which utterances are not shaped by each partner alone but are affected by the interlocutor´s utterances. Garrod and Anderson (1987) demonstrated empirically that participants implicitly agreed upon a semantic concept when jointly navigating in a labyrinth which helped to communicate effectively. Another form of linguistic alignment is *structural priming* (Bock, 1986) as the tendency of conversation partners to implicitly adapt to the sentence structure of previous sentences. Also, Branigan, Pickering and Cleland (2000) showed that there is a convergence of syntactic structures during a dialogue.

Lexical alignment is analyzed by Brennan and Clark (1996): Based on the work by Garrod and Anderson (1987) they argue that using the expression which has been used by the interaction partner facilitates appropriate reference to something even without having to know anything about the interlocutor or his/her experiences. Additionally, the frequent usage of a term within an interaction will cause it to be remembered better and to be activated more easily. For the duration of the interaction the interlocutors will agree on a conceptual pact, an implicit, temporary agreement on which terms can be used. The process usually starts by an arbiter using – and thereby - suggesting a term that is then picked up by the follower. Jucks, Becker and Bromme (2008) analyzed lexical alignment within doctor-patient dialogues. Students of medicine had to answer questions by patients who either used lay language or expert terms. They showed that indeed participants aligned to the terms used in the questions. However, they also aligned with terms used in a figure that was provided additionally.

2.2 Linguistic Alignment in Human Computer Interaction

Since linguistic alignment serves both communicative as well as social functions it has been argued that these mechanisms need to be implemented in embodied conversational agents or other artificial dialogue systems (Kopp, 2010). However, even if computers are not yet able to accommodate to the human user, alignment has been described since human users tend to not only adapt to other humans but also to computers (in spoken dialogue). A review by Branigan et al. (2010) summarizes that linguistic alignment indeed occurs in HCI and this to an even greater extent than in face-to-face dialogues, a phenomenon also known as computer talk. Bell, Gustafson, and Heldner (2003) demonstrated that human users align to the speech rate of the computer. Also, accommodation with regard to loudness of speech and pauses has been observed (Suzuki & Katagiri, 2007). Brennan (1996) could even show lexical alignment in human-computer interaction – even if the computer (or better the wizard) deliberately used alternative terms to those that had been used by the human interaction partner.

As prerequisite and explanation for these observations the fact that humans react socially to computers and artificial entities can be offered. Early evaluation studies of conventional computers characterized by human-like attributes (Nass, Moon, Morkes, Kim & Fogg, 1997) as well as with embodied conversational agents (Sproull et al., 1996) showed that machines and agents are readily perceived as social entities: minimal cues and conditions in terms of similarity with humans are sufficient to lead users to show behavior that would be expected in human-human interaction (for an overview, see Krämer, 2008). For example, mimicry behavior is shown (Krämer et al., 2013) and socially desirable behavior is triggered (Sproull et al., 1996). Nass, Moon, Morkes, Kim and Fogg (1997) suggest that users automatically and unconsciously apply social rules to their interactions with computers - due to the fact that humans are inherently social. Nass and Moon (2000) term this phenomenon "ethopoeia" for behaviors observable in social situations in reaction to a group of contextual cues that trigger scripts and expectations. Nass and Moon (2000) thus expected and empirically demonstrated that people would consciously object to the suggestion that it is appropriate to react socially towards artificial agents. Nevertheless, on an unconscious level, these reactions are indeed shown.

2.3 Research Questions

Based on the theoretical background above, we posit the following hypotheses and research questions:

H1: Participants show lexical alignment with the virtual agent:

a) Participants interacting with an agent using lay language will use predominantly everyday language during interaction.
b) Participants interacting with an agent using expert terms will use predominantly technical terms during interaction.

With regard to person perception of the agent we assume the usage of technical terms to influence the perceived competence. Although no specific hypothesis can be derived we were also interested in analyzing the word choice of the evaluation of the agent´s likeability – especially since likeability has been seen as related to accommodation and alignment (see Branigan 2010; Kopp, 2010).

H2: Participants interacting with an agent using technical terms will perceive the agent as more competent than the agent using lay language.

RQ1: Does the use of technical terms influence participants` perception of likeability of the agent?

Similarly, we were interested to analyze whether the usage of technical terms influences the evaluation of the interaction in general.

RQ2: Does the use of technical terms influence participants` evaluation of the interaction?

Independent of the conditions, we further expected the interaction with the tutoring system to have an effect on perceived test anxiety:

H3: Participants feel less test anxiety after usage of the oral exam tutor program.

3. Method

3.1 Study design and independent variables

In order to test our hypotheses an experimental study was conducted in which the participants were asked to communicate with a virtual agent in the context of a tutoring program that should reduce test anxiety before oral exams. Within the one-factorial between-subjects design the utterances of the animated character were varied in two conditions. In the first condition, the agent used everyday language in its expressions. In the second condition, it made use of technical terms to convey its message.

The two conditions were created by altering the use of technical and everyday language within the stimulus material. The stimulus material consisted of three different texts addressing medical subjects. The topics in particular were Diabetes, Alzheimer's disease and osteoporosis. The facts presented contained, for example, details about the course of the respective disease, its risk factors, consequences and possible causes. These texts were presented to the participants via synthesized speech of the virtual agent. The basic structure and syntax of these texts remained the same in both conditions with certain words being replaced by their respective technical or everyday equivalent. The medical term *Diabetes*, for example, was changed to its German colloquial expression *Zuckerkrankheit* ("sugar sickness"). Further modifications included *amnesia* ("Amnesie") – *memory loss* ("Gedächtnisverlust"), *consumption of nicotine* ("Nikotinkonsum") – *smoking* ("Rauchen") or *physical* ("physisch") – *bodily* ("körperlich") (see Jucks et al., 2008). A total of about 42 terms were altered in the three texts which were presented in three training sessions.

Following the presentation of each individual text, questions were formulated which could be expected to be asked in an oral exam situation. The questions inquired general or specific information about the respective disease and were designed to avoid yes/no answers and instead provoke long answers by the participants (e.g. "What is diabetes and what are the special concerns of patients during their everyday life?"; "Please list the risk factors of osteoporosis.").

3.2 Dependent variables

As dependent variable we analyzed the verbal behavior of the participants, which was recorded and transcribed for this purpose. It was observed whether the participants matched their linguistic behavior to the one of the agent and used everyday terms or technical language in turn. Additionally, we assessed the participants' person perception of the virtual tutor, the general evaluation of the interaction and the whole system, and the perceived competence of the tutor by means of a paper-and-pencil questionnaire after the interview. In the following, all measurements are described in detail.

Verbal behavior: linguistic alignment / knowledge units

In order to determine whether the participants adapt their verbal behavior to the behavior of the virtual interviewer, we analyzed how often participants aligned their word choice to the virtual agent. In total 42 expressions were varied for the lay language and technical term conditions. We handled these expressions as knowledge units which were asked for by the virtual agent during the "oral exam" after the training session. We analyzed how many of these *knowledge units* were mentioned by the participants and for how many of these mentioned knowledge units participants chose the same expression as the virtual agent. From both values we calculated an *alignment ratio* (aligned words / mentioned knowledge units). Moreover, we analyzed the *amount of words* participants used to answer the questions.

Likability and competence of the virtual tutor

How participants perceived the virtual interviewer's likability was measured with a semantic differential consisting of 8 bi-polar pairs of items (friendly-unfriendly, likable–unlikable, pleasant-unpleasant, honest-dishonest, nice-mean, warmhearted-cold, compassionate- unconcerned, committed-uncommitted), which are rated on a 7-point scale (Cronbach's alpha = .902). Furthermore, we assessed the agent`s general competence as a tutor and examiner, and its specific competence in conducting a training and exam about medical topics, on a 5-point Likert-scale from "not at all competent" to "very competent".

General evaluation of the tutoring system

The general evaluation of the interaction was assessed by items that asked for the participants' sense of control during the interaction, the enjoyment of the interaction, and whether participants liked to use a system like this for other tasks. Here, participants stated their level of agreement by means of a 5-point Likert-scale (Cronbach's alpha = .747).

Test anxiety

We measured participants´ situational actual test anxiety before and directly after the interaction with the virtual agent. Participants are prompted to imagine being in a test situation and rate their test anxiety on seven adjectives (afraid, fearful, filled with fear, excited, unconfident, stressed, worried) from "not at all" to "very" on a 7-point Likert scale (Cronbach`s alpha = .941) (Jacobs, 1981). They could also indicate their actual perceived test anxiety on a 10-point Likert scale from "no fear" to "extreme angst".

3.3 The virtual agent

To implement the communication between participant and agent, the software *CharAt* by the Charamel Company (www.charamel.com) was used. It provides a humanoid virtual agent and a text-to-speech engine enabling the programmer to put out any given text via synthesized speech and change the character´s movements and general body language. For the study at hand, neutral movements were implemented. When speaking, the animated character moves its mouth accordingly and changes its facial expressions, while otherwise showing idle movement like blinking and posture shifts. All participants of the study interacted with the female agent *Gloria* (see Figure 1).

3.4 Participants and Procedure

Using the cover story that we search for volunteers to test a training program to reduce test anxiety before oral examinations, we recruited 40 students (30 female, 10 male) for the study. Their age ranged from 19 to 27 with a mean of 21.45 years (SD = 2.3). Upon arrival participants signed informed consent, were instructed and seated in front of two computer screens. A headset was also provided. On the first screen, the participants had to fill in a questionnaire with questions regarding demographics, personality traits and their current test anxiety.

Following this, participants turned to the other screen, put on the headset and began the actual interaction with the virtual agent. The first text about diabetes and the subsequent inquiries about this topic were presented by the virtual agent. The participants then answered the questions by speaking into the headset's microphone. The texts about Alzheimer's disease and osteoporosis were treated in the same manner. The answers of the participants were recorded. The interaction was based on a Wizard-of-Oz scenario with a confederate operating the virtual agent. The interaction followed a predefined interaction script which guaranteed that every participant received the same treatment.

After the interaction with the virtual agent, the participants' attention was once again drawn to the first screen. They were asked to fill in some final questionnaires asking again for their current exam anxiety in order to assess a possible effect of the training with the agent. The next questionnaires examined the participant's evaluation of the agent and the interaction (see dependent variables for more details). Finally, participants were asked to indicate their affinity towards the use of technical terms in everyday life and in a professional context.

After this, the participants were fully debriefed and thanked for their participation. Participants received extra course credit for participation.

Figure 1: The virtual agent Gloria.

4. Results

4.1 Lexical alignment and total amount of words

To examine whether and how people show lexical alignment during the interaction with the virtual tutor, the tutor presented 42 facts (knowledge units) related to the three medical topics. During the interactive part of the interaction participants were requested to reflect on the previously heard input and answer questions asking for these 42 knowledge units. We calculated the number of mentioned knowledge units for each participant. Further, we calculated for how many of these mentioned knowledge units the participant aligned to the agent`s expression. A ratio (number of aligned knowledge units / number of mentioned knowledge units) was calculated. Participants on average mentioned 13.32 knowledge units (*SD* = 3.81). They differed strongly in the number of knowledge units they were able to reproduce

	Min-Max	M (SD)	Word choice of virtual agent	M	SD
Total amount of mentioned knowledge units	3–20	13.32 (3.81)	Technical term use	13.15	3.47
			Lay language use	13.50	4.21
Amount of aligned knowledge units	2–17	11.15 (3.50)	Technical term use	11.10	3.09
			Lay language use	11.20	3.94
Alignment ratio			Technical term use	.85	.07
			Lay language use	.82	.12

Table 2: Means and standard deviations for lexical alignment with the agent (N = 40).

(ranging from 3 to 20 facts, see Table 2). Moreover, 11.15 (*SD* = 3.49) of these knowledge units were presented using the same expression as the agent used before which means that overall participants aligned their expression in 83% of all cases. One-factorial ANOVAs showed no significant differences for the number of mentioned knowledge units, the number of aligned knowledge units and the lexical alignment ratio with regard to the two conditions (cf. Table 2).

With regard to the total amount of words participants used to answer the agent´s questions, one-factorial ANOVAS did not show any significant differences between conditions, neither for the total amount of word regarding all answers, nor when solely looking at the answers to questions regarding one medical topic.

4.2 Competence and likability of the agent

In order to test whether the usage of technical terms results in a higher perceived competence of the virtual agent (H2) we calculated one-factorial ANOVAS with the dependent variables *general competence as a tutor and examiner* and *specific competence in conducting a training and exam about medical topics* which showed no significant effect. In general the agent was evaluated as very competent (*M* = 7.83; *SD* = 1.45 on a 10-point Likert scale). Moreover, we tested whether the usage of technical terms results into a lower perceived likability of the virtual agent (RQ1). Here also, the usage of technical terms versus lay language did not influence participants` evaluation of the agent as indicated by a one-factorial ANOVA.

4.3 Evaluation of the interaction with the agent

In order to test the research question whether the usage of technical terms influences participants` evaluation of the interaction (RQ2) an ANOVA was conducted. However, word choice also did not influence participants` general evaluation of the interaction. An ANCOVA with the participants` affinity for technical terms usage (participants were asked how regularly they use technical terms in their private and professional life) also did not show any effect.

4.4 Test anxiety

To test whether our tutoring system was successful in reducing test anxiety by training we calculated a repeated-measure ANOVA with the participants` scores in test anxiety prior to the training and after the training (H3). Participants on average reported slightly less test anxiety after the treatment (*M* = 27.20; *SD* = 13.28) than before (*M* = 29.65; *SD* = 11.21) this difference, however, was not significant.

5. Discussion

In order to investigate whether and to what extent people lexically align with a virtual agent in a learning situation, we conducted an experimental study in which the virtual tutor presented information on three medical topics either using lay language or technical terms. Results show that people indeed aligned with the word choice of the agent. Participants in the lay language conditions predominantly used lay language to answer the agent`s questions, while participants in the other condition used predominantly technical terms. Overall participants in both conditions aligned their answers in 83% of all cases showing that the tendency to converge lexically with the interaction partner observed in human-human interaction and "traditional" human-computer interaction (Brennan & Clark, 1996) also takes place in human-agent interaction. A limitation of this preliminary study is certainly that we are not able to directly compare our results to human-human interaction. We observed a high level of alignment, but it is unclear whether alignment with a human interlocutor would have been stronger or weaker. Thus, further studies with a direct comparison of human and virtual interlocutors are needed.

Looking closer at the stimulus material we recognized that alignment varied strongly depending on the specific knowledge unit and the corresponding word (in lay language or technical term). Some knowledge units were obviously commonly known to the participants and therefore mentioned more often and showed a greater degree of alignment (e.g. sugar sickness /diabetes was mentioned 33 times; smoking/nicotine consumption was mentioned 33 times). Other expressions were not commonly known and mentioned just by a few participants (e.g. hyperglycemia, densitometry, and arteriosclerosis were mentioned by less than three participants).

Therefore, the specific learning material is a limitation of the study since a priori knowledge might confound results. Thus, the approach of Branigan et al. (2010) to investigate lexical alignment using preferred and not preferred words (e.g. for everyday objects like sofa vs. couch) in interactions might be preferable. Another limitation to this study is that we used a learning scenario by which we created a very special social situation, where people received facts about medical topics which were subsequently inquired by the agent in an oral exam. Thus, we cannot eliminate the possibility that we did not observe signs of the social phenomenon alignment, but rather an effect of prompting or priming, respectively (for a discussion on priming see Branigan et al., 2010).

Besides linguistic alignment, we expected that a virtual agent using technical terms would be perceived as more competent which might mediate participants` behavior. We did not find any significant difference with regard to the agent`s person perception neither with regard to competence nor likeability. But because studies showed a relationship between alignment and likability, future work should address this topic more explicitly, e.g. by introducing the agent as a likable or not likable (or more or less competent) interlocutor in order to examine whether people align more or less with likable or competent agents, respectively.

Concerning the field of application, we found that, although not statistically significant, participants reported less text anxiety after the interaction with the system. It would be interesting to see whether repeated usage would help students to significantly reduce test anxiety. Moreover, it should be tested whether the effect of lexical alignment could be used to enlarge the vocabulary of users. This could be helpful in diverse training systems, not only with regard to a student learners or medical topics.

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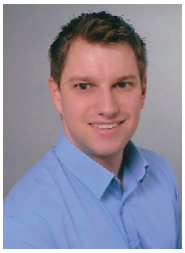
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