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Explicit feedback from users attenuates memory biases in human-system dialogue

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ABSTRACT

In human–human dialogue, the way in which a piece of information is added to the partners' common ground (i.e., presented and accepted) constitutes an important determinant of subsequent dialogue memory. The aim of this study was to determine whether this is also the case in human-system dialogue. An experiment was conducted in which naïve participants and a simulated dialogue system took turns to present references to various landmarks featured on a list. The kind of feedback used to accept these references (verbatim repetition vs. implicit acceptance) was manipulated. The participants then performed a recognition test during which they attempted to identify the references mentioned previously. Self-presented references were recognised better than references presented by the system; however, such presentation bias was attenuated when the initial presentation of these references was followed by verbatim repetition. Implications for the design of automated dialogue systems are discussed.

1. Introduction

Human-system dialogue is a goal-oriented activity during which a human being (usually referred to as a user) uses language to interact with an automated dialogue system. Such interactions are increasingly frequent, as it is not uncommon nowadays to interact with a system using natural speech or keywords in order to buy a train ticket or to book a flight (see Barrett and Jiang, 2012; Grudin, 2005; Pieraccini and Huerta, 2008; Zhou, 2007).

The psychological processes at play in human-system and human-human dialogue are supposed similar, as users' expectations and beliefs regarding dialogue system are analogous to those held by human partners engaged in dialogue (e.g., Bergmann et al., 2015; Branigan et al., 2010; Branigan et al., 2011; Branigan et al., 2003; Brennan, 1991, 1996; Cavedon et al., 2015; El Asri et al., 2014; Iio et al., 2015; Johnstone et al., 1995; Kiesler, 2005; Koulouri et al., 2015; Le Bigot et al., 2013; Powers et al., 2005; Suzuki and Katagiri, 2007; van Lierop et al., 2012; Zoltan-Ford, 1991). In this sense, dialogue psychology provides important insight for the development of automated dialogue systems. In particular, one major finding is that human dialogue partners attempt to produce partner-adapted utterances as they interact (Brennan and Clark, 1996; Clark and Wilkes-Gibbs, 1986; Yoon and Brown-Schmidt, 2012). To do so, they rely on their memory for past interactions, or dialogue memory (e.g., Gibbs, 1986; Keenan et al., 1977; Le Bigot et al., 2013; Pasupathi and Hoyt, 2010). However, such memory is subject to a number of biases which cause some of the encoded pieces of information to become less readily accessible than others (Knutsen and Le Bigot, 2015; Knutsen, Ros, and Le Bigot, in press). The first goal of the current study is to determine whether these biases are also observed when a human user interacts with a dialogue system. Verifying this assumption would imply that users are likely to systematically have difficulty remembering part of the information produced by the system. Accordingly, the second goal of this study is to determine how these biases can be attenuated, in particular by manipulating the kind of feedback produced by humans and systems during the interaction.

The remainder of this paper is organised as follows. Section 2 describes literature on human-human and human-system dialogue. The current study, which involved interactions between naïve participants and a simulated dialogue system, is described in Section 3. The results are reported in Section 4 and discussed in Section 5. Section 6 includes directions for future research.

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2. Theoretical background: dialogue memory in human-human interactions

Collaborative dialogue is an activity during which at least two partners interact in order to reach a common goal (Clark, 1992, 1996) and which might involve human partners only or human (s) and automated dialogue systems (see Klein et al., 2005).

Dialogue partners attempt to adapt to each other by favouring the production of easily understandable utterances not only at the beginning of the interaction, but also during the remainder of the dialogue. For instance, human partners talking about pictures of New York buildings adapt the references they use to designate the buildings depending on whether their partner knows New York well (in which case they might produce the reference "the Empire State Building") or not (in which case they might produce the reference "the pointy building") (Isaacs and Clark, 1987; see also Brennan and Clark, 1996; Clark and Wilkes-Gibbs, 1986; Nückles et al., 2006). In a similar way, users interacting with a dialogue system about everyday objects reuse the same references to these objects as those previously used by the system, as they assume that the system should be capable of understanding them again (Bergmann et al., 2015; Branigan et al., 2011; Iio et al., 2015; for other examples, see also Branigan et al., 2003; Cavedon et al., 2015; Kiesler, 2005; Koulouri et al., 2015; Powers et al., 2005; Suzuki and Katagiri, 2007; Zoltan-Ford, 1991).

To determine what his or her partners are capable of understanding, each partner relies on the common ground, which consists in the knowledge and information that two dialogue partners share and are aware of sharing (in human dialogue) or the information which the user believes to be shared with the system (in human-system dialogue). Part of the common ground consists in the information produced earlier during the current interaction or during past interactions. Precisely, information is added to the common ground through a joint *contribution* process (Clark and Brennan, 1991; Clark and Schaefer, 1989; Clark and Wilkes-Gibbs, 1986; for a generalisation to human-system dialogue, see Brennan and Hulteen, 1995; Cahn and Brennan, 1999). One of the speakers starts by presenting a piece of information. For instance, Speaker A might say: "I would like to go to the cinema on Saturday." during an interaction with Speaker B. The latter then accepts this information, that is, he or she indicates that he or she believes that the information presented was understood well enough for current purposes. Acceptance is more or less explicit: Speaker B might accept the utterance produced by A by repeating it verbatim, by saying "okay" or by nodding his or her head. In any event, once presented and accepted, the information is added to the speakers' common ground (Clark and Brennan, 1991; McInnes and Attwater, 2004); in this example, this would imply that both A and B are aware that they both know that A would like to go to the cinema on Saturday. Either speaker may then resort to it for subsequent adaptation purposes. The partners' capacity to remember *what* was said previously is therefore a central determinant of successful partner-adaptation.

Importantly, studies on human dialogue suggest that dialogue memory is more or less accurate depending on whether one needs to retrieve initially self- or partner-produced information from memory (Hjelmquist, 1984; Jarvella and Collas, 1974; Knutsen and Le Bigot, 2015; Stafford et al., 1987; Stafford and Daly, 1984). For instance, Knutsen and Le Bigot (2015; see also Knutsen et al., in press) have recently shown that the distinction between self- and partner-production at the time of common ground construction directly affects dialogue memory. Indeed, after the end of an interaction, each partner remembers the information that he or she presented him- or herself better than the information presented by his or her partners; information accepted through verbatim repetition is also remembered better than information accepted implicitly (regardless of whether the acceptance was self- or partner-produced). Such memory biases have important consequences for subsequent partner-adaptation, as readily accessible information is more likely to be reused in the remainder of the interaction (Knutsen and Le Bigot, 2012, 2014; Knutsen et al., in press).

To date, these biases have exclusively been investigated in human-human dialogue. However, as mentioned already, similar processes are at play in humans engaged in human-human dialogue and in users engaged in human-system dialogue (e.g., Brennan, 1991; Powers et al., 2005), implying that users should also be subject to presentation and acceptance biases. This could have important consequences for human-system dialogue. Most users engage in this kind of dialogue in order to obtain pieces of information held by the system (e.g., the various stations at which a train calls or the departure time of a plane). If users' dialogue memory for human-system dialogue is subject to a self-presentation bias, this would imply that the information obtained from the system (i.e., system-presented information) would systematically be remembered less well than the information produced by the user him- or herself (i.e., self-presented information). Furthermore, designers may rely on the fact that speakers tend to reuse words and structures previously mentioned by the system to ensure that users only produce words and structures that the system is capable of understanding (e.g., Koulouri et al., 2015; Zoltan-Ford, 1991). However, if the users' dialogue memory is biased towards remembering self-presented information better, then such convergence might not occur systematically, thus potentially impairing the interaction.

The acceptance bias might have important consequences for human-system dialogue as well. In the presentation-acceptance model, acceptance is more or less explicit (Clark and Brennan, 1991; Clark and Schaefer, 1989). When acceptance involves verbatim repetition of the presented reference, this reference becomes more readily accessible to both speakers (compared to references accepted through other means) (Knutsen and Le Bigot, 2014, 2015; Knutsen et al., in press). Such acceptance effect might be sufficient to attenuate the presentation effect from the point of view of the speaker performing the acceptance. For instance, if a system-presented reference is accepted through verbatim repetition by a user, this reference should benefit from a self-production effect (due to verbatim repetition at the time of acceptance) from the user's point of view, just like self-presented references. This should result in an increase in accessibility in memory of the system-presented reference, thus attenuating the strength of the presentation bias by reducing the difference in accessibility between self- and partner-presented references from the user's point of view. Importantly, there are both pros and cons associated with explicit acceptance in human-system dialogue. The main advantage associated with the user or the system repeating the information presented by the other partner is that it allows this partner to check that the information presented was understood correctly (Cahn and Brennan, 1999; Dybkjaer and Bernsen, 2001; Dybkjær and Bernsen, 2000). Furthermore, system explicit acceptance can increase user satisfaction, especially when the information repeated is important within the context of the task framework (Stent et al., 1999). However, explicit repetition by the system is sometimes cumbersome and is not well adapted to all users (e.g., to users whose speech is typically well recognised; see Litman and Pan, 1999); in a similar way, explicit repetition by the user might feel unnatural and not always necessary. Furthermore, explicit repetition (by the system and/or by the user) decreases the efficiency of the interaction, as it increases the number of speech turns necessary to complete the task at hand (e.g., Wolters et al., 2009), potentially overloading the users' memory. The results of the current study are discussed below in light of these pros and cons.