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Integrating laughter into spoken dialogue systems: preliminary analysis and suggested programme

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Abstract

This paper presents an exploratory scheme, which aims at investigating perceptual features that characterise laughables (the arguments laughter is related to) in dialogue context. We present the results of a preliminary study and sketch an updated questionnaire on laughables types and laughter functions aimed to be used for Amazon Mechanical Turk experiments. Furthermore we present preliminary programme for integrating laughter into spoken dialogue systems.

1 Introduction

Laughter as a prominent non-verbal social signal (NVSS) is a crucial element in our daily interactions, being very frequent in our dialogues (the dialogue part of British National Corpus contains approximately one laughter token every 14 turns) regardless of gender and age. It is produced in many different contexts being associated with very different emotional states and intentions to affect the interlocutors [Poyatos, 1993; Glenn, 2003; Mazzocconi *et al.*, 2016]. In all of its use, laughter has propositional content that needs to be integrated with linguistic import since it is able to enrich and affect the meaning conveyed by our utterances Ginzburg *et al.* [2015]. Following Ginzburg *et al.* [2015], Mazzocconi *et al.* [2016] and Mazzocconi *et al.* [subm], we consider laughter as involving a predication $P(l)$, where P is a predicate that relates to either incongruity or closeness (see following section for explanation) and l is the laughable, an event or state referred to by an utterance or exophorically.

Understanding the role of laughter in our interactions involves several levels of analysis. In the current work we will be mainly concerned with the resolving its argument, the laughable, which, importantly, needs to be distinguished from the *function* the laughter is performing (see Mazzocconi *et al.* [2016] and Mazzocconi *et al.* [subm] for more detailed argumentation).

In the rest of the paper we briefly survey existing approaches towards adding laughter as a non-verbal modality into spoken dialogue systems (section 2) and provide some background on incongruity types (section 3). In section 4 we present some results obtained from a preliminary study on the classification of laughables and its relation to Gricean maxims violations and our proposal for a new and more detailed questionnaire that we intend to administer to naive coders via the Amazon Mechanical Turk platform. We finish (section 5) with proposing a programme for integrating laughter into spoken dialogue systems.

2 Laughter in spoken dialogue systems

In order to test theoretical models of human conversation, it is important that a proof of concept computational model is not based on traditional strict turn-taking between user and system. Schlangen and Skantze [2009] propose an *incremental* approach to dialogue processing. This approach allows a dialogue system not to restrict its input and output to utterance boundaries. For example, the system can use results that are not yet established with high confidence or are incomplete from speech recognition with very short latency. This enables the system to provide rapid feedback. Incremental speech synthesis allows the system to monitor itself and quickly retract depending on the feedback from a user.

Existing integration of smiling and laughter in embodied conversational agents (ECA) is not based on incremental processing and typically is triggered by a joke told by a user or an agent. This means that a variety of laughter functions that exist in spontaneous human-human interaction cannot be accommodated. Ding *et al.* [2014] developed one of the first approaches to laughter animation synthesis (lip, jaw, head, eyebrow, torso and shoulder animation) for a virtual character based on the input which is represented as pseudo-phonemes of laughter. Regarding the speech signal [Aucouturier *et al.*, 2016] created an audio platform that is able to add emotional tone to the voice of a speaker, including sadness, fear and happiness. However, the problem of incremental real-time laughter synthesis still remains to be addressed.

Laughter detection and classification is a more developed topic compared to synthesis. State of the art laughter detection is based on machine learning techniques: from support vector machines (SVMs), Gaussian mixture models (GMMs) [Tahon and Devillers, 2015] and automatic language independent speech processing (ALISP) [Pammi *et al.*, 2012] to deep learning approaches, including convolutional neural networks (CNNs) [Kaushik *et al.*, 2015]. These studies provide a strong baseline for further improvements in laughter detection among speech signals.

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3 Categorising incongruity

Most scholars interested in the study of laughter, would agree that most of its occurrences are related to the perception of an incongruity, i.e., an inconsistency between the expectations of the conversational participants and some event. This hypothesis has been studied extensively in theories of humour [Hempelmann and Attardo, 2011; Raskin, 1985], since it is easily applicable and able to account for the laughter in response to humourous stimuli (e.g., jokes). However, although the notion of incongruity seems intuitive and offers an explanation for (some) causes of laughter, it cannot be consistently identified in all cases in which laughter occurs. Also, incongruity, as it has often been used, is a vague and general notion, with incongruities being available at all levels of linguistic interaction (e.g., phonology, semantics, pragmatics). It is therefore difficult to build a computational account of incongruity as it is currently conceived. In order to offer a more fine-grained account, we are planning to assess (i) which of the types of incongruity proposed in Mazzocconi *et al.* [subm] can be recognised by naive coders, and (ii) whether it can be subdivided into categories that correspond to Grice's conversational maxims [Grice, 1975].

Following the account of [Mazzocconi *et al.*, subm] we will distinguish two major classes of laughter arguments: the ones in which an incongruity can be identified and the ones which do not involve incongruity. When incongruity is present, we distinguish three different categories: i) pleasant incongruity, ii) social incongruity, iii) pragmatic incongruity.

With the term *Pleasant* incongruity we refer to any cases in which a clash between the laughable and certain background information is perceived as witty, rewarding and/or somehow pleasant [Goel and Dolan, 2001; Shibata and Zhong, 2001; Iwase *et al.*, 2002; Moran *et al.*, 2004]. Common examples are jokes, puns, goofy behaviour and conversational humour, therefore closely connected with the definitions offered in humour research (e.g. Raskin [1985]).

We identify as a *Social* incongruity all instances in which a clash between social norms and/or comfort and the laughable can be identified. Examples might be, a moment of social discomfort (e.g. embarrassment or awkwardness), a violation of social norms (e.g., invasion of another's space, the asking of a favour), or an utterance that clashes with the interlocutor's expectations concerning one's behaviour (e.g., criticism) [Owren and Bachorowski, 2003; Caron, 2002; Fry Jr, 2013].

With the term *Pragmatic* incongruity we classify incongruity that arises when there is a clash between what is said and what is intended. This kind of incongruity can be identified, for example, in the case of irony, scare-quoting, hyperbole etc. Typically in such cases laughter is used by the speaker herself in order to signal changes of meaning within his/her own utterance to the listener.

But as already mentioned, laughter can also predicate about laughable where no incongruity can be identified. In these cases what is associated with the laughable is a sense of *closeness* that is either felt or displayed towards the interlocutor, e.g., while thanking or receiving a pat on the shoulder.

(1) *(Pleasant incongruity, enjoyment of incongruity)*
Lecturer: The other announcement erm is er Dr *** has asked me to address some delinquents, no that's not fair, some er hard working but misguided students...
Audience: **[laughter]**
Lecturer: erm... (BNC,JSM)

(2) *(Social incongruity, smoothing)*
Interviewer: ... [cough] Right, you seem pretty well qualified.
John: I hope so **[laughter yes]** erm (BNC, JNV)

(3) *(Pragmatic incongruity, marking irony)*
Lecturer: ... And then of course you've got Ronald Reagan ... and **[laughter]** history ends with Ronald Reagan. (BNC, JSM)

(4) *(Closeness, affiliation)*
Richard: Right, thanks Fred. You're on holiday after today?
B: mh mh
Richard: Lovely. **[laughter]** (BNC, KDP)

4 Analysing the causes of laughter

In the current work we will analyse how coders perceive laughter and its laughable from different perspectives: (a) presence/type of incongruity and (b) Gricean maxims. Furthermore we will check how judgements about the functions of laughter correlate with our previous studies. We also intend to figure out the commonalities between these judgements and personal psychological traits of the participants.

4.1 Preliminary investigation

For our preliminary study, we randomly selected one full dialogue from The Switchboard Dialog Act Corpus (SWDA) [Jurafsky *et al.*, 1997], 5 excerpts from other conversations in SWDA (provided with a brief context) and 5 from part of the British National Corpus (BNC), previously analysed for laughter [Mazzocconi *et al.*, subm], and presented them in textual form.

Our questionnaire contained: i) four questions related to general understanding of given excerpt and positioning of laughter and laughable, ii) four questions reflecting violations of Gricean maxims, iii) one question reflecting presence of incongruity, and iv) two free-form questions: about the cause of laughter and its function.

The results that we report here are from a pilot study with 3 annotators[1]. While there is not enough data to calculate inter-annotator agreement, the free-form answers to the question about the cause of laughter suggest that, at least in some cases, coders understand and agree on the cause of the laughter.

Some of the presented excerpts show that it can be hard to describe the cause and function of laughter even when they understood the laughters quite well. Example 5 shows disagreement between the coders regarding the position of the laughable (whether it occurred before or after the laughter); the cause of the laughter (e.g. "Saying something sad about

[1]The annotators were not native English speakers, however some examples in BNC were not produced by native speakers either. We are planning to involve native speakers in our study.

another person" vs "Being depressed of other peoples' problems, and at the same time bringing them their problems"); and its function ("Softening" vs "Marking incongruity").

(5) A: We have a boy living with us who works for a credit card, uh, company that,
A: and he makes calls to people who have problems, you know, credit problems,
B: Huh-uh.
A: that are trying to work out
A: and, uh, **[laughter]** . Poor thing he comes home very depressed every night [laughter],
B: Oh. (SWDA, sw2883, 451–481)

Preliminary experiments have also shown that the prosody and phonetic form of laughter are crucial in identifying its causes and functions and we are going to explore its role further in our study.

The full report on the preliminary study was presented in Maraev and Howes [2018 to appear].

4.2 Integrated questionnaire

In the present study we will carry out an Amazon Mechanical Turk experiment consisting of the following steps.

1. Listen to an audio recording of a fragment containing laughter.
2. Respond to a questionnaire consisting of 18 questions (see Appendix A) regarding both the laughable type and the laughter function classification.
3. Repeat steps 1–2 for 80 sound fragments.
4. Respond to a questionnaire on people's experiences of their own laughter production and perception

Our aim is to explore the evaluation of laughable and laughter functions as perceived by naive coders completely unfamiliar with our framework (different from the agreement obtained for example in Mazzocconi *et al.* [2016, subm], where coders, even if naive, had been introduced to the authors' framework and exposed to examples of annotations). It will therefore provide us of a broader perspective on a more ecological perceptual features classification. We will conduct the experiment using Chinese materials, by means of dialogues from the DUEL corpus [Hough *et al.*, 2016], and using English materials by means of data from the BNC and the SWDA[2]. All annotators will be native speakers of the languages investigated. Such data will then be compared to the annotations already available from the work of Mazzocconi *et al.* [2016, subm], conducted by the authors of the framework and naive coders provided of explanations before the laughter analysis. We will also attempt to conduct some correlation between the data collected and the results of the "Questionnaire on people's experiences of their own laughter production and perception" (Master Thesis, UCL) and explore for the first time differences in laughable and laughter function classification with respect to specific laughter perception profiles.

[2]We will ask to classify both laughable types and function also in order to have a means of checking whether the participants are actually paying attention and verify that the functions selected could actually be compatible with the ticked laughable type.

4.3 Analysis of results

Considering the shortcomings of agreement calculation using chance-adjusted metrics, e.g. Krippendorff's α, for tasks such as ours, we will use a probabilistic annotation model [Dawid and Skene, 1979] that has been successfully applied to crowdsourced NLP data collection tasks, such as word sense annotation [Passonneau and Carpenter, 2014]. In such tasks, where there is no gold standard, as in our study, these methods are more reliable for inducing the ground truth from the population of annotators.

5 Suggested programme

In order to construct a framework for dialogue interaction that would include laughter, the KoS framework (not an acronym but loosely corresponds to Conversation Oriented Semantics) [Ginzburg, 2012] will be taken as a basis. The reason for it is that KoS provides among the most detailed theoretical treatments of domain general conversational relevance. Three basic components are required: (i) an incremental interface that would operate word by word to enable the speech and laughter to be appropriately positioned and compose the online meaning of an utterance, (ii) appraisal techniques that would infer emotion reaction from the incrementally processed utterance, (iii) local pragmatics that would enable online pragmatic reasoning needed for evaluating incongruity. The incremental interface processing will be based on the account that was developed in order to accommodate disfluencies [Ginzburg *et al.*, 2014, 2017].

The components of the dialogue system will refine existing software. The dialogue manager (DM) will be developed using Talkamatic/GoDIS [Larsson and Berman, 2015] or OpenDial [Lison, 2015], the embodied (avatar) part will be established on Greta system [Niewiadomski *et al.*, 2009], grammars for natural language understanding (NLU) and generation (NLG) be based on on DS-TTR [Hough, 2014], for automatic speech recognition (ASR) HTK [Young *et al.*, 2002] or Kaldi [Povey *et al.*, 2011] can be used, and TTS module will be built on the David system [Aucouturier *et al.*, 2016]. The utility of each component to the main goal of testing of a formal dialogue model will be evaluated in order to decide how each component can be updated or changed.

In order to test different components of the theoretical model and compare their impact, the general approach will be grammar-based (for NLU and NLG) and rule-based (for DM). There is a category of fully data-driven approaches, including systems based on partly observable Markov decision process (POMDP) optimized using reinforcement learning that require a minimal amount of handcrafting and are less prone to the errors in speech recognition while operating in a noisy environment [Young *et al.*, 2013]. Neural conversational models that are created using deep learning techniques also seem promising [Li *et al.*, 2016]. Our primary aim requires inserting explicit rules that will follow the theoretical model, thus fully data-driven approaches are not be suitable here. However, interactions that include laughter are fairly complex, and programming them using straightforward rules will be challenging. Hence, it is intended to build a DM based on an approach that includes manual specification of the rules

while transitions between them are defined by probabilistic networks that will learn probabilities from data [Lison, 2015]. The way the rules are organized will be based on information-state update (ISU) approach [Larsson, 2002] which provides a simplified implementation of the KoS framework. This approach will be combined with incremental dialogue processing [Schlangen and Skantze, 2009]. Achieving this integration, specifically with respect to the definition and learning of the probabilistic rules, will be one of the challenges of this project.

A hybrid grammar- and probabilistic-based approach will also be followed for the NLU and NLG modules along with the general requirement of incremental processing. DS-TTR (Type Theory with Records for Dynamic Syntax) grammars will be used bidirectionally, both for NLU and for NLG. Such grammars allow to parse sequences incrementally, word-by-word, include probabilistic parsing and incorporate non-verbal pragmatic information.

We believe that our work will contribute to linguistic research by creating a proof of concept system that will be feasible to test theoretical insights about human conversation. It will demonstrate how laughter contributes semantic and pragmatic import to dialogue. The potential of this work concerning natural language processing involves making future dialogue systems more reactive to laughter. This will enable natural and highly responsive behaviour of an artificial agent in interactive settings.

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A Supplemental Material

	Do you think that: () before, () during, () after the laughter one of the speakers (more than one tick allowed):
1	gives more information that was needed?
2	gives information that was false or wasn't supported by evidence?
3	gives information that was irrelevant for the discussion?
4	gives information that was obscure or ambiguous?
	Why are they laughing? (one tick allowed)
1	Because of some funny, witty or anyways pleasant incongruence
2	Because of a moment of social discomfort (e.g. embarassement, critics, asking favour etc)
3	Because of a discrepancy between the literal words and the intended message
4	Because they want to show closeness and affiliation to the others
	What is the laughter used for? (one tick allowed)
1	Show enjoyment
2	Mark incongruence
3	Smooth
4	Soften
5	Induce benevolence
6	Mark irony
7	Signal the need of enrichment of literal interpretation
8	Thank
9	Show affiliation
10	Agree

Table 1: Laughable type and laughter function questionnaire

Item
1) I rarely laugh when I am on my own.
2) I have a subdued laugh.
3) Hearing laughter makes me nervous.
4) I dislike people who laugh a lot.
5) I find things funny but I rarely laugh out loud.
6) I laugh less often than most people I know.
7) I laugh more than most people I know.
8) When I'm upset hearing someone laugh makes me feel better.
9) I rarely break into uncontrollable laughter.
10) If I find something funny, I often laugh out loud.
11) If I am happy, hearing someone laugh makes me even happier.
12) I often laugh deliberately to show that I like someone.
13) Hearing people faking laughter irritates me.
14) I can tell when people are laughing because they want something from me.
15) I can tell when someone is laughing to stop me getting angry at them.
16) I enjoy the sound of people laughing.
17) I can tell when someone is deliberately laughing to pretend that they are amused.
18) A friend's laughter is always good to hear.
19) Laughter has a positive influence on interactions with people.
20) I find laughter an important part of intimate relationships.
21) I laugh more when I want people to like me.
22) I can never tell if someone is deliberately laughing to pretend that they are amused.
23) I can never tell if someone is laughing because they want something from me.
24) I can never tell if someone is laughing to stop me getting angry with them.
25) Sometimes I laugh to stop other people from getting angry with me.
26) Sometimes I find it difficult to tell when someone is laughing nastily.
27) I sometimes laugh to avoid expressing sadness.
28) Sometimes I find it difficult to tell when someone is laughing just to be polite.
29) I often laugh to avoid expressing frustration.
30) I can always tell if someone is laughing at or with me.

Figure 1: Questionnaire on people's experiences of their own laughter production and perception