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# Towards Investigating Gaze and Laughter Coordination in Socially Interactive Agents

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## ABSTRACT

Gaze and laughter play a crucial role in managing miscommunication and coordinating social interactions. We hypothesise that models of laughter and gaze coordination in human dialogue extend to virtual entities. This paper describes methodology of the future experiment which involves a socially interactive agent (SIA) that incorporates previous theoretical findings.

## CCS CONCEPTS

• **Human-centered computing** → *User models*.

## KEYWORDS

gaze, laughter, virtual agents, socially interactive agents

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## 1 INTRODUCTION

Socially interactive agents (SIAs) are autonomous agents which have physical robotic bodies or virtual appearances and communicate both verbally and non-verbally with humans and other agents. With advances in computational linguistics and computer vision, SIAs that are able to hold conversations that are engaging and human-like have recently gained momentum.

There is some understanding of how humans use laughter and gaze in dialogue, and theoretical models are derived from humans. Nevertheless it is unclear how this knowledge extends to virtual entities. In a previous corpus study, [18] established that social incongruity laughs (i.e. laughs not related to humour, but rather aimed

at smoothing dialogue acts and conversations) are accompanied by distinct gaze patterns. In this paper we outline the forthcoming perception study of SIA's laughter and gaze behaviours associated with social incongruities.

## 2 BACKGROUND

### 2.1 Gaze and laughter in human dialogue

The role of gaze in maintaining conversational flow and coordinating dialogue acts is crucial in face-to-face interactions. While many works have argued for the importance of individual gaze for the fine regulation of turn-taking [6, 11], some scholars highlighted a lack of systematic relationship between gaze and turn-taking [3, 28, 33], proposing rather that gaze might function to elicit a response [2, 12]. Gaze patterns have also been found to differ depending on the speech act they accompany and on their pragmatic function [20, 27, 29]. Of interest in the study is also gaze aversion [14, 25, 26]. It has been proposed that gaze aversion could also be explained (or influenced) by social stress [31], with evidence from patients with social disorders [30]. Conversely, results from other studies suggest that cognitive load has the most impact on gaze aversion [5, 9].

The circumstances under which we can produce laughters are affected by the perceived context and expectations of the interlocutors regarding possible changes of context. [8] borrow the term *laughable* from Conversational Analysis [10] as denoting something that laughter *relates to* while being agnostic about whether it is humorous or not. [19] present a taxonomy of laughter functions from the perspective of the intended effect on the context and use it to annotate laughs in various corpora. It takes into account four types of incongruity that characterise a laughable and groups the functions accordingly. It is also necessary to mention that laughter has intrinsically important social effects, being crucial for bonding and managing relationships, while also being immensely influenced by social context [24].

### 2.2 Gaze and laughter in SIAs

SIAs benefit from a detailed analysis of multimodal input and output patterns observed during human-human interactions. Recently, there has been a growing research interest both on gaze and other

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non-verbal behaviours, especially in the Affective Computing community, for the implementation of SIAs which are more competent from a pragmatic perspective and able to process and produce appropriate emotional responses [1, 15, 22, 32]. [1] established a basis for a context-aware eye-gaze generator for a SIA. To develop an improved gaze generator we should isolate the significant events detected in the multimodal scene that impact the gaze. [15] discuss the interpersonal role of gaze in interaction to signal feedback and direct conversation flow which current SIAs still lack. In a dynamic environment, even state-of-the-art SIAs struggle to direct gaze attention to peripheral movements. SIAs should therefore employ social gaze not only for interpersonal interaction but also to possess human attention attributes so that its eyes and facial expression portray and convey appropriate distraction and engagement behaviours.

Several models have been proposed to generate laughter [4, 13] and to decide when a SIA should laugh. For example, [4] created a laughter behaviour controller to generate face and body motions from laughter audio. [13] created a listening agent that predicts when to smile or to laugh depending on its interlocutor’s behaviours. [34] proposed a neural network learning model based on an attention mechanism to compute where to place a given type of laughter. Several recent studies have investigated laughter synthesis [16, 21]. Overall, they highlight that laughter synthesis in different contexts serving different functions still remains to be addressed. For instance, how can social laughter which accompanies an apology be synthesised together with speech in a naturalistic way? Laughter detection is a more developed topic compared to synthesis. State-of-the-art laughter detection is based on machine learning techniques: from support vector machines to deep learning approaches [7].

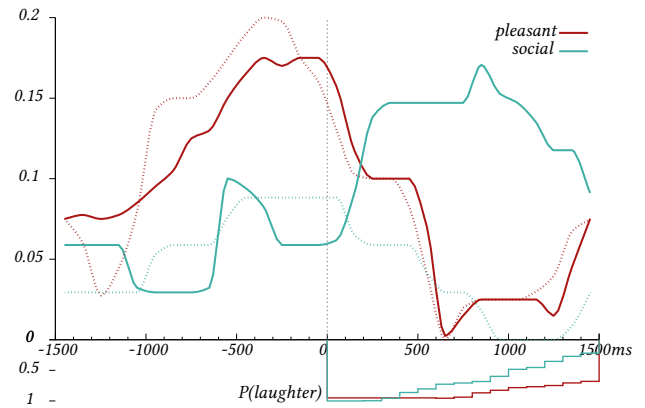
### 3 THEORY AND METHOD

#### 3.1 Laughter and gaze coordination

In [18] we designed a study to determine gaze patterns in association with laughter. We showed that gaze plays a role in laughter coordination. For some cases, we observed that gaze is used to synchronise the onsets and offsets of laughter. Another important finding is that different types of laughter are accompanied by different gaze patterns both by the person laughing (the *laugher*) and their partner. In the case of pleasant (humorous) incongruity, laughter the *laugher* is more likely to look at their partner before the onset of laughter, whereas after the onset, social incongruity more likely to involve gazing at the partner (see Figure 1 and example 3.1). These findings suggest that any future SIA should not address all laughs in a uniform fashion – they should be sensitive to the precise coordination between laughter and gaze that are critically dependent on the types of laughables.

- (A) Good Housekeeping Institute (GHI) corpus, Pair 15 (00:01:25). Gaze at partner is marked with “x”, gaze anywhere else with “-”.

```
-----xxxxxxxxxxxxxxxxxxxx-----
A: Shall we say... No. Ta- tasty <laughs>
B:                                     <laughs>
-----
```



**Figure 1: Probability of gaze at the interlocutor around the onset of laughter depending on laughable incongruity type. Solid line – laugher; dashed line – partner. The probability of laughter duration is shown at the bottom of the figure.**

#### 3.2 Method

The Greta platform<sup>1</sup> simulates SIAs able to communicate verbally and nonverbally. Given a set of intentions and emotions to be communicated, the platform instantiates them into sequences of synchronised nonverbal behaviors. It can be used to compute these multimodal behaviors when the SIA acts as a speaker or as a listener.

Regarding laughter in Greta, the main focus has been on synthesising the multimodal behaviours of “hilarious” laughter [4] and on measuring the impact of laughter on engagement and interaction quality during a human-agent interaction [17, 23]. Here, we will specifically focus on laughs associated with *social incongruities* [19]. The functions of such laughs include softening and trouble-telling (e.g., to accompany a criticism), benevolence induction (e.g., to accompany self-criticism), smoothing and showing sympathy.

We will select “ground truth” samples of laughing behaviours from [18] dataset (3 female-female interactions, 23 minutes of video recordings annotated for laughter functions and gaze). We will reproduce short fragments of face-to-face dialogues from the corpus study but with a SIA, through fine-grained orchestrations of behavioural patterns of an agent. The stimuli will be created by replacing a human in a dyad by a SIA. Subsequently, the reproduced samples will be modified with alternative (to [18]) and random gaze patterns. We will then conduct an observation study to measure perception of a SIA and to compare the understanding of social laughters by observers in contrast with ground truth. Observers will be asked about the naturalness of laughter behaviours and their perception of a SIA in terms of warmth and competence. The samples will be annotated by experts for pragmatic functions of laughter, based on [19] protocol, as for the ground truth. We will then compare ground truth annotations and annotations of reproduced behaviours (including modifications). The experiments will be guided by the following research questions:

<sup>1</sup>Greta is available on Github: <https://github.com/isir/greta>

- (1) How agents are perceived in two conditions – reproduced behaviour vs. modified behaviour.
- (2) How pragmatic functions of laughter are perceived in a virtual agent compared to ground truth.

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