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What's your laughter doing there? A taxonomy of the pragmatic functions of laughter.

Chiara Mazzocconi, Ye Tian, and Jonathan Ginzburg

Abstract—

LAUGHTER is a crucial signal for communication and managing interactions. Until now no consensual approach has emerged for classifying laughter. We propose a new framework for laughter analysis and classification, based on the pivotal assumption that laughter has propositional content. We propose an annotation scheme to classify the pragmatic functions of laughter taking into account the form, the laughable, the social, situational, and linguistic context. We apply the framework and taxonomy proposed in a multilingual corpus study (French, Mandarin Chinese and English), involving a variety of situational contexts. Our results give rise to novel generalizations about the range of meanings laughter exhibits, the placement of the laughable, and how placement and arousal relate to the functions of laughter. We have tested and refuted the validity of the commonly accepted assumption that laughter directly follows its laughable. In the concluding section, we discuss the implications our work has for spoken dialogue systems. We stress that laughter integration in spoken dialogue systems is not only crucial for emotional and affective computing aspects, but also for aspects related to natural language understanding and pragmatic reasoning. We formulate the emergent computational challenges for incorporating laughter in spoken dialogue systems.

Index Terms—Laughter, taxonomy, dialogue semantics, pragmatics, laughter functions

1 INTRODUCTION

Laughter is a social vocalization universal across cultures and languages [1], [2]. Research has demonstrated that laughter is a very complex behaviour from an emotional, social-cognitive, and linguistic perspective. It can inform us about cognitive and emotional processes and evaluations [3], both when occurring in relation to humorous events, but also when occurring in a wide range of other contexts that require different interpretations and responses from the conversational partner(s). It can express amusement, joy, success, and relief; it can occur when we feel embarrassed, angry, sad or bitter; it can be a tool to cope with tragic or painful situations; and it can also be produced ironically or for politeness reasons [4]. Laughter in the context of a conversation can also be used to maintain the flow of interaction, the interest and attention of the listener [5] and can modify the content of utterances. Its relevance for enriching conversational exchanges is supported also by the unexpected finding that speakers tend to laugh significantly more than their audience [6], [7], [8]. Thus laughter is an important component of interaction, requiring highly developed pragmatic skills together with cognitive and emotional attunement to other people, by reason of being, like other social signals [9], ambiguous and able to serve multiple functions depending on the social and linguistic context. Given its important role in our daily interactions, the study of laughter is a crucial one for human agent interaction [10], [11]. Several researchers have highlighted the importance of

integrating laughter in the implementation of dialogue systems, stressing its role from an affective and emotional perspective and its effect on the agreeableness and naturalness perception of the conversation [10], [11]. Interesting research about the role of laughter in conversational dynamics (e.g. turn-taking, change of topic, end of conversation) and its sequential patterns of occurrence and acoustic characteristics is available and proliferating (among others [12], [13], [14], [15]). Nevertheless, little attention has been devoted to identifying what laughter is about, and most researchers takes as given the assumption that laughter is adjacent to what it is related to. In the current work, we will argue that laughter has an important role also for natural language processing, since it conveys meaning and can modify or disambiguate spoken utterance meaning.

The research questions we are trying to answer, crucial for the implementation of dialogue systems that aim to process laughter, are: How is laughter used in adult conversation? How do we respond to another person's laughter? What does laughter relate to? Do patterns of laughter use change across languages?

The rest of the paper is composed of two main parts: in the first, we try to tackle the theoretical challenges for understanding and creating the base for modelling laughter use in conversation: we critically review existing taxonomies (Sec. 2) and present a novel approach for the classification of laughter, grounding this in a semantic and pragmatic analysis (Sec. 3 and 4); in the second part, we tackle some empirical questions: we apply our framework to a multilingual corpus study (Sec. 5), testing the validity of the framework proposed and exploring and discussing patterns of laughter use in natural dialogue (Sec. 6). In section 6 we test and discuss, for the first time to our knowledge, the assumption that laughter is always adjacent to what it is

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related to. We also explore whether laughter function can be directly predicted from lower level features. Finally, in Section 7, we present our conclusions, stressing the implications for spoken dialogue systems implementation and indicating paths for further work.

NOTE: When reporting extracts of conversations we will use the annotation guidelines used in the DUEL corpus [16]. Especially relevant will be these two conventions: < laughter/ > to tag standalone laughter not overlapping with speech (e.g., “that’s cool < laughter/ >”) and < laughter > < /laughter > to tag speech-laughter (e.g., “< laughter >yeah< /laughter >”). Acknowledging that in written form the examples reported will lack all of the richness brought by prosody and the laughter acoustic form in itself, so crucial for the pragmatic interpretation of the dialogue, we provide audio-files for the extracts marked with a † at <https://www.dropbox.com/sh/vn38ih9d0mh0119/AABOwHK7FrOasWsyFw700of3a?dl=0>.

2 BACKGROUND

The search for the nature of laughter goes back at least to Aristotle [17] and has been discussed also by Kant, Hobbes, and Bergson among many others (see [18] and [19] for reviews), being often, not surprisingly, intertwined with the elaboration of theories about humour. Our approach is *dialogical*, trying to understand and account for all the occurrences of laughter in conversational interaction, whether humour is present or not.

2.1 Existing taxonomies

In the literature of the last decades many taxonomies for laughter has been proposed, from different disciplines and for very different aims. We believe that one reason for the lack of agreement, and even for inconsistency within systems themselves, is that there are several layers relevant to distinct types of laughter. Sometimes, discussions about distinct “types” of laughter have been in fact about different layers of analysis. Laughter classification can concern at least three areas: the sound, the context, and the function. Studies of the sound of laughter analyze phonetic, acoustic, kinesic and anatomical features (e.g., [20], [21], [22], [23]) or propose constitutive elements of laughter (e.g., [1], [22], [24], [25], [26]). Our focus here is on contextual and functional classifications.

2.1.1 Contextual classifications and unfunniness

Studies on the contexts where laughter occurs investigate the position of laughter in relation to the stimulus and the position of a laugh in relation to speech (both from the laugher and the conversational partner) and others’ laughter. Regarding laughter positioning in relation to others’ laughter several authors distinguish (with mildly differing parameters and timing thresholds) between isolated laughter, i.e., laughter not shortly preceded by others’ laughter [27], reciprocal/antiphonal/chiming in laughter, i.e., laughter that occurs shortly after a partner’s laughter [27], [28], [29], and co-active/plural laughter ([27], [29]). Vettin and Todt [8] propose a taxonomy based on a combined analysis of positioning in relation to others’ speech, laughter and conversational turns. They put forward an initial distinction between speaker and audience laughter. Subsequently, they

characterize the event preceding the laughter as being a complete sentence, a short confirmation, or a laughter bout. Combining these parameters, they obtain 6 mutually exclusive contexts where laughter can occur (see Supplemental Material (SM) 1 for a scheme of [8]’s classification). Vettin and Todt [8] therefore use exclusively timing parameters (i.e. what precedes and what follows) to support claims about laughter eliciting situations. However, their classification runs into problems in the way it deals with the referentiality of laughter, specifically with what in the rest of the current work, in line with the conversation analysis tradition [4] will be called *laughables*, those events or states the laughter is related to. The adjacency relationship between laughter and laughable has never been tested, misalignment between the two might occur and timing parameters might therefore not be optimal as a means for inferring laughables. In our view also the distinction between speaker and audience can be problematic, indeed a subject might laugh while speaking, but the laughter produced might be a response to the conversational partner’s previous comment, rather than being a modification of her/his current contribution.

Studies of laughter stimuli generally distinguish those that are “funny” (though that in itself is a tricky matter to characterize) and those that are not. It has been suggested that contrary to “folk wisdom”, most laughs in fact follow banal comments [30], [31]. This proposal though is based on the assumption that a laugh refers to what immediately precedes it. However, as we have already pointed out, this assumption has never been validated. Moreover, even if the laughable is the immediately preceding contribution, funniness rarely lies simply in the utterance itself, but is most frequently to be found in the relation between that utterance and the context, or can reside in the enriched content of the utterance, not necessarily accessible to an overhearer. Therefore, it is misleading to come to any conclusion about what laughter is about by analysing merely what immediately precedes it. To see this, consider (1), where the expression ‘du cours de sémantique de ce matin’ is not humorous in itself. Nonetheless, we cannot assume that the laughter is not related to humour, since it is in fact only the enriched denotation of ‘the semantics class of this morning’, accessible only to the interlocutors that should be judged as amusing (or not). PC is indeed sure that MA will remember the funny event that happened during the morning semantics class.

(1) *Example translated from [32]*

PC: what would you like to speak about?

MA: about...

PC: about the semantics class < laughter > of this morning
< /laughter >

2.1.2 Functional classifications

This is the area where debate is still quite unresolved. Szameitat et al. [33] distinguish between physical (tickling) and emotional laughter (including joy, taunts, and schadenfreude). Poyatos [20] bases his classification on the social functions that laughter might have. He distinguishes between eight social functions: affiliation, aggression, social anxiety, fear, joy, comicality and ludicrousness, self-directedness, amusement and social interaction. Shimizu et al. [34] identify three types of laughter: laughter due to pleasant feel-

ing, sociable laughter, and laughter for releasing tension. Hayakawa [29] distinguishes three non-mutually-exclusive functions: laughter for joining a group, balancing laughter for releasing tension, laughter as a concealer (to soften or evade). A yet different classification comes from Campbell et al. [26], who distinguish four laughter type on the basis of their segmental composition: hearty, amused, satirical, social.

In some classifications confusion between form, appropriateness, trigger, and function can be observed. For example Jokinen and Hiovan [35] propose 6 mutually exclusive kinds of laughter: *mirth*, *embarrassed*, *breath*, *polite*, *derision* and *relief*. Whereas *breath* is a formal characteristic of the form, *mirth* and *embarrassment* might be considered as triggers, *polite* is an attribute relative to the appropriateness of the context, and *derision* and *relief* might be viewed as social and psychological functions. We can indeed have a breathy embarrassed laughter that is also polite, or a mirthful derisive laughter etc. It is clear therefore that the types proposed are not an efficient classification, especially given the intended application for conversational annotation. Similarly, in Poyatos's taxonomy [20], functions and triggers are confused, having, for example, in a mutually exclusive relationship, *affiliation* laughter (e.g., to agree) in opposition to *joy*. Here the former can be roughly defined as the illocutionary act performed by the laughter, whereas the latter can be considered as a feature of the laughter trigger. Once more we are confronted with overlaps, for instance, a joyful laughter that has an affiliative function.

2.1.3 Acoustically-based classification

Some studies classify the function of laughter using solely acoustic parameters (e.g. [26], [36]). Tanaka and Campbell [36] asked participants to listen to laughs played in isolation and judge whether they were *mirthful* or *polite* (a similar approach is adopted also in [37]). While there is clearly value in studying affective laughter perception, one might point out that the names of the categories 'mirthful' and 'polite' do not belong to the same level of analysis, and the two categories are not mutually exclusive, making the classification inapplicable for dialogue annotation i.e., one can politely laugh while feeling mirthful, and one can impolitely laugh without feeling mirthful. Moreover we believe that laughs with similar acoustic features can have different functions in different contexts. We partially test this hypothesis in our data, as discussed in Sec. 6, specifically whether the function of laughter can be predicted by form-based measurements (perceived arousal), while more detailed analysis of acoustic features is presented in [38].

2.2 Necessity of different levels of analysis

We believe that in order to avoid confusion and overlapping types it is useful to draw an analogy with the study of speech [39]. First, from a physical point of view, we can study the physiology and the acoustics of laughter, the former regarding the human body and the latter regarding the acoustic features of the laughter itself. Then, one can study the phonetics and the positioning of its smaller units: the building blocks of a laughter sequence and any combination rules there might be. It's only when we come

to the meaning and function levels that things get unclear. By analogy with the study of speech, once again, we believe that it is important to separate different objects of analysis and especially not to confound the physiological cause, the trigger, the meaning and the social function [40]. The goal of the current paper is to understand what laughter can mean and how it is used to affect our dialogues.

3 MULTILAYERED ANALYSIS

3.1 Form and contextual levels

The first aspects of laughter production that can be analysed are its phonetic and acoustic features (e.g. fundamental frequency, pitch, voice quality, exhalation and inhalation phases and duration), and how its smallest discrete elements get combined in longer sequences (see Sec. 2.1.3 for some references). Secondly we can look at its positioning in relation to other parts of speech. In the current work we are interested to explore laughter ordering in relation to (1) linguistic material, (2) others' laughter and (3) its argument, the laughable (Sec. 3.4). Different orderings and combination of laughter and linguistic material can indeed affect the meaning conveyed [27], [41].

- 1) A laugh can occur alone or can overlap with verbal production by the laugher her/himself, i.e., *stand alone* and *speech-laughter* [42], [43].
- 2) A laugh can occur in isolation (i.e., laughter not preceded by any other laughter), follow (i.e., *antiphonal laughter*: starting during the partner's laughter or within 1 sec. after its offset) or have the same onset time of another laughter from an interlocutor (i.e. *coactive laughter*) [27], [28].
- 3) A laugh can occur after (more commonly), but, on the base of anecdotal observations, also before or during its argument.

3.2 The Semantic level: debating the meaning of non-verbal social signals

In speaking about the *meaning* of laughter we are broaching a long-standing debate about the use of non-verbal social signals (such as smiling, crying, sighing etc.): does laughter reflect something about the emotional and cognitive state of the laugher or it is merely produced to influence the receiver? The most traditional approach is the representational one (e.g., [44] and [18]), which argues that any emotional expression refers to some internal state and conveys such information to the receiver [45]. Laughter emerges in infants around 3-4 months of age [46] and several researchers, endorsing the representational approach, have proposed to consider its first occurrences as a reflex of positive internal states [44], [47], [48], the use of which, during development, becomes gradually much wider and more sophisticatedly intertwined with language. The skepticism from some scholars stems from the fact that laughter can occur in so many different situations, being linked to several emotional states (e.g. amusement, embarrassment, nervousness, sadness, astonishment etc.), needing interlocutors to interpret it and respond to it in so many different ways that it would be unreasonable to assume that laughter has a unique core meaning that passively reflects the laugher's internal state. The Affect Induction Approach (AIP) [49] therefore states,

following the behavioural-ecology argument [50], [51], [52], that facial or vocal expressions in general, and laughter in particular, do not serve a representational function. Rather, according to the AIP, they are produced exclusively in order to influence the listener's attention, arousal and emotion, more or less unconsciously, inducing positive affective responses in listeners, relying on the positive affect that laughter acoustic properties can have in themselves or by conditioning through experience [49], [53].

While acknowledging the fact that laughter, being extremely adaptive, can be produced in many different emotional states and that it can positively influence the interlocutor, we believe that this does not necessarily imply that it cannot have a core meaning and that it is not informative about the cognitive and emotional laughter's states. While taking an agnostic position in the long-standing debate about the relation between emotion and facial/non-verbal expression [52], we believe that when an interlocutor hears a laugh s/he can attribute to it the general meaning that it conveys most commonly. Whether the expression is mirroring or not an emotion, it doesn't prevent the listener's inference about a core meaning/state intended to be conveyed/felt. The fact that facial/non-verbal "emotional" expression can be influenced by the presence of an observer (i.e., an audience effect), has been used by Crivelli and Fridlund [52] as an argument against the fact that those have a direct connection to internal emotion, and are exclusively used to convey information to interlocutors and to affect them. For our aim, to investigate the meaning conveyed by laughter in interaction, this is further support for our proposal that laughter has propositional content. As stated by Bavelas and Chovil [54] a signal being influenced by the presence of others is one of the criteria for considering a non-verbal behaviour a visible/audible act of meaning. We believe that the two approaches do not contradict each other. On the one hand, as argued in [55, p.209], 'The fact that a given gesture can be used in a wide range of situations and relationships, and that it may receive different interpretations in different cases, does not mean that it does not have a constant semantic core. For example, a performer's bow, a greeting bow, and a bow performed by a priest or an altar boy in front of an altar can all be assigned the same semantic formula (that is, the same meaning) — with the proviso that this formula will be flexible enough (or general enough) to lend itself to different interpretations in different contexts.'. On the other hand, it is true that laughter as a positive emotional expression has important social effects: it is crucial in the management of affective states in interaction and in establishing and maintaining social bonds (but also marking boundaries and distancing people), it positively affects the interlocutor, as well as helping to deescalate negative emotional experiences, being linked to physiological positive effects that reduce bodily stressful reactions characteristic of unpleasant emotions (e.g. fear, anger, disgust) [56]. But all the effects that it can have are not inconsistent with the fact that it can have a constant core meaning.

A large part of the literature on laughter is dedicated to the distinction between spontaneous and volitional laughter in term of its acoustics [8], [57], physiology and neurological path (with respect to both production and perception)

[58], [59], [60]. In our study we will ignore this distinction because, in line with Wierzbicka [40], we think that the actual psychological experience behind a behaviour such as laughter, does not change the meaning conveyed and how it would interact with the linguistic material, our focus in the current work. Nevertheless, this does not mean overlooking the fact that when a laugh is perceived as non-genuine by a conversational partner that can trigger additional mentalising and the derivation of relevant inferences according to the social context and the current interlocutors' mental and intentional states; the analysis of these however goes beyond the aim of the current paper. Moreover as noted by Gervais and Wilson [61] and McComas [62], in conversational laughter the boundary between spontaneous and volitional is much more blurred than in an experimental setting. Laughter becomes a learnt behaviour, which can reach a high level of automaticity as indicated by the significant tendency to under-report own laughter production by subjects [8].

When not focusing on the physiological and psychological states underlying a laugh, most of the literature concentrates on some potential triggers for laughter, especially humour and tickling (by several scholars considered as a form of proto-humour, e.g. [6], [63]). Traditionally humour theories have been divided in 3 branches: the ones taking a deep cognitive perspective and focusing on incongruity as a central aspect in the perception of humour [64], [65], [66], [67]; theories of superiority, focusing on the relation that humour can have to hostility, criticism and disparagement [68]; and theories of release which, taking a psychoanalytic approach stemming from Freud [69], consider humour as one of the substitution mechanisms available to humans to sublimate socially tabooed aggressive impulses to acceptable ones, therefore avoiding wasting additional mental energy to suppress them. The material on the topic is immense and the debate about what is humour and why it triggers laughter is still very active and unresolved. Nevertheless, nowadays, most scholars, despite supporting different theories, models, motivations and mechanisms (e.g. [70], [71], [72]) agree about the crucial role played by *incongruity* with respect to the perception of humour [61]. We will not take any stance about humour theories apart from recognising a crucial role played by the recognition of (pleasant) incongruity, taking an agnostic stance with regards to the precise mechanisms underlying such positive evaluation (e.g. the necessity (or not) of resolution of the incongruity to be appraised as pleasant/humorous [70], [71]).

3.3 Laughter meaning

We propose, following [73], that the core meaning of laughter involves a predication $P(l)$, where P is a predicate that relates to either *incongruity* or *closeness* in senses we explain shortly and l is the laughable, an event or state referred to by an utterance or exophorically. This core meaning, when aligned with rich contextual reasoning, can yield a wide range of functions. We further assume, in line with Wierzbicka [55] and Morreall [18] that this core meaning is, in turn, the argument of an emotive relation corresponding to *pleasure* or *enjoyment* by the laugher. This represents

the *force* of the laughter. We embrace, following cognitive theories of emotions, the idea that pleasure/enjoyment (positive in valence and arousal) arises as a consequence of an *appraisal process* [74], [75]. We can summarize this view in the formula:

- (2) Laughter meaning: The laughable l having property P triggers a pleasant positive shift of arousal of value d within A 's emotional state e .

3.4 The laughable and its properties: the 1st dimension of laughter meaning

The first dimension is a categorical one, which relates to the kind of event that the laughter takes as an argument. The laughables selected by laughter as arguments can be divided in two big classes: those involving incongruity and those that do not. A more detailed classification of incongruities (and lack thereof) is presented below.

3.4.1 Laughable types

Given that incongruity is a central part of our classification of laughables we need a clear definition. We assume a view of incongruity as proposed in [73] whereby this involves a clash between a general inference rule (a *topos*) and a localized inference (an *enthymeme*), a view inspired by work in humour studies (e.g., [64], [76]). An exemplification is available in SM 2.

1. Pleasant 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 [77], [78], [79], [80]. Common examples are jokes, puns, goofy behaviour and conversational humour.

2. Social incongruity. We term 'social incongruity' any situation where a clash between social norms and/or comfort and the laughable can be appraised. Examples of such instances 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) [49], [81], [82]. We classify as social incongruity also those situations in which someone is speaking about something "painful" for herself for two reasons: the first is that speaking about unpleasantness can run counter to social norms and can make the interlocutor feel uncomfortable. Moreover, when a laugh is produced in such circumstances, it fulfils the same effect as a laugh produced during felt embarrassment, i.e., it helps to cope with the uneasy situation by giving the impression that we are taking the situation in the best way and that also the interlocutor should do so [83]. Similar reflections have also been proposed in [84], [41] and [85].

3. Pragmatic incongruity. The term 'pragmatic incongruity' is used for cases when there is a clash between what is said and what is intended [86]. This kind of incongruity can be identified, for example, in the case of irony, scare-quoting, hyperbole etc. (e.g. "What a beautiful day! <laughter/ >" meaning "It is an awful day!"). In such cases laughter is used by the speaker herself to signal changes of conventional meaning of her/his own utterance.

4. Pleasantness/Closeness. While in the types described above we can always identify the presence of an incongruity in the laughable, there are other laughables where no incongruity can be identified. In these cases what is associated with the laughable is a sense of pleasantness/affiliation that is either felt or displayed towards the interlocutor, e.g., while thanking or receiving a pat on the shoulder.¹

3.4.2 Locations of laughables

In order to identify the laughable, contextual reasoning and reasoning about others' informational, attentional and intentional states is needed.

The laughable can be constituted by the eventuality described by a verbal contribution (3), by an exophoric event (4), or by a metalinguistic stimulus (e.g., a slip of the tongue, pun, violation of conversational rules, inappropriate speech act etc.), as in (5) and (6).

(3) Laughable: **Linguistic denotation** (*Translated example from DUEL French 3_1: DA*) †

B: so that's (the: + the) the first floor huh?

A: < laughter/ > the ground floor; B: here it is!

A: with a: + a parking like in Batman you know like you go under ground < laughter/ >; B: < laughter/ >

(4) Laughable: **Exophoric event** (*Example from BNC KDE - Interaction mother child home setting*)

Child looking cutely for something that is in front of him.

Mother: < laughter/ > There he is!!

(5) Laughable: **Metalinguistic** (*Translated example from DUEL French 3_2: FS*) - Speaker A and B saying the same thing at the same time.

A: Can put stuff in it

B: We can put stuff in i < laughter/ >

(6) Laughable: **Metalinguistic** (*Translated example from DUEL French 1_3: BC*) - Mispronunciation †

Officer: And are you keeping in touch with (that +this) said child?; Traveller: I see him but uh I I gi yeah I g I I (NV) I < laughter/ >

In more detail: in (3) the incongruity arises from the inappropriateness of getting inspired by a luxury house from a film for the design of the participants' house, as well as the disproportionate price that a garage of that type would cost (especially in relation to a student real life budget). The laughable is therefore the situation described by speaker A's utterance. On the other hand, in (4) the laughable is in the (non-linguistic) situation, the incongruity arising from the child's apparent anguish triggered by the search of something that was just in front of him. In (5) speaker B laughs because both participants said the very same thing at the very same time, a deviation from the normal case where speakers provide distinct contributions. In (6) the participant role-playing the traveller laughs about her/his repeated misspelling and stuttering. Thus, in both (5) and (6) the laughables involve the utterance situation itself, as opposed to a situation described by the utterance.

We also annotate for the origin of the laughable i.e., if the laughable is produced by the laughter her/himself or by the other participant, by something external to the conversation (e.g., someone making a weird noise in the

1. Despite not being the focus of the current work it is inevitable to speculate about laughter origin and functions in evolution. In [38] we hypothesise possible evolution paths on the basis of phylogenetic and ontogenetic data, offering an account of this in terms of co-option.

next room) or whether the laughable is jointly constructed by the conversational partners (e.g., an identical utterance simultaneously).

3.5 Arousal: the 2nd dimension of laughter meaning

The second dimension laughter is informative about is arousal. Arousal is a continuous dimension which can go from very low to very high, a well attested dimension in the study of emotional expressions, both facial [87] and vocal [56], [88]. In some previous work it has been referred as 'laughter intensity' (e.g. [89], [90], [91]), but in the current work we prefer to refer to it as 'arousal' since we believe it allows the interactional partner to derive inferences about the shift of arousal² experienced by the laugher in the appraisal of the laughable, typically constituted by an incongruity, [94], [95], and because it avoids confusion with acoustic intensity, i.e. loudness. Laughter arousal can depend on the trigger/argument itself, on the individual current emotional state, and on social context [6], [96], [97], [98].

We emphasize that, in our view, laughter does not signal that the speaker's current emotional state is positive, just that there was a *shift* which was positive. The speaker might have a very negative baseline emotional state (being very sad or angry) (e.g. example 20 below), but the recognition of a pleasant incongruity in the laughable or the feeling of in-groupness can cause a pleasant positive arousal shift, which could be very minor and very brief. We are aware that in some occurrences of laughter (e.g., that occurring in an embarrassing situation, or when speaking about current serious problems to a doctor etc.) it is hard to think that the laugher is actually experiencing a pleasant positive shift in arousal [18]. In such cases it is important to distinguish between (i) the actual physiological state, (ii) the content of the laughter, namely the predication $P(l)$, where P in such cases is *social incongruity*, and (iii) the conditioned positive effects that laughter can have [99], [100].

There is no dearth of work focussing on the analysis of laughter in patient-doctor interaction [41], [85], [101]. In these situations it is not rare for the patient to produce laughter while explaining her/his problems to the doctor. Nonetheless, the laughs that take place in such cases are never reciprocated by the doctor. We hypothesize that in such cases the pleasant positive shift is either felt/simulated by the laugher her/himself, in order to help coping with the trouble-telling, or intended to be felt by the addressee.

The production of laughter in uncomfortable situations may be related to the Facial Feedback Hypothesis, i.e., facial emotional expressions can affect or induce the emotion they normally are associated to [99], [102], [103]³. The phenomenon might be described as a loop where laughter,

2. With the term arousal we refer to the state of activation or wakefulness as intended for example in the dimensional approach to emotion literature (e.g. [92]) or in [93]) in as much as signalled by the laughter itself

3. Despite the fact that the Facial Feedback Hypothesis is one of those theories within psychology that has failed to be replicated with consistency, recent studies suggest that the failure of the replications can actually be attributed to slight modifications of the experimental design [104]. Specifically: the fact that participants knew they were going to be filmed, which reduces reliance on internal cues in making judgements. Recent studies seem to confirm this hypothesis [105], [106], [107].

expressing a pleasant feeling, over time becomes associated with those and pleasant in itself, inducing positive and pleasant feelings in the laugher her/himself [108]. Thus, laughter in embarrassing situations, despite seeming to constitute a case that contrasts with the core laughter meaning postulated in the current section (i.e., "the laughable l having property P triggered a positive shift in arousal of value d in the laugher"), can still be a valid account of two possible mechanisms: on the one hand, one can laugh aiming to show that is taking the situation (i.e., the laughable) in the best possible way, potentially causing an improvement in the current cognitive and emotional appraisal of the situation; conversely, considering the effects that laughter acoustics in itself can have [49], together with its powerful contagiousness [109], the laugher can aim to affect positively the interlocutor and induce her/him to appraise the situation in a positive way. Moreover, as proposed in [110], in such situations laughter can signal a resistance to taking something too seriously. Finally, laughter is linked to several positive effects, both psychological and physiological [111], [112], [113], helping to reduce negative affective reactions to stressful situations [59], [114].

3.6 Ironic uses of laughter

As with speech [86], laughter can be used ironically, produced with the intention of conveying some aspect that is incompatible with (sometimes the reverse of) its semantics or pragmatics [115]. For laughter this could involve either the imputation of *non*-incongruity to a laughable or the failure of the incongruity to trigger a pleasant positive shift of arousal/enjoyment. Examples of such uses are the laughs produced after an unfunny joke where the intent is to convey that the joke uttered is banal and/or did not provoke a pleasant positive shift in the listener.⁴ In extract (7) the mother is using laughter ironically⁵ in relation to a laughable (having to pay the swim club) which is neither incongruous neither pleasant to her, therefore conveying the opposite of the conventional laughter meaning. In extract (8) Nicola uses laughter ironically to mark the fact that the incongruity between doing the hoovering and having a nice day does not in any way provoke a positive shift in her, rather the opposite.

(7) Example from Providence corpus [120], Lily 030010 †

Child: Who's this from?

Mother: Um... that is from the swim club.

Child: What is it?

Mother: It says we havta have to pay them. < laughter/ >

(8) Example from interaction between two adult women (BNC, KDE)†

Nicola: Thank you! It's very nice of you!

Linda: Have a nice day!

Nicola: < laughter/ > Doing the hoovering < laughter/ >

L: < laughter/ >

N: < laughter/ > Thanks Lyn I'll see you on Wednesday.

4. Maybe even a negative shift because the positive expectation was deflated.

5. It is possible to hypothesise, even though work on the subject is lacking, that ironic laughter might have specific acoustic features which stress its faked and voluntary production, similarly to ironic verbal comments [116], [117], [118], [119]. However, we are not aware of any study investigating specifically acoustics of ironic laughter production.

It is at this point important to distinguish between ironic laughter, laughter to mark irony, and laughter which shows enjoyment of the incongruity contained in an ironic comment, all of which are offered in (8). The first laugh produced by Nicola, as previously stated, is an ironic laughter, where the speaker reverses the conventional meaning of the laughter itself. The second laugh produced by Nicola is a laugh to mark the irony of the preceding contribution. While the laugh from Linda is used to show enjoyment of Nicola's ironic comment.

4 A TAXONOMY FOR LAUGHTER FUNCTIONS

On the basis of conversational data, we developed a semantically and pragmatically grounded taxonomy of laughter function. In our approach the crucial elements used to categorise the function of a laughter are the laughable together with cues about others' informational, attentional and intentional states indispensable for its identification, the acoustic features of the laughter itself, and the prosodic contour of the speech in which it is embedded [121]. In order to guide the process of function classification, we postulated a binary Decision Tree - hereafter referred to as DT (Fig. 1, a larger version is reported in SM 7).

We do not assume the existence of a limited set of discrete functions that are associated with laughter; in principle, distinct laughter episodes can give rise to an unbounded number of distinct inferences, as assumed, for instance in Scherer's view of appraisal with respect to emotional episodes [75]. Nonetheless, the four different kinds of properties that we associated above with laughables, can be viewed as *modal cases*—ones that occur more frequently as a result of the contingencies of interaction and potentially psychobiological hard wiring.⁶

Before going into a detailed description of specific functions, we think it is important to clarify what we mean by function and what we consider to be beyond that, therefore on another level of analysis. By 'function' we mean the effect that the laugher intends her/his laughter to have on the current dialogue. This in turn can come in the form of different dialogue acts: e.g. a laugh to show enjoyment of incongruity can be an answer to a question, a statement of opinion, a rejection, a back-channel etc. Moreover, on another level of analysis such a laugh can have a cooperative or a non-cooperative goal (e.g., mocking). This distinction therefore allows one to easily account for what in the literature as been often referred to as *superiority laughter*. In our framework such a case would be analysed as a laughter related to a laughable appraised as incongruous and pleasant (someone's misfortune in this case), with a hostile attitude towards the target.

In what follows, we present examples the functions which we utilise in our framework. We mean functions to be mutually exclusive.

6. Not assuming a fixed number of functions might, at first glance, be viewed as a step that weakens the empirical content of our account. However, by claiming that the four functions mentioned here are modal cases, the account is open to refutation by corpus studies that exhibit different distributions or more perceptive clusterings of functions.

4.1 Laughter referring to an incongruity

4.1.1 Pleasant incongruity

1) Enjoyment incongruity

(9) *Example from politics lecture (BNC, JSM)†*

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/ > .

(10) *Example from politics lecture (BNC, JSM)†*

Lecturer: and so the Korean war started and the United Nations' forces were commanded by one General Douglas MacArthur, General Douglas MacArthur, in case you don't know, won the second world war single handedly.

Audience: < laughter/ > .

L: "er < laughter/ > it's not funny, he believed it!"

Both examples (9) and (10) contain laughter used to show enjoyment of a pleasant incongruity: in (9) the students's laugh appreciating the lecturer's joke where students are incongruously compared to delinquents; while in (10) students laugh recognizing the sarcastic tone of their professor stating that the General Douglas MacArthur won the second world war single-handedly. In this way they recognize and enjoy the incongruity between what was said and what was meant, as well as appreciate the incongruous pretence and impossible eventuality that a man could win a war alone.

2) Marking incongruity

(11) *Example from job interview (BNC, JNW)†*

Ian: with a ... with a er client then ... we appreciate the business ... comes first .

John: Mm ... it it may it may not be in that nature because the nature of of supply teaching work of course is that; I: Yes.

J: there tends to be a phone call

I: Can you make it? we're desperate < laughter/ > .

J: Can you make it in half an hour's time, you know < laughter/ > .

In extract (11) John uses laughter at the end of a sentence in order to mark the presence of an incongruity in what is being said, stressing the absurdity of feeling desperate for a music class and the incongruity of asking to be ready to be at their place for a lesson in a short time window. Compared to the previous two examples (9 and 10) the laugh does not serve the function of showing enjoyment of the incongruity, but merely to meta-communicatively mark it for the interlocutor, adding subtly his own personal opinion on such requests from the clients.

4.1.2 Social incongruity

1) Softening and trouble-telling

(12) *Translated example from DUEL French (2_1 - DA)†*

(While drawing the apartment they designed)

Speaker B: ah you didn't put anything in the bathroom < laughter/ > .

In (12) Speaker B uses laughter to soften the criticism addressed towards her partner concerning his drawing, in this way she tries to make the

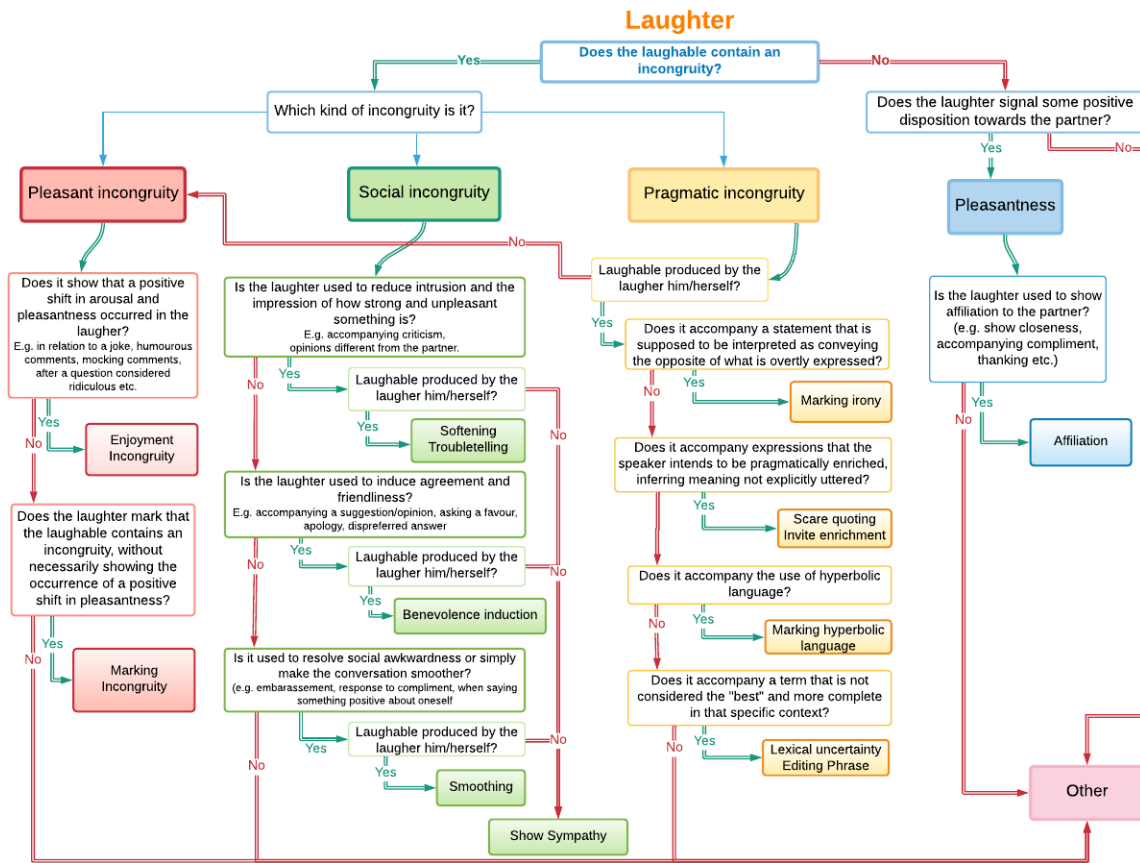


Fig. 1. Decision tree for classifying the pragmatic functions of laughter

observation as minimally aggressive and impolite as possible, signalling to the interlocutor not to take her words too seriously.

2) Benevolence induction

(13) *Example from a job interview (BNC, JNV)†*

Interv.: Do you play in the cathedral yourself or..?
 John: I have done it in the past, not recently. There have been other things < laughter > occupying me recently < /laughter >.
 Interv.: Right. Yeah.

In (13) John uses laughter while saying something that might be slightly negative about himself in the context of a job interview: he confesses that he has not played very often in cathedrals lately, while at the same time he tries to induce the job interviewer to avoid evaluating this last statement too harshly; he also avoids explaining what “other things” have been occupying him recently.

3) Smoothing

(14) *Example from a job interview (BNC, JNV)†*

Interv.: Right, you seem to be pretty well qualified.
 John: I hope so < laughter > yes < /laughter >

In (14) the laughter is used to smooth the response to a compliment. Normally it is culturally frowned upon to speak well of oneself. Here the little laugh helps avoid being viewed as presumptuous and arrogant, thereby helping to minimize potential social discomfort.

4) Show sympathy

(15) *Example from an interview with Michael Heseltine after his heart attack (BNC, K6A)†*

MH: And it it so they give you some m medicine for that. A side effect of which can be that you can develop gout. And so the what what what that...
 Interv.: Ah, that explains
 MH: ..everybody saw was not the; Interv.: Mhm.
 MH: fit strapping Heseltine which I wished
 Interv.: You looked terrible.
 MH: which I wished to portray.
 Interv.: < laughter / >.

(16) *Translated example from DUEL French (3_1 - DA)†*

A: These are the stairs?? ... we are going to do this like this... I put the staircases because I've badly drawn!; B: < laughter / >.

In both (15) and (16) the underlined laughs are used as a response to the display of some kind of weaknesses from the interlocutor. In these cases laughter is used to show the understanding of the social discomfort expressed by the partner, showing closeness and assuring the partner that they are not being judged for what they are sharing.

In order to clarify the difference between softening and benevolence induction it is useful to refer to [122]'s politeness theory, i.e., we call *softening* the uses whose aim is to reduce intrusion (e.g. accompanying criticism, opinion different from the partner and answering inconveniently to a question), while we classify in the *benevolence induction*

class all laughter that accompanies suggestions, opinions or the asking of a favour looking for agreement and friendliness, with the aim of inducing agreement and benevolence). Within social incongruity we also include laughter used to *show sympathy* that occur as a response to such acts (i.e. softening, benevolence induction, smoothing) both antiphonally (laughter in response to a laughter of that class) or as a response to the act in itself from the partner (as in (15) and (16)).

Note that laughter used to *show sympathy* can sometimes seem very similar to the one that we categorise as laughter to *show affiliation* (in the no-incongruity part of the DT - see Sec. 4.2.1), but context and laughable are generally different and constitute the discriminant between the two.

On the other hand, we associate a *smoothing* function with laughter when it is used to resolve social awkwardness in general (e.g. embarrassment) or to help the flow of the conversation when a conversational partner reacts in an unexpected way.

4.1.3 Pragmatic incongruity

1) Marking irony

(17) *Example from Politics Lecture (BNC, JSM)†*

Lecturer: ... And then of course you've got Ronald Reagan ... and < laughter / > history ended with Ronald Reagan.

Laughter can be used in order to signal to one's interlocutor that what is going to be said or that has just been said is not to be taken literally, but rather should be interpreted as an ironic comment. This signals an incongruity between what is said and what is meant, masking the real opinion of the laugher. In (17) the Professor's laughter indicates that the upcoming statement is not to be taken seriously, but ironically.

2) Scare quoting/Invite enrichment

(18) *Example from Trial Court (BNC, F7X)†*

A: I don't know if you can help that man or not.

B: I'll have < laughter > a word < /laughter > with him Terry

A: [...] Because Mr had represented him .

This extract is taken from a conversation between lawyers just after a trial court session. The laughter is here used in order to signal that the expression "a word" is used in a way that deviates slightly from the most standard understanding (see e.g., [123] on scare quoting).

3) Lexical uncertainty/Editing phrase

(19) *Example from Politics Lecture (BNC, JSM)†*

Lecturer: So what er Richard Newstat is saying in his argument is, is, and go back to the beginning of this lecture, is to say the constitution of the United States makes life extremely difficult for any president. ... There are a whole range of things he can't do, he can't direct congress, he can't appoint who he wants freely, he can't make treaties with whom he wants when he wants, he can't start wars < laughter > if he wants to start wars < /laughter >.

Here the laughter is used as an *editing phrase* [124],

signalling the speaker's need to reformulate and correct his previous contribution.

4.2 Laughter not referring to any incongruity

4.2.1 Pleasantness/Closeness

1) Affiliation

(20) *Extract from interview to Eagles of Death Metal†*

A: [speaking about the terrible terrorist attack which happened during their own concert the 13th of November 2015 in Paris];

B: [pat on A's shoulder]; A: < laughter / >.

In (20) laughter does not refer to the appreciation of any incongruity, neither pleasant neither social or pragmatic, but rather to the positive appreciation (pleasantness) of some action from the partner and/or is performed to show closeness and friendliness.

5 CORPUS STUDY AND RESEARCH QUESTIONS

We now proceed to apply the framework presented in the previous section. Our aim is generally to test whether the framework can be an interesting, viable and reliable way to structure laughter behaviour observation, and whether it is able to capture most of its uses. The questions we are trying to address are: How is laughter used in adult conversation? How does it contribute to the semantic and pragmatics of the messages conveyed? How does it interact with the linguistic material? Do patterns of laughter use change across languages? More specific questions will be introduced below, adjacently to the results that are presented.

5.1 Materials

The work presented in the current paper is based on the analysis of natural adult conversation data consisting of 1072 instances of laughter. We analysed data from two different corpora: the DUEL corpus [16] and the British National Corpus (BNC) [125].

5.1.1 DUEL data

The corpus consists of 10 dyads/24 hours of natural, face-to-face, loosely task-directed dialogue in French, Mandarin Chinese, and German. Each dyad conversed while performing three tasks the total duration of which was between 45 minutes and one hour. The three tasks were:

- 1) **Dream Apartment (DA)**: the participants are told that they are to share a large open-plan apartment, and will receive a large amount of money to furnish and decorate it. They discuss the layout, furnishing and decoration decisions;
- 2) **Film Script (FS)**: The participants spend 15 minutes creating a scene for a film in which something embarrassing happens to the main character;
- 3) **Border control (BC)**: one participant plays the role of a traveller attempting to pass through the border control of a fictional country, who is being interviewed by an officer, who happens to be a parent-in-law of the traveller.

TABLE 1
Laughter annotation scheme

Form and Context	Type of laughter		Standalone laugh
			Speech-laugh
	Position in relation to others' laughter		Isolated laughter
	Position in relation to the laughable		Dyadic: Antiph./Coactive
Semantics	Arousal		Before/During/After
			Low/Medium/High
	Laughable	Presence incong.	Incongruity/No Incongruity
		Type	Denot./Metaling/Exoph.
		Origin	Self/Partner/External
Pragmat.	Function		Refer to DT (Fig. 1)
	Goal		Cooperative / Non-Coop.
	Speech-act / Move		Comment, answer, etc.

The corpus was transcribed in the target language and translated into English. Disfluencies, laughter, and exclamations were annotated. The current paper presents analysis of laughter in three dyads in French and two in Chinese (3 tasks x 5 pairs) for a total of 210 minutes and 897 instances of laughter.

5.1.2 BNC data

In order to balance the friendly, extremely cooperative and task-oriented bias of the first set of data, recorded in a structured setting, we integrated the analysis with the use of data from the spoken part of the BNC. The corpus covers British English conversations audio-recorded between 1991 and 1994 in a wide range of contexts. The subset of conversations used in our study was selected in order to cover as wide a range as possible of interaction settings, varying in genre, register, level of familiarity between the interlocutors, number of conversational participants, topic and goal of interaction (SM 4). Overall, 21 conversations (604 minutes) were analysed, for a total of 289 laughs.

5.2 Audio-video coding of laughter

Coding was conducted by the first and the second authors and by three postgraduate students. We made sure that at least once (whether in the first phase or in the agreement testing) the material had been annotated by a native speaker of the language investigated. All disagreements were resolved after discussion (examples of disagreements and resolutions are presented in SM 8). Whenever possible, laughter was identified and marked by examining the audiovisual signal, a method that has been shown to be optimal for laughter recognition and detection [126], [127]. For the BNC we had to rely exclusively on audio-based detection and coding of laughter. When a laugh occurred, the annotator stopped the video/audio-tape, marked the exact onset and offset using the software ELAN [128] for DUEL and Praat [129] for the BNC, and conducted a detailed analysis using the multi-layered framework presented in the previous section (summarized in Tab. 1).

Agreeing with [21] we consider the laughter offset (inhalation at the end of a laugh) as part of the laughter event itself, thus resulting in an average laughter duration longer than other authors (e.g., [25] [130]). Occurrences of laughter from each participant, together with their laughables, were

marked and coded. Coding criteria were elaborated in order to capture the differences stressed in previous sections between the form, the meaning, the functions and the effect of laughter production in dialogical interaction. We captured some features related to the form of laughter in marking whether the laughter co-occurs with speech (i.e., speech laughter or standalone laughter) and coding the level of arousal communicated which, despite being a crucial tier in the semantic analysis in our framework, is inevitably and intrinsically related to the acoustic features of the laughter. Such an assumption is justified by results from neuro-imaging studies [56], where vocalizations presented in isolation and exclusively in audio form activated proportionally different areas of the brain according to the perceived arousal, namely the pre-supplementary motor areas and the bilateral pre-motor cortex. For this measure we relied on the natural expertise of the coders, who have acquired long training in perceiving and producing laughter over years of ecological interactions [90], [131]. The classification of arousal (or intensity of the laughter) is therefore based on a qualitative judgement expressed on a 3 point scale: Low, Medium and High.⁷

5.3 Audio-video coding of laughable

We define the laughable as the the entity laughter predicates of. Every time a laugh was identified, coders would mark the laughable based on their personal judgment. The temporal boundaries were marked, the content (whether verbal or not) was annotated, and an index was assigned in order to link laughter and laughables. Laughables were then classified according to the type of incongruity or absence of incongruity present, according to their source (linguistic denotation, meta-linguistic or exophoric event), and the origin of the laughable (the laugher her/himself, the partner or external - see Sec. 3.4.2).

5.4 Audio-video coding of laughter function

The classification of the laughter functions is based on rich pragmatic contextual reasoning, taking account of the form and contextual features of the laughter, the kind of laughable identified, together with the relationship between the interlocutors and their intentions, and performed by the coders using the binary DT illustrated in Fig. 1.

6 RESULTS AND DISCUSSION

6.1 Are our framework and taxonomy reliable tools to annotate laughter in dialogue?

The reliability of our classifications, was assessed by having 20% of each corpus analysed by three coders: the first, the second author, and three postgraduate students native

7. It is important to clarify that the laughter arousal annotation, cannot be informative about the degree of arousal shift experienced by interlocutors. A low arousal laughter might signal a huge shift in arousal if the overall emotional state was very negative, while a high arousal laughter might actually signal a small shift in arousal if the laugher was already in a particularly excited and exhilarated state. In order to investigate carefully the shift in arousal experienced (or not) by participants we would need an experimental procedure that could establish a state baseline before the laughter occurs. This is certainly an interesting investigation that for the moment we defer for future work.

speakers of the language analysed (one for each language). The three postgraduate students were naïve to the analyses proposed and proceeded to the annotation after a brief explanation of the framework and the decision tree. An *Other* category was offered to all coders, whenever specific instances of laughter could not be fitted in the functional taxonomy proposed. A table reporting results in terms of percentage of agreement and Krippendorff's α [132] is available in the SM 5. Despite the apparently complex framework proposed, entailing as it does multiple layers, our annotation scheme attains overall a high rate of agreement, even when applied by naive coders (BNC: 88.45%, DUEL French: 90.96%, DUEL Chinese: 97.14%). At the same time, although there is a high percentage of agreement between coders, the Krippendorff's alpha results are negatively affected by the instances in which a value is present in only one of the coder's annotations while being totally absent in the others' (BNC: 0.58, DUEL French: 0.67, DUEL Chinese: 0.76). That can happen especially for the rarest categories e.g., absence of incongruity in the laughable - Chinese $\alpha = .38$. We think that the slightly lower percentages of agreement reported for the BNC might be attributable to the fact that the annotation was exclusively based on audio data, therefore lacking a lot of multimodal cues available for the DUEL corpus. This explanation is also based on studies showing that the audio-visual signal is the best condition for laughter detection [126], [127], and probably also for its analysis. Lower percentages of agreement are reported across languages for the classification of the specific functions (i.e., terminal nodes of the DT - Fig. 1) especially *show enjoyment of incongruity*; occasionally the boundary between *show enjoyment of incongruity* and *mark incongruity* can be quite blurred. Moreover, since *show enjoyment of incongruity* is the most basic use of laughter, it can sometimes be more subtle to distinguish when the laughter is actually there to serve another function for which laughter has been co-opted. We discuss examples of disagreement in SM 8.

6.2 What are the general patterns of laughter and laughable use?

6.2.1 How often do we use laughter in our interactions?

Laughter is in general very frequent (Tab. 2). Substantial differences are observed depending on the setting of the conversation. In the DUEL corpus, both in French and Chinese, laughter was much more frequent than in the BNC.⁸ The discrepancy in laughter frequency across corpora could be related to the very friendly and cooperative nature of the DUEL corpus, ideal circumstances for laughter to occur frequently. The different nature of the corpora analysed should not be considered as a weakness of the study presented. One of the goals of the current study was to develop a classification of laughter based on a variety of settings. Our central aim, hence, was to characterise the use of laughter in as broad a range of situations as possible.

8. Although some cross-gender differences have been found in other works (e.g. [133], [134]), we did not conduct any cross-gender analysis because the sample was not balanced and not sufficiently large.

TABLE 2

Laughter occurrences and frequencies in different datasets: Minutes of conversation analysed (Dur); Laughs detected (N' laughs); Frequency over 10 minutes (/10m); Occurrences and percentages of speech-laughter over the total of laughs analysed (SL(%))

Corpus	Dur	N' laughs	/10 m	SL (%)
DUEL Fr.	125 m	562	45	179 (31%)
DUEL Ch.	85 m	221	26	105 (47%)
BNC	603 m	289	5	87 (30%)

6.2.2 Can laughter production communicate about different levels of arousal?

The arousal level was qualitatively assessed by the coders on the basis of perceived acoustic and respiratory features, as qualitatively perceived for their effect on vocal production and body movement.⁹ Across all corpora low arousal laughter is the most frequent regardless of the types of laughable and function, followed in frequency by medium and high arousal laughter in all languages. Interestingly a greater proportion of high arousal laughter has been found in the more natural and spontaneous data (BNC), in comparison to the more structured and controlled data available from DUEL (Tab. 3). We can speculate that this is due to the specific context in which the DUEL conversations were recorded: being observed is a condition in which the occurrence of an intense display of emotions might be inhibited [137]; moreover, the interaction was restricted to specific tasks, which in turn can affect the intensity and especially the interest and the emotional involvement of participants. Especially in the DUEL corpus subjects are required to have close and friendly dialogues, where humour is likely to be involved, sometimes with people that are not even acquaintances. Displays of humour appreciation or humour production in such situations can become a risky matter [131], because the level of familiarity does not enable one to know enough about the other's cultural norms and boundaries. The risk of offending or overreacting and thereby producing embarrassment or resentment is high. In this type of situation, consequently, a low aroused laughter is always a more ambiguous, and therefore safer option. As observed also by McKeown [131], low arousal laughter can serve all the pragmatic functions listed, therefore opening several options as to its interpretation (see also Tab. 5).

TABLE 3

Level of arousal perceived in the laughter

Arousal	DUEL Fr	DUEL Ch	BNC
Low	341 (60.67%)	169 (76.47%)	136 (47.06%)
Medium	214 (38.08%)	49 (22.17%)	115 (39.79%)
High	7 (1.25%)	3 (1.36%)	38 (13.15%)

6.2.3 What does laughter predicate about?

In Table 4 we report the exact numbers and percentages of the type/absence of incongruity contained in the laughable,

9. Arousal is quite a complex phenomenon to judge quantitatively. For example, when considering only loudness and frequency, one can miss the classification of some highly aroused laughter where several silent segments are produced, as shown by [135]. We defer to further studies a deeper investigation of objective measures of arousal, which will definitely entail a multimodal approach that takes into account acoustic features, respiration, quality of voice, but also posture and body movements, as already considered in [136] for laughter detection.

i.e., the second branch of the DT - Fig. 1. In each corpus a small percentage of the laughter produced could not be classified according to our framework, and was therefore assigned to the “Other” category (0.6% in French; 0.4% in Chinese and 0.6% in BNC) and excluded from further analysis. In Chinese we observe a higher proportion of laughter related to social incongruities. Laughter that relates to pragmatic incongruity is very rare, almost absent in Chinese. Laughter that does not refer to any incongruity is quite rare in DUEL and almost absent in the BNC. The vast majority of the laughs observed in our data involves pleasant incongruity, having a pragmatic function of either *showing enjoyment of incongruity* or *marking incongruity* (74% in DUEL French, 67% in DUEL Chinese and 75% in BNC). Such data is in contrast with Provine’s proposal [138] that laughter is very rarely about something humorous and that it is most of the time related to ‘banal comments’, functioning almost exclusively as a ‘social lubricant’. We should emphasize that our distinction between pleasant and social applies exclusively to the type of incongruity contained in the laughable; we are not by any means trying to argue that around 70% of laughter produced in natural conversation have no social effect or are not influenced by social context. We are naturally enough aware of the important role that humour and laughter have for social bonding, managing relationships, and conversation [4], [139], [140], [141]. However, the investigation of such effects goes beyond the scope of this work, which is to analyse laughter in dialogue characterising its use, way of predication, reference and effects on the meanings conveyed. Our conclusion is therefore intended to be valid only in relation to the laughable: most of the time laughter predicates pleasant incongruity of its argument and in order to be grasped requires a rich interpretation of the context, in terms of situational and cultural information and of personal experience [142]. Very often laughter makes reference to comments or events that do not overtly involve a pleasant incongruity when considered in isolation, but are amusing only when the enriched denotation of the event is accessible to the listener. This is valid not only for pleasant incongruity but also for social incongruity: context, past events, intentions, expectations, and desires of other people are always crucial for incongruity detection (see example 1 and relevant discussion in Sec. 2.1.1). In SM 9 we report details about the laughable locations (whether it is constituted by the eventuality described by a verbal contribution, by an exophoric event or by a meta-linguistic stimulus –see sec. 3.4.2) and origin (whether the laughable is produced by the laugher him/herself, by some other participant, by something external to the conversation or whether the laughable is jointly constructed by the conversational partners –see sec. 3.4.2).

6.2.4 What are the functions of laughter in conversation?

In Fig. 2a we report frequencies of the more detailed functions (i.e., the terminal nodes of the DT - Fig. 1).¹⁰ In order to make the graph easier to inspect with regard to the other functions, in Fig. 2b we present the same results excluding

10. Given the low frequency of specific functions related to pragmatic incongruity, we collapsed all of them in a general class named *Meaning modification*.

the laughter whose laughable contained a pleasant incongruity (i.e., laughter with the function of *showing enjoyment of an incongruity* or *marking an incongruity*), which constitute the large majority. Across languages there are surprising similarities in the proportion of functions laughter is used for. The strikingly high percentage of laughter produced with the function of showing enjoyment of pleasant incongruity in all languages can be justified by the fact that this appears to be the function closest to its phylogenetic origin [143], [144]. In order of frequency we see then *smoothing*, *softening*, *benevolence induction*. These can be considered as a co-option of the original meaning, communicating “this incongruous thing is not bad, I hope you’ll like me” [38]. The use of laughter in relation to pragmatic incongruities, effecting meaning modification of utterances, is the more sophisticated use of laughter, the furthest from its origin and the rarest in the conversations considered here (though extremely interesting from a linguistic perspective). We observe nevertheless a higher proportion of this type of function in the BNC, which involves non task-oriented speech, meaning that perhaps the extremely friendly, task-oriented and cooperative DUEL corpus, might offer a less complex and more explicit environment for communication.

TABLE 4
Occurrences and percentages of laughter according to the type/absence of incongruity in the laughable

Corpus	Pleasant	Inc. Social	Pragm.	NoInc. Pleas.	Other
DUEL Fr	414 (74%)	112 (20%)	2 (0.4%)	31 (5%)	(.6%)
DUEL Ch	148 (67%)	66 (30%)	0 (%)	6 (3%)	(.4%)
BNC	218 (75%)	61 (21%)	6 (2%)	2 (.6%)	(.6%)

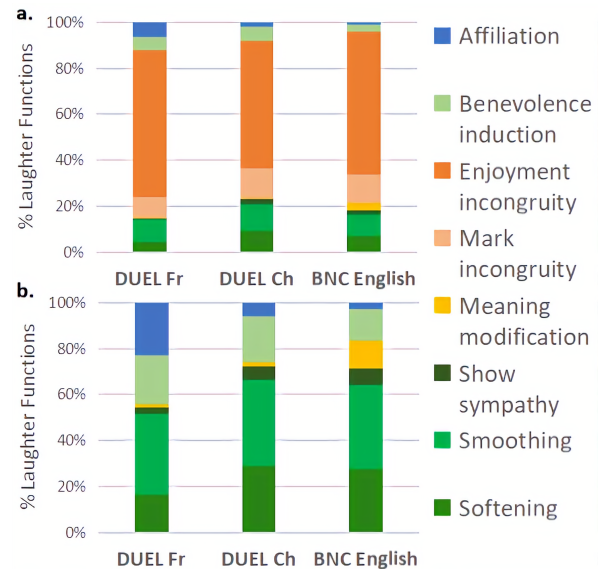


Fig. 2. Detailed distribution of pragmatic functions (a); Detailed distribution of pragmatic functions excluding those related to laughables containing pleasant incongruities (b).

6.2.5 Is laughter arousal influenced by some feature of the laughable?

Previous studies, using different laughter classifications, found differences in the acoustic and perceptual features

TABLE 5
Contingency table *Arousal * Type/Absence of incongruity*

Corpus	Arousal	Inc.			NoInc.	Other
		Pleas.	Social	Pragm.	Pleas.	
DUEL French	High	5	0	0	0	1
	Medium	192	16	1	6	0
	Low	217	96	1	25	2
DUEL Chinese	High	1	2	0	0	0
	Medium	36	13	0	0	0
	Low	111	51	0	6	1
BNC	High	38	0	0	0	0
	Medium	103	11	0	0	1
	Low	77	50	6	2	2

of different types of laughter (e.g. [145], [146]). The laughter analysed in those works was, however, most typically recorded in isolation, in response to funny videos, or recorded by actors asked to produce laughter with diverse emotional valences. Inspired by this work we wanted to check whether laughs predicating different kinds of incongruity would differ in the level of arousal perceived (actual numbers are reported in Tab. 5). We therefore performed a Fisher Exact test to explore the distribution of the level of arousal coded (low, medium, high) across laughter related to different kinds of laughable according to our taxonomy scheme. The level of arousal coded is extremely dependent on the type of incongruity present in the laughable, both for French (DUEL) and English (BNC) (two-tailed Fisher’s Exact Test, $p < .001$ and $p < .001$), while in Chinese such dependency is not observable ($p = .3$).

The level of arousal is also significantly different across specific functions. For example, a significant difference in the level of arousal coded has been found between the laughter used to *show* enjoyment of incongruity and the ones used to *mark* incongruity in French and English, but not in Chinese (DUEL French $p = .002$; DUEL Chinese $p = .7$; BNC $p < .001$).

Perhaps unsurprisingly high arousal laughter is exclusively related to laughables containing pleasant incongruities. Conversely, laughter in relation to pragmatic incongruity is mostly low arousal and never high. We can speculate that this is the case because of the more controlled nature of laughs used to mark pragmatic incongruity, being more carefully and consciously positioned as markers for meaning modification. Laughter unrelated to any incongruity, but produced with the intent of showing pleasant appreciation of the laughable is typically low arousal.

It is interesting to note that low arousal laughs are in any case the most common across all functions. McKeown’s statement that “the intensity of a laugh most strongly distinguishes the function to which laughter is oriented” [131, p.14] does not apply to our data. In a way intensity can give some hints, especially when dealing with high arousal laughter (which is generally classified as a laughter to *show enjoyment of incongruity*), but in most other cases it would be hard to determine which function the laughter is serving considering exclusively arousal. We find this data a convincing argument for the conclusion that any function classification based exclusively on laughter arousal cannot be fully reliable. We therefore claim that any computational dialogue system aiming to integrate laughter and language

cannot rely exclusively on laughter form for its interpretation. On the other hand, as far as production is concerned, a discrete low arousal laughter might always be a safer and more acceptable option for a dialogue system, because of its ambiguity and multi-functionality (see also Sec. 6.2.2 for further discussion).

6.2.6 How often do we respond to laughter with a laugh?

Over 69% of all the laughs observed in all corpora are isolated, resulting therefore in percentages of dyadic laughter (i.e. antiphonal and coactive) ranging between 26% and 39%. Very similar percentages have been found in the two languages explored in the DUEL corpus, while in the BNC lower percentages are observed (see Table 6).

In the DUEL corpus we had enough data from the same couples to calculate the transitional probability of a speaker laughing antiphonally and coactively in response to the partner’s laughs (i.e., the number of dyadic laughs produced by one speaker given the total number of laughter occurrences from the partner). In French we found an overall transitional probability of 21.9% (sd 10.84) for antiphonal laughter and 20% (sd 8.9) for coactive laughter, for an overall transitional probability for dyadic laughter of 42.18% (sd 15.07). While in the Chinese data we observed an overall transitional probability of 16.18% (sd 5.6) for antiphonal laughter and of 25.94% for coactive laughter, for an overall transitional probability of dyadic laughter of 42.13% (sd 17.47)¹¹.

The occurrence of dyadic laughter (i.e., antiphonal and coactive) is very similar in the two languages examined in the DUEL corpus. It is less frequent in the BNC. Again, the result could be explained by the very specific setting of the DUEL corpus, which makes it highly conducive to antiphonal laughter: the interactions are all good natured, cooperative (cf. the facilitating value of the chameleon effect for cooperation [147]), and require participants to come to an agreement on some proposals [148], [149]. It should be noted that the observation of antiphonal laughter is extremely dependent on setting, context, and goal of the interaction [28], [150].

As pointed out in previous works ([28], [151], [152]), laughter represents an optimal opportunity for joint vocalisation. In comparison to linguistic contributions, where usually only smaller overlaps are tolerated, laughter overlap is common and can last for several seconds and even in cases where the laughs did not have the same onset, temporal vicinity (e.g. antiphonal laughter) often leads to overlap. A detailed study of the acoustic features of laughter overlapping others laughter and isolated has been conducted by Truong and Trouvain [152], showing that non-overlapping laughs are very distinctive from initiating laughs, and that responding laughs (what we call antiphonal in our annotation) seem to have intermediate-level features. Also, in the corpora examined, as already reported in other studies (e.g., [8]), laughter from one speaker can often overlap with the conversational partner’s speech turn.

11. We emphasize that this calculation is based on the total laughter produced by the partner and not exclusively on what has been called inviting or initiated laughter [85], [101] that occurs at the end of a turn inviting the partner to join the laughter.

These phenomena constitute another argument in support of the idea that laughter be considered an interacting but parallel and separated channel from speech, where different alignment rules apply (see 6.3 for further argumentation). Like Trouvain and Truong [152], we did not find the familiarity effect observed by Smoski and Bachorowski [28] in the occurrence of dyadic laughter (either antiphonal or coactive). What we did observe though, despite not having enough statistical power to assert this firmly, is that most of the variance is due to the couples where the participants are not close friends. In those couples there seems to be always a “dominant” participant and a more submissive one with a discrepancy of almost 20% of transitional probability in antiphonal laughter between them (the less dominant laughing antiphonally more often). Moreover, in our data, such phenomena do not seem to be gender related. Nevertheless, our results have to be considered with significant caution due to the very limited number of dyads analysed in DUEL. In the BNC such analysis could not be performed due to the lack of information about the people involved in interactions and the lack of standardised environment for comparisons.

TABLE 6
Occurrences and percentages of dyadic (antiphonal and coactive) and isolated laughter

Corpus	Antiphonal	Coactive	Dyadic	Isolated
DUEL Fr.	121 (21%)	97 (18%)	218 (39%)	344 (61%)
DUEL Ch.	40 (18%)	41 (18%)	81 (37%)	140 (63%)
BNC	33 (11%)	42 (15%)	75 (26%)	214 (74%)

TABLE 7
Laughter - Laughable alignment: Laughter before, during or after the laughable (occurrences and percentages)

Laughter position	DUEL Fr	DUEL Ch	BNC
Before	15 (2.67%)	16 (7%)	16 (5.54%)
During	99 (17.62%)	81 (37%)	75 (25.95%)
After	448 (79.71%)	124 (56%)	198 (68.51%)

6.3 Positioning of laughter

6.3.1 How is laughter positioned in the speech stream?

Speech-laughter (SL), i.e., laughter co-occurring with speech from the laugher her/himself, was frequent in all the corpora analysed. We observed higher proportions of SL in Chinese (47%) compared to French and English, where a very similar pattern has been found (respectively 31% and 30%) (Tab. 2). Frequencies of SL across the 3 datasets are significantly different ($\chi^2(1)=23.63$, $p < .001$). We found 14 standalone laughs (5%) in French and 12 (8.6%) in Chinese that occurred in utterance-medial positions. These proportions are statistically higher than zero (French $\chi^2(1)=12.3$, $p < .001$; Chinese $\chi^2(1)=10.5$, $p = .001$). Such analysis is not available for the BNC: this is due to the absence of video data and the more impoverished annotations in that no exact timing of the onset and offset of laughs has been marked. Our data together with results from [42], [43] and [84], who found percentages of speech-laughter even higher than ours (respectively 50%, 60% and 58%), definitively refute the old hypothesis of laughter punctuating speech, occurring exclusively at phrase boundaries [153].

6.3.2 Does laughter always follow the laughable?

We observe significantly different patterns regarding the positioning of laughter in relation to its laughable in the three corpora ($\chi^2(4)=46.612$, $p < .001$) - raw data in Tab. 7. Interestingly, in all the corpora analysed there is a fairly high percentage of speech laughter that does not refer to the co-occurring speech it overlaps with (BNC: 34.48%; DUEL French 60.89%; DUEL Chinese 41.90%). The majority of laughter occurs after the respective laughable, as might be expected; however laughs can occur also before or during the laughable they refer to. These results, together with the interesting relatively high proportion of speech-laughter not related to the overlapping speech and the data reported in the previous section about overlap with speech suggest the existence of a rather free alignment between laughter and the respective laughable, displaying similarities to the one observed in gestures in relation to speech [154], [155]. This suggests that speech and laughter rather than being part of a single comprehensive communicating process or channel, might constitute two different and parallel ones (see Fig. 3 for a graphical illustration). Comparing results across the 3 languages we observe a higher percentage of laughter produced during or before the laughable in Chinese (Tab. 7) which does not depend on the functions used.

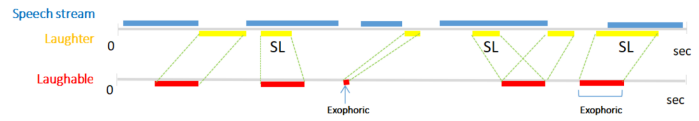


Fig. 3. Temporal misalignment of speech stream, laughter and laughable. Illustration from [156]. (SL stands for ‘speech laughter’.)

6.4 Can the type of laughter prediction be predicted on the basis of lower level features?

Given the results from previous sections, we wanted to test whether the different patterns of laughter use observed, in terms of form, positioning, origin, and type of laughable, could be predictive of the laughter function and whether some specific features might be more crucial than others in characterising functions. We therefore performed a Multinomial Logistic Regression in order to explore whether functions could be predicted by specific features from “lower” layers. A table reporting coefficients of log odds and p-values comparing each pair of laughable types is available in SM 6. In particular we tried to predict the first branching of functions, the one related to the type (or absence) of incongruity contained in the laughable.¹² We ran the analysis independently for the different corpora and languages using positioning of laughter in relation to speech production (speech-laughter or standalone laughter), to the laughable (before, during or after), and to others’ laughter (antiphonal, coactive or isolated), the producer of the laughable (whether the laugher her/himself or the partner) and the level of

12. It was not possible to perform the same analysis for the more detailed functions because of lack of statistical power (i.e., some of the functions occurred very rarely) and because overall functions belonging to different branches did not have the same “distance” between each other, therefore being inadequate data for a regression.

arousal perceived (low, medium, high) as features to predict the laughable type branching (pleasant, social or linguistic incongruity or pleasantness - Fig. 1). Specifically, we explored the odds ratio of one type of laughable over another. For the French data (DUEL) the model manages to predict correctly 75.09% of the laughable type classification. The result was slightly improved when adding duration as a supplementary feature, having the model being able to predict 75.63% of the branching correctly. For the Chinese data (DUEL) the model manages to predict 73,4% of the laughable types classification and when adding duration as a predictor, 73,86%. For the BNC data the results were even better with an overall accuracy of 80.36%, even without the inclusion of duration as supplementary factor. Duration could not be added to the model for the BNC data since the fact that only audio files were available meant that we did not have sufficiently precise conditions to mark exact laughter onsets and offsets. The results obtained from our multinomial logistic regression are encouraging. We found specific clusters of relevant features both for the different languages and for the specific functions: classes cannot be predicted on the base of a single feature, but each of these is characterised by a specific cluster. This result is also mirrored in a more specific investigation about the relationship between positioning of laughs in relation to the laughable and the pragmatic function performed reported in SM 10. We believe that our model can be improved by having a larger set of data for the rarer branches and will definitely benefit from implementation with methods similar to the ones used in [157], i.e., Classification Trees and Support Vector Machines applied using the most relevant acoustic features of laughter.

7 CONCLUSIONS AND FURTHER WORK

In the current paper we have tackled both theoretical and empirical challenges related to the understanding of laughter, a significant non-verbal social signal in interaction. Our principal aim is an improved understanding of the use of laughter in spontaneous adult conversation. We initially elaborated a comprehensive framework for the analysis of laughter based on the pivotal assumption that laughter has propositional content. In line with this, we have suggested that different layers of analysis need to be distinguished, by analogy with the study of speech: form, position, semantics and pragmatics. We propose that laughter has a core semantic meaning that, when aligned with rich contextual reasoning, can generate a wide range of functions. We tested the applicability and validity of this approach by means of a multilingual corpus study of adult conversation (French, Chinese and English) in a variety of contextual situations. The classification of laughter function proposed, set out in concrete terms in the form of a binary decision tree, attains a high level of agreement among naive coders.

Our theoretical approach considers laughter as involving a predication applied to a contextually given argument, the *laughable*, with an associated intention for pleasantness change in the interlocutors cognitive states, partially determined by *arousal* encoded in the laugh. Hence, on this view, both the laughable and the arousal are important parameters of laughter meaning. Our results give rise to

novel generalizations about the range of meanings laughter exhibits, about the placement of the laughable, and about how placement and arousal relate to the range of functions laughter has. Taking these in order: the data shows that most of the time laughter meaning involves the predication of *incongruity*, which can be of three types: pleasant, social, or pragmatic. We have tested, apparently for the first time, the validity of the commonly accepted assumption that laughter directly follows its laughable. Our data refute this, showing that while laughter following the laughable is the commonest case, overlap or precedence also occur. Thus, laughter patterns with manual gesture in its relation to speech [158]: meaning arises from an interaction with speech, that takes place on distinct and partially independent channels. Our statistical analysis shows that the laughable, and consequently the function, cannot be reliably predicted on the base of a single lower level feature (arousal, positioning in relation to other's laughter, to the laughable or to speech), but that laughs serving different pragmatic functions are rather characterised by a cluster of language dependent features. On the other hand, some similarities observed across languages (arousal, production of laughs in response to the partner's laughter, positioning in relation to the laughable and distribution of different types of laughables), especially when context is fixed, allow us to suggest tentatively that certain laughter features are *not* heavily influenced by the language spoken and the culture of origin.

While acknowledging the limitations of our study, above all in so far as a much larger range of genres and cultures needs to be considered, we believe that our work has implications for designers of Spoken Dialogue Systems (SDS). There are two main issues here: should SDS incorporate laughter? And if so, how? Previous literature has already pointed to a positive answer to the first question in that laughter plays a role in turn-taking and contributes to improving the perception of a conversation in terms of agreeableness, naturalness and a sense of bonding [11], [159]. However, the fact that laughter has propositional content and can interact with content emanating from spoken language means that an SDS that only treats input where laughter is filtered away is deficient not only with respect to emotional and affective computing [160], but has impaired NLU capacity. Stated positively, the existence of pragmatic incongruity in laughter contributes to disambiguation, along with other non-verbal cues, for instance to irony detection [161], [162], [163]. Laughter can contribute to dialogue act classification [164] and to predicting how a dialogue unfolds, with different types of laughter allowing for different outcomes [41], [85], [165]. Our results highlight that SDS cannot rely exclusively on arousal to determine the pragmatic function of a laugh. Low arousal laughter is actually the most common type across all categories. Given this, as far as production is concerned, a discrete low arousal laughter might always be a safer and more acceptable option for an SDS, because of its ambiguity and multi-functionality. Finally, we know from clinical studies that laughter has atypical patterns of use in several pathological conditions (e.g. autism, schizophrenia) [27], [166], [167], [168], integrating laughter use processing in systems aimed at an automatic analysis of linguistic production for pathology screening could be highly useful [169].

Our work opens up important computational challenges, some of which are already the subjects of ongoing work. These concern (i) the task of automatically identifying laughables [170], given that these play a central role in how functions gets classified in our framework, (ii) formally characterizing incongruity in the different classes distinguished, exploiting contextual reasoning models [171], (iii) formally characterizing laughter meaning and associated inferences within cognitive states [172], and, (iv) deepening the analysis of the acoustic forms of laughter and laughable, along with their sequential and other multimodal features, in order to automatically predict functions. We therefore believe that laughter is an important resource for SDS, paving the way to more socially intelligent agents that are able to deal with pragmatic reasoning.

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Supplemental Materials

What's your laughter doing there? A taxonomy of the pragmatic functions of laughter

Chiara Mazzocconi, Ye Tian and Jonathan Ginzburg



1 VETTIN AND TODT, 2004

Label	Description
Conversational Partner	A participant's laughter occurs immediately (up to 3s) after a complete utterance of her conversational partner
Participant	The participant laughed immediately (up to 3s) after her own complete utterance
Short confirm	Participant's laughter occurs immediately (up to 3s) after a confirming "mm", "I see" or something comparable, by herself or her conversational partner
Laughter	Participant's laughter occurs after (up to 3s) a conversational partner's laughter.
Before utterance	Participant's laughter after a short pause (less than 3s) in conversation, but immediately (up to 500ms) before an utterance by herself.
Situation	Laughter occurring during a pause in conversation (at least 3s), not followed by any utterance. The laughter is attributed to the general situation and not to an utterance.

TABLE 1
BASED ON VETTIN AND TODT, 2004 - CONTEXT CLASSIFICATION

2 ENTHYMEME AND TOPOS EXEMPLIFICATION FROM GINZBURG ET AL. 2015.

We assume a view of incongruity as proposed in Ginzburg et al. 2015 whereby this involves a clash between a general inference rule (a *topos*) and a localized inference (an *enthymeme*), a view inspired by work in humour studies (e.g., Raskin, 1985; Hempelmann and Attardo, 2011). To exemplify: (3a) is an enthymeme, an instance of the topos in 3b). A's utterance (3) in (3c) relies on the enthymeme in (3d), which clashes with the topos in (3b). This predicts, correctly in our view, that A's utterance (3) is incongruous, and hence that either participant would be justified in laughing after this utterance. Either because this is indeed a somewhat zany thing to say (what we call below pleasant incongruity) or because A can use laughter to signal that her utterance is not to be taken seriously (what we call below pragmatic incongruity).

- (3) a. Given that the route via Walnut street is shorter than the route via Alma, choose Walnut street.
 b. Given two routes choose the shortest one
 c. A(1): Which route should I choose?
 B(2): The route via Walnut street is shorter.
 A(3): OK, so I will choose the route via Alma.
 d. Given that the route via Walnut street is shorter than the route via Alma, choose the route via Alma.

3 EXAMPLES LAUGHABLE TYPES

The laughable can be constituted by the eventuality described by a verbal contribution (1), by an exophoric event (2), or by a metalinguistic stimulus (e.g., a slip of the tongue, pun, violation of conversational rules, inappropriate speech act etc.), as in (3) and (4).

(1) Laughable: Utterance denotation

Extract from DUEL French (3_1, Dream apartment)†

Speaker B: donc ça c'est (la: + le) premier étage hein?
 Speaker A: < laughter/ > le rez-de-chaussée
 Speaker B: voila!
 Speaker A: avec un: + un parking comme dans Batman t'sais genre tu tu vas sous terre < laughter/ >
 Speaker B: < laughter/ >

B: so that's (the: + the) the first floor huh?

A: < laughter/ > the ground floor; B: here it is!

A: with a: + a parking like in Batman you know like you go under ground < laughter/ >;

B: < laughter/ >

(2) Laughable: Exophoric event

Example from BNC, KDE

[Child looking in anguish for something that is in front of him.]

Mum: < laughter/ > There he is!!

(3) Laughable: Metalinguistic: speaker A and B saying the same thing at the same time.

Example from DUEL French (3_2, Film Script)

Speaker A: Va pourrait mettre un truc dedans

Speaker B: On va pouvoir mettre des trucs de
<laughter/ >

A: *Can put stuff in it*

B: *We can put stuff in* <laughter/ >

(4) Laughable: Metalinguistic: Mispronunciation
From DUEL French (1_3, Border Control)

Officer: Et tu tiens toujours des: contacts avec cet euh ce dit enfant?

Traveller: je le vois pas mais euh je je lui do ouais je lui d j'ai je (NV) je <laughter/ >

Officer: *And are you keeping in: touch with (that +this) said child?*

Traveller: *I see him but uh I I gi yeah I g I I (NV) I*
<laughter/ >

In more detail: in (1) the incongruity arises from the inappropriateness of getting inspired by a luxury house from a film for the design of the participants' house, as well as the disproportionate price that a garage of that type would cost (especially in relation to a student real life budget). The laughable is therefore the situation described by speaker A's utterance. On the other hand, in (2) the laughable is in the (non-linguistic) situation, the incongruity arising from the child's apparent anguish triggered by the search of something that was just in front of him. In (3) speaker B laughs because both participants said the very same thing at the very same time, a deviation from the normal case where speakers provide distinct contributions. In (4) the participant role-playing the traveller laughs about her repeated misspelling and stuttering. Thus, in both (3) and (4) the laughables involve the utterance situation itself, as opposed to a situation described by the utterance.

4 LIST OF CONVERSATIONS FROM BNC

Specifically conversations analysed have been taken from sections: D9 (union meeting), DC (Amnesty International meeting), F7 (court trial), FL (chemistry lecture), G5 (selection candidate for European elections), GY (private lesson chemistry), HE (radio interview after Piper Alpha tragedy), HU (air traffic control tower), J3 (gardening radio program), JN (job interview), JS (politics lecture), K6 (interview with politician), K7 (history interview about the post-war period), KB, KC and KD (informal conversations bartender-customers and informal conversation in domestic contexts: wife-husband, children and mum-child).

TABLE 2
LIST OF BNC CONVERSATIONS ANALYSED, DURATION AND LAUGHTER OCCURRENCES

Audio	Description	Duration	N° laughter
F7X	Clitheroe magistrates' court: trials.	47	2
KCV	Wife husband	47	3
HEE	Interview Piper Alpha tragedy	26,4	4
KD5	children conversation	47	3
KBK	Wife Husband interaction	43	4
KDE	Home setting mum and little child	47	10
JSM	Politics Lecture	46,4	13
K7G	Oral history project interview	47	15
KDP	Conversation recorded by Richard - barman	47	21
JNV	Interview at TEC	15	20
FLY	Lecture chemistry	45	24
JNW	Interview question and answer, explanation, discussion	30	31
DCH	Amnesty international meeting	20	27
K6A	Interview politician after heart attack	22	36
KD4	Wife-husband conversation about buying a new car	15	3
GYR	Tutorial chemistry	13	16
HUG	Air traffic control tower	11	6
KDU	Multiparty informal conversation	10	27
J3Y	Gardeners' Question Time: radio programme.	10	12
G5G	Selection of candidate for election to European Parliament	10	8
D96	Pensioners' and Trades Union Association meeting	5	4
		603,8	289

5 INTER-ANNOTATOR AGREEMENT

TABLE 3
INTER-CODERS ANNOTATION AGREEMENT¹

Feature	BNC English		DUEL French		DUEL Chinese	
	% agreem. 3 coders	Krip. α	% agreem. 2 coders	Krip. α	% agreem. 2 coders	Krip. α
L-SL	89	0.73	*	*	*	*
Isolated	94	0.85	87.5	0.74	100	1
Antiphonal	94	0.85	90	0.71	100	1
Coactive	96	0.73	92.5	0.75	100	1
Low Arousal	72	0.37	77.3	0.53	92.6	0.68
Medium Arousal	72	0.33	77.3	0.53	91.4	0.68
High Arousal	100	1	/	/	/	/
After	85	0.65	97.5	0.94	100	1
During	85	0.65	95	0.88	100	1
Before	100	1	97.5	0.87	100	1
De - Ling	94	0.37	92.5	0.53	100	1
Self - Par	94	0.87	95	0.88	100	1
Inc - No inc	96	0.73	93.3	0.58	96.3	0.38
Pleasant	74.2	0.47	88	0.71	92.6	0.66
Social	78.5	0.52	89.3	0.65	96.3	0.78
Friendliness	95.7	0.72	94.6	0.68	96.3	0.38
Ling	93.5	0.37	/	/	/	/
Enj Inc	63	0.28	85.3	0.70	91.4	0.67
Mark funniness	85	0.15	86.7	0.42	96.3	0.38
Softening	96	0.73	93.3	0.51	/	/
Ben Ind	85	0.34	94.7	0.47	96.3	0.38
Smoothing	94	0.47	92	0.36	97.5	0.61
Show sympathy	91	0.16	/	/	/	/
Affiliation	96	0.73	100	1	98.7	0.85
Overall	88.45	0.58	90.96	0.67	97.14	0.76

6 MULTINOMIAL LOGISTIC REGRESSION RESULTS

TABLE 4
DUEL AND BNC CORPUS - MULTINOMIAL LOGISTIC REGRESSION RESULTS: COEFFICIENTS OF LOG ODDS AND P-VALUES (ADJUSTED FOR MULTIPLE COMPARISON) COMPARING EACH PAIR OF LAUGHABLE TYPES.

DUEL - French						
speech-	coeffcnt	-0.35	/	0.03	/	0.39
laugh	p-adjst	0.27	/	0.93	/	0.46
antiphonal/	coeffcnt	-1.00	/	-0.27	/	0.73
isolated	p-adjst	0.003	/	0.57	/	0.003
coactive/	coeffcnt	-1.46	/	0.49	/	1.96
isolated	p-adjst	0.003	/	0.31	/	0.003
medium/low	coeffcnt	-1.40	/	-1.17	/	0.23
arousal	p-adjst	5.22e-06	/	1.76e-02	/	0.68
laughable-	coeffcnt	-1.28	/	0.61	/	1.9
par/self	p-adjst	4.30e-05	/	0.14	/	1.27e-04
laughable-	coeffcnt	0.53	/	1.62	/	1.08
ex/self	p-adjst	0.20	/	0.01	/	0.12
Bef/aft	coeffcnt	-0.41	/	-0.03	/	0.38
	p-adjst	0.56	/	0.97	/	0.75
Dur/aft	coeffcnt	0.21	/	-0.89	/	-1.11
	p-adjst	0.54	/	0.54	/	-0.21
duration	coeffcnt	-0.19	/	-0.40	/	-0.20
	p-adjst	0.14	/	0.11	/	0.46
DUEL - Chinese						
speech-	coeffcnt	-1.05	/	-9.00	/	-13.82
laugh	p-adjst	0.01	/	0.88	/	0.00
antiphonal/	coeffcnt	0.03	/	1.22	/	1.18
isolated	p-adjst	0.95	/	0.49	/	0.51
coactive/	coeffcnt	0.36	/	1.93	/	1.56
isolated	p-adjst	0.14	/	0.41	/	0.23
mid/low-	coeffcnt	-0.08	/	-18.67	/	-38.26
arousal	p-adjst	0.87	/	0.00	/	0.00
laughable-	coeffcnt	-0.68	/	-0.58	/	0.10
par/self	p-adjst	0.66	/	0.10	/	0.93
laughable-	coeffcnt	3.46	/	2.38	/	-11.50
ex/self	p-adjst	0.00	/	0.98	/	0.00
Bef/aft	coeffcnt	0.04	/	-41.24	/	-46.30
	p-adjst	0.93	/	0.00	/	0.00
Dur/aft	coeffcnt	0.36	/	-6.50	/	-15.26
	p-adjst	0.42	/	0.86	/	0.00
duration	coeffcnt	-0.44	/	-1.60	/	-1.16
	p-adjst	0.07	/	0.25	/	0.41
BNC - English						
speech-	coeffcnt	0.43	-0.90	/	-1.33	/
laugh	p-adjst	0.40	0.50	/	0.32	/
antiphonal/	coeffcnt	-0.79	-8.40	/	-12.73	/
isolated	p-adjst	0.15	0.92	/	0.00	/
coactive/	coeffcnt	-28.33	11.75	/	33.97	/
isolated	p-adjst	0	0.00	/	0	/
low/high-	coeffcnt	24.32	35.43	/	-0.78	/
arousal	p-adjst	0.00	0	/	0	/
mid/high-	coeffcnt	22.94	6.06	/	-19.86	/
arousal	p-adjst	0	0	/	0	/
laughable-	coeffcnt	-1.2	-31.04	/	-19.46	/
par/self	p-adjst	0.00	0.00	/	0.00	/
laughable-	coeffcnt	-0.39	-40.40	/	-19.54	/
ex/self	p-adjst	0.76	NaN	/	0.00	/
Bef/aft	coeffcnt	-0.83	1.86	/	2.70	/
	p-adjst	0.28	0.16	/	0.05	/
Dur/aft	coeffcnt	-0.18	1.70	/	1.89	/
	p-adjst	0.73	0.29	/	0.24	/

¹ The percentage of agreement for detection and classification of laughter and speech-laughter are not available for the DUEL corpus because that information was already present in the transcriptions coders were provided with when performing the annotation in ELAN.

7. DECISION TREE FOR LAUGHTER FUNCTION CLASSIFICATION

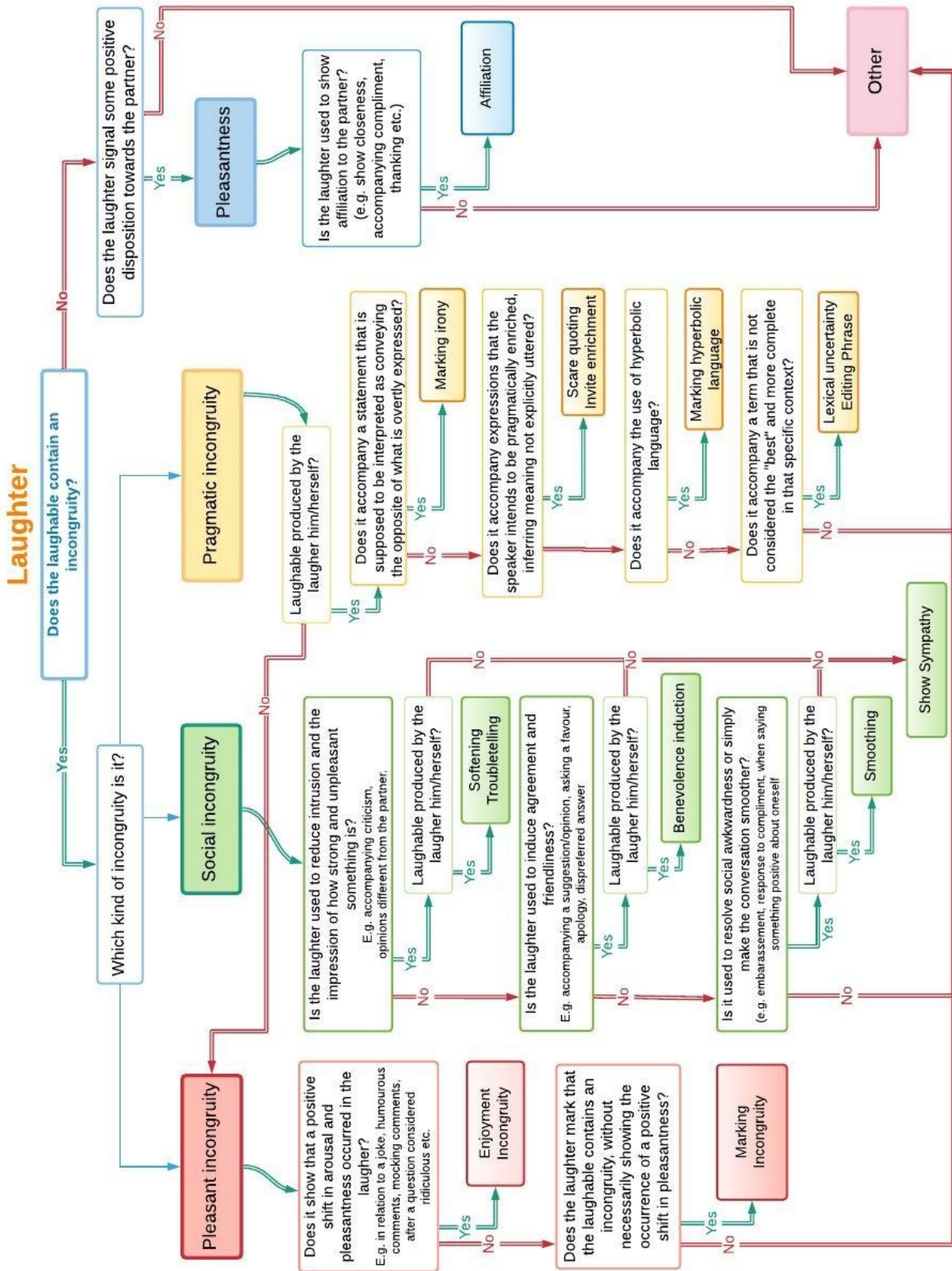


Fig. 1 Decision tree for classifying the pragmatic functions of laughter

8. ANALYSIS OF DISAGREEMENTS

In what follows we present and discuss instances of disagreements between annotators in the classification of the laughter function.

All disagreements were resolved after discussion. We think plausible that there are cases which are truly ambiguous and should not be resolved, in line with a recent trend in dialogue annotation.

Though we have not implemented the more complex approach this inevitably requires in the current work.

In the extract (1) one annotator interpreted the laughter from Ian (underlined) as a laughter produced with the function of softening the request of double checking the bank account numbers, avoiding to look too critical regarding the hand writing of the client; while a second annotator interpreted the laughter as a simple appreciation of the incongruity of having the money transferred to the wrong bank account.

(1) Extract from a job interview (BNC, JNV)

Disagreement: softening a social incongruity vs showing enjoyment of pleasant incongruity

Ian: That's...two ... two and six [...] One ... two ... two.

Right if you'll just erm ... check the details .

John:

Ian: If you want to just check the bank account cos we don't want the ... we <laughter> don't want </laughter> the money going to the wrong account

John: Okay yes that's important [...] [...] close your zero there in case it looks like a six [laugh]. O one ninety four.

After discussion the two annotators agreed, listening to the audio together, focusing on prosody, laughter acoustics and laughter positioning, that despite it could be a slightly funny accident to have the money sent to the wrong bank account, in this context the interviewer (Ian) is most likely softening his request for clarification.

In example (2) one annotator interpreted the laughter as serving the function of smoothing the interaction, given the pause caused by Ian having difficulties reading small characters, while a second coder interpreted it as an pleasant appreciation of the incongruity of not being able to see with the current glasses, and the Ian's declaration of the need to change them in order to be able to see clearly.

(2) Extract from a job interview (BNC, JNV)

Disagreement: smoothing for social incongruity vs showing enjoyment of pleasant incongruity

Ian: Right so that's six to twelve months

John: That's six to twelve months wasn't it yes.

Ian: I must get my glasses <laughter> changed </laughter>.

John: <laughter/> They must print their

Ian: Yes

John: forms on slightly bigger pieces of paper I think

Ian: Right

After discussion and further analysis of the audio-file, both annotators agreed that the laughter had mostly a function of smoothing the conversation rather than showing enjoyment of a pleasant incongruity. The laughter helped to smooth the momentary difficulty of the interviewer, the momentary break-down of the interaction and the following laughter produced by John can be interpreted as a laughter to show sympathy and reassure Ian.

In extract (3) the annotators disagreed on the classification of the function served by the laughter produced by B (underlined). While one annotator interpreted it as laughter to soften the different opinion regarding the idea of getting a leather couch, the other annotator interpreted it as a laughter to show enjoyment of the incongruous, slightly silly, justifications provided for her opinion against getting a leather couch, i.e. "because it is cold and it is noisy".

(3) Extract from DUEL French (FR1_1 - Dream Apartment task)

Disagreement: smoothing for social incongruity vs showing enjoyment of pleasant incongruity

A: d'accord pour le grand canapé mais je veux pas qu'il soit en cuir

B: bah pourquoi c'est vachement cool?

A: (parce que je: + parce que (c'est <p=froid> f- </p> + c'est froid)) et ça fait du bruit <laughter/>

B: <laughter/>

A: *I agree for the big couch but I do not want it to be made of leather*

B: *but why it is pretty cool?*

A: *(because I: + because (it is <p=cold> c- </p> + it is cold)) and it is noisy <laughter/>*

B: *<laughter/>*

After discussion both annotators, taking especially in account facial expressions, prosody and laughter positioning, agreed that the laughter produced has mainly the function of smoothing speaker B's quite resolute, despite a bit bizarre, rebuttal to speaker's A inquiry.

In extract (4) one annotator interpreted the laughter from speaker A (underlined) as having the function of showing enjoyment of the incongruity of spending all the money provided (one million euros) which for a student is an incredible amount of money just for furnish the apartment, while the other annotator interpreted it a laughter to show affiliation to the interlocutor, showing that her opinion is close to her interlocutor.

(4) Extract from DUEL Chinese (Ch 1_1 - Dream Apartment task)

Disagreement: showing enjoyment of pleasant incongruity vs affiliation (friendliness)

A: 我们要不要把一百万都花掉?

B: { 嗯 1} 留一点点好了 <laughter/>

A: <laughter/> <laughter/>我们要留一点点 </laughter/>

A: *We are going to spend all one million euros?*

B: {en} *Leave a little bit <laughter/>.*

A: <laughter/> <laughter/> *We need to leave a little </laughter/>*

After discussion both annotators agreed that in this case the laughter produced was very likely produced to show enjoyment of the incongruity. It has to be noted indeed that the dyad is performing a task, the money available to them for the furnishing their “dream apartment” is not real and the amount of money is particularly high for a standard student. Focusing on the discourse structure, prosody, laughter acoustics and positioning, both annotators agreed that the laughable was most likely constituted by the situation A and B are in, incongruous in that they are “poor” students but are given a full budget for furnishing the apartment. The laughter was therefore related to the absurdity of being speaking and reasoning cautiously about a very unrealistic budget as if they actually had the money, rather than being laughter to show affiliation and agreement with the partner.

In most of the examples discussed the disagreement is to be attributed to one of the annotators attributing the function of showing enjoyment. We observe that this is the general pattern in our data, which justify the low Krippendorff’s alpha for the *showing enjoyment of pleasant incongruity* function. We believe that this has to be ascribed to the fact that showing enjoyment of incongruity is the most basic function of laughter which has been co-opted to serve other functions and that it can therefore be hard to discriminate between the original function and the more sophisticated ones. In some cases it might also arise from different interpretation of the interaction and the relationship between participants.