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Laughter meaning construction and use in development: children and Spoken Dialogue Systems ^{*}

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Abstract. In the current work a brief overview of some studies conducted on laughter taking a multidisciplinary perspective will be presented. The integration of analyses of corpus data, theoretical and formal insights, behavioural experiments, machine learning methods, and developmental data, turned out to be fruitful to gain insight into laughter behaviour and on how its production contributes to our conversations. A crucial claim emerging from the studies presented is that laughter conveys propositional meaning interacting with other modalities, in a manner akin to other content bearing words. The implications that such results have for the implementations of more competent, from a semantic and pragmatic perspective, spoken dialogue systems will be outlined. Especially the qualitative and quantitative analysis of developmental data will offer the basis for the proposal of some specific applications.

Keywords: Laughter semantics · multimodal communication · pragmatic development · communication feedback · spoken dialogue systems.

1 Introduction

Laughter has for long been dismissed by the field of semantics, on the wave of a markedly speech- and text- oriented analysis of meaning. By now awareness that meaning is conveyed multimodally is granted and semantic formal accounts of behaviour or features that used to be considered out of the remits of linguistics, or anyway out of those of semantics, (e.g. gestures, facial expressions, prosody, disfluencies) are flourishing (e.g. [5,4,54,96,48,38]).

Embracing the spirit of the workshop, inviting for exchange of methods and insights across disciplines, in the current work a brief overview on some of the

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investigations conducted on laughter will be presented, showing how a quantitative and qualitative analysis of cross-linguistic corpus data, in triangulation with theoretical and formal insights, behavioural, machine learning methods, and developmental data turn out to be beneficial for the understanding of laughter behaviour and of how it contributes to our conversations. The multidisciplinary investigations conducted points to the need to integrate laughter in frameworks aimed at modelling meaning in interaction, stressing the importance of a multi-modal approach to the study of dialogue semantics, having therefore important implications for the design of Spoken Dialogue Systems.

The paper is structured as follows: in the first part, a corollary of studies related to the use of laughter in adult conversation supporting the idea that laughter should be treated in a manner akin to language and on how its meaning interacts with other modalities will be presented; in the second part, the attention will be shifted to studies on laughter behaviour development, focussing especially on two aspects: (1) a quantitative and qualitative analysis of caregivers' responses to child laughter in development, highlighting similarities with studies in language acquisition; (2) the use of laughter in relation to potentially discomforting situations (e.g. criticising/correcting the interlocutor, asking a favour, apologising). Those will constitute further ground for a concluding discussion about the implications and potential applications that the results presented have for the implementation of more competent Spoken Dialogue Systems (SDS) and Embodied Conversational Agents (ECAs), spotlighting especially on aspects related to natural language processing. Explicitly, in what follows some elements aimed at answering (at least partially) the following questions will be presented:

- Does laughter convey meaning? How does it affect dialogue?
- How does it interact with other modalities in terms of time-alignment and function?
- How do children learn laughter meaning?
- What do adult and developmental studies of laughter can contribute to the implementation of spoken dialogue systems?

NOTE: When reporting extracts of conversations, for laughter transcriptions we will use the annotation guidelines used in the DUEL corpus [49]. 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 >”). Through out the paper, whenever an extract of the interaction is reported, this is provided with an hyperlink to a video-clip of the original recording.

2 Laughter as Language: triangulating methods and insights

2.1 A multi-layered framework for laughter analysis

Laughter is a universal [88,89] and ancient, both phylogenetically [56,23] and ontogenetically [93,76], non-verbal vocalization; one which is pervasive in our

interactions (5.8 (sd=2.5)/10 mins [102]; speed-dating 21(sd=9.28)/5 min [33]; DUEL French 45/10m, DUEL Chinese 26/10m; BNC 5/10m [71]). It is so deep-rooted that it is one of the behaviours for which contagious effects can be observed, fostering bonding and affiliation [44]. Despite mostly associated to funniness, laughter does not occur only in response to humour. Especially studies in Conversation Analysis have shown its crucial role in managing conversations at several levels: dynamics (turn-taking and topic-change), lexical (signalling problems of lexical retrieval, imprecision in the lexical choice), pragmatic (marking irony, disambiguate meaning, managing self-correction) and social (to smooth and soften difficult situations, to show (dis)affiliation and mark group boundaries) [104,40,80,51]. It is not surprising therefore that laughter has been object of scholar investigation since millennia from many different disciplines (for reviews see [55] and [14]). Nevertheless, the taxonomies available and the theories proposed, especially for what concerns the classification of laughter uses, resulted hard to integrate. The reasons for the difficulty can be assigned partly to the fact that the different taxonomies were created from different perspectives and for different aims, partly, as argued in [71], might be related to the fact that often different levels of analysis were considered, and inconsistencies or overlap between those could be identified even within the same framework (e.g. acoustic characteristics, spontaneity, triggers and functions). Therefore, in order to comprehensively integrate insights from previous studies, and effectively characterise laughter use, a framework that would clearly distinguish different levels of analysis has been proposed [71]. Making an analogy with speech, it has been argued that for the study of laughter it is likewise fruitful to differentiate aspects relative to the form, the positioning, the meaning, the effects on dialogue and the resulting social dynamics. A pivotal node to highlight is therefore that laughter has meaning, which can be spelled out in propositional form and multimodally interact with speech and other modalities.

The foundations of this claim come from the analysis of adult dialogic corpus data in different languages (French, Chinese and English) and contexts [71] and on attested examples of: successful standalone laughter uses to perform a dialogue act (e.g. answering a question) (as in 1 – and in 7 later in the manuscript), elicitation of propositional clarification requests or rebuttals (as in 4 and 5), laughter reversal meaning (i.e. ironic use of laughter³) (2), derivation of pragmatic implicatures (1), and displacing of laughter affecting the meaning of the uttered speech (3) (see [71] and [39] for more examples and detailed discussion).

(1) [Buying ingredients for Carbonara Pasta]

A: Do we need sour cream?

B: < laughter/ >

(2) *Example Providence Corpus, Lily 030010* – Ironic use of laughter.

C (Child): Who's this from?

M (Mum): Um... that is from the swim club .

³ This is typically marked by peculiar acoustic features, a characterisation of which is still underexplored.

C: What is it?
M: It says we havta have to pay them. < laughter/ >
C: We have to pay them?
M: Yeah.
C: What .. what do you havta have to pay ?
C: What do you havta pay what do you have to pay mommy ?
M: Well we have to pay so we can go to the swim club this summer.

- (3) *Example from Ginzburg et al. 2020*
(i) Jill is John's, < laughter/ > long-term friend.
(ii) A: She is John's long-term < laughter/ > friend

[71] and [39] propose that laughter has propositional content that arises from the *laughable* (i.e. the entity the laughter is related to – regardless of the presence of a humourous element), exhibiting certain similarity in behaviour with eventive anaphors. This is constituted by a core simple meaning of type $P(l)$ which could be expressed as “The laughable l having property P triggers a positively valenced shift of arousal of value d within A's emotional state e ”. The laughable therefore is a crucial element for laughter meaning interpretation, being a constituent of laughter content, which can be incongruous and/or pleasant. In example 2, an example of ironic use of laughter, is provided where both of these properties are negated: having to pay for being allowed to access the swimming pool is not incongruous, neither pleasant for the economy of a family.

This core meaning then, when aligned with contextual reasoning gets enriched and nuanced as a function of the type of laughable it is related to, the type of incongruity appraised, and the context, being able to generate the wide variety of functions observed in adult conversations. Specifically, [71] distinguish four main classes of laughables depending on the presence (or absence) of incongruity and on its type: *Pleasant incongruity* (cases in which a clash between the laughable and certain background information is perceived as witty, rewarding and/or somehow pleasant, ca. humour), *Social incongruity* (instances involving a clash between social norms and/or comfort and the laughable, e.g. criticism to the interlocutor, asking a favour, apologising for a mistake, etc), *Pragmatic incongruity* (when there is a clash between what is said and what is meant, e.g. irony and scare-quoting) and cases where no incongruity can be identified and the laughable seems to reside solely in a sense of *pleasantness* felt or aimed to be shown to the interlocutor. A structured classification of laughter pragmatic functions has been proposed in [71] in the form of a binary decision tree. It has to be noted that despite the core meaning and phylogenetic origin of laughter are related to pleasantness and affiliation, laughter can also have a negative valence being produced at the expenses of others. The framework proposed in [71] and [39] account also for such uses taking as a starting point the same basic meaning previously stated. The cooperative or non-cooperative goal of the laughter production pertains indeed to another level of analysis. In the case of mocking for example, what in the literature has been often referred to as superiority laughter, would be analysed as laughter related to a laughable appraised as

incongruous and *pleasant* (someone’s misfortune in this case), produced with a hostile attitude towards the target. Due to space constraints, we defer to [39] for a detailed description of the formal representation of laughter meaning proposed, embedded in a framework for dialogue modelling (KoS) [37] (formulated within the framework of Type Theory with Records (TTR) [19]), able to capture the interplay of contextual, as well as cognitive and emotional (i.e. mood) elements, which influence meaning and implicatures derivation.

2.2 Positioning Laughter

The distinction of different levels of analysis pertaining to the analysis of laughter, similarly to speech, and the structured annotation of its argument, proved to be fruitful especially for what concerns insights on how meaning is coordinated and aligned across modalities. Specifically, the data presented in [98] disconfirmed the common sequential adjacency assumption (i.e. laughter always follows what it is related to) (e.g. [102]), showing that laughter can follow, but also overlap or precede its argument. In addition, we observed that laughter does “interrupt” and does overlap with own and others’ speech, invalidating thus the claim that laughter occurs exclusively during pauses and at phrase boundaries (Laughter punctuation effect [82]). The patterns observed resemble therefore those reported for manual gesture in relation to speech [86,2].

2.3 Characterising different laughter functions: gaze and accompanying dialogue acts

Regarding the pragmatic functions performed by laughter, the statistical analysis reported in [70] suggests that they cannot be reliably predicted from a single factor of the analysis, but that they are rather characterised by specific (partly language-dependent) cluster of features. A further analysis, exploring in detail acoustic features, showed that acoustics, taken in isolation, cannot be considered a reliable cue of the laughter function [66, chapt. 6].

In the same attempt to characterise different laughter uses, [69] investigates whether laughs performing different pragmatic functions would be accompanied by different gaze patterns at the interlocutor. A multimodal corpus of dialogical interactions is analysed [92] in order to conduct an event-related analysis centered around laughter onset and offset from both participants. The results show that laughs performing different pragmatic functions are related to different gaze patterns, both for the laugher and her partner, corroborating with studies reporting different gaze patterns depending on the accompanying dialogue act [52]. Data reported in [7] come in support of this conclusion. Becker-Asano and Ishiguro [7], evaluating the role of laughter in perception of social robots, found that when the robot was gazing directly at the participant while laughing, that led to the perception of the robot’s laughter as “laughing at someone” rather than “laughing with someone”. Moreover, it has been observed that gaze is an important cue exploited by interactants when reciprocating laughter, similarly to what

can be observed in speech-turn taking [6,87]. Those data stress therefore the importance of integrating laughter and gaze for modelling of meaning construction and coordination in interaction, especially highlighting how the combined consideration of different modalities can help in the respective interpretation and classification, and even prediction when desirable [69].

From the corpora studies reported, it emerges that laughter is able to perform or accompany a variety of dialogue acts. This led to an investigation on how laughter is distributed across the different dialogue acts, as annotated in the Switchboard Dialogue Act Corpus [63]. The analysis shows how different dialogue acts are characterised by different laughter patterns, both from the participant performing the act and from the partner, and showed that laughs can positively impact the performance of Transformer-based neural networks models (BERT [26]) in a Dialogue Act Recognition task. These results highlight the importance of laughter for meaning construction and disambiguation in interaction [63].

3 Learning to laugh: developmental data and communicative feedback

While on one hand we observe a quite pragmatically sophisticated use of laughter in adulthood, on the other we know that laughter is a rather old behaviour, emerging in babies around the third month of life [76,93]. At this early age, the neuropsychological infrastructure that would be necessary for an adult-like use is not yet available, suggesting therefore that it is a vocalisation the use of which must undergo development. According to [28], laughter emerges as an unconscious vocalisation reflex to a positive inner-state and, through the modelling and influence of the environment [3,60], it becomes an important and varied form of non-verbal communication, one that is crucially social in its nature.

Several scholars have pointed out how laughter can be important from a socio-cognitive perspective in the development of infants [73,85] and how its occurrences could be informative from very early on about the underpinning neuropsychological development [81,72,64], but nevertheless a structured longitudinal characterisation of laughter use in the early years was still lacking. Indeed laughter has been often excluded by fascinating and thorough studies on pre-verbal infant vocalisations, partly because these were mostly focused on speech-like production, partly because of its putative reflexive nature (e.g. [59,50]). Far from being a reflex behaviour (stereotyped and unconditioned by the environment [79]), laughter is actually importantly affected by the contextual and social circumstances, both in production and perception [101,1,22], and can be carefully positioned in our utterances [41]. Furthermore, it is a peculiarly valuable means for a developing young communicative partner at several levels.

Like other vocalisations produced in the first months of life it is a means to get practice with turn-taking [45,95] and engage in the first reciprocal communicative exchanges. What is special about laughter is that it is a vocalization typically involving positive affect which induces the same effect in the partner [77,78], being particularly effective in initiating, engaging and maintaining in-

teractions with caregivers [85], and in setting off the virtuous dynamic circle of meaning construction and social coordination as described in [35,34]. It is moreover one of the first means available to children to attract attention, first to the self and then to external targets [95], but especially to contribute to the conversation, respond, occupy a dialogical turn and conveying meaning with the same level of proficiency of an adult. It is moreover a signal that supports the comprehension of non-literal or not sincere meaning very early on, e.g. humorous intentions [47]. It may therefore be a crucial means in helping to scaffold abilities which form the basis for further complex mentalising processes.

In order to compensate for the lack of structured insights about laughter development, a longitudinal observation of laughter behaviour in four typically developing (North-American English) children in interaction with their mothers from 12 to 36 months of age has been conducted [67,66] (Providence Corpus, [25]) using the multi-layered framework proposed in [71]. Significant changes over time have been observed both in laughter use (in terms of frequency, laughable and function) and in behaviour in response to the partner's laughter both in children and mothers, mirroring the neuro-psychological development of the child on different levels (especially linguistic, pragmatic and attentional) and the mother's attunement to it [67,66].

What follows will be focused specifically on a quantitative and qualitative analysis of some caregiver responses to child laughter observed in our longitudinal study, that might model and influence the construction of laughter meaning in interaction. Notably, it will be highlighted how those patterns/behaviours identified mirror what has been observed and studied in relation to the first speech-like vocalisations and speech utterances produced by children, namely: contingent responses [59,8,50], reformulations [9], and clarification requests [20,58].

3.1 Contingent responses

Multiple studies investigated mother responsivity to speech-like pre-verbal vocalisations in infants and their effect on the successive vocalisations. These studies all highlight the tendency of caregivers to reply contingently to speech-like vocalisations (either in the same modality or in another one – e.g. gesture, body posture, facial expressions) [59,8,50,43] and the beneficial role of these contingent responses on successive language production and learning [97,42,65]. Those works though, being focused strictly on speech acquisition, systematically excluded laughter – viewed as non-speech and deemed as a reflex.

Data from the longitudinal exploration of laughter development from 12 to 36 months of age show though that mothers give important value to its infants' laughter productions especially up until 24 months of age showing similar responses to those observed for speech-like vocalisations [67]. Figure 1 presents the reciprocal contingent responses (within 1 second from laughter offset) to the partner's laughter as observed in the Providence Corpus with 6 months interval. On the left, Fig. 1a illustrates the transition probabilities⁴ of laughter mimicry

⁴ Transition Probabilities are calculated as a proportion of the count of behaviour x to occur from participant A over the total of laughter productions from partner B.

(laughter produced in response to laughter – as in 6), while on the right, Fig. 1b presents the contingent explicit responses occurring also in other modalities (e.g. gaze, smile, exclamations and clarification requests).

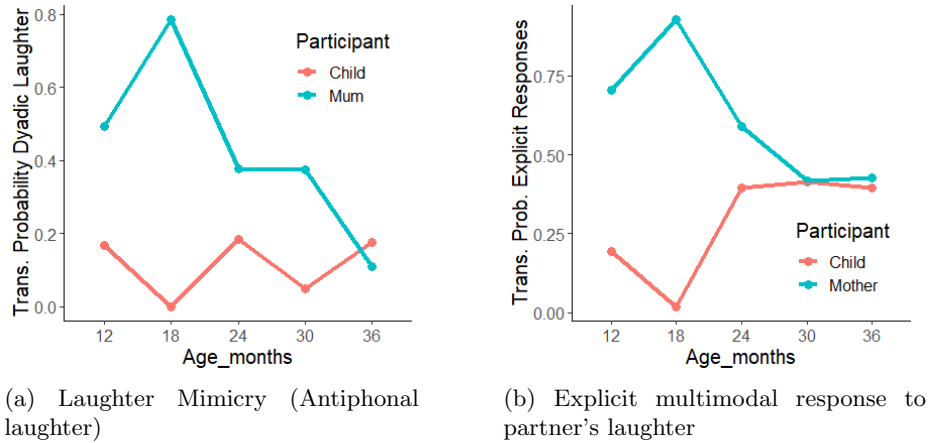


Fig. 1: Responses to each other's laughter: children and mothers. – Transitional Probabilities (TP) (taken from [67]).

We observe high transitional probabilities of mothers being contingently responsive to child laughter (within 1 sec). The urge to respond contingently to child laughter is particularly high at the earliest time points of interest (12 and 18 months), while it decreases over time (24, 30, and 36 months) (Figure 1a). The transitional probabilities of contingent responses to child's laughter is even higher if we consider other multimodal reactions (i.e. exclamation, smile, orienting look, clarification requests) (Figure 1b).

While allowing the earliest equitable exchanges, a systematic contingent response from the caregiver (either aligning with or providing a response in other modalities) teaches the child that his/her contribution is meaningful, communicatively relevant and helps them shape its use [34,21,24]. The decrease observed in contingent alignment from mothers, can be explained by the fact that over time laughter is not anymore one of the few means the child has to engage in interaction, by 24 months indeed the repertoire of communicative abilities is much broader, including speech, and the mother might therefore have a lower urge to reinforce laughter production specifically. In detail, it is worth noting that around 36 months contingent responses constituted by pure laughter mimicry have lower transitional probabilities compared to explicit multimodal responses. This is in line with [59] and [32], who observed that as the child grows older mothers diversify the type of their responses, being therefore more variegated and less consistent, both in the form of response provided and in the timing.

The variation in laughter alignment and contingent multimodal explicit responses over time in mothers might therefore be one of the features of caregivers' adaptation to the communicative development of their children, similarly to the well known characteristics of child directed speech [105,90,57]. The data presented also matches results from other studies suggesting that when interacting with simpler systems, e.g., virtual agents or robots, human behavioural alignment is particularly marked [13,12]. The same seems to apply also to very young children, partly motivated by the will to be at the same level and partly (even unconsciously) aiming to reinforce behaviour, offer explicit feedback, contingent response, and helping scaffolding a functional communication development. The dynamic nature of mothers' responsiveness to laughter (similar to what has been observed in the context of play, exploration, and vocalization) (e.g. [10]), adapting to the neuro-psychological development of the child, supports a dynamic view of interaction [21,34]. Such a view distance itself from a perspective where interaction is only modelled in terms of a sender and a receiver, but where children themselves play an active role in eliciting caregivers behaviour.

The high responsivity of caregivers to laughter and the observation of similar dynamics to those observed in relation to speech, stress the high importance of laughter in early interactions, as well as, once again, highlighting how speech and laughter meaning are similarly treated, constructed and negotiated in interaction, pointing to the fact that they should also be modelled and accounted for their semantic import similarly.

3.2 Reformulation and Clarification Requests

Of particular interest are the cases when the contingent response to child laughter from the mother is a verbal reformulation of the non-verbal laughter vocalization, asking for confirmation or a clarification request (as in 4 and 5). In so doing the mother makes explicit that laughter has a communicative value, propositional content [68], and shows availability to negotiate jointly its meaning and reference.

Similar patterns have been for long studied also for what concerns the earliest speech productions: adult reformulations of child utterances or clarifications requests constitute feedback from caregivers which allows them to correct and/or refine their knowledge [16,15,17,91].

- (4) *Example from Providence Corpus – Lily 010611*
 M: There's miss spider. She's eating a piece of cake!
 C: < laughter/ >
 M: Yeah .
 C: < laughter/ >
 M: < laughter/ > Is that silly ? Whada [: what do] you think the spider should do on her birthday ?
- (5) *Example from Providence Corpus – Naima 02004*
 M: March eighteenth.
 C: [non-word vocalisations]

M: Can you say that?
 C: < laughter/ >
 M: Can you say March eighteenth?
 C: < laughter/ >
 M: < laughter > Is that funny? < /laughter >
 C: < laughter/ >

It is worth noting that all the clarification requests presented assume as default the most basic meaning of laughter, i.e. expressing the appraisal of a *pleasant incongruity* (ca. funniness). This is in fact the most common use of laughter also in adult dialogue [71] and it is, until 24 months of age, the only use observed in children [66]. Nevertheless, in (6) we observe also a propositional reformulation in the form of a confirmation request which addresses rather the pleasantness component of laughter meaning, alluding to the positively valenced appraisal it can be sign of, regardless of the appraisal of an incongruity (“Isn’t that good?”).

- (6) Example from Providence Corpus – William 010605
 (finishing reading a book and closing it)
 M: now everybody was beautiful.
 C: < laughter/ >
 M: < laughter/ > isn’t that good ? here, what’s in here!

In example (7) we then see an instance of laughter produced by Naima (18 months old) as a response to the mother’s clarification request. The mother interprets it clearly as an affirmative answer (instantiating therefore a case in which laughter performs effectively a complete dialogue act in its standalone use) and makes explicit one of the most common implicatures that can be derived when a laughter is produced accompanying an utterance patently incongruous, i.e. the utterance contains a pleasant incongruity and it is intended not seriously (i.e. doing/saying the “wrong” thing on purpose [47] with humorous intentions).

- (7) Example from Providence Corpus – Naima 010604 – Reformulation
 M: Where did you make the coffee?
 C: Tea.
 M: Tea? there was no tea ! did you make the coffee in the bathroom ? no!
 Where did you make the coffee ? where did you make the coffee this morning?
 C: < smiling > upstairs.
 M: upstairs !? that’s a joke , right ?
 C: < laughter/ >
 M: < laughter >yeah< /laughter >, you’re making a joke ! you know that coffee ... there’s no kitchen upstairs !

In example (8) we can nicely observe the process of laughter meaning and reference clarification and negotiation between mother and child, coming to a final agreement. We see the child laughing and the mum responding contingently to the child laughter with a laugh, but her production sounds particularly posed

and aimed only at imitating the child, potentially mocking her. The child then, probably felt misunderstood, rephrases her laughter making explicit its propositional content “It is a funny one!”, which triggers a sequence of clarification requests about the laughter meaning and the laughable, finally coming to an agreement by the end of the extract.

(8) *Example Providence Corpus – Lily 020004 – Meta-linguistic laughable*

M: Hello *Jessica!* Can you say that?

C: < laughter/ >

M: < laughter/ > [laughter from the mother, imitating/mocking the child]

C: This is a funny one!

M: < laughter/ > It’s a funny one? < laughter/ >

C: It’s a funny word!

M: It’s a funny word? “Jessica” is a funny word?

C: Yes! M: Ok!

These pieces of data are interesting from two perspectives: on one hand they support, again, the claim that laughter has propositional content, being object of clarification requests like other content bearing words [68,83]; on the other hand they show that dynamics akin to those observed in relation to speech, in terms of meaning clarification [57,91] and negotiation [11], are at play also for laughter, reinforcing its semantic relevance, and shedding light on how its meaning and use can be shaped and modelled through interaction.

4 Laughter to correct

This section will be focused on two laughter uses: (i) laughter production in relation to *social incongruities* and (ii) laughter production in the appraisal of *pleasant incongruities* related to mistakes. The term *social incongruity* has been used to refer to situations where there is a clash between social norms and/or comfort and the laughable. In these cases laughter can come in handy to smooth the potential discomfort (e.g. embarrassment), function as a face-saving device (e.g. apologising, dispreferred answer), softening a potential face-threatening or intrusive action (e.g. criticising and asking a favour) [84,41,51,66,80].

Despite mother use of laughter in terms of pragmatic functions differs from the distribution observed in adults [66], children are exposed since the first years to a variety of laughter uses. In (9) we have an example of a laugh produced by the mother which is classified as *social incongruity*. The mother is indeed reproaching the child for his disproportionate negative reaction, and the laugh softens her request to stop behaving loudly and being naughty. Her laughter proves to be very successful in helping the child regulate, and (maybe realising he was being funnily distressed) he even joins the mother’s laughter.

In particular, in mother-child interaction it is observed a rather relevant percentages (8%) (equally distributed in the different dyads analysed) of cases where laughter resulted hard to classify being at the limit between laughter related to a *pleasant incongruity* and a *social* one. These are most often cases

where the mother is laughing at her baby making a mistake, a clumsy movement or mispronouncing a word (whether the mother added a successive correction or not). The mother seems to laugh at the incongruous/imprecise behaviours partly because she finds them funny, but at the same time she is also smoothing the situation and reassuring the child that everything is fine and that s/he can go on with her/his activities/strivings, and in some cases she also softens a co-occurring correction. An example is proposed in (10). In these cases therefore laughter can be considered as a negative feedback, or, when the mum explicitly reformulates or corrects the child, as accompanying one.

(9) *Example Providence Corpus – Alex 030103 – Social incongruity*

C: [non-word vocalisations] try this . No this one !

M: alright could I use the pen ?

C: nope [no] . *Nooo!* [screaming]

M: < laughter > stop it < /laughter >.

C:< laughter/ >

(10) *Example Providence Corpus – William 010412 – Mislabelling*

M: what's that ?

C: [non-word vocalisations].

M: nose. Where's your nose ?

C: *eye!*

M: < laughter > that's your nose , this is your eye. < /laughter >

< laughter/ > You're funny.

These cases stress the importance of laughter in managing interaction and softening potential criticalities from a very early age, and its important role in social referencing, reassuring and encouraging the child as s/he learns to cope with the first challenges [94,31], having potentially evolutionary benefits [46].

Laughter in relation to social incongruity is crucial in our interaction and in managing the impression of the interlocutor, in its use indeed it reassures the interlocutor that the situation is not to be taken too seriously and at the same time, in induce a positive disposition in the partner [84,77,78]. In the latter part of the next section it will be proposed how taking in account such uses of laughter might have useful applications for SDS and ECAs.

5 Implication for Spoken Dialogue Systems

The multi- and inter- disciplinary work (sketchily) overviewed stresses with little doubt the necessity to integrate laughter, and other non-verbal social signals [39], in any framework aimed to model meaning in interaction, not only for what concerns aspects related to affecting computing [7,74], but also for aspects related to natural language processing [71]. The studies overviewed have shown indeed how laughter conveys meaning and how it can affect the meaning of speech utterances and the unfolding of the dialogue.

The investigations conducted, offered empirical relevant insights for the implementation (either in perception or production) of SDS at several levels:

- Laughter conveys meaning which needs to be integrated and treated in interaction with speech and other modalities.
- Laughter can co-occur with speech from the laugher herself and from the partner, and can interrupt speech utterances.
- Its positioning in relation to the argument can be rather free, occurring most often after, but also during or before the argument it is related to; mirroring patterns observed in manual gestures [86].
- In order to interpret the laughter functions performed, acoustics in itself is not sufficient, since they seem rather characterised by a language-dependent cluster of features: positioning in relation to speech, in relation to others' laughter, position in relation to the laughable, characteristics of the laughable, and contingent gaze patterns from the laugher and from the partner.
- Taking in account laughter, ideally in synergy with other modalities (e.g. gaze and facial expressions), can help in tasks of Dialogue Act Recognition and discrimination, disambiguating illocutionary forces and social meaning.

It is here embraced a view that sees computational models useful to study human behaviour and language development (e.g. [99]), but also a view that the other direction can also be valuable (e.g. [18]). The patterns observed in development can tell us a lot about the behaviour object of analysis in itself and can help designers of SDS teach their algorithms how to have a better grasp about what is going on in conversation, getting inspired by the most efficient conversation learners ever: babies. The patterns observed in mother-child interaction brought us to propose two possible applications for SDS.

5.1 Communicative feedback learning for laughter meaning adjustments.

Currently there are not SDS able to process or produce efficiently laughs with different pragmatic functions. There have been work aimed at aligning with human laughter behaviour [100,29], as well as work in order to implement laughing avatars mainly focused on laughter as a reaction to jokes [27]. Interpreting laughter meaning or producing it in a pragmatically appropriate way is still an important challenge for SDS, since it requires crucially the identification of the laughable entailing rich multidimensional contextual processing. Maraev et al. [62] present a suggested programme to achieve an efficient integration of laughter into SDS highlighting most importantly three essential components: (i) an incremental interface that would operate word by word to enable the speech and laughter to be appropriately positioned and compose the online meaning of an utterance, (ii) appraisal techniques that would infer emotion reaction from the incrementally processed utterance, (iii) local pragmatics that would enable online pragmatic reasoning needed for evaluating incongruity.

The reflections raised about the importance of caregivers' communication feedback for child laughter use learning, showing patterns akin to those observed in relation to language learning, can lead to the proposal of a line of application related to the implementation of SDS able to take in account communicative

feedback from the user to adjust laughter interpretation and use. In models of automatic language learning it has been shown that the alternation of Cross Situational Learning and Communicative Feedback is the most effective training setting to have better performances in a simulated ideal language learner [75]. We can imagine a similar algorithm to be applied specifically in relation to laughter: where its production get reinforced by contingent mimicry or explicit multimodal responses, its meaning and argument is discussed, clarified and negotiated similarly to what happens with speech utterances. Positive and negative feedback provided by the user in relation to agent’s laughter, might help the system in the negotiation of laughter meaning and in the identification of the laughable. Moreover, we can also imagine such a system to be useful for tuning the SDS to the users’ personal or culture-influenced laughter use preference [40,36,71]. This would necessarily need to be implemented in a framework able to represent laughter meaning, as well as shared and private informational and emotional states, in order to account for grounding and clarification requests, as proposed in [61] within the KoS framework [37].

A similar idea has been implemented in a robot producing jokes, where contingent laughter was considered as a positive reinforcement feedback to accommodate the user’s personal humour taste [103]. The application proposed here would relate to the accommodation of laughter meaning and use, requiring a more complex semantic representation of the dialogic interaction situated in context [61]. It is worth mentioning that the empirical data provided by [98], i.e. laughter alignment in relation to the laughable is rather free, would have been beneficial in the study of [103]. The authors indeed report how the fact that laughter might occur with a rather free misalignment in relation to the punch line (even before the end of the joke or several seconds after its offset) had a negative impact on the reliability of their feedback measure, causing their robot to miss some of the laughter responses from the users given that it was programmed to detect them only shortly after the punchline offset.

5.2 Failure detection and Failure management

In caregiver-child interaction, it has been observed a particular use of laughter from mothers, who often laugh in response to mistakes produced by the child (in terms of phonetics, phonology, semantics, pragmatics, or kinematics) [66]. Similarly also in adult conversation we can observe laughter to be produced in the context of incongruous misunderstanding. Taking into account laughter user’s production might therefore be a valuable piece of information to be integrated in SDS, being a potential indicator to support failure detection: when not expected indeed, laughter from the user might signal that the generated behaviour or utterance has been appraised as incongruous by the user in relation with the contextual interaction. Some exploratory work in this direction is being conducted in the context of chat bot interactions, analysing the occurrence of laughter reaction to the automatically generated messages [30].

Moreover, as observed in numerous corpus studies, laughter is not exclusively related to humour and can be used to smooth potentially unpleasant situations,

where the incongruity resides in the clash between the ideal flow of a conversation or social comfort and the current situation. This can occur for example in cases where the interlocutor is criticising the partner’s proposal or action, is disagreeing, is offering a dispreferred answer, or is feeling embarrassed, or is somewhat intruding the space of the interlocutor asking for a favour or apologising. When a failure is detected, a SDS might therefore exploit laughter in order to manage the failure or the breakdown. This would therefore expand recent investigations on user perceptions of different artificially inserted failures of communication in robots [53]. Analysing the user perception and cooperativeness when laughter is inserted in comparison to when it is not, will offer moreover good experimental data to test the possible co-option psychological explanation advanced in [71,66].

Similar considerations have been put forward by Maraev and colleagues [61] who present in detail how SDS would benefit from the integration of specific laughter uses at different levels, proposing a proof-theoretic architecture of a dialogue manager based on KoS framework [37].

6 Conclusion, limitations and further directions

It is important to acknowledge various limitations of the studies presented especially in terms of sample size and languages and cultures considered, as well as the numerous questions that are still open. Nevertheless, the studies overviewed show with little doubt the importance of taking a multimodal approach in the modelling of dialogue meaning in interaction. Triangulating methodologies and different approaches it has been shown that laughter has propositional content which interacts with speech and other modalities creating meaning incrementally. This helped in understanding laughter behaviour in itself, allowing to construct, on this pivotal assumption, a structured and reliable framework of analysis, which resulted fruitful to capture patterns in adult conversation and to characterise trajectories in development at different level of analysis, but also in integrating laughter import in a formal representation of meaning in dialogue.

In particular in the current manuscript reflections on the responses produced by caregivers to child laughter were presented. The analysis of those, mirroring behaviours observed in responses to speech like production, once more, goes in support of the importance of laughter meaning in dialogue modelling and sheds light on how it is constructed and negotiated in interaction similarly to other content bearing words.

Taken all together, the data acquired constitute useful empirical material for the implementation of SDS and ECAs more competent from a semantic and pragmatic perspective, both for what concerns processing and production. We outlined the most important clear implications that we envisaged, and proposed some possible suggestions for further applications.

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