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► **To cite this version:**

Chiara Mazzocconi, Jonathan Ginzburg. Growing up laughing: Laughables and pragmatic functions between 12 and 36 months. *Journal of Pragmatics*, 2023, 212, pp.117-145. 10.1016/j.pragma.2023.04.015 . hal-04415471

HAL Id: hal-04415471

<https://hal.science/hal-04415471>

Submitted on 25 Jan 2024

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Growing up laughing: Laughables and pragmatic functions between 12 and 36 months.

Chiara Mazzocconi¹ and Jonathan Ginzburg²

¹ Aix-Marseille University, CNRS, Laboratoire Parole et Langage (UMR 7309), Aix-en-Provence, France

¹ Institute of Language Communication and the Brain

² Université de Paris, CNRS, Laboratoire de Linguistique Formelle (UMR 7110), Paris, France

Abstract

Laughter serves a wide variety of functions in adult interaction, some of which are quite sophisticated from a pragmatic perspective. Nevertheless, it is a vocalization that emerges very early in ontogeny. We present a longitudinal semantic and pragmatic study of laughter among four American English mother-child dyads interacting freely at home from 12 to 36 months of age. Our data show differences in child laughter-use compared to mothers and a developmental trajectory in terms of the entities the laughter is related to, of laughter pragmatic functions, and in the amount of shared attention on the object of mothers' laughter. We observe differences in mother laughter-use by comparison to patterns observed in adult-adult interaction. This suggests that laughter production, conveying meaning in a manner akin to speech, gets modulated in child directed interactions similarly to spoken utterances. Our data show that laughter-use can be informative about the neuro-psychological development of babies very early on: mirroring acquisition of physical world knowledge, development of social cognition, linguistic and pragmatic abilities. Our results constitute the basis for hypotheses about the co-option trajectory of laughter in humans and suggest that laughter production in interaction is a valuable resource for early pragmatic development evaluations.

Keywords— laughter; laughables; mother-child interaction; pragmatic development; shared attention.

Corresponding Author Chiara Mazzocconi: chiara.mazzocconi@univ-amu.fr

ORCID: 0000-0002-8267-1590

Aix-Marseille University, CNRS, Laboratoire Parole et Langage (UMR 7309)

Institute Language Communication and the Brain

5 Avenue Pasteur, 13100, Aix-en-Provence, France

Second Author Jonathan Ginzburg: yonatan.ginzburg@u-paris.fr

ORCID: 0000-0001-5737-0991

Université de Paris, CNRS, Laboratoire de Linguistique Formelle (UMR 7110), Paris, France

8, Rue Albert Einstein 75013 Paris

Declaration of interest The authors have no relevant financial or non-financial interests to disclose.

Availability of data and material The videos annotated for the current work are all publicly available on the CHILDES database at <https://phon.talkbank.org/access/Eng-NA/Providence.html>. Raw annotations and data will be released and linked to the current paper in its final version.

Authors' contributions Both authors contributed to the study conception and design. Material preparation and data analysis were performed by Chiara Mazzocconi. The first draft of the manuscript was written by Chiara Mazzocconi. Jonathan Ginzburg contributed to reviewing, commenting and editing on previous versions of the manuscript. Both authors read and approved the final manuscript.

Acknowledgements We owe heartfelt thanks to Véronique Pouillon and Dina Kolliakou Ginzburg for their help with interannotator agreement. This work, carried out within the Labex BLRI (ANR-11-LABX-0036) and the Institut Convergence ILCB (ANR-16-CONV-0002), has benefited from support from the French government, managed by the French National Agency for Research (ANR) and the Excellence Initiative of Aix-Marseille University (A*MIDEX). This work has been also partially supported by another public grant overseen by the French National Research Agency (ANR) as part of the program “Investissements d’Avenir” (reference: ANR-10-LABX-0083) and contributed to the IdEx Université de Paris - ANR-18-IDEX-0001.

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Keywords— laughter; laughables; mother-child interaction; pragmatic development; shared attention.

1 Introduction

Laughter offers a special window into children's neuro-psychological development from very early on, emerging around 3 months of age (Nwokah et al., 1994), long before (manual) gesture, language, or walking, and slowly developing to reach adult competence (Mireault and Reddy, 2016). Rather than being a reflex behaviour, a putative status that often causes it to be excluded from studies on vocalization development (e.g. Leonardi et al., 2016), laughter, in both production and perception, can in fact tell us a lot about the neuro-cognitive development of babies, about their attunement to the social and cultural environment, and about the development of their communicative, linguistic and pragmatic skills (Mireault and Reddy, 2016; Reddy, 2008). Laughter is in fact a valuable tool with which to engage in initial interactions with adults, convey meaning, perform dialogue actions and affect interlocutors behaviour (Scarantino, 2017) from the first months of life (Walker, 2017, 2013) (Author, Year). Through development it starts to be more intertwined with speech and able to affect and shape the meaning of utterances as observed in adults (Glenn and Holt, 2013; Glenn, 2003; Bryant, 2016) (Author, Year). In adults, it is most often produced to show enjoyment of pleasant incongruities (our technical term for humour, as we explain below) and to manifest playfulness, but also to smooth dialogue acts having a potential negative effect on the ideal flow of a conversation¹ (e.g. disagreement, asking a favour, criticism), to mark incongruities between what is said and what is intended (e.g. irony, scare quoting), or to show pleasant appraisals without any incongruity (e.g., accompanying a compliment) whose main function is to show closeness and facilitate bonding (Jefferson et al., 1977; Glenn, 2003; Glenn and Holt, 2013; Dunbar, 2022) (Author, Year).

Studying laughter, in relation to humour or not, can yield important insights into what children are directing their attention to, into what children are learning about the world, about interaction, communication and language, as well as being informative about their interest in and understanding of others individuals minds

¹We use the term 'ideal flow of a conversation' to refer to idealized segments of conversation where participants are cooperative (Grice et al., 1975) and polite (Brown and Levinson, 1987), without ever intruding on their interlocutor's space or performing face-threatening actions neither for the speaker or interlocutor.

(Mireault and Reddy, 2016). Observing the ontogenesis of laughter can also help to shed light on how laughter comes to be co-opted to serve a variety of pragmatically sophisticated functions observable in adult humans interactions (Author, Year). By studying laughter in the early years of life, we can learn a lot about laughter itself, about children, and about adulthood. Until now though, there has been a dearth of work devoted to exploring the development of laughter production and use in interaction, especially for what concerns laughter not related to humour.

In order to fill this gap, we conducted a longitudinal corpus study analysing laughter production in natural mother-child interaction from 12 to 36 months, focusing especially on a detailed analysis of the object of laughter (the *laughable*, (Glenn, 2003)), of the pragmatic functions of the laughter, and of the shared attention on the laughable.

The paper is structured as follows: we start by presenting a literature review that motivates our interest in laughter as a sign of cognitive and communicative development, both in cases involving humour and ones that do not. Our motivation draws on research in laughter semantics and pragmatics, and child development (Section 2). We here present also a very brief synthesis on laughter studies in non-human primates, which we consider importantly informative about the possible core function of laughter, helpful for framing our object of study. We present our longitudinal corpus study stating explicitly our research questions in Section 3, we explain the methodology applied in Section 4, and report and discuss results for each of the features analysed in Section 5 and 6 respectively. We conclude the paper with a general discussion, a summary and a brief proposal concerning future work (Section 7).

2 Background

2.1 How to do things with laughter

In the last decades, there has been a shift away from studying language solely from a speech-centered perspective, and towards a growing recognition of the importance of a multimodal approach in the study of language, since different modalities have been shown to be interrelated, complementary and part of the same integrated system (Perniss, 2018; Vigliocco et al., 2014; Cartmill et al., 2014), (Author, Year). In this line of work, we have not only studies investigating the interaction of manual gesture and speech, but also gaze, facial expressions and more recently laughter. The Theory of Affective Pragmatics (Scarantino, 2017), suggests that emotional expressions are an integral part of the way we use and interpret language in social contexts. Scarantino (2017) presents a detailed discussion of the role that emotional expressions can have in dialogues and especially about what “they can do” in a manner akin to speech. He transposes some constructs from Speech Act Theory (Austin, 1975; Searle, 1979) to the study of emotional expressions, therefore recognising they can have a locutionary, illocutionary, and perlocutionary force. Nonetheless, somewhat surprisingly, he states that they lack propositional content. The work by (Author, Year) focuses more specifically on laughter, in a similar spirit to much of Scarantino’s proposal, both from a formal and empirical perspective. But they also provide a formalisation of laughter meaning which does include a propositional content. They propose that laughter has two possible core meanings, one related to the predication of incongruity and one to the predication of pleasantness. These, when embedded in context, can generate a wide range of functions, from showing appreciation of a pleasant incongruity (roughly humour), to manifesting closeness to the interlocutor, softening criticism, smoothing an embarrassing situation, inducing benevolence when asking a favour, or even as a marker of *less probable understandings*² via devices such as irony, scare-quoting, and hyperbolic language. The work by Scarantino (2017) and (Author, Year) therefore support a conception of emotional expressions (and more specifically for the current paper, laughter) as “means of engaging in a variety of communicative moves such as *expressing* what’s inside, *directing* other people’s behavior, *representing* what the world is like, and *committing* to future courses of action” (Scarantino, 2017, p.1). Several corpus studies have highlighted the interaction of laughter and speech, and how the first can affect the meaning conveyed, and therefore language processing and the interpretation of speakers intentions (Jefferson et al., 1977; Bryant, 2011) (Author, Year). Experimental work on this score is emerging (Bryant, 2016), (Author, Year).

The semantic and pragmatic cross-pollination between speech and laughter is further corroborated by some peculiar dissociations observed in neuro-different populations. In populations where lexical and syntactic

²These have often been called ‘non-literal meanings’, a terminology we will eschew.

language abilities are impaired (e.g., some types of aphasia and dementia), laughter comes to be used frequently to manage interaction (e.g., as a turn-taking cue, as a display of understanding, as an orienting cue, and as instruction to hear), to convey meaning and disclose intentions and opinions, more so than in healthy controls (Madden et al., 2002; Lindholm, 2008; Pressman et al., 2017). On the other hand, in clinical conditions where pragmatic abilities are somewhat impaired (e.g. autism and schizophrenia), the production of laughter in itself is preserved, but atypicalities (and difficulties) emerge both in adequate and comprehensible production and in perception (Samson, 2013; Reddy et al., 2002; Jones, 2009; Polimeni and Reiss, 2006).

2.2 How (to learn how) to do things with laughter

Despite the pragmatic complexity associated with adult laughter use, laughter emerges very early in development (around 3 months of age (Nwokah et al., 1994; Sroufe and Wunsch, 1972)), when such a level of pragmatic complexity cannot have been attained and when speech has not yet emerged.

Corpus studies have shown that laughter can be used even by pre-verbal infants in a very structured way, as a tool to occupy conversational turns, practice turn-taking (Stevenson et al., 1986; Hilbrink et al., 2015) and to perform multiple dialogue acts. Walker (2013) and Walker (2017) show how laughter can be used by children to invite for affiliation from the caregiver after having being reproached for a mischievous action, or can be used to constitute a full-fledged answer to a question (as observed in adults, e.g. Author, Year) already during the second year of life (between 16 and 23 months). Moreover, some work highlighted also the importance of laughter for caregivers, who consider it as a response to their actions and questions and as reassurance that their actions have been perceived and appreciated (Stearns, 1972). This is a crucial means therefore for setting off the synergic interactional dynamic of dialogue (Fusaroli et al., 2014) in the child-caregiver dyad (Author, Year). Laughter can thus be informative about some aspects of the “mastery of communication”, before any “mastery of speech” emerges (Forrester et al., 2006), constituting important basis also for the latter.

Even when considering simply laughter in relation to humour, what laughter can tell us about the neuropsychological and pragmatic development of babies is deeper than it might appear at a first glance. The relation between laughter and humour is indeed far from being of a reflexive-like nature. Laughter does not occur exclusively in relation to humour and humour does not always imply laughter (Gironzetti, 2017). Nevertheless laughter is certainly one common non-verbal cue used to frame some interaction, event or contribution as humorous (Gironzetti, 2022; Coates, 2007). From a semantic and cognitive perspective it remains a complex task to formalise what makes something humorous, and interesting debates are still open in the humour studies community (Ritchie, 2018)³; on the other hand, from a pragmatic perspective it is generally agreed upon that appreciating funniness relies deeply on shared knowledge, conventions, and cultural norms, and that often when abstracting a humorous stimulus from its context it loses any humorous connotation (Cunningham, 2005). Humour then can occur in many forms, from physical to verbal. In adults it is often channelled in speech utterances, requiring a combination of lexical, rule-based and pragmatic competences for their understanding. When considering laughter unrelated to humour, such as laughter used to smooth embarrassing situations, criticisms or asking a favour, a very deep awareness of cultural norms and others’ affective states seem to be essential in order to realise that some speech utterances might come across as too intruding or aggressive to the interlocutor and might benefit from being accompanied by an expression able to affect their meaning and disambiguate intentions. Furthermore, when laughter is used in order to cue for less probable interpretations of utterances (e.g. when accompanying irony, hyperbole, scare quoting), even more sophisticated linguistic and pragmatic abilities need to be mobilised. In order to learn how to do things with laughter in interaction (and in synergy with speech) cognitive, but also social and pragmatic skills are required. In the following sections we will elaborate and explain in detail how this comes about.

2.2.1 Laughter as a sign of cognitive mastery.

The topic of laughter development was long neglected until the appearance of Developmental Psychology in the 20th century (with the sole exception being, to our knowledge, Darwin (1877)), and often (not surprisingly)

³In the current work, while embracing the importance of incongruity as a characterizing notion associated with laughter, we will take an agnostic stance with respect to theories about humour/funniness (but see Canal et al., (2019) for a proposal about the sequential cognitive processing of humour). We focus mainly on laughter itself and on describing its (semantico-pragmatic) constituents in detail.

intertwined with humour. Interestingly, in humour development studies, contrary to what happens in adult humour studies, incongruity appears to have an undisputed role. Piaget (1945) proposes one of the first theories that aims to explain laughter in relation to humour in children, considering smiling and laughter as signs of cognitive mastery⁴. In Piagetian theory (Piaget, 1945), when a child perceives information that does not fit with her/his existing schema about a particular object or event, s/he experiences incongruity. To make sense of this incongruous information, the child normally either reinterprets the perceived information to make it fit with the existing schema (*assimilation*), or modifies the schema so that it can incorporate the new information (*accommodation*). In this way the incongruity is eliminated and the child's cognitive capabilities are expanded. A baby in a phase of assimilation would laugh (and smile) at her newfound skill, and typically would appreciate funniness in things that are just at the *zone of proximal development* (Vygotsky, 1980): i.e. not too difficult based on the current acquired knowledge about the world but also not too easy, requiring an optimal amount of effort to grasp (McGhee, 1979). The Piagetian hypothesis that laughter in relation to humour appreciation might be a sign of cognitive achievement has been experimentally supported in work conducted by Shultz and Zigler (1970), McCall (1972) and Zelazo (1971, 1972).

Fascinating in this respect are the studies on peek-a-boo. Shultz (1976) showed that 6 month to 12 month-old infants particularly enjoyed the game when they were in the process of mastering "object permanence", i.e. the recognition that objects continue to exist even when they are not visible to the child. In the same experiment he also showed the importance of the social factor in the elicitation of laughter and the degree of familiarity with the interactant: children would not appreciate the game if instead of a person it was a toy that disappeared and reappeared (Shultz, 1976), and would enjoy it far more if the person who disappeared and reappeared was familiar (especially the mother) (MacDonald and Silverman, 1978). A study conducted on infants between 2 and 8 months old (Parrott and Gleitman, 1989) shows that the ability to predict what is going to happen has an important effect on the level of the peek-a-boo enjoyment experienced by children. The experimental paradigm involved the exposure to a traditional peek-a-boo sequence in contrast to two other conditions in which either the disappearing and reappearing subject was changed or reappeared in another location. At all ages children would smile and laugh³ more in the condition where the outcome could be correctly predicted and the appreciation of the "switched condition" even decreased with age. This data support again the hypothesis that surprise/incongruity has to be balanced with ability to predict, and incongruity must be supported by knowledge in a fun environment. Such a factor seems to remain crucial also later in development. Zigler et al. (1966) observed the reaction of children from the second to the fifth grade (approximately 7.5-10.5 years old) to a set of cartoons. They observed an increase in the comprehension of cartoons until fifth grade (as expected), but they observed an increase in appreciation only from first until fourth grade, and then a decrease in fifth grade. In order to explain their data they hypothesise a "cognitive congruency" theory, suggesting the existence of an inverted-U shaped relation between cognitive difficulty and enjoyment of humour, where laughter at too-simple stimulation abates over time. Similar results were also obtained by McGhee (1977).

Sroufe and Wunsch (1972) tested children aged less than 12 months old, exposing them to a series of potentially humorous stimuli. They observed an increase of laughter in older children and a significant change in the stimuli more likely to elicit it over time: auditory and tactile stimuli around 3-4 months of age, visual stimuli around 5 months, and social games, social inappropriateness and incongruous acts around 7-9 months of age (Sroufe and Wunsch, 1972; Wolff, 1987). The stimuli used in those studies, however, contained significant confounding factors since none of the stimuli proposed could indeed be considered exclusively visual, physical, auditory or social (e.g. lip popping was considered as an auditory stimulus while it necessarily also has a visual component), and crucially all of them involved social interaction by default, being presented by the caregiver. Notably (McGhee, 1977) proposed a model of humour development based on Piaget (1950)'s developmental stages: Sensorimotor Stage: (1) 18-20 months, Incongruous actions towards objects (closely related to the ability to recognise symbols and to pretend, paralleling the emergence of pretend play); (2) 20-24 months, Incongruous labeling of objects and events; Preoperational Stage: (3) 3-7 years, Conceptual incongruity; Concrete operational Stage: (4) 7-11 years, Multiple meanings and playing with words.

The right level of complexity in the stimuli seems to be an important element for more than one researcher, despite the differences between theories. It is exactly this factor that makes humour appreciation such a valuable

⁴In several works smiling and laughter are considered on a scalar continuum. Specification of the relation between smiling and laughter is out of the scope of the current paper. But see for example Van Hooff (1972), Lockard et al. (1977), Mehu and Dunbar (2008), Wood et al. (2022) for discussions. In the current study, we focus exclusively on laughter.

tool to track cognitive and world knowledge development in children. In order for humour to be sustained, the interlocutor needs first to recognise it, understand it, and appreciate it (Hay, 2001)⁵. The ability to appraise and eventually enjoy a specific type of incongruity entails the understanding and learning of a typical pattern—without it there is no incongruity. Despite research pointing towards the highly informativity of laughter production in relation to pleasant incongruity there is surprisingly little work looking at its development longitudinally, especially in interaction.

2.2.2 Laughter as a sign of social mastery, cultural attunement and pragmatic development

Laughter as contextual and intentional cue More recent studies on the topic have been conducted by, among others, Mireault and Reddy (2016) who stress, beside the “purely” cognitive aspects⁶, the crucial role of the social environment. The criticality of the social sphere in laughter production, emphasising once again the incorrect view of laughter as a reflex, is the strong social facilitation effect observed already in pre-school children (Addyman et al., 2018). Reddy (2008), especially, stresses the fact that to laugh at socially inappropriate or incongruous acts (e.g. putting a shoe on one’s head), the infant needs to know the common conventions of her social and cultural environment, learnt thanks to interest in others’ actions, emotions and mental states. This interest in turn supports the development of a mind-reading ability needed to infer the playful intention of others and to find unusual behaviours amusing instead of frightening or uninteresting (Semrud-Clikeman and Glass, 2010; Mireault et al., 2012). The evolution of humour appreciation is grounded in social referencing i.e., a tendency by children to gather information from other individuals as a means of regulating their own behaviour in ambiguous situations (Klennert et al., 1983, see Fawcett and Liszkowski (2015) for a review). This is indeed crucial in orienting babies in how to react to the appreciation of an incongruity which, depending on the cognitive level and the social context, can be appraised as scary, as a simple mistake, or as amusing (Mireault et al., 2014). A fascinating series of studies by Hoicka and her colleagues (Hoicka and Gattis, 2008; Hoicka and Wang, 2011; Hoicka, 2016) shows how toddlers are able to use contextual non-verbal cues (notably laughter) to guide their appraisal of ambiguous events and discriminate between mistakes and jokes from the second year of life (18-24 months). These studies support the idea that humour might be one of the first forms of pragmatically rich meaning young children are exposed to, as well as the most accessible (Hoicka et al., 2017). Therefore, as proposed by Reddy (1991, 2001), the understanding of humorous intentions could be the first step in understanding that someone might want to do the wrong thing, the basis for bootstrapping the successive abilities to understand pretence (Rakoczy et al., 2004), deception (Sullivan et al., 1995), and other forms of pragmatically rich meaning (such as metaphors (Pouscoulous, 2014) and irony (Filippova, 2014)).

Even for older children contextual cues are crucial in directing their appraisal of new objects/events. McGhee (1979) reflects on the fact that (anecdotally) up to an unspecified threshold, the more the incongruities the funnier the event. After that the object/event might be so distorted that rather than being appreciated as an incongruous familiar object/event, it is just appreciated as a totally new unknown object/event. Whether the child would opt for a fantasy- or a reality- assimilation can depend crucially on the contextual cues (i.e., playful or serious) (McGhee, 1979). From here it emerges clearly how humour appreciation is highly influenced by culture, since different behaviours (physical or verbal) would be considered as violations depending on shared conventions or moral rules. While some work is available regarding cultural differences in laughter and humour production and perception (see (Bryant and Bainbridge, 2022) for a review), work tackling their development cross-culturally, is, to our knowledge, still missing.

⁵According to (Hay, 2001) the relationship between these stages is scalar. Bell (2015) though calls for caution since interlocutors can at times show appreciation of an attempt at humour without having fully understood it. In the view we assume of laughter, this follows from the assumption that laughter expresses either incongruity or enjoyment of an event. Nonetheless, in the current empirical study we cannot assess the understanding underpinning the enjoyment or its authenticity. We will restrict our analysis to a consideration of the *expression* of enjoyment.

⁶We do not embrace a view that sees cognition, social competence and emotion as distinct systems. In the current paper we use the formulation “pure cognition” to refer to the acquisition of world knowledge that has little to do with the social environment (even though clearly often learnt through social interaction): e.g. naive physics (understanding of mechanical or material phenomena, such as objects colliding, falling, or having mass), naive biology (understanding of everyday physiological states and processes, such as illness, birth, growth, and death) (Wellman and Gelman, 1992).

Laughter to elicit reactions and manage interactions In the child development literature, it is common to refer to the first attempts of children to elicit laughter from other people as 'clowning' (Reddy, 2001). These behaviours are first observed between the eighth and eleventh month of age (Reddy, 2001). During the first year of life the episodes of clowning are constituted by repetition of actions that elicited laughs in adults, even without truly grasping the reason for the funniness; at this stage therefore these actions derive their clowning meaning from the adults' reaction. With time though the child will become more and more creative and will actively violate motor schemas, conventions and meaning to elicit laughter, until the age of 24 months when half of the acts intended to elicit laughter will be novel, with almost all being novel by the third year (Hoicka and Akhtar, 2012). Parents report that infants cue their jokes with laughter or smiling, while looking for a reaction, from the first year (Hoicka and Akhtar, 2012). Such reports are corroborated by observational studies (Hoicka and Akhtar, 2012; Bainum et al., 1984; Hoicka and Akhtar, 2011) showing that 2- and 3- year-olds produce significantly more laughs when producing incongruous or clowning actions and utterances rather than when producing conventional ones. As anticipated, engaging in clowning signals an early awareness and interest in the emotional states of others, as well as showing awareness of conventions, social rules and expectations. All the more fascinating is then the emergence of teasing, when clowning actually becomes a sort of provocation and occasion to test boundaries (Reddy and Mireault, 2015; Walker, 2013). Even more-so than in clowning, in teasing the child shows understanding of the emotional attitudes of others, their expectations, and their intentions, together with an early social understanding of conventions, rules and agreements. When teasing, the child engages in play with her meta-representations of others' mental states. A laugh produced in a context where the partner is in a contrary affective attitude (either real or fake for the sake of the game) can be paraphrased as "I love when you look shocked as long as you are not really angry" (Reddy et al., 2002, p.230). Walker (2013) interprets laughter produced after a transgression as a way to invite a display of affiliation from the mother (e.g., an invitation to reciprocate the laughter) which can be accepted or declined.

Cameron et al. (2008) conducted a microanalytic study observing one girl of 30 months during a full day. They observed how humour served both socio-emotional and cognitive-linguistic functions: i.e., making affective connections (to create connection and effort in affecting others by her actions), negotiating social situations to hedge against disapproval (accompanied by "that was a joke!"), testing the environment, and learning meanings of concepts and words. In particular, Cameron et al. (2006) stress how the first episodes of humour are interpersonally co-constructed and how humour production (together with the relative cues) can be considered as a sign of growth of internal representations and advances in interpersonal synchrony and resilience, as well as signaling the assimilation of social discourse rule and engagement with the cultural environment. We stress yet again how humour and laughter, in the context of clowning and teasing, can be highly informative about cognitive, emotional, social and pragmatic development (Reddy et al., 2022).

Laughter and shared attention Laughter is one of the first means to attract attention to the self (as a gestural attractor (Tomasello et al., 1989, 1994)), and successively towards external targets (Stevenson et al., 1986; Reddy, 2003). Making an analogy with gesture, we can therefore speculate that the first laughter (dyadic) use is a precursor to and the basis of acquiring the second use: when the child begins to use it triadically, in contexts involving self, other and a third entity. Laughter can thus be one of the first ways (emerging around 3-4 months (Nwokah et al., 1994)) in which babies experience and learn about the possibility of influencing others' mental states, enabling and facilitating the first episodes of shared attention (Reddy, 2008). These are commonly considered (Camaioni, 1992) fundamentals for the later ability to share intentions, and are essential precursors for the development of mind-reading and social abilities. Experiencing the effect that their laughter has on the interlocutors enables the child to learn that also others' laughter always relates to something in the context, and like pointing, it can be used as an attention getting device, inviting the partner to share attention. Many researchers have argued that the ability to establish shared attention implies early awareness of others' mental states (Tomasello et al., 1995; Baron-Cohen, 1997; Charman et al., 2000; Camaioni, 1992) and positively correlates with later language abilities (Carpenter et al., 1998a; Mundy and Gomes, 1998; Tomasello and Farrar, 1986).

Since laughter is a rewarding vocalization both in production and perception (Owren and Bachorowski, 2003; Sander and Scheich, 2001), children might be even more motivated than for pointing to look for the object of the partner's laughter in the context and share attention (and eventually appreciation) on it. The use of laughter and the response to others' laughter can be therefore an early way to see what children are learning about the mental states of others (Author, Year), being informative about, and providing support for attaining successive

steps in their pragmatic development. First, learning that an interlocutor's attentional and emotional states can be influenced and that one's interlocutor might want to influence their own mental states; second, learning to follow their interlocutor's attentional states as they identify the object of their attention/laughter. In the earliest stages, that might "simply" imply the grasping of a causal relation between their action and the interlocutor's laughter. Later, the ability to share attention on the object of their interlocutor's laughter comes also to imply more complex reasoning needed to grasp the object the laughter is related to (see also preceding section 2.2.1).

The studies reviewed above suggest that laughter related to early humour episodes constitutes one of the first steps towards understanding the intentions, emotions, and informational states of one's interlocutors. Laughter plays an important role in helping children discriminate between intentions. It might be considered one of the first means that a baby has to access information about mental states that are usually left implicit in interactions (Westra and Carruthers, 2017). Moreover, laughter, when produced as a response to humorous stimuli, provides a signal that those stimuli have been grasped, and when produced for other social reasons (e.g., smoothing a moment of embarrassment, accompanying a criticism or an apology etc) indicates that the potential cause of the problem has been recognized. This implies awareness of one's own and others' mental states, it presupposes assimilation of common conventions and rules for an ideal flow of interaction¹, as well as the intention to not effect harm and protect one's self-image. Laughter, despite being often a spontaneous non-verbal signal, requires developed pragmatic skills together with an empathic and emotional attunement to other people in its conversational "use" and "understanding", whether produced in relation to humour or not. Not only is laughter a special tool for children to start *playing* with and *studying* others' mental states from very early on, but furthermore, in its interactional use, it can be informative about the mastering of successive social-pragmatic milestones. Finally, laughter production can give us specific insights about linguistic and pragmatic skills.

2.2.3 Tickling

It is worth taking some space to discuss tickling, which is probably the first situation that comes to mind when thinking about laughter in babies. Despite seeming to be the result of an exclusively physically-based reflex-like pattern, probably the heritage of an evolutionary adaptation to escape predators (Provine, 2004), there are indications suggesting a more complex picture. Tickling involves stimulation of body parts which are typically sensitive and vulnerable, but the laughter, often also displayed by the tickler, is a sign of recognition of what can be considered a mock attack, classifiable as an instance of humour (Martin, 2010). Darwin (1872) and Hecker (1873) proposed a close parallelism and equivalence between tickling and humour, relying on a common underlying mechanism (the Darwin-Hecker Hypothesis)⁷. Panksepp (2000) and Wattendorf et al. (2012) proposed that laughter in response to tickling and to humour might share the same neurological activation. This hypothesis found support also in a study by Harris and Christenfeld (1997) showing a positive correlation between the amount of laughs produced by their participants in response to tickling and in response to humorous stimuli. Harris and Alvarado (2005) applied the Facial Action Coding System (FACS) (Ekman, 1997) to annotate facial expressions during laughter in response to tickling and in response to humorous stimuli and argued against the Darwin-Hecker hypothesis. They found that during tickling additional Action Units related to expressions of pain and distress were activated. From our point of view, this is not a strong argument against the Darwin-Hecker hypothesis: enjoying tickling as a kind of mock attack occurring in a playful context does not eliminate the fact that the "attack component" is present, and that being touched in vulnerable parts triggers discomfort and distress⁸. Indeed, we believe that it is specifically in the incongruity between the attack (of course discomforting) and the playful intentions (pleasant) that the possibility of considering tickling as a humorous event resides.

Tickling is one of the first stimuli that can elicit laughter in infants emerging around 6-7 months of age (Leuba, 1941). Leuba (1941) observed that children particularly loved intermittent tickling, typically asking for more by pulling the adult's hands back if the adult interrupted the stimulation, but pushing the hands away if the tickling was too prolonged. This is consistent with the idea that in order to be appreciated, humour needs a perfect

⁷"The imagination is sometimes said to be tickled by a ludicrous idea; and this so-called tickling of the mind is curiously analogous with that of the body. [...] Yet laughter from a ludicrous idea, though involuntary, cannot be called a strictly reflex action. In this case, and in that of laughter from being tickled, the mind must be in a pleasurable condition; a young child, if tickled by a strange man, would scream from fear. The touch must be light, and an idea or event, to be ludicrous, must not be of grave import. (Darwin, 1872 p.199)"

⁸See Minsky (2007) and Oatley and Duncan (1994) regarding mixed emotions.

calibration of arousal (Rothbart, 1973), being incongruous and discomforting, but not too much (Sroufe and Wunsch, 1972). In addition, the tickling stimulation elicits laughter only if the subjects involved are bonded by a close relationship (Harris, 1999), similar to the pattern observed in peak-a-boo studies (Section 2.2.1). In the case where it is a stranger who tickles vulnerable body parts, the tickle can be an actual threat. Indeed, tickling requires a non-self “other”: self-tickling has been shown to be much less effective than externally produced stimulation (Harris and Christenfeld, 1999; Bays et al., 2006; Claxton, 1975; Weiskrantz et al., 1971). Interestingly, Lemaitre et al. (2016) observed that self-applied tactile stimulations are felt to be more ticklish by healthy individuals high in schizotypal traits, signalling a possible attenuation of the sensory consequences of self-generated movements by a predictive sensorimotor process (Blakemore et al., 2000; Shergill et al., 2005).

The relation between tickling and laughter seems therefore to be determined by cognitive, social and psychological factors, the study of this relationship, far from being an innate reflex-like behaviour, can therefore give us insight into deeper neuro-psychological processes, both in child development and in adults.

2.3 Laughter in evolution

For a long time it was thought that humans were the only laughing animals (Stearns, 1972); a conviction stemming from Aristotle (Lennox et al., 2002). Nowadays there is though plenty of evidence that homologous behaviours can be observed in other mammals, especially in our closest cousins, the non-human primates (Winkler and Bryant, 2021). We believe that non-human ape laughter is important for research on human laughter, since it can help us reconstruct what laughter emerged for in our common ancestor, dating around 10 to 16 million years ago (Davila-Ross et al., 2009). An understanding of its use in non-human apes can help us frame laughter study in the best way: similarities in use between humans and great apes might be informative about the core function of laughter emergence, and might help in developing a framework able to account for all of its occurrences, from tickling to the most complex pragmatic uses. This is a challenge that many previous accounts of laughter have failed (see though (Palagi et al., 2022)). We will therefore briefly review what we share and what we do not share with non-human apes regarding laughter.

The first to draw a parallel between human laughter and the energetic panting and exhalations observed during play in chimpanzees was Darwin (1872). The same behaviour was also subsequently observed in other apes (Van Hooff and Preuschoft, 2003; Davila-Ross et al., 2009). In order to test the hypothesis that the expression of laughter has evolved from non-human displays, Davila-Ross et al. (2010, 2009) conducted a fascinating study comparing the acoustic features of tickle-induced laughter in orangutangs, gorillas, chimpanzees, bonobos and humans. The acoustic similarities and differences observed were then used to generate a phylogenetic tree. This tree reflects the well-established genetic relationships of great apes and humans. This study supports therefore the claim of a phylogenetic continuity in expressions of positive valence between apes and humans, and validates the use of the term ‘laughter’ to refer to the vocalisation observed in the five species.

Van Hooff (1972) and Van Hooff and Preuschoft (2003) propose that laughter has its most ancient homologous behaviour in the ‘play face’ displayed in primates and monkeys: a facial expression characterised by wide opening of the mouth, typically without retraction of the lips which still cover the teeth. Laughter and play face occur in the context of play, especially rough-and-tumble (a kind of wrestling), chasing and tickling, and seem to be important signals for displaying affiliation and for action coordination (Van Hooff and Preuschoft, 2003; Bard, 2007; Byrne, 2003; Hatfield et al., 1994). Play face/Laughter in this contexts seem also to be needed to signal that the attack is a mock attack, that the chase is a mock chase, etc. and that the activity is pleasant. This data seems to oppose a view of laughter as a behaviour that evolved in the context of aggression as a means to show dominance (Gruner, 1997). On the contrary, it supports positions that view laughter as crucially linked to the joy of play, incongruity, friendly interactions and bonding (Darwin, 1872; Panksepp, 2004; Dunbar, 2012; Scott et al., 2014). This notwithstanding the fact that, at least in interactions involving older children (Cekaite and Andr n, 2019) and adults (Szameitat et al., 2022), laughter can come to be negatively valenced (as in the case of mockery) (Author, Year).

While the fact that laughter is shared with non-human primates is now generally accepted, the debate on whether the 50Hz chirping observed in rats when tickled can also be considered homologous (Panksepp and Burgdorf, 2000, 2003) is still open (Gervais and Wilson, 2005). However, there is support (Schwartz et al., 2010) for the hypothesis that it could: devocalised rats (therefore unable to produce the 50Hz chirping), despite being liked by other rats, are more likely to be bitten during play interaction. This suggests that their play behaviour

when not accompanied by laughter is more ambiguous, and more likely to be perceived as aggression and therefore trigger serious attack reactions.

3 Current study

The literature presented hitherto indicates clearly that a child’s use of laughter undergoes development in parallel with their cognitive, communicative and linguistic skills and that it might be crucial in helping to scaffold abilities which form the basis for other complex pragmatic processes and *less probable understandings* via devices such as irony, scare-quoting, and hyperbolic language. What is missing is a longitudinal detailed investigation looking not only at the occurrence of laughter and its formal features (e.g. Author (Year)), but also at its production from a semantic and pragmatic perspective.

The nature of the current study is in the first instance exploratory, aiming to observe laughter production in mother-child interaction from 12 to 36 months of age and how its use neurotypically develops from a semantic and pragmatic perspective. We focus exclusively on the analysis of the object towards which the laughter is related—the *laughable*—, on the laughter’s effect on the dialogue, and on the shared attention on interlocutors’ laughables. Methodologically, we choose to abstract away from an evaluation of the spontaneity of the laughter and of the intentionality concerning the production of laughables (when one’s action constitutes a laughable for the partner) (but see [Del Ré et al. \(2013\)](#)). Our analysis is conducted on video-recordings of mother-child interaction in familiar contexts, applying a semantically and pragmatically grounded framework for the annotation of laughter and laughables elaborated for adult interaction, as proposed by Author (Year). The current corpus study serves also to test the adequacy of the framework for different developmental stages and its generalizability to different interactional contexts. The same analysis is carried out both for children and care-givers.

More specifically, our research questions are:

1. How does laughter constitute a marker of cognitive and communicative development during the second and third year of life?
 - What are the laughables of a child’s laughter? How do they change over time?
 - Is laughter produced to serve different functions as the child grows older?
 - How does the child’s interest in an object of others’ laughter, and the ability to identify and appreciate it, change over time?
2. Is there something special about laughter use in mother-child interaction?
 - What are the laughables of a mother’s laughter when interacting with her child? What are the pragmatic functions such laughter is performing?
 - How do the objects and pragmatic functions of mothers’ laughter differ in comparison to those observed in adult-adult interaction?

4 Method

4.1 The corpus

Laughter is a non-verbal vocalisation which affects our facial expressions, our body movements and posture ([Griffin et al. 2013](#); [Cosentino et al. 2016](#)). It is very important to adopt a multimodal approach both to laughter identification (laughter can be silent) and to its interpretation: in order to identify laughables, infer intentions, observe gaze direction and attentional states, and take into account other non-verbal social signals. For that reason, and moreover because the study would investigate children for whom language is just emerging, where a good proportion of the communication and interaction is necessarily non-verbally mediated, we decided to use a longitudinal corpus for which video data was available allowing for a holistic annotation: the Providence corpus ([Demuth et al. 2006](#)). The Providence Corpus was compiled during 2002-2005, collecting data from participants

in southern New England. It contains longitudinal audio/video recordings of 6 monolingual English-speaking mothers and their children from approximately 1 year to 3 years of age during spontaneous interactions at home: 3 boys (Alex, Ethan, William) and 3 girls (Lily, Naima, Violet). Each child was recorded for approximately 1 hour every 2 weeks. Recording began around the age of one year or once the parent reported that the child was producing approximately four words. Digital audio/video recordings took place in each child's home⁹

4.2 Our data

Our corpus study focuses on a subset of the Providence Corpus (Demuth et al., 2006), looking at laughter behaviour development in 4 children: Alex, Lily, Naima and William. We analyse 30 minutes of spontaneous interaction with the mother at intervals of 6 months from the age of 12¹⁰ to 36 months, for a total of 5 time points per child (see Table 6 in Appendix A for more precise information), and ultimately annotating 313 laughs. We excluded Ethan from our study partly because no videos were available, and partly because he was later diagnosed with Asperger's syndrome; Violet was excluded arbitrarily, without having looked at her data, simply because we were aiming at a gender balanced corpus (two female subjects and two male subjects). In order to avoid selective bias, the 30 minutes of annotation for each video started from the very beginning of the recording session. Parts of the videos with no interaction (e.g. child and mother in different rooms) or where both mother and child were not visible for too long were excluded from further analysis¹¹

NOTE: When reporting extracts of conversations, for laughter transcriptions we will use the annotation guidelines used in the DUEL corpus (Hough et al., 2016): < 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 >"). We underline the laughter we are discussing, and use italics for the entity the laughter relates to. Acknowledging that in written form the examples reported will lack all of the richness brought by prosody and multimodal cues, crucial for the pragmatic interpretation of the dialogue, 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. The full list of available video-clips is reported in Appendix D

4.3 Our annotation

All of our annotations have been conducted using the software ELAN (Brugman and Russel, 2004). This was viable thanks to the availability of the videos and of the corresponding CHAT files with transcriptions. Coding was conducted by the first author watching and listening to a video until a laugh occurred. The coder then stopped the videotape, went back in the recording in order to mark the onset and offset of the laugh, and coded the form, the temporal sequence in relation to speech and others' laughs, the context of laughter occurrence, the laughable it was related to, the partner's response, and the pragmatic function following the annotation proposed in Author (Year). Inter-annotator agreement has been calculated with 2 other coders (see Section 5.1). The framework embraced for the analysis of laughter (Author, Year) is based on the assumption that laughter has propositional content and distinguishes different levels for the analysis of laughter, similarly to speech: the form, the positioning (syntax), the semantics, and the pragmatic function (see Table 1). In the current work we will focus exclusively on the features of the entities the laughter is related to (i.e. the *laughables*, defined below), the presence of shared attention on it, and the laughter pragmatic function performed.

4.3.1 Laughable Annotation

Following (Author, Year; Author, Year) we assume that the content of a laugh is an event predicate, which has two arguments: the laughable and the arousal (the latter will not be analysed in the current paper, and is the focus

⁹All the interactions are orthographically transcribed using CHAT conventions (cf. MacWhinney (2000)). All speech transcriptions, as well as audio/video files, can be found on the CHILDES database (<https://phonbank.talkbank.org/access/Eng-NA/Providence.html>).

¹⁰Choosing to work on the Providence Corpus entails that we miss the earliest laughter episodes which occur between the 3rd-4th month of life (Nwokah et al., 1994). Our investigation starts therefore from 12 months due to data availability and we defer to further work detailed investigation of laughter behaviour during the first year of life.

¹¹For these two reasons we were forced on two occasions (Lily and Naima at time point 5: 36 months) to integrate the analysis of the originally selected video with the temporally closest other video available, and sum the duration of minutes and laughs analysed (see Table 6). We selected the videos closest to our age of interest, but an important exception was made for Alex: the first video, which we analyse as related to the first time point (12 months), was actually recorded at 16 months of age (the time when his parents reported he had a vocabulary of about 4 words).

Table 1: Features analysed

Laughable	
Predication	Incongruity: Pleasant, Social, Pragmatic Verbal No Incongruity: Pleasantness
Laughable Channel	Utterance content, Meta-linguistic, Non-speech, Exophoric
Laughable Origin	Self, Partner, Collaborative, External
Laughter Positioning	Before/During/After the Laughable
Laughter Pragmatic Function (Author, Year)	Show enjoyment of pleasant incongruity, Marking incongruity, Softening, Benevolence induction, Smoothing, Meaning modification (marking irony, scare quoting, editing phrase etc.), Affiliation [see decision tree, Figure 5, App. C]
Engagement	Interaction/No Interaction Shared attention/No shared attention

of another work - Author, Year). By *laughable* we mean the entity the laughter predicates about, an event or state referred to by an utterance or exophorically (Glenn, 2003), not constituted necessarily by a humorous element. This can be analysed at different levels, which will constitute the variables taken in account in the current study.

Origin of Laughable We annotate for the producer/source of laughable i.e., if the laughable is produced by the laugher her/himself (*self*) or by the other participant (*partner*), by something external to the conversation (e.g., a weird noise in the next room) (*external*) or whether the laughable is jointly constructed by the conversational partners (e.g., an identical utterance produced simultaneously) (*collaborative*).

Laughable Channel The laughable can be constituted by the eventuality described by a verbal contribution (*utterance content*), by an exophoric event or source (e.g. toys, books, window) (*exophoric*), by a non-speech production (vocal or gestural) (*non-speech*), or by a metalinguistic stimulus (e.g., a slip of the tongue, pun, violation of conversational rules, inappropriate speech act etc.) (*metalinguistic*).

Type of predication and incongruity in the laughable Different kinds of laughable can be distinguished based on whether they contain an incongruity or not (see Author (Year) for a formal definition of incongruity), and if so, on which kind of incongruity (Author, Year). The annotation categories are as follows:

1. *Pleasant incongruity* is a clash between the laughable and certain background information perceived as witty, rewarding and/or somehow pleasant. Common examples are jokes, puns, goofy behaviour, solving a puzzle, and conversational humour¹².
2. *Social incongruity* is a clash between social norms and/or comfort and the current situation. Examples include, social discomfort (e.g. embarrassment or awkwardness), violation of social norms (e.g., invasion of another's space, asking a favour), or an utterance that clashes with the interlocutor's expectations concerning one's behaviour (e.g., criticism, dispreferred answer).

¹²In that class we include both intentional humour and unintentional funniness (McGhee, 1979, p.7). We leave to future work a more detailed investigation of this class in what concerns humour and other dynamics at play.

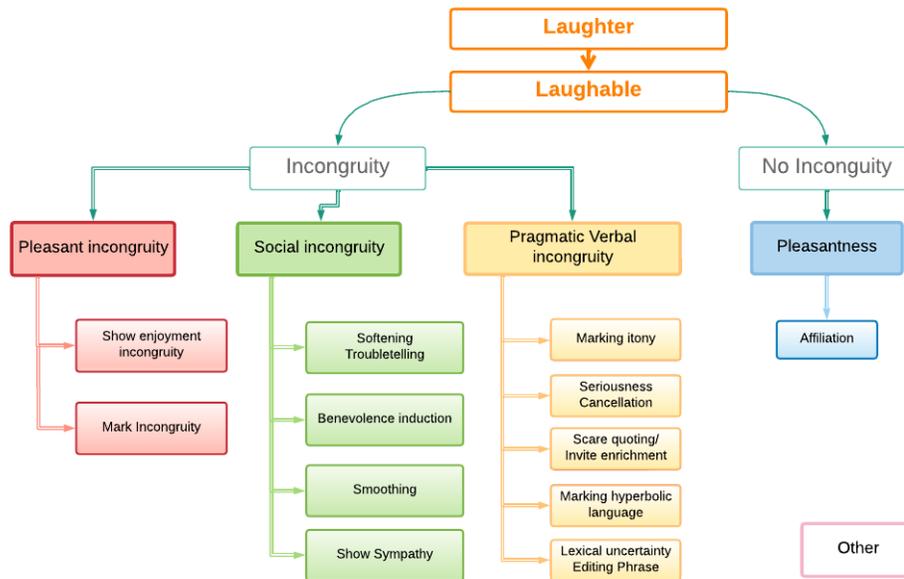


Figure 1: Laughter functions classification from Author (Year). (The binary decision tree to guide classification is presented in Figure 5 in Appendix C)

3. *Pragmatic verbal incongruity* arises when there is a clash between what is said and what is intended. This kind of incongruity can be observed, for example, in the case of irony, scare-quoting, hyperbole etc. Typically in such cases laughter is used by the speaker in order to signal changes of meaning within their own utterance¹³
4. *Pleasantness* refers to cases where no incongruity can be identified. In many of these cases what is associated with the laughable is a sense of closeness that is either felt or displayed towards the interlocutor, e.g., while thanking or receiving a pat on the shoulder.

Shared attention on the laughable For every laughable we mark whether shared attention on the laughable is established between participants: i.e., if both participants are directing/redirecting their attention towards the laughable, be it an external target, an act/movement produced by one of the interactants, or something present in the linguistic content/form of the interaction. Depending on the laughable channel slightly different criteria were applied in order to mark shared attention:

- External target (*exophoric* laughable): we consider shared attention to be established if the laugher’s partner directs her/his gaze to the external object/event during or within one second after the laughter;
- Act/Movement produced by one of the interactants (*non-speech* laughable): we consider shared attention on the laughable to be established if the laugher’s partner displays attention/awareness through gaze at the action, laughing/smiling back during or providing a pertinent verbal response during or within one second after the laughter;
- Linguistic content/form of the interaction (i.e. *utterance detonation/metalinguistic* laughable): we consider shared attention on the laughable to be established if the laugher’s partner displays attention/awareness either through gaze at the partner, laughing/smiling back or providing an appropriate verbal response during or within one second after the laughter.

¹³We intend this class as being specifically related to language associated with lesser probable interpretations; it does not include therefore phenomena as pretence, physical play or role-play.

4.3.2 Laughter pragmatic functions

With the term *pragmatic function* we mean the effect that the laugher wants her laughter to have on the current dialogue. This, in turn, can come in the form of different dialogue acts (Stolcke et al., 2000): e.g. a laugh to show enjoyment of incongruity can be an answer to a question, a statement of opinion, a rejection, a provocation etc. For the laughter pragmatic function annotation we relied on the binary decision tree proposed by Author (Year) (See Appendix C), of which Figure 1 represents a simplified version (without the guiding questions) as a helpful summary of the structure of the taxonomy of laughables and laughter functions. In this scheme, depending on the type of incongruity contained in the laughable, the laughter can be used to serve different functions:

- Show enjoyment of pleasant incongruity, Marking pleasant incongruity, Softening, Benevolence induction, Smoothing, Meaning modification (marking irony, scare quoting, editing phrase etc.) and Affiliation. See the decision tree (Figure 5, App. C) or the simplified version in Figure 5) and Author (Year) for a detailed description of those.

For each of the variables presented above, we had also the option of specifying if the interaction was *Not visible* (either because out of camera or because of the mother-child positioning in relation to the camera) not allowing a reliable interpretation and annotation of the interactional dynamics, or if the classification of that specific feature was too ambiguous to fit the adopted framework (*Other/Unclear*), in order to avoid forced-choice bias (Frank and Stennett, 2001). The same procedure for laughter annotation was applied both for children and mothers. All the categorisations proposed are intended as mutually exclusive.

5 Results and specific discussions

All the statistical analyses reported in the following sections were conducted using the statistical software R (R Core Team, 2022), version 4.2.2¹⁴

5.1 Inter-annotator agreement

The corpus was annotated completely by the first author (for whom English is a second language). The reliability of our classifications, was assessed by having 15% of the corpus annotated by two native speakers of English (one American and one British): one post-graduate student and an undergraduate student, both naïve to the framework used for the analysis and to the hypotheses of the study. The second and third annotator proceeded to the annotation after a detailed explanation of the framework and the decision tree (App. C), following a tutorial where examples of each feature was presented¹⁵. An *Other/Unclear* category was offered to all coders, whenever specific instances of laughter could not be fitted in the taxonomy proposed.

We assessed the agreement on laughable identification and segmentation (start-time and end-time boundaries) using the Staccato algorithm implemented in ELAN (Lücking et al., 2011). We ran the analysis with 1000 Monte Carlo Simulations, a granularity for annotation length of 10, and $\alpha = 0.05$. The average degree of organisation between 3 annotators is 0.81.

The results in terms of percentage agreement and Krippendorff's α (Krippendorff, 2012) for each level of analysis are given in Table 2. Agreement on child laughter annotations is lower than the one obtained for mother laughter annotations (a pattern observed also in other works e.g. Bodur et al. (2021)). After discussion, annotators came to unanimous agreement on the annotations and those values were used for the analysis reported in the current paper. The following analysis is based on the analysis of 313 laughs, 126 from the children and 187 from the mothers. Child laughs were much rarer at the first time points analysed. An in-depth analysis of the frequency of laughter in development and the reciprocal influence of child and mother laughter production on the behaviour of the partner is the focus of another study (Author, Year).

¹⁴The full data set will be released with a final version of the current manuscript.

¹⁵A link to the annotation tutorial will be provided in the final version of the paper.

Table 2: Inter-coder annotation agreement

Feature	Providence	Overall	Children		Mothers	
	% agreem. 3 coders	Krip. α	% agreem. 3 coders	Krip. α	% agreem. 3 coders	Krip. α
Positioning	91.87	0.82	90.91	0.82	92.98	0.79
Laughable channel	96.15	0.95	94.12	0.92	100	1
Laughable origin	81.30	0.67	71.21	0.57	89.47	0.75
Type incongruity	84.62	0.64	80.39	0.42	92.59	0.86
Pragmatic Function	80.12	0.60	81.37	0.59	77.78	0.61
Overall	86.81	0.73	83.6	0.66	90.56	0.8

5.2 Laughable features

5.2.1 Laughable positioning in relation to the laughter

Percentages of the positioning of laughter in relation to the laughable (before, during and after) are shown in Table 3. To allow easier comparison with data from adult-adult interactions, Table 3 presents data from the current study together with data reported by Author (Year) from corpora of adult interactions (DUEL corpus (Hough et al., 2016) and BNC (Burnard, 2000)). In (1) we have an example of laughter occurring after the laughable, while (2) provides an example of laughter occurring during the laughable.

Table 3: Positioning of laughter in relation to the laughable: Providence Corpus and adult-adult conversations (Author, Year).

Corpus	Before	During	After	No vis.
Providence Mother	0 (0%)	48 (25.67%)	137 (73.26%)	2 (1.07%)
Providence Child	1 (0.79%)	45 (35.72)	78 (61.9%)	2 (1.59%)
DUEL Fr	15 (2.67%)	99 (17.62%)	448 (79.71%)	
DUEL Ch	16 (7%)	81 (37%)	124 (56%)	
BNC	16 (5.54%)	75 (25.95%)	198 (68.51%)	

- (1) *Example from the Providence Corpus - William 010412¹⁶* - Laughter after laughable produced by the laughter's partner
 Mother (M): who's hiding in the honeycomb ?
 M: huh , what's that ?
 Child (C): *a zee*.
 M: < laughter > bee! < /laughter >, that's right! zzzzz a bee. < laughter/> \ < laughter > (a)n(d) who is hiding among the flowers ? < laughter/>
- (2) *Example Providence Corpus - William 020012* - Laughter during collaborative laughable
 C: We go up and down!
 M: We go up and down?
 C: Yeah
 M: Yeah
 C: *Up...*
 M: *and down*
 C: *Down*
 M: *Up and down*
 C: < laughter/>
 M: < laughter/>

¹⁶Each extract is provided with the age of the child following the conventions used in the CHILDES database (MacWhinney, 2000), namely specifying year, month and day of age: yymmdd.

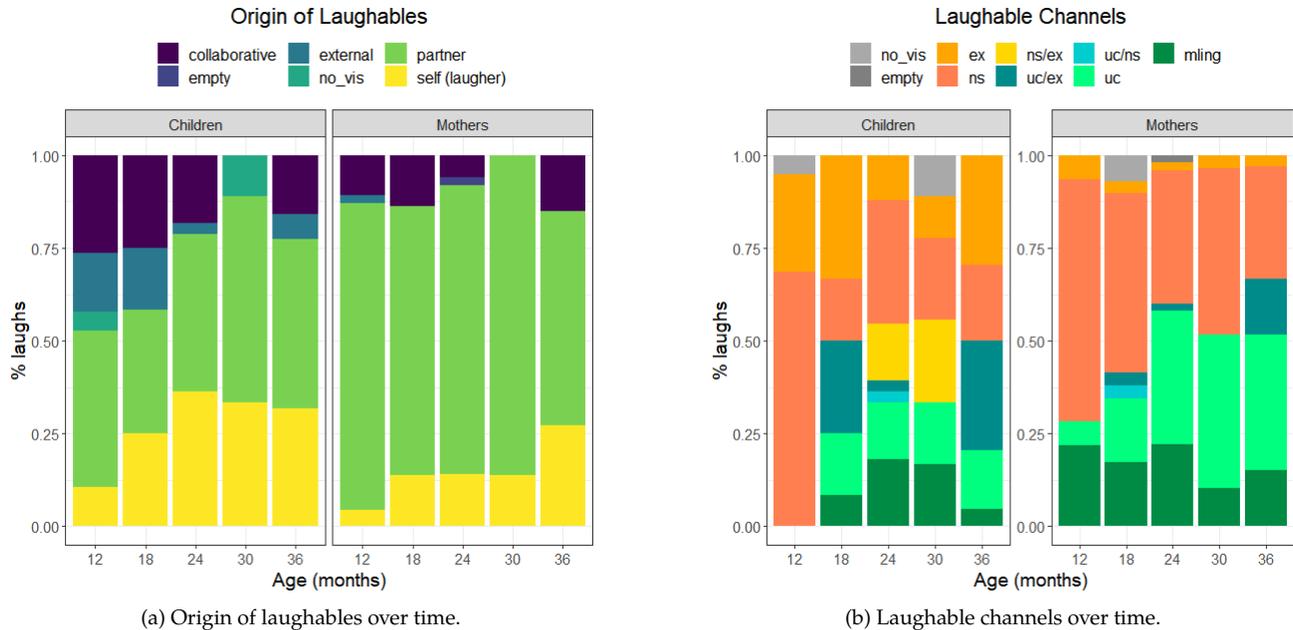


Figure 2: Origin and channel of laughables over time for children and mothers: percentages.

5.2.2 Origin of laughable

In Figure 2a, we report percentages of the different laughable origin classes (section 4.3.1) annotated for children and mothers. Overall, we observe significantly higher percentages of laughter related to *external* stimuli in children (McNemar’s χ^2 ¹⁷ = 112.08, $df = 1$, $p < .001$) and significantly lower percentages of laughs related to laughables produced by themselves (*self*) in mothers compared to children (McNemar’s $\chi^2 = 76.4$, $df = 1$, $p < .001$).

It is interesting to observe the changing patterns over time both in children and mothers (Figure 2a). While we see a higher percentage of *external* laughables in children at all time points in comparison to mothers, we nevertheless see a slight decrease over time. In children we observe an increase in the percentage of laughs related to laughables produced by themselves (*self*) from 12 to 18 months, which then stabilises. In mothers on the other hand, we see a progressively increasing percentage of laughs related to laughables produced by themselves from the first to the last time-point of observation. At the age of 36 months, we observe mothers and children converging to similar distributions regarding this variable. Example (3) constitutes an instance of a laughable classified as *external*, a perfect example of what Piaget (Piaget, 1945) and McGhee (1979, p.61) described when speaking about laughter as a sign of cognitive mastery, occurring only after a phase of accommodation (Section 2.2.1): the child laughs only after a serious and focussed exploration of the toy, when he has grasped its functioning. In (2) we have an example of laughable produced *collaboratively*; while in (1) and (4) we have two examples of laughables produced by the *partner*, one by the child and one by the mother respectively; and in (6) an example of a laughable produced by the laugher herself.

- (3) [Example Providence Corpus - William 010412](#) - External laughable

C: mamy

M: yeah ? Whoop . What’s this ? what’s that ?

C: yyy .

M: squeezing it ? Squeeze it again! Oh good job . Try again . Try again . Here push it right there , push it right in the middle . You gotta squeeze it quick , xxx .

¹⁷We decided to perform a McNemar’s Chi-squared test since it is a good non-parametric alternative to the Pearson’s Chi-squared test, and is a better fit for small paired nominal data samples (2x2 contingency table) compared to Fisher’s Exact Test.

C: Tea.

M: Tea? there was no tea ! \ did you make the coffee in the bathroom ? \ no! Where did you make the coffee ?

M: where did you make the coffee this morning?

C: < smiling > *upstairs*.

M: upstairs !? \ M: 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 !

C: listen Mommy .

M: what ?

C: nursie Daddy .

M: nursie Daddy , that's another joke ! \ you're being funny now , oh , no , we do not draw on clothes .

- (7) [Example Providence Corpus - Naima 010604](#) - Meta-linguistic laughable produced by the laugher's partner

M: what is Daddy's name ?

C: yyy Daddy .

M: and what is Dadaji's name ?

C: xxx !

M: and what is Babaji's name ?

C: yyy .

M: xxx , right . \ and what is Great Grandma's name ?

C: Turtle . \ Myrtle .

M: Myrtle , right .

C: *Myrtle the turtle* .

M: Myrtle < laughter > the turtle < /laughter >, it's just Myrtle , Great Grandma's name is just Myrtle.

- (8) [Example Providence Corpus - Naima 020611](#) - Utterance content laughable produced by the laugher's partner

M: [reading book] He swallowed something

C: why did he swallow the key chain ?

M: oh dear... the teacher called an ambulance \ there it is \ the ambulance people put me on a stretcher they asked me what happen but I still didn't want to tell \ oh see they don't know he swallowed his key chain...

C: Why?

M: they just know that he's very sick \ *it was a little hard to explain why I put a key chain in my mouth*

C: < laughter/>

M: I hope that you never do anything like that it'll be very bad for you!

5.3 Incongruity in the laughable and laughter pragmatic functions

5.3.1 Type of Incongruity

The vast majority of laughter relates to *pleasant incongruity* both in children (91%) and mothers (73%), while *social incongruity* constitutes a laughable in 6% of the cases in mothers (23% if we consider also a hybrid class that will be defined later) and 2% in children (Table 5). In (9) the child laughs while engaged in a pretence play with a puppet. The laugh here relates to the appreciation of a *pleasant incongruity*: the mother puts the shoes on the puppet's head (incongruent object use) and make it stand upside down on its head (violating the normal human-like positioning). (10) is an example of a laugh produced by the mother classified as *social incongruity*. The mother is 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.

Note that for mothers we decided to add an additional class in order to categorise some specific occurrences which at first were simply annotated as borderline between *pleasant* and *social incongruity* being unable to decide

between the two (allocated therefore to the *Other* category). 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) (e.g. (11)). 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. At the end of the analysis we realised however that this group was quite large (17%) and was equally present in all mothers, and that as a result it should probably constitute a class in itself, seeming to be somewhat characteristic of mother-child interaction. These cases stress the importance of laughter in managing interaction from a very early age, and its important role in child social referencing, reassuring and encouraging the child as s/he learns to cope with 'life' and the first challenges (Stenberg, 2017; Feinman, 2013; Fawcett and Liszkowski, 2015) (see discussion - Section 6).

Table 5: Occurrences and percentages of laughter according to the type/absence of incongruity in the laughable

Corpus	Incongruity			Pleasant/ Social	No incong. Friendl.	Other/ No vis.
	Pleasant	Social	Verb. Prag.			
Prov. Mother	137 (73%)	11 (6%)	0 (0%)	31 (16.5%)	7 (4%)	1 (0.5%)
Prov. Child	115 (91.26%)	3 (2.38%)	0 (0%)	-	4 (3.18%)	4 (3.18%)
DUEL Fr	414 (74%)	112 (20%)	2 (0.4%)	-	31 (5%)	3 (0.6%)
DUEL Ch	148 (67%)	66 (30%)	0 (%)	-	6 (3%)	1 (0.4%)
BNC	218 (75%)	61 (21%)	6 (2%)	-	2 (0.6%)	2 (0.6%)

(9) [Example Providence Corpus - Alex 020606](#) - Pleasant incongruity

M: what , shoes on his head ? \ no: , that's silly!

C: < laughter/>.

M: then he can do a flip. \ ooo boop ! (making sound of potato head flipping .)

C: on 'his (.)' head .

M: he stands on his head .

C: on yyy his hat .

M: tuuuu . (sounds of potato head flipping .)

C: < laughter/>

M: he's so silly .

(10) [Example Providence Corpus - Alex 030103](#) - Social incongruity

C: yyy try this . No this one !

M: alright could I use the pen ?

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

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

C:< laughter/>

M: stop that screaming. Stop that screaming !

C: xxx try this .

(11) [Example Providence Corpus - William 010412](#) - Pleasant/Social Incongruity (Mislabelling with correction)

M: what's that ?

C: yyy .

M: nose. Where's your nose ?

C: eye !

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

(12) [Example Providence Corpus - Naima 020004](#) - Pleasantness

M: he's talking to his sister whose name is DW . She has a helmet in her hands . "I'm a little nervous", said Arthur. *He said "I'm a little nervous"* .

C: < laughter/>

M: you'll do a fine job .

In children, from 12 months up to the age of 24 months we observe exclusively the use of laughter in relation to *pleasant incongruity*. We see the first occurrence of laughter not related to any incongruity, but rather to a pure sense of *pleasantness*, either felt or wanted to be shown to the interlocutor, at 24 months (e.g. (12)). The use of laughter in relation to a *social incongruity*, that is a laughter related to a socially potentially uncomfortable incongruity, in our data is observed only when the child is 36 months old. Laughter related to *pragmatic verbal incongruity* (the more complex from a pragmatic linguistic perspective and the rarest also in adult-adult interaction (Author, Year) is absent both in mothers and in children (see Table 5). We observe ironic uses of laughter only twice by Lily's mum in the video-recording where the child is 36 months old (extract 13). See Author (Year) and Author (Year) for discussions about laughter meaning reversal.

(13) [Example Providence Corpus, Lily 030010](#) - Ironic (pleasant incongruity) laughter.

C: Who's this from?

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

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.

The percentages of laughter pragmatic functions observed over all the time-points in mothers are not so different from those observed in adult-adult conversation, though lower percentages of laughs related to *social incongruity* and *pragmatic verbal incongruity* are observed. To allow easier comparison, Table 5 presents data from the current study together with data reported by Author (Year) from corpora of adult interactions (DUEL corpus (Hough et al., 2016) and BNC (Burnard, 2000)).

5.3.2 Laughter Pragmatic Functions

Both for mothers and children, over 70% of the laughs produced have the function of *showing enjoyment of a pleasant incongruity*, covering the majority of laughter-uses, as is also reported for adult-adult interaction (Author, Year). While for mothers, in comparison to adult interaction, the percentages are quite similar (Chinese being the corpus with the lowest percentage of laughs related to pleasant incongruity), in children the percentage of laughs used to *show enjoyment of pleasant incongruity* (84%) is significantly higher (McNemar's $\chi^2 = 80.27$, $df = 1$, $p < .001$) and the range of functions used in children is smaller than the one observed in mothers (Figure 3). As commented in the previous paragraph in mothers we notably have some uses of laughter which seem to relate both to a pleasant and a social incongruity, "polysemy" which is mirrored also in the annotated functions (in the yellow range in Fig. 3). In children we observe a progressive emergence of different laughter functions: at 12 months of age child laughs are used to *show enjoyment of a pleasant incongruity*; at 18 months we observe the emergence of laughter to *mark incongruity*; at 24 months laughter to *show affiliation*; at 36 months laughter to *smooth* the interaction (see Fig. 3).

5.4 Shared attention on the laughable

Percentages relative to the occurrence of laughter in interaction (or not) together with the percentages of whether mother and child were sharing attention on the laughable (see Section 4.3.1 for annotation guidelines) are reported in Figure 4. Not surprisingly, given the literature reviewed in the introduction, most of the laughs are produced while child and mother are engaged in interaction. What is more interesting to observe are the percentages of laughs produced with established/establishing shared attention on the laughable with the partner, or lack

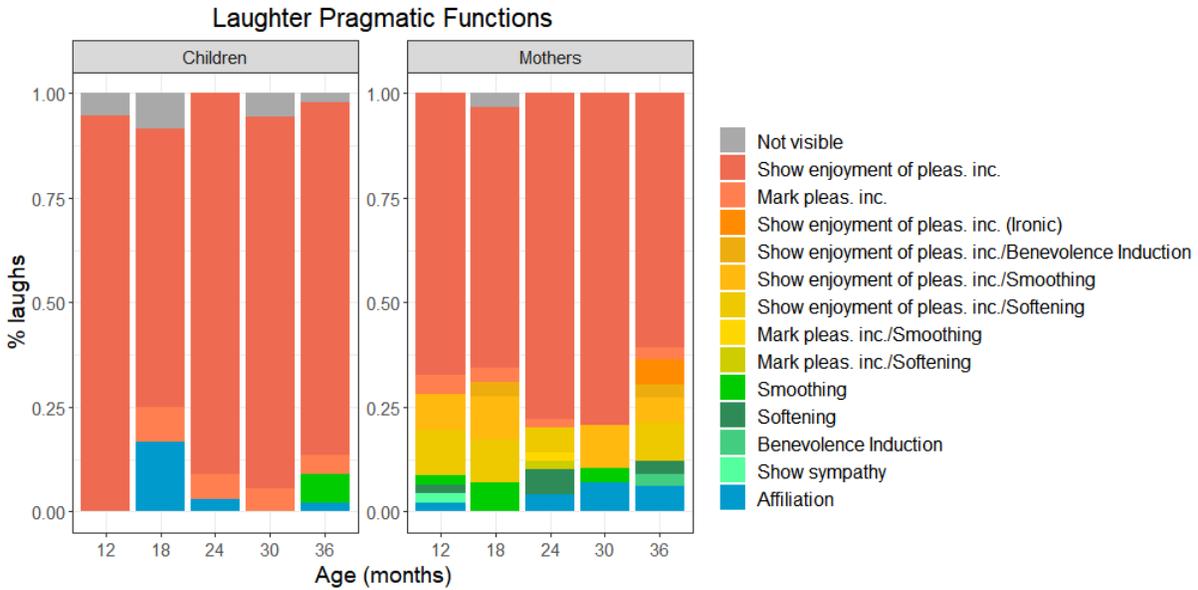


Figure 3: Laughter functions in children and mothers over time.

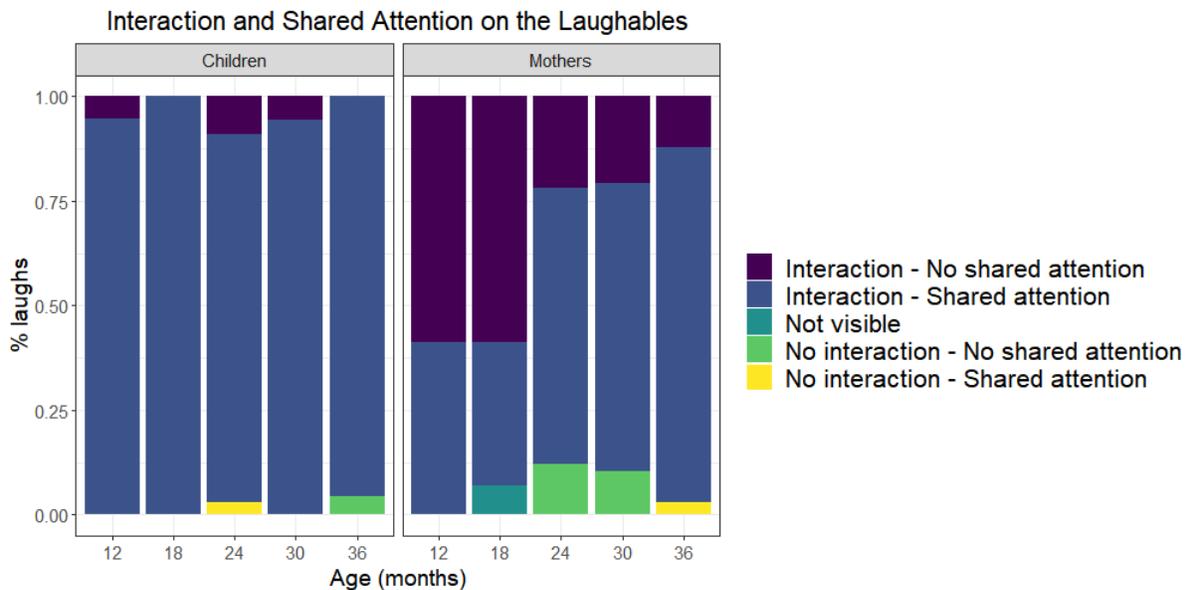


Figure 4: Interaction and shared attention on the laughable

thereof. In 94% of the cases, when a child produces a laughter, the mother will share (or is already sharing) the attention on the laughable. The same is not true for the laughs produced by mothers. At the first time points (12 and 18 months), in 59% of the cases when the mother laughs, the child does not share her/his attention on the laughable. The percentage of *lack of shared attention* on the laughable from the child decreases significantly between the second, the third and the fourth year of life. We conducted statistical analyses considering only the laughs produced by mothers *in interaction*. In order to explore whether a developmental trend in the amount of episodes where *shared attention on the laughable* of the partner's laughter could be observed in children, we

divided our time-points of interest (12, 18, 24, 30, 36 months) into 3 periods¹⁸: one relative to the second year (12 and 18 months), one relative to the third year (24 and 30 months) and one relative to the beginning of the fourth year (36 months) of child development. We observe significant differences in the amount of shared attention over the laughables of mothers' laughter between the second/third year of life and the beginning of the fourth year (McNemar's χ^2 test with continuity correction: 2nd vs 3rd year $\chi^2 = 1.55$, $df = 1$, $p = 0.21$; 3rd vs 4th year: $\chi^2 = 10.25$, $df = 1$, $p = .001$; 2nd vs 4th year: $\chi^2 = 25.87$, $df = 1$, $p < .001$). Remarkably we see also an episode of shared attention on the mother's laughable even when the child is not interacting with her (*noint_share*) at 36 months.

6 Discussion

We have analysed in detail laughable features and laughter pragmatic functions, both in mothers and children at different stages of development between 12 and 36 months, as well as the amount of shared attention on each-other's laughables. Below we discuss each of the features object of analysis individually, while a general discussion is proposed in the next section.

6.1 Laughable Features

6.1.1 Laughable positioning

Both for mothers and children, more often than not laughter follows the laughable it is related to, with a smaller percentage of laughs overlapping with it (Table 3), similarly to what has been observed in other corpora of adult-adult interaction (Author, Year). Surprisingly, no cataphoric laughter, i.e. laughter produced before the laughable, was observed in mothers. Even if cataphoric laughter does occur with lower frequency compared to other positions (i.e., after or during the laughable), it is, nonetheless, always observed in other corpus studies of adult interaction cross-linguistically (DUEL French 2.67%; DUEL Chinese 7%; BNC: 5.54% - Author (Year)). To explain this, we can tentatively suggest that cataphoric laughter may require more complex pragmatic abilities in order to resolve the laughable, and that mothers instinctively do not use it with their very young babies. Despite the obvious need for more research on the topic, we can speculate that this could be one of the modifications adults adopt when speaking with language-beginner partners, i.e. Child Directed Speech (Ratner, 2013; Soderstrom, 2007; Dominey and Dodane, 2004; Cox et al., 2022). It may be one of the fine-tuning adjustments to the child's perceived comprehension abilities (Snow, 2017, 1989; Sokolov, 1993) – in this case, possibly of a syntactic and pragmatic type. Similarly, we observe an (almost) absence of cataphoric laughter in children (we observe only one cataphoric laugh in Naima, the child with the fastest language development, at the age of 24 months). A possible explanation, paralleling the one related to mothers' behaviour, is that the use of laughter to signal a laughable in advance to the interlocutor might require more sophisticated pragmatic abilities and intentions to cue specific interpretations for the partner. A cross-linguistic study of adult conversation (English, French, Chinese) shows that the distribution of laughter positioning is partly influenced by the function the laughter is performing (e.g. Author, Year). This evidence clearly shows how multimodal channels overlap from the earliest years of life to convey meaning in synergy. At the same time it is suggestive of a developmental trend that might be observed in terms of alignment of different channels over time as influenced by their pragmatic use.

6.1.2 Origin of laughables

This variable allows to explore what children are directing their attention to and gives interesting information about the interactional dynamics at play. We observe higher percentages of laughter related to *external* laughables in children and a decrease over time, as well as higher percentages of laughter related to laughables produced by the children themselves (*self*) in comparison to mothers (*partner*). Mothers on the other hand have higher percentages of laughter related to laughables produced by the child. Mother and child percentages converge to similar values around 36 months.

The very high percentages of mother laughs related to laughables produced by the child (*partner*) coheres well with the dynamics generally observed in western middle-class mothers' interactions with their infants (Hoff,

¹⁸This choice was made in order to obtain a more powerful statistical analysis given our limited sample size.

2006), where mothers tend to continuously follow the child's attentional focus. For mothers, the infant is the primary focus of attention, and the infant's behaviours often constitute laughables for the mothers (Nwokah and Fogel, 1993; Hogan, 2007). According to some theorists humour reduces to the recognition of childlike features or behaviours, having an evolutionary adaptive function: helping caregivers to be instinctively inclined to attend to children's behaviours and actions (e.g. Hogan, 2007). This contrasts sharply with the child's perspective, for whom the mum is not necessarily the primary focus of attention, which, in turn, can also explain the higher percentage of external laughables observed in children. Moreover, on the whole, western middle-class mothers often explicitly direct the child's attention toward objects, external targets and images in books (Hoff (2006)).

It is also interesting to note the lower percentage of laughs related to laughables produced by themselves (*self*) in mothers, in comparison to adult-adult interaction (Table 4). This piece of data suggests that mothers use laughter mainly as a response/comment to child behaviour and less so to modify and shape the meaning or the intention of their own productions. When interacting with children they therefore display a behaviour quite different from the one often observed in interactions among adults, where laughter is mostly produced by the speaker herself to shape her own discourse (Vettin and Todt, 2004) (Author, Year).

Finally, the increase observed in child laughs related to laughables produced by themselves (*self*) between 12 and 18 months, might be interpreted as an increase in active and personal laughable creations, but possibly also in terms of increased awareness of laughter as a means to direct the attention of their interlocutors, or to disambiguate intentions and meanings.

6.1.3 Laughable channels

The data on *laughable origin* are then partially reflected in the amount of child laughter related to *exophoric* laughables as opposed to laughables constituted by an *utterance content*, a *non-speech* element (either vocal or gestural), or a *meta-linguistic* incongruity (Figure 2b). In children we see higher percentages of laughs related to exophoric events compared to mothers/adults at all time points. From 18 months we observe the emergence and a progressive increase of laughs related to laughables constituted by the *utterance content* or by its interaction with other elements (i.e. exophoric elements, or non-speech production). From 24 months we then observe the emergence of laughter related to reflections on the language itself, or to the violation of conversational conventions (cases dubbed *meta-linguistic laughables*). These patterns can be considered informative about the development of cognitive and linguistic competences, which enable increasing interest concerning linguistic and pragmatic rules (and the incongruities they can give rise to).

In parallel, in mothers there is a progressive *reduction* of laughter related to *non-speech laughables* over time and an increase in laughter related to *utterance content* (Figure 2b). Interestingly, from 12 months to 30 months of age mothers have quite consistent percentages of laughs produced in relation to what we have been calling *meta-linguistic laughables*, constituted most typically by mispronunciations or mislabellings from the child (an example is provided in (11)). This finding is particularly interesting when taken together with the first instances of clowning from the children, which often contain creative mislabelling, neologisms or inappropriate use of words during the second year (Hoicka and Akhtar, 2011; Loizou, 2005) (as in (6)). It could be the case that children opt for such humour strategies especially because, from their very first words, those actions, at first definitely not intentional, have been highly successful in eliciting laughter from the caregiver. Moreover, it should be considered that the period between 18 and 24 months is particularly crucial for what concerns language and speech development: a period including the so called vocabulary explosion (Hoff, 2013; Barrett, 2017; Nelson, 2016) and the successive move towards multi-word speech utterances and more complex syntactic structure (Lieven, 2016). Therefore, metalinguistic laughables can definitely be considered at the (quintessential) zone of proximal development and can even constitute a way to test linguistic boundaries and conversational rules.

Even though child humour is not the focus of the current paper, it is relevant to compare our interactional data with one of the most famous models of child humour development, the one proposed by McGhee (1979) on the basis of Piaget (1950)'s cognitive stages. The first three stages of humour appreciation postulated by McGhee (1979), (in interaction) seem to be reached earlier than he postulated. In our corpus we observe children laughing at incongruous actions and events already at 12 months, in line with Reddy (1991) who report appreciation of these incongruities in infants already during the first year of life. In the model of McGhee (1979) this should be observed only from 18 months. We also observe laughter in relation to the production of incongruous labelling earlier than postulated by McGhee: 20-24 months– in (6) an example from a child aged 18 months. In particular,

we observe appreciation/production of humour involving conceptual incongruity or playing with assonances and rhyming from 18 months, while in McGhee (1979)'s model this should be observed only from 36 months.

6.2 Incongruity in the laughable and laughter functions: an ontogenetic perspective

In children, we observed a progressive emergence of different types of incongruity in the laughables and, consequentially, of different pragmatic functions: *pleasant incongruity* (12 months), *pleasantness* (24 months) and *social incongruity* (36 months) (Figure 3). Such progression can help us shedding light on the laughter co-options observed in human adults. The only function we observe in children from 12 months is laughter to *show enjoyment of pleasant incongruity*. Interestingly, the second one to emerge at 18 months, *marking pleasant incongruity*, pertains to the same “incongruity branch” type: the Pleasant Incongruity branch (the mentioned branches are relative to Figure 1 or 5). In progression, we then see at 24 months the emergence of laughter used to *show affiliation* (Pleasantness branch) and at 36 months laughter with a *smoothing* function (Social Incongruity branch). Laughter related to the *Pragmatic Verbal Incongruity* branch is not observed neither in mothers nor children.

Thus, until the age of 18 months we observe solely laughter produced in social contexts where *pleasant incongruities* could be appraised, with the function of *showing enjoyment of* or *marking pleasant incongruity*. These are plausibly the most ancient and basic functions of laughter, which can also be observed in non-human apes (Section 2.3). They use laughter exclusively in the context of play to signal playful and pleasant incongruity, serving also as an important tool for disambiguating the import of certain events and for the maintenance and the prolongation of the interaction (both in play and tickling) (Davila-Ross et al., 2010; Matsusaka, 2004; Provine, 2001; Vettin and Todt, 2005; Van Hooff and Preuschoft, 2003). It is then around 24 months that we observe the first laughter unrelated to the enjoying or signalling of any incongruity. This is the first use of laughter that is not found in non-human apes (Davila-Ross et al., 2011; Gervais and Wilson, 2005; Owren and Bachorowski, 2001). It is the first co-opting of laughter that can be observed in humans: the abstraction of the meaning of pleasantness without reference to any incongruity. In our classification these are the laughables that would be classified in the *Pleasantness branch*, i.e. ‘the pleasantness seems to reside exclusively in a sense of closeness either felt or aimed to be shown to the interlocutor’ (Author, Year). This is the first co-option, but still quite close to the original function: laughter, even when occurring as a display of pleasant incongruity appreciation, usually occurs in the context of play and does not just mark the existence of an incongruity, but the fact that the laugher enjoys it and that s/he, crucially, enjoys it with her/his interactional partner (Davila-Ross and Palagi, 2022; Dunbar, 2012). Also among non-human apes, laughter plays an important adaptive role in promoting social affiliation, bonding and coordination (Bard, 2007; Byrne, 2003; Hatfield et al., 1994; Dezecache and Dunbar, 2012; Scott et al., 2014). Davila-Ross et al. (2011) observes that reciprocated laughter in chimpanzees impacts significantly on play—by extending its duration. This highlights the important cooperative and communicative advantages that laughter can have for an individual (Caruana, 2017; Dezecache and Dunbar, 2012). This feature is then abstracted away when the aim is to exhibit closeness to a partner, regardless of the detection or the marking of an incongruity.

It is only around 36 months that we observe in children the use of laughter most distant from its origin. Laughter, the signal used to show and mark appraisal of a *pleasant incongruity*, seems to be co-opted among humans for use in totally different situations (not observed in non-human apes) (Gervais and Wilson, 2005; Owren and Bachorowski, 2001; Davila-Ross et al., 2011). In these cases the laughter is still related to an incongruity (at least in our framework (Author, Year)), but it is rather a potentially unpleasant one: a violation of social norms or comfort that might disrupt the smoothness and agreeableness of the interaction (dubbed *social incongruity*).

We believe that each co-option observed in laughter use, especially when used in relation to *social incongruity*, mirrors complex processes from a socio-pragmatic point of view involving multiple factors. Firstly, it involves awareness of socio-cultural norms and of the ideal conversational dynamics⁶, as well as the awareness that violation of these might cause unpleasantness and disruption of the social interaction, and the intention to prevent this. Secondly, it requires the experience, and the awareness (more or less conscious), that laughter can affect the interlocutor both with regards to the appraisal of the current situation, and with regards to her disposition towards the laugher (Owren and Bachorowski, 2003). Lastly, it involves the transposition of a positive signal, emblem and hallmark of playfulness and pleasure, in a – in principle – totally inappropriate context, i.e. an unpleasant event/situation. The aim of this transposition, arguably, is to make unpleasant circumstances less bad both for the laugher and for the interlocutor, and in some instances to provide reassurance and support (e.g. Jefferson (1984); Petitjean and González-Martínez (2015)). Examples might be situations of embarrassment,

awkwardness, invading another's space, asking a favour or saying something that clashes with the interlocutor's expectations on our own behaviour (e.g. when criticising our colleague's proposal) (Raclaw and Ford, 2017)—see Author (Year) for attested examples. Children are exposed to the use of laughter in unpleasant situations since very early on: especially at the first time points of our exploration we observed mothers often laughing while the child was in a negative mood, e.g. crying or upset, or when making a mistake or falling. Among these instances there are some that fall in the borderline category that we needed to establish for mothers: laughter related to a pleasant/social incongruity. This peculiar use of laughter from the mothers is in line with the proposal of humour being caused by anything that reminds us of childlike behaviour, an inclination which according to Hogan (2007) has an adaptive evolutionary function for the offspring: i.e., if childlike behaviour, especially mistakes and striving, is appraised as pleasantly incongruous, that will help caregivers to be neither too apprehensive nor too disengaged. Indeed caregivers, given the pleasant reward that those actions elicit, will unconsciously be driven to pay attention to the children striving to grow, while at the same time let them explore and make mistakes without controlling them too much (Hogan, 2007).

Laughter related to social incongruity is crucial in our interactions also for managing the interlocutor's opinion about us (e.g. Partington (2006) Raclaw and Ford (2017)). It is perhaps not coincidental that we observed the first laughter used for *smoothing* at 36 months, the age in which a sense of the public self (i.e. reputation) starts to emerge in children (Tomasello et al., 2005; Dweck, 2013). Interestingly, the child to show earlier laughter use in relation to different kinds of laughables (Naima) is the child with the fastest language development.

The absence of laughter related to *pragmatic verbal incongruity* in children can be interpreted considering that the use of laughter to modify linguistic meaning (e.g. marking irony, hyperbole, editing phrase) is an even more complex and sophisticated adaptation of laughter function, importantly interacting with language abilities typically acquired much later (e.g. Pexman and Glenwright (2007); Recchia et al. (2010); Zufferey (2016)).

Despite the fact that analysing the speech acts performed by each laugh is not the focus of the current paper, it is interesting to highlight how in the extract 6, the laughter produced by the child (18 months old), works perfectly as a full-fledged answer to the mum's question "That's a joke right?", so much that the mothers ratifies it uttering "Yeah! You're making a joke". This observation corroborates a study by (Walker, 2017) showing how laughter can be used by children to answer questions either when unable to respond fully with speech or when unwilling to do so properly. In both cases, such laughter-use signals the recognition of the partner's dialogue act and the awareness that a response is expected from them.

6.3 Shared attention on the laughable

Almost all child laughs occur in interaction and are related to laughables on which mothers are sharing attention. This can be linked to the pattern already mentioned in section 6.1.2, that children tend to be the main focus of mothers' attention (Hoff, 2006). Moreover, western middle-class mothers tend to follow the child's focus of attention as much as possible and try to exploit it as a means of establishing joint attention and interaction (Hoff, 2006). Engaging in moments of joint attention is indeed extremely important for the communicative development of the child. Following the child's attention in order to engage in interaction, providing linguistic input and verbal and non-verbal contingent responses to child behaviour (Leonardi et al., 2016), is associated with more rapid language development (Akhtar et al., 1991; Harris et al., 1986; Tomasello and Farrar, 1986; Carpenter et al., 1998b).

On the other hand, we observe a decrease in the percentage of mothers' laughs occurring in *interaction without shared attention* from the child (cases that in Del Ré et al. (2013) would be named 'humour non partagé', i.e. unshared humour). Specularly, we observe an increase in *shared attention* on mothers' laughables from children. This reflects the fact that over time the child becomes more interested in participation, and more able to redirect her/his attention in response to the mother's expressions and cues. At the same time the child also becomes progressively more able to identify (and eventually appreciate) the laughables of mother's laughter. This data matches the finding from Hollich et al. (2000) that 24 month old children are able to take the speaker's point of view and map a word to a referent intended by the speaker, regardless of whether the referent arouses their interest. Most importantly, this data shows an increasing attunement to the social and cultural environment, as well as increased linguistic and pragmatic abilities considering that from the time the child is aged 24 months and over about 50% of mothers' laughables are constituted either by *utterance content* or *meta-linguistic* elements.

7 Summary and future work

The aim of our study was to offer a detailed description of laughter development in children from 12 to 36 months, from a semantic and pragmatic perspective.¹⁹ We have shown how to capture interesting aspects of the development of laughter production utilizing a framework developed for analyzing adult laughter in dialogue (Author, Year)—the method adopted has enabled us to address our motivating questions, the answers to which will be summarised in what follows.

7.1 How does laughter constitute a marker of cognitive and communicative development during the second and third year of life?

Our analysis shows that the laughter behaviour of children, from 12 to 36 months of age, is very different from that of adults. Differences between children and mothers (and adults more generally) were found at each level of analysis: positioning, origin, channel, incongruity in the laughable, and laughter pragmatic functions. Crucially, we observe development in almost all of the features considered. Some of the changes we found seem to reflect purely cognitive achievements, while others seem to be more specifically informative about the increasing social attunement to the cultural environment, and about the developing pragmatic and linguistic abilities of the child.

We observe children becoming progressively more interested in laughables produced by the partner rather than in laughables related to external targets, as well as appreciating more and more over time incongruities to be found in the content of utterances and in the violation of conversational rules. In this respect therefore the laughable analysis is informative about the increasing interest and appreciation of linguistic material (and the incongruities they can give rise to) and about the integration of pragmatic and linguistic rules. Moreover, we observe an increase over time of child laughs related to laughables produced by themselves, showing that, as the child grows, laughter can be used to cue information to the interactional partner and to shape her/his own productions, potentially signalling the emergence of more interlocutor oriented productions.

A striking observation we make is in relation to the type of incongruity the laughter is related to and the laughter functions over time. We observe a pattern of emergence which offers the basis for hypotheses about the laughter co-options observable in human adults. In non-human apes, laughter is used to mark the presence and enjoyment of a pleasant incongruity to the interactional partner (Davila-Ross et al., 2010; Vettin and Todd, 2005), which could be glossed as “This is not an attack, it’s play! And it is fun with you!”. This use in relation to a pleasant incongruity, is the one we also observe from the first time-point of our dataset (12 months). In children, from the age of 24 months, we then see a use of laughter that has not been attested in non-human apes (Gervais and Wilson, 2005; Owren and Bachorowski, 2001; Davila-Ross et al., 2011), i.e. laughter used when no incongruity can be detected, exclusively to show affiliation and closeness to the interactional partner. It seems that the positive social effect of laughter in the incongruous playful interaction is abstracted for use in contexts where no incongruity is present. Finally, around 36 months we observe the furthest co-option of laughter use from the one observed in non-human primates. Laughter is now also produced in relation to incongruity which is not pleasant, but rather unpleasant, i.e. violation of social norms and comfort, which might cause disruption of the social interaction. The hallmark of laughter – incongruity and pleasantness – starts to get used in relation to unpleasant circumstances (incongruity and potential discomfort) (Raclaw and Ford, 2017). We speculate that this transposition is to make unpleasant circumstances less bad both for the laugher and the interlocutor, reassuring about closeness, and in some cases aiming to improve them. We propose that this co-option is the result of an implicit learning from social interactions of laughter (typically positive) effects on the laugher him/herself and on the interlocutor (Owren and Bachorowski, 2003; Sander and Scheich, 2001), together with an awareness of own and others’ mental states and the willingness to avoid social frictions or inducing harm.

The absence of laughter used to cue towards less-probable linguistic understanding (e.g. irony, scare-quoting), seems to suggest that such laughter use might constitute the most complex laughter co-option in humans, requiring more sophisticated linguistic and pragmatic abilities, not yet acquired by 36 months of age. The observation of the interactional context and the shared attention on the laughable shows that over time the child is progressively more attuned to the mother’s attentional state, and more able to identify, infer and appreciate the argument of mother’s laughter, even when this is not already the object of his interest.

¹⁹Frequency, duration, arousal, and responsiveness to eachothers’ laughter are the object of another work (Author, Year).

Our data therefore show that a detailed analysis of laughter, taking into account the different aspects involved in its interactional use, can be informative about specific aspects of the neuro-psychological development, including pragmatic and linguistic abilities, as well as constituting the basis for their further development.

7.2 Is there something special about laughter-use in mother-child interaction?

Strikingly, in contrast to the patterns of laughter-use observed in adult-adult interaction, mothers' laughter is more likely to be related to laughables produced by the partner rather than by themselves. This suggests that mothers use laughter mainly as a response to/comment on child behaviours and less so to modify and shape the meaning of their own productions. Furthermore, in comparison to adult interactions, a larger amount of mother laughter is related to *exophoric* and *metalinguistic* laughables, which might be informative about the interactional dynamics with the child in general. In mothers, as in children, over time we observe an increase in laughables contained in the *content* of their utterances, which in adult-adult interaction are by far the most frequent. Even in terms of positioning we observe a total absence of mother laughter produced before the laughable (usually observed, even if in small percentages, in adult-adult interactions (Author, Year)).

Notably, in mothers we observe a very specific use of laughter that brought us to include a new hybrid class of laughables, i.e. *pleasant/social incongruity*. In previous work conducted on adult data (Author, Year), the authors report that coders always managed to make a decision and come to an agreement during the discussion. Annotating mother laughs, prioritising one category over the other proved to be very difficult in the cases where the mother seemed to laugh at a mistake or misbehaviour, both because it was funny in itself, but also so she could smooth the situation, encourage the child, or soften a correction. We also observe a total absence of laughter related to *pragmatic verbal incongruity*, which, even if rare, is present in all the corpora of adult conversation analysed in Author (Year). Overall, in terms of laughter functions, we therefore see mothers using a narrower range of functions in comparison to the range used in adult interaction. We observe especially the absence of functions which are more distant from the original core function of laughter. We can therefore speculate that the use of different laughter functions, and potentially also the positioning of laughter (partly influenced by the function), is adapted to the interaction with the child in a similar fashion to that observed for speech, potentially being part of the calibration adopted by adults in Child Directed Speech (Cox et al., 2022).

To sum up, we observe specific and evolving patterns in mothers' laughter use, distinct from the ones observed in adult-adult interaction. Interestingly, the changes observed in mothers' laughter behaviour over time are also indirectly informative about the development of the child's cognitive, linguistic and pragmatic abilities.

7.3 Conclusion and Further Studies

Grounded in an interactional and multimodal approach to the study of language, we have provided a study of children's laughter development in natural interaction with their mothers in a familiar environment from 12 to 36 months. Our observations show how laughter behaviour (in terms of laughables and pragmatic functions) and the amount of shared attention on the interlocutor's laughables undergo a significant development, mirroring the child's cognitive, linguistic and pragmatic development. We use a framework originally developed for laughter in adult interaction (Author, Year), and this has proved to be a useful tool also for the study of laughter behaviour in children and its evolution.

Child laughter production is shown to be very different from adult laughter behaviour and to display marked developmental trajectories over the five time points considered in each layer analysed. All the changes observed over time have been discussed in the light of cognitive, linguistic and pragmatic developmental data. We offer what is to our knowledge the first detailed longitudinal analysis of laughter development from a semantic and pragmatic point of view, from 12 to 36 months. Our main contribution is to have provided evidence that laughter in interaction, rather than just laughter in response to isolated stimuli, can be a valuable source of information about the child's cognitive, linguistic and pragmatic development, complying with hypotheses from the literature. Moreover, we offer naturalistic data to refine and enrich previous models of humour development, such as the one proposed by McGhee (1979), suggesting that (in interaction) some of the stages proposed are achieved earlier than previously postulated.

We acknowledge the limitations of our study especially in terms of sample size and cultural bias (Lieven, 1994; Harkness, 1990). We nevertheless believe that it offers interesting results providing a foundation for

future studies and opening a broad range of further research questions. For example, cross-cultural adult studies on laughter show similarities, but also specific differences (see Author (Year) for a cross-linguistic corpus study and (Bryant and Bainbridge, 2022) for a review). It would be interesting to test for potential cultural differences in laughter use in caregiver-child interaction, investigating at which level of analysis they emerge and eventually at which point in development. In particular, we are interested in extending the age range of observation to the first months of life. It is at this stage that laughter observation might be most valuable. Emerging much earlier than speech and other non-verbal signals commonly used to track infant cognitive and social development (e.g. pointing, gesturing), laughter could be an effective means to track communicative and pragmatic development, and potential difficulties or delays early on. In order to further sustain this hypothesis, a parallel and comparative analysis between laughter behaviour and non-verbal communication development (pointing, gesturing, eye gaze, etc.) together with a periodic age-adapted assessment of language, social and pragmatic skills is needed. Moreover, considering our data in relation to those reported in (Cekaite and Andr n, 2019) about older children in pre-school settings, we believe it will be interesting to compare the patterns observed in toddlers interacting with their caregivers to those that could be observable in peers or in multiparty interaction, both from the adult and the child perspective.

Finally, in observing the close relation between laughter and the establishing of shared attention, we believe that a promising path of work might investigate the role of laughter and speech-laughter in child word learning. Laughter and speech-laughter are characterised by higher fundamental frequencies as compared to baseline speech (Truong and Van Leeuwen, 2007; Ludusan and Wagner, 2020), characteristics typical also of Child Directed Speech (Cox et al., 2022), which have been shown to be predictive of word learning (Grassmann and Tomasello, 2007; Graf Estes and Hurley, 2013; Ma et al., 2011; Shi et al., 2022). Laughter moreover can be used to direct attention and is often related to heightened arousal, being rewarding both for the producer and the interlocutor, and preliminary studies seem to suggest that these highly facilitate learning (Savage et al., 2017). Studies similar to those conducted on the effect of caregivers' use of heightened pitch, representational gestures, gaze, use of yes/no questions and pointing on vocabulary learning (Shi et al., 2022; Bohn and Frank, 2019; Law et al., 2012; Dong et al., 2021; Goodwyn et al., 2000) could be envisaged.

Laughter can therefore tell us a lot about the development of children from a cognitive, linguistic and pragmatic perspective. It is crucial for the development of communicative competences even before speech emerges and, later, for more complex operations related to less-probable meaning processing and intentions recognition (e.g. pretence, metaphors, hyperbole and irony). Much research is needed to further elucidate its role in language learning, the cross-cultural similarities (and potential differences) in development and its developmental trajectory in neuro-different populations.

A Video analysis details

The MLU (in morphemes) values reported are calculated over the full length of the videos partially annotated for laughter. These were computed using the MLU program in CLAN (MacWhinney, 2000). We excluded from the MLU calculation words that were unintelligible using the formula $MLU + t*CHI - t*\%mor -syy -sxx @$ for children and $MLU + t*MOT - t*\%mor -syy -sxx @$ for the mothers. We see that the children all have typical language development, with Naima standing out for her faster language development.

Child	Time	Age	MLU	Video	Transcript	Minutes
Alex	1	01;04.27	1(0)	010427	010427	30
	2	01;06.14	1.1(0.3)	010614	010614	30
	3	02;01.02	1.82(1.11)	020102	020102	30
	4	02;06.06	2.32(1.51)	020606	020606	26.5
	5	03;01.03	2.6(1.86)	030103	030103	30
Lily	1	01;01.02	1.51(0.5)	010102	010102	31
	2	01;06.11	1.33(0.54)	010611	010611	30
	3	02;00.04	2.28(2.06)	020004	020004	30
	4	02;06.04	3.15(2.31)	020604	020604	30
	5	03;00.03		030003	030003	20.12
	5	03;00.10		030010	030010	6.15
	5	sum	3.28(2.5)	-	-	26.27
Naima	1	01;00.14	1.09(0.28)	010014	010014	30
	2	01;06.04	2.82(2)	010604	010604	30
	3	02;00.04	3.63(2.66)	020004	020004	30
	4	02;06.11	3.11(2.9)	020611	020611	30
	5	02;11.23		021123	021123	15.66
	5	03;01.01		030101	030101	15
	5	sum	4.41(3.48)	-	-	30.66
William	1	01;04.12	1.22(0.43)	010412	010412	26.08
	2	01;06.05	1.27(0.66)	010605	010605	28
	3	02;00.12	1.51(0.82)	020012	020012	30.04
	4	02;06.12	2.39(1.73)	020612	020612	30.18
	5	03;00.11	3.52(2.47)	030011	030011	27.73

Table 6: Information about videos analysed – Age, links and transcripts

B Annotation protocol

The detailed annotation protocol for laughter and laughables will be available in a final version of the current manuscript.

C Decision tree for classifying laughter pragmatic functions

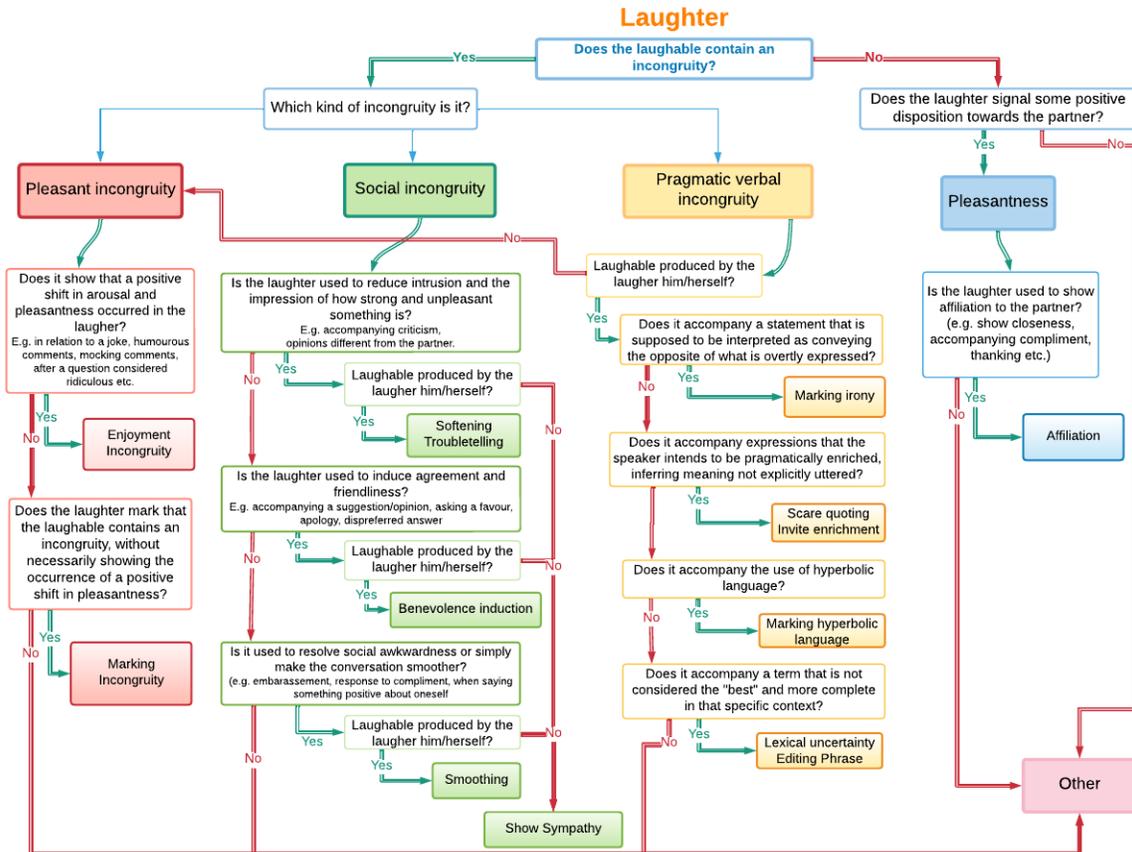


Figure 5: Decision tree for classifying the pragmatic functions of laughter (Author, Year)

D Links to video-clips

All the following video-clips are extracted from the Providence Corpus (Demuth et al., 2006), available at <https://phonbank.talkbank.org/access/Eng-NA/Providence.html>

1. William 010412 - Laughter after laughable produced by the laugher's partner (1)
<https://www.dropbox.com/s/brww582yb6se4e5/Example02.mp4?dl=0>
2. William 020012 - Laughter during collaborative laughable (2)
<https://www.dropbox.com/s/rk6evo5m1egyj0v/Example03.mp4?dl=0>
3. William 010412 - External laughable (3)
<https://www.dropbox.com/s/tehy8d5ri81w32c/Example04.mp4?dl=0>
4. Naima 010014 - Non-speech laughable produced by the laugher's partner (4)
<https://www.dropbox.com/s/k7d7z3gfy4pvdqt/Example05.mp4?dl=0>
5. Lily 020004 - Meta-linguistic laughable (5)
<https://www.dropbox.com/s/36y5ybn591e16a4/Example06.mp4?dl=0>
6. Naima 010604 - Meta-linguistic laughable (6)
<https://www.dropbox.com/s/cks7h62ozay9heb/Example07.mp4?dl=0>
7. Naima 010604 - Meta-linguistic laughable (7)
<https://www.dropbox.com/s/cegmjz7dmposhv4/Example08.mp4?dl=0>
8. Naima 020611 - Utterance content (8)
<https://www.dropbox.com/s/i05dah9i9me5ef9/Example09.mp4?dl=0>
9. Alex 020606 - Pleasant incongruity (9)
<https://www.dropbox.com/s/vxejdqm0mao2c2i/Example10.mp4?dl=0>
10. Alex 030103 - Social incongruity (10)
<https://www.dropbox.com/s/vsff76j3f5em5gt/Example11.mp4?dl=0>
11. William 010412 - Pleasant/Social Incongruity (Mislabelling) (11)
<https://www.dropbox.com/s/wjl87b3slmwmsy0/Example12.mp4?dl=0>
12. Naima 020004 - Pleasantness (12)
<https://www.dropbox.com/s/hrmm3ehjodf5ls1/Example13.mp4?dl=0>
13. Lily 030010 - Ironic laughter related to laughable produced by the laugher herself (13)
<https://www.dropbox.com/s/huhsc676rs9qm6d/Example14.mp3?dl=0>

E Annotation files

The annotations and the dataset used in the current study will be publicly available in the final version of the current manuscript.

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