Laughter in interaction : semantics, pragmatics, and child development

Chiara Mazzocconi

Thèse de doctorat

Université de Paris

Préparée à l' Université Paris Diderot

Ecole doctorale 132 - Sciences du langage
Laboratoire de Linguistique Formelle UMR 7110

Laughter in interaction: semantics, pragmatics, and child development

---

Par:
Chiara Mazzocconi

Dirigée par:
Prof. Jonathan Ginzburg

Thèse de doctorat de Linguistique

Présentée et soutenue publiquement à Paris le 27 Septembre 2019

Rapporteurs :	Scott, Sophie K. / PR / University College London
	Holler, Judith / PR / Max Planck Institute
Examinateurs :	Gervain, Judit / DR / CNRS Université de Paris
	Pelachaud, Catherine / DR / CNRS Sorbonne Université
	Morgenstern, Aliyah / PR / Université Sorbonne Nouvelle
	Priego-Valverde, Béatrice / MCF / Aix-Marseille Université
Directeur de thèse :	Ginzburg, Jonathan / PR / Université de Paris

"The most exciting phrase to hear in science, the one that heralds new discoveries, is not "Eureka! I found it!" but "That's funny . . . ""

Isaac Asimov

UNIVERSITÉ DE PARIS

Abstract

Science du Langage
Laboratoire de Linguistique Formelle - UMR 7110

Doctor of Philosophy

Laughter in interaction: semantics, pragmatics, and child development

by Chiara Mazzocconi

Laughter is a social vocalization universal across cultures and languages. It is ubiquitous in our dialogues and able to serve a wide range of functions. Laughter has been studied from several perspectives, but the classifications proposed are hard to integrate. Despite being crucial in our daily interaction, relatively little attention has been devoted to the study of laughter in conversation, attempting to model its sophisticated pragmatic use, neuro-correlates in perception and development in children. In the current thesis a new comprehensive framework for laughter analysis is proposed, crucially grounded in the assumption that laughter has propositional content, arguing for the need to distinguish different layers of analysis, similarly to the study of speech: form, positioning, semantics and pragmatics. A formal representation of laughter meaning is proposed and a multilingual corpus study (French, Chinese and English) is conducted in order to test the proposed framework and to deepen our understanding of laughter use in adult conversation. Preliminary investigations are conducted on the viability of a laughter form-function mapping based on acoustic features and on the neuro-correlates involved in the perception of laughter serving different functions in natural dialogue. Our results give rise to novel generalizations about the placement, alignment, semantics and function of laughter, stressing the high pragmatic skills involved in its production and perception. The development of the semantic and pragmatic use of laughter is observed in a longitudinal corpus study of 4 American-English child-mother pairs from 12 to 36 months of age. Results show that laughter use undergoes important development at each level analysed, which complies with what could be hypothesised on the base of phylogenetic data, and that laughter can be an effective means to track cognitive/communicative development, and potential difficulties or delays at a very early stage.

Key words: Laughter taxonomy, dialogue semantics, pragmatics, laughter functions, fNIRS, laughter development, laughter evolution, mother-child interaction, communicative development.

Résumé

Le rire en interaction:
sémantique, pragmatique et développement de l'enfant.

par Chiara Mazzocconi

Le rire est une vocalisation universelle à travers les cultures et les langues. Il est omniprésent dans nos dialogues et utilisé pour un large éventail de fonctions. Le rire a été étudié sous plusieurs angles, mais les classifications proposées sont difficiles à intégrer dans un même système. Malgré le fait qu'il soit crucial dans nos interactions quotidiennes, le rire en conversation a reçu peu d'attention et les études sur la pragmatique du rire en interaction, ses corrélats neuronaux perceptuels et son développement chez l'enfant sont rares. Dans cette thèse, est proposé un nouveau cadre pour l'analyse du rire, fondé sur l'hypothèse cruciale que le rire a un contenu propositionnel, plaidant pour la nécessité de distinguer différentes couches d'analyse, tout comme dans l'étude de la parole: forme, positionnement, sémantique et pragmatique. Une représentation formelle de la signification du rire est proposée et une étude de corpus multilingue (français, chinois et anglais) est menée afin d'approfondir notre compréhension de l'utilisation du rire dans les conversations entre adultes. Des études préliminaires sont menées sur la viabilité d'un mappage forme-fonction du rire basée sur ses caractéristiques acoustiques, ainsi que sur les corrélats neuronaux impliqués dans la perception du rire qui servent différentes fonctions dans un dialogue naturel. Nos résultats donnent lieu à de nouvelles généralisations sur le placement, l'alignement, la sémantique et les fonctions du rire, soulignant le haute niveau des compétences pragmatiques impliquées dans sa production et sa perception. Le développement de l'utilisation sémantique et pragmatique du rire est observé dans une étude de corpus longitudinale de 4 dyades mère-enfant de l'age de 12 à 36 mois, locuteurs d'anglais américain. Les résultats montrent que l'utilisation du rire subit un développement important à chaque niveau analysé et que le rire peut être un indicateur précoce du développement cognitif, communicatif et social.

Mots clefs: Taxonomie du rire, sémantique du dialogue, pragmatique, fonctions du rire, fNIRS, développement du rire, évolution du rire, interaction mère-enfant, développement de la communication.

Acknowledgements

I am so grateful to so many people for these four years that this is for me the most intense section of my thesis. I was so lucky in every encounter I made, and I got so much help and inspiration from people around me!

I firstly owe heartfelt thanks to my supervisor Jonathan Ginzburg, for taking me as his student, for being an example of creativity and curiosity both in the academic world and outside, for all the fun chats, for all the laughs produced and discussed, for allowing me to follow (as far as possible!) my passions and my inclinations, supporting me even when I really didn't expect it, as well as for bearing with my character and tolerating my unstoppable desire to go to all of the talks and trainings possible. But especially for all the fun anecdotes I'll bring with me (about which I'm not sure he's totally aware!)!

Special thanks are then for all the components of the jury: to Judith Holler and Sophie Scott for taking the time to read and correct my thesis (during summer!) and to Judit Gervain, Catherine Pelachaud, Aliyah Morgenstern and Beatrice Priego-Valverde for having accepted to come discuss my work with me. Especially thanks to Judit Gervain for having helped me so much in a moment when I felt really stuck and for being an example of talent, passion and efficiency. I owe also deep thanks to Sophie Scott for having welcomed me in her lab, offering me her time and allowing me, despite the total lack of experience, to conduct my first brain imaging experiment. I will bring forever with me memories of the long hours spent with Gulun Jin, an amazing work mate and friend, preparing stimuli and trying to figure out stuff! I am also very thankful to Paola Pinti for her precious help and time spent trying to fill my lacunae!

I am very grateful to all the Laboratoire de Linguistique Formelle for having been a very stimulating working environment and to the Labex EFL for offering me the possibility to take part in conferences and summer schools which turned out to be really valuable experiences for my personal and professional growth. I am especially thankful to Marina Davila Ross for allowing me to take part in a life changing experience with the Danau Girang Field Centre in one of the most magical place I've ever been, teaching me to observe with patience and method animal behaviour and putting all my research in perspective; and thanks to Danica Stark for accompanying me in this exciting and moving experience, through trees, rivers, primates and crocodiles of the Borneo tropical rainforest. Thanks also to all the organisers and participants of the 16th International Summer School and Symposium on Humour and Laughter for being such a warm, light-hearted, fun and welcoming community and to all the friends with whom I shared ESSLLI 2018 for being a special team to spice up long days of learning!

A special place in my heart is taken for sure by Ye Tian, without which this all PhD adventure would have never started! For encouraging me since my master in going on and not being scared of the unknown, for being an example of sparkly creativity and intelligence at the service of an enthusiastic search for knowledge.

A big grateful hug is then for Vlad, for our uncountable Skype calls, for being one of the few person I could talk with about a single laughter for hours! For being an amazing conference and party mate! For showing me around Saint Petersburg and for being always serene and encouraging. The one that, knowing it or not, was a special rock in the last two years of this adventure.

I'm enormously thankful to Yair for having helped me for statistical analysis in the (very very) last days of my PhD, for having accepted to be engulfed by my questions, for having kindly embraced my worries and for having spoken Italian during our meetings, which made stats-talk so much sweeter for me! I really wish I had met him sooner!

Crucial companions in my PhD adventures have been my office-friends (my Hippos!): Vero, Maud, Eimear and Lea, thanks for making our office such a fun and safe place where to be, and for listening to all my stories! More specifically I thank Maud for being our Hashtag, example of a very good researcher and teacher for all of us. For being always very positive, lively, determined, organised (we really needed someone like you in the group!!), for our trips to Le Pouliguen, to Rome and for all the advice in any little bureaucratic (and not!) step I made in this 4 years. Special thanks are also for Vero, for her contagious, and probably never attested before!, deep curiosity about any topic on earth! For being so passionate about details, so sensitive, strong and.... for all the good food she has always prepared for Thanksgiving day!! And then sweet thanks to Eimear! For being always the best shoulder in my roller-coasters, for being the best hugger in the world, for teaching me so much about Ireland and politics and.... for your amazingly incredible sun burns!!!

Despite time has passed, I still owe deep thanks to Markus, who during one of our random night chats about my random readings in the UCL world told me "Why don't you write your thesis about this?" Of course I laughed! But he was serious! And since then he pushed me to structure the ideas I had and to find people I could work with! At points I was not sure whether I should thank or hate him for this but... I'm now definitely grateful and amused by how a random chat with a close friend can draw the path of your life for the next 6 years! I hope he could be closer these days! A lot of colourful thoughts go then to Giames, a special friend who attempted to make me juggle when my brain was melting and that, despite everything, keeps being close to me since the very beginning of my academic adventure! Able to write the best letters, suggesting the best books and making the best pictures ever! And who always opened to me his doors when begging for a roof in London. Same sweets thoughts are also for Elisa and Kim! The sweetest djs! With the most cosy nest and

the most comfortable couch in London! For all the lovely night chats on the terrace, the colours, for their unconditioned hospitality and for making me scratch for the first time (between experiments!)!

Thanks to my little (and not little anymore!) patients for being huge sources of laughter, distraction, work and inspiration at the same time!! For keeping me playing on the floor when academia was making me spend long hours with computers!

And thanks to Paris for being a very special frame of these intense years, for catalysing some encounters that will be in my hearth forever! Thanks to Colette for taking me in her atelier even if I could not speak a single word of French, for offering me the best motivating context to learn it and for having dedicated some of her time to my projects! A special thanks also to Mordjane for being the best "coach" I've ever had, for her smiles, for making my Wednesday evenings sparkly, for taking up the challenge of making my muscles do something again (!), for making them feel happy and playful on a trapeze, for pushing me beyond the fear of not making it, and for making me look at my week from high, playing and laughing. And thanks to all the Faun Arts staff and friends for being such a nice welcoming family!

No less importantly, thanks to the amazing "Parisian" group that kept me happy and alive in these years! Thanks to Diego for our never-ending chats about *massimi sistemi*, for trying to explain me complicated physics concepts about time, space and energy, for being my favourite and most creative bike-doctor, for his passion and incredible curiosity (fostered by procrastination!)! Especially thanks for all the hours spent together in front of our computers trying to figure out all kinds of Python scripts!! A good quarter of this thesis could not have been written without his patient and sweet help! Thanks to Yulia, for being one of the first person able to deal with and amplify all of my facets, a special companion for enjoying Paris to the fullest! Thanks to Federica G. for her laughs, for all the baguettes and viennoiseries, for being with me when I broke my right arm and I was a useless human being, for her sweet thoughts and creamy heart! Thanks to Annina for her sparkly hyperactivity and positive energy, for being sweetly reckless and for attempting to teach me snowboarding! Thanks to Federica M., for being always so light-hearted, for being the best circus mate, motivating me even when I couldn't motivate myself, for the cosy dinners at her place and for saving me more than once from impossible dangerous positions on the trapeze! Thanks to Lorenzo for being a constant source of inspiration! So incredibly clever and good in anything he does (within and outside academia!)! And especially thanks for attempting to speak with me about stats, and for saving my life in one of my deepest Matlab crisis! Thanks to Flavia for caring so much about her and our stomachs, making us feel home in the "deep north". Thanks to Francesco, Tommaso and Davide for having shared one of the most restoring holiday ever! Especially thanks to Francesco for having listened and tutored me so much

in these years, thanks to Tommaso for being a *comare* and thanks to Davide for the sunrise in Belleville, the exploded cappuccino and for the music. Thanks to Luca for being a brother during the first years, for his constant enthusiasm, for all the "stupid" afternoons and evenings spent together, for the irrational New Year's Eve plans, for skating in Decathlon, for helping me buying Heureusité, for the kilometres biked together, for the concerts and for all the parties and bbq at his amazing place! Thanks to Irene for having sewn my head back together! Importantly then, thanks to Anna, Manuel and Giorgio for being the best family I could hope for, making the arrival in Paris sweet and easy, and making the melancholy of the first nights far from home fade away!

And then thanks to my Roman heart made of very precious people. The first super big thanks is for Tattu for being the best life, travel and PhD companion in the years! And because every time I travel I think about how beautiful it would have been to have her with me! Thanks to Elena for being there since the veryvery beginning with her witty and annoying comments! Thanks to Livia and Daniela for being "assennate con amore" and for proving everyday that love has *no borders*! Thanks to Marco for being (fortunately or unfortunately -as we say!) always close to my heart, being able to understand me and help me with no words! Thank also to all the *Pomodori*, for making me forget about my duties so easily as soon as I land in Rome!

And thanks to Liliana, for making me dream every time we meet! Because "Noi sarte.... possiamo fare tutto!" And for supporting me despite the disappointment when I told her I was leaving Rome, deciding to dedicate my time to something else... and for being my safe and happy nest every time I come back home.

Finally a super deep thanks to my parents, for being so crazily themselves, so intense in every second, for being the highest example of passion, love for other people and dedication in every millimetre of their life, for being supportive in every step, for all the calls that I didn't pick up and for all the boxes full of food and oil, because opening them I found always so much nourishment, and not only for the stomach!!! And to my brother, er Bestia, for being so different, for being everything I lack! For being an example of very raw kindness and cleverness covered in annoying and fun spikes!

And very colourful and special thanks to Claudio... for being there ogni giorno, for being an example of mind openness in every respect, for being so free, for being the best researcher I've ever met, for offering a smile to anyone, for colouring every day, for being funnily fun, for dancing at home if the soirée didn't work out, for getting enthusiastically caught up in my passions, for all the uncountable little things, for feeding me (especially the last months!), for taking care I would go to sleep every now and then and especially for teaching me profoundly that after all... laughter is the most important thing!!

Publications

1. Jonathan Ginzburg, Chiara Mazzocconi and Ye Tian. Laughter as Language. (Submitted).

2. Chiara Mazzocconi, Ye Tian and Jonathan Ginzburg. What's your laughter doing there? A taxonomy of the pragmatic functions of laughter. (In resubmission for the Journal of Transactions in Affecting Computing).

3. Chiara Mazzocconi, Qing Cai, Gulun Jin, Judit Gervain, Jonathan Ginzburg, Sophie K. Scott. Perception of laughter related to different laughables in spontaneous conversation: a fNIRS pilot study. Society for Neuroscience, Neuroscience 2018, San Diego, California, November 3-7, 2018.

4. Chiara Mazzocconi, Vladislav Maraev and Jonathan Ginzburg. Laughter repair. In Proceedings of AixDial 2018, the 22nd Workshop on the Semantics and Pragmatics of Dialogue (SemDial), Aix-en-Provence (France), November 8-10, 2018.

5. Chiara Mazzocconi, Vladislav Maraev and Jonathan Ginzburg. Clarifying laughter. In Proceedings of the Laughter Workshop 2018 (pp. 16-20), Paris, France, September 27-28, 2018.

6. Jonathan Ginzburg, Chiara Mazzocconi, Ye Tian Interaction, Appraisal, and Non-Verbal Social Signal Meaning, Cognitive Structures 2018, Düsseldorf, September 13, 2018.

7. Vladislav Maraev, Chiara Mazzocconi, Christine Howes, Jonathan Ginzburg, Integrating laughter into spoken dialogue systems: preliminary analysis and suggested programme. In Proceedings of the FAIM/ISCA Workshop on Artificial Intelligence for Multimodal Human Robot Interaction (pp. 9-14), Stockholm, Sweden, July 14-15, 2018.

8. Chiara Mazzocconi, Vladislav Maraev, Christine Howes, Jonathan Ginzburg, Analysis of laughables: a preliminary perception study. In Proceedings of the Workshop on Dialogue and Perception 2018 (pp.43-48), Gothenburg, Sweden, June 14-15, 2018.

9. Chiara Mazzocconi. Book Review: Oring, Elliot (2016). Joking Asides: The Theory, Analysis and Aesthetics of Humour. University Press of Colorado. The European Journal of Humour Research, 5(3), 101-103.

10. Chiara Mazzocconi, Ye Tian and Jonathan Ginzburg (2016). Time alignment between laughter and laughable. The 4th European and 7th Nordic Symposium on Multimodal communication, Centre for Language Technology, University of Copenhagen.

11. Ye Tian, Chiara Mazzocconi, and Jonathan Ginzburg (2016) 'When do we laugh'. In Proceedings of the 17th Annual Meeting of SigDial the Special Interest Group on Discourse and Dialogue (pp. 360-369), USC.

12. Chiara Mazzocconi, Ye Tian, Jonathan Ginzburg. (2016) Multi-layered analysis of laughter. In Proceedings of SemDial, JerSem, the 20th Workshop on the Semantics and Pragmatics of Dialogue (pp. 97-107), New Brunswick.

Contents

List of Figures

List of Tables

Chapter 1

Whys and hows

1.1 Why this thesis?

Laughter is a social vocalization universal across cultures and languages (Ruch and Ekman, 2001; Sauter et al., 2009), commonly, but not exclusively, associated with positive emotional feelings. It is one of the oldest forms of non-verbal communication, both from a phylogenetic (Ross, Owren, and Zimmermann, 2010; Vettin and Todt, 2005; Leavens, 2009) and ontogenetic (Sroufe and Wunsch, 1972; Wolff, 1987) perspective, pervasive in social interaction and crucial for bonding (Martin and Kuiper, 1999; Provine and Fischer, 1989).

Laughter has been the subject of philosophical speculation since ancient times by thinkers such as Plato, Aristotle, Cicero, Hobbes, Kant and Schopenhauer, among many others (Kozintsev, 2011; Chafe, 2007), who provided insights that are still at the centre of current theories about laughter and humour. Perhaps unsurprisingly the study of laughter has often been linked to the study of humour and the two terms frequently used interchangeably. In recent years it has received growing attention from different disciplines ranging from biology, neuroscience, psychology, linguistics and anthropology.

However, laughter does not occur only in response to humour. Especially studies in conversation analysis have shown its crucial role in managing conversations at several levels: dynamics (turn-taking and topic-change), lexical (signalling problems of lexical retrieval, imprecision in the lexical choice), pragmatic (marking irony, disambiguate meaning, managing self-correction) and social (to smooth and soften difficult situations, to show (dis)affiliation and mark group boundaries) (Wessel-Tolvig and Paggio, 2017; Cosentino, Sessa, and Takanishi, 2016; Potter and Hepburn, 2010; Glenn and Holt, 2013; Petitjean and González-Martínez, 2015; Shaw, Hepburn, and Potter, 2013; Jefferson, 1984).

Importantly, research in psychology has focused on laughter as an emotional expression (Ruch and Ekman, 2001; Martin, 2010), and on the important effects that it can have on interlocutors (Bachorowski and Owren, 2001; Ruch, 2009); highlighting the effects of empathy and mentalising abilities in its production and perception (McGettigan et al., 2013). Also, the fact that neurological studies found two distinct pathways for spontaneous and volitional laughter production (Wild et al., 2003),

and that speakers tend to use it more than listener (Vettin and Todt, 2004), stress the importance of its use in order to shape meaning and effect on interlocutors (Bachorowski and Owren, 2001).

The social function of laughter is so deep-rooted that it is one of the behaviours for which contagious effects can be observed, fostering bonding and affiliation (Provine, 1992; Bush et al., 1989; Hatfield, Cacioppo, and Rapson, 1994). Interestingly also in apes it is possible to observe fast replication of laughter (Davila-Ross et al., 2011). Despite some similarities regarding laughter behaviour in primates, they have been shown to produce laughter exclusively in the context of play and tickling (Ross, Owren, and Zimmermann, 2010; Matsusaka, 2004; Owren and Bachorowski, 2001; Provine, 2001; Vettin and Todt, 2005; Van Hooff and Preuschoft, 2003). Many laughter uses observed in human interaction are therefore absent in primates (Gervais and Wilson, 2005; Owren and Bachorowski, 2001; Davila-Ross et al., 2011).

Laughter has therefore been studied in many different fields, and many researchers have attempted at classifying it. The taxonomies proposed though are hard to integrate, both because they arise from different perspectives and have different aims, and because classes of laughter proposed are often not mutually exclusive and confusions between levels of analysis are present. A comprehensive taxonomy of laughter able to account for all of its uses and able to integrate insights from previous works is still lacking.

Even though work from conversational analysis has stressed the role that laughter plays in interaction and how it can affect meanings, there has been little work on laughter within formal grammar. A possible reason for this lack of interest is the assumption, arguably stemming from Kant (1790b), that laughter has no propositional content (Potter and Hepburn, 2010; Hayakawa, 2003). With isolated exceptions, such as Ginzburg et al. (2015), no account of laughter meaning and its interaction with linguistic import is therefore available.

In contrast, extensive work is available investigating the acoustic features of laughter. Notably, research shows that laughter form displays more intra- rather than inter-variability (Urbain and Dutoit, 2011a; Ruch and Ekman, 2001). Bachorowski, Smoski, and Owren (2001), Kipper and Todt (2003), and Vettin and Todt (2004) studied the perception of spontaneous laughter produced while watching a funny video-clip and found out that depending on their voiced or unvoiced features, laughs were perceived as more or less positively by listeners. In the strive to classify laughter types some researchers have proposed to distinguish classes of laughter function based on their form, arguing for the possibility of a form-function mapping (e.g. (Szameitat et al., 2009a; Tanaka and Campbell, 2014)).

Studies in clinical populations have highlighted important aspects about laughter. In populations where lexical and syntactic language abilities are impaired (e.g. aphasia and dementia), laughter comes to be used frequently to manage interaction, convey meaning and disclose intentions and opinions, more so than in healthy controls (Madden, Oelschlaeger, and Damico, 2002; Lindholm, 2008). 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 difficulties are faced both in adequate and comprehensible production and in perception (Samson, 2013; Reddy, Williams, and Vaughan, 2002; Polimeni and Reiss, 2006).

Despite these data and laughter pervasiveness in conversation, in the field of neuro-psychology little attention has been devoted to the perception and production of laughter in conversation with most of the effort being dedicated to the study of laughter, produced or perceived, in isolation as a response to humourous stimuli (e.g. McGettigan et al. (2013)) or recorded by actors asked to express different emotions through laughter (e.g. Szameitat et al. (2010)). Therefore little is known about the processing of laughter occurring in conversation.

Finally, studies in children development, despite viewing laughter as a marker of cognitive mastery, have tended (with very few exceptions - e.g. Nwokah et al. (1994) and Reddy, Williams, and Vaughan (2002)) to focus exclusively on laughter as a response to humorous stimuli or on humour itself (e.g. Sroufe and Wunsch (1972) and Loizou (2005)). Detailed research on how the complexities observed in adult conversations emerge in interaction, however, is lacking.

1.2 Aim of the thesis

Research therefore shows that laughter is a much more complex behaviour than previously thought, both in response to isolated humour stimuli and in its conversational use. The main aim of my work is to deepen our understanding of laughter semantics and pragmatics in adult conversation, and to then explore its development in children.

In light of the above, my thesis attempts at filling some of the gaps in the literature, answering the following research questions:

1. How can laughter be classified in a systematic and reliable way accounting for its multifaceted nature?

2. How is laughter used in dialogue? How to develop a formal theory of the meaning of laughter?

3. Laughter can serve a variety of functions in interaction, can we identify a form-function mapping in laughter productions?

4. Do different types of laughter require different levels of pragmatic reasoning about others' mental states? Is that mirrored in neuro-cortical activation?

5. Does laughter behaviour in interaction develop during childhood? Can laughter be informative of pragmatic development? How can we relate laughter use in humans and primates?

1.3 How?

My approach will be dialogical, I will focus specifically on laughter, trying to account for all of its uses in interaction, whether humour is present or not. As essential starting points I will take the proposal put forward originally first by Plessner (1970) and then by Glenn (2003) and Ginzburg et al. (2015) that laughter conveys meaning; and the hypothesis that laughter comprehension and production rely importantly on contextual and pragmatic reasoning (Reddy, Williams, and Vaughan, 2002).

Multimodal approach to the study of language My work is crucially rooted in the by now generally well-accepted conviction that communication in interaction involves multiple modes and channels outside of speech, capable of conveying meaning (Iedema, 2007; Jones and LeBaron, 2002; Kress and Van Leeuwen, 2001; Streeck, Goodwin, and LeBaron, 2011; Wierzbicka, 2000). Those visual, paralinguistic and embodied meaning-making elements are pervasive in our interaction, and a deeper understanding of these could provide opportunities for new and interesting theoretical, empirical and methodological insights (Bell and Davison, 2013; Jancsary et al., 2017). An example of this is the study conducted by Tian, Maruyama, and Ginzburg (2017) on disfluencies in relation to the self-addressed questions they accompany. Although traditionally disfluencies have been seen as errors that should be excluded from linguistic analysis, they found that different types of disfluencies accompany different types of self-addressed questions, providing information about different types and degrees of the problem faced by the speaker: lexical, syntactic, or about the structuring of the message to be conveyed. These *extra-verbal* channels are indeed more intertwined with linguistic import than previously thought (Batliner et al., 2010), and therefore they should not be studied in isolation, given the possibility of intersections and alignment to generate meaning (e.g. Rieser (2015), Nygaard and Queen (2008), and Portes and Beyssade (2015)). Sometimes they even compensate for lacunae and limitations in languages, and enhance expressiveness and understanding (Goldin-Meadow and McNeill, 1999). Speaking about laughter more specifically, it is not only a suprasegmental overlay on the segmental organisation of speech (Nwokah et al., 1999): unlike stress and prosody (also modifiers of meaning) laughter can even standalone and can constitute in itself a meaningful communicative act, being often carefully embedded in the syntactic structure (Glenn, 2003; Batliner et al., 2010).

In recent years, also in the field of formal semantics there has been growing interest in developing frameworks that can capture context, cognitive states and language in its multimodality with the precision and rigour that formal semantics initiated to sentence grammar (Ginzburg, 2012; Purver, 2006; Poesio and Traum, 1997; Rieser and Poesio, 2009). A dialogical perspective on grammar synthesizing these views is developed in (Ginzburg and Poesio, 2016) and from a closely related

perspective (Kempson et al., 2016). Specifically, in the current thesis, I will propose an integration of laughter in dialogue semantics within the framework KoS[1].

Multi- and Inter-disciplinarity In order to deepen our knowledge about laughter behaviour in adults and children, I take a radically multi- and inter-disciplinary approach (Choi and Pak, 2006). I believe indeed, that especially for a complex behaviour like laughter, it is impossible to avoid a multidisciplinary approach when aiming to integrate insights from diverse disciplines such as psychology, biology, neurology, physiology and linguistics[2]. In my work I therefore used a variety of methods, investigating aspects of laughter semantics and pragmatics from different angles, aiming at a comprehensive understanding of the data collected, and always interpreted in the light of findings from different disciplines and areas of research.

I make use of corpus study methods, of acoustics analysis, a behavioural experiment, a questionnaire study and neuro-imaging techniques. This is all in support of gaining deeper insights into the semantic and pragmatic use of laughter in interaction. In the analysis of the corpus data I take both a quantitative and a qualitative approach, to see both the bigger picture and the nuance in the details and the unavoidable cases of blurred boundaries - I believe that the classification is not 'the end of the story', but a starting point for gaining deeper insights into conversational dynamics (Haakana, 2002; Steensig and Heinemann, 2015).

1.3.1 Structure

In **Chapter 2** I take up the challenge of formulating a framework for laughter analysis which unifies insights from previous research in different disciplines. As will be discussed in detail, previously available laughter taxonomies are highly diverse and, consequently, difficult to integrate, partly because they were proposed by researchers in different fields (psychology, linguistics, biology, neuro-science, anthropology) and driven by very different research goals. One of the central assumptions that shapes my work is that laughter analysis can be decomposed into different layers, similar to what has been done for centuries in traditional linguistics: separating out the acoustic and phonetic form, the positioning in the larger discourse structure (syntax), the semantics, the pragmatics and the social effects, goals and functions for interactions. This thesis therefore proposes, in line with Plessner (1970), Glenn (2003), and Ginzburg et al. (2015) that laughter *deserves* a semantic layer, i.e. laughter has propositional content.

In order to test this assumption and understand the dynamics of how laughter meaning arises and get incrementally composed, I conducted two different corpus

[1] KoS is a toponym – the name of an island in the Dodecanese archipelago – bearing a loose connection to *conversation-oriented semantics*.

[2] I think it is appropriate here to borrow a famous disclaimer from Schrödinger (1967/1944:1) saying *"...that some of us should venture to embark on a synthesis of facts and theories, albeit with second-hand and incomplete knowledge of some of them–and at the risk of making fools of ourselves."*

studies. The first investigates the applicability of the framework proposed and explores the details of laughter use in adult conversation in 3 different languages (French, Mandarin Chinese and English) (**Chapter 3**); the second looks more specifically at the questions that interlocutors happen to ask in order to clarify laughter meaning and arguments, and uses them as a diagnostics for the components interlocutors need to interpret laughter meaning (**Chapter 4**). In **Chapter 5** I try to systematise the insights from both building a framework for the analysis of laughter and the two corpus studies described above, in order to integrate laughter into a dynamic model of dialogue semantics.

Laughter can serve many different functions in interaction and some scholars claim that a mapping between form and function is possible. **Chapter 6** tests whether this hypothesis holds true when parameters relative to other levels of analysis are held constant, conducting an acoustic analysis comparison between laughter similar in everything but pragmatic function. An analysis of this kind could have significant implications both for the implementation of dialogue systems aiming to interpret and produce laughter effectively, as well as for therapeutic treatments. More importantly, it provides evidence about whether, from a neuro-psychological point of view, context is an important factor in the interpretation of laughter functions or whether people can simply rely on lower level features like acoustics.

Still with the aim of exploring the neuro-psychological processes involved in the interpretation of laughter serving different functions, I conducted a pilot neuro-imaging study (**Chapter 7**). The main question was whether different laughter uses might differ in their pragmatic complexity in perception, with some requiring more need for mentalising compared to others. This hypothesis is based on recent results from neuro-imaging laughter perception studies (McGettigan et al., 2013) and on data related to the atypical laughter use and comprehension in populations where pragmatic abilities are typically particularly undermined (e.g., autism and schizophrenia) (Reddy, Williams, and Vaughan, 2002; Samson, 2013; Polimeni and Reiss, 2006; Hudenko, Stone, and Bachorowski, 2009).

Finally, having set a benchmark for the sophisticated adult laughter use, I explore how the complexities observed in laughter interpretation and production could evolve in children development and whether that could give us insight into laughter evolution. In **Chapter 8** I report a detailed longitudinal study looking at laughter use in mother-child interaction from 12 to 36 months, from a semantic and pragmatic perspective.

1.4 Summary

To sum up, and to anticipate the main points, my work puts forth the following hypotheses:

1. For an accurate and informative analysis of laughter, able to comprehensively unify insights from different fields, we need to distinguish different levels,

similarly to the study of traditional linguistics: the form, the positioning, the semantics, the functions and the pragmatic effects on dialogue, on the interactions and on the relationship between interactants;

2. Laughter has propositional content and interacts with linguistic import;

3. The interpretation of laughter functions cannot rely exclusively on the acoustic features of the laughter, but involves more complex pragmatic reasoning requiring contextual reasoning and inferences about others' attentional, emotional and intentional states;

4. The sophisticated pragmatic use of laughter observed in adults is not innate, but evolves in interaction and undergoes important development, offering insights about laughter evolution. Observing laughter use in early childhood can, therefore, be informative about the development of specific neuro-psychological processes and, when analysed in detail, could be used as an early marker of communicative and social development.

Figure 1.1 offers a graphical overview of the thesis structure, with links to specific chapters that might help navigation.

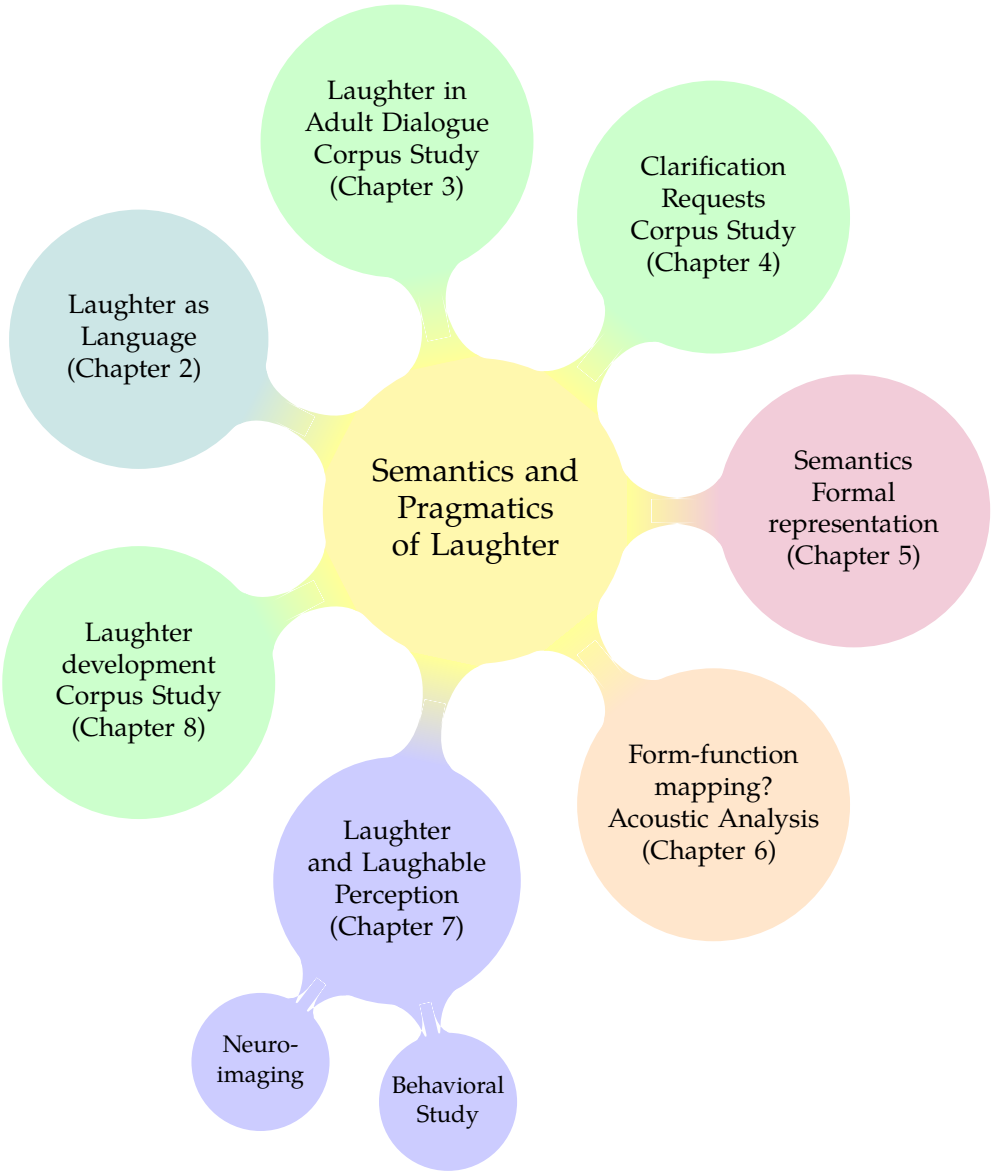


FIGURE 1.1: Thesis structure

Chapter 2

Our Framework

2.1 Why this chapter?

Classifying the functions of laughter, due to its complexity and multifaceted nature, is a tricky task and so far, as I will show, no consensual approach has emerged across disciplines.
In the current chapter I will argue, making an analogy with the study of language, that there are different levels relative to the analysis of laugher: form, positioning, semantics and pragmatic functions[1]. I think that overlooking these distinctions is a significant cause of the difficulties in integrating results from different studies. One of the crucial points of the approach proposed is that laughter has a core propositional meaning, which when aligned with rich contextual reasoning can yield a wide range of functions (Ginzburg et al., 2015).
On the basis of this theoretical position, I will propose a new, comprehensive taxonomy, aimed to unify insights from previous works. I believe that this might be a useful tool to guide a more detailed analysis of laughter semantics and pragmatics in conversation, both in healthy and clinical populations, as well as offering a base for the integration of future insights that research might bring and be a useful means to generate research questions, test hypotheses and bring forward our understanding of laughter behaviour. No less importantly, the work here presented will be potentially useful for the implementation of dialogue systems, aiming to fully comprehend and respond naturally to users.

In the introduction (Section 2.2) I propose a brief review of some approaches to the study of laughter which suggest that laughter involves complex pragmatic skills in its use and perception and that it has a crucial role in our interactions; in Section 2.3 I will critically review existing taxonomies, stressing the importance of adopting a system of analysis that distinguishes different levels. The main body of the chapter (Section 2.4) will be devoted to a detailed presentation of a multi-layered framework. I will argue that laughter has propositional content and important effects on the semantics of our utterances. In section 2.5 I will propose a taxonomy for the classification of laughter function guided by a binary decision tree.

[1]The reflections and framework proposed in the current chapter are the results of a collaboration with Ye Tian and Jonathan Ginzburg (Mazzocconi, Tian, and Ginzburg, 2016; Mazzocconi, Tian, and Ginzburg, 2019).

The results of this chapter find their first application in a corpus study of natural dyadic interaction in Chapter 3.

NOTE: In the current work, when reporting extracts of conversations, I will use the annotation guidelines used in the DUEL corpus (Hough et al., 2016). Especially relevant will be these two conventions:

Tag	Description	Example
< laughter/ >	laughter bout	thats cool < laughter/ >
< laughter >< /laughter >	laughed speech	< laughter >yeah< /laughter >

Acknowledging that in written form the examples reported will lack all of the richness brought by prosody and the laughter acoustic form in itself, so crucial for the pragmatic interpretation of the dialogue, audio-files (and videos when possible) will be provided for most extracts via hyperlinks.

2.2 Introduction

Laughter is a social vocalisation universal across cultures and languages (Ruch and Ekman, 2001; Sauter et al., 2010). Laughter has received growing attention from several fields such as philosophy, linguistics, psychology, neuroscience, ethology and computer science. This research has demonstrated that rather than being a trivial non-verbal vocalisation, laughter is a very complex behaviour both from an emotional, social-cognitive and linguistic perspective. It can inform us about cognitive and emotional processes and evaluations, both when occurring in relation to humourous events, but also when occurring in a wide range of other possible contexts that require different interpretations and responses from the conversational partner(s). It can express amusement, joy, success, and relief; it can occur when we feel embarrassed, angry, sad or bitter; it can be a tool to cope with tragic or painful situations; and it can also be produced ironically or for reasons of politeness (see (Glenn, 2003; Glenn and Holt, 2013)). Laughter in the context of a conversation can also be used to maintain the flow of interaction, the interest and attention of the listener (Foot and Chapman, 1976) and, given that it has propositional content (Ginzburg et al., 2015), can modify the content of utterances. Its relevance for enriching conversational exchanges is supported also by the unexpected finding of speakers tending to laugh significantly more than their audience (Provine, 1993; LaGreca et al., 1996; Vettin and Todt, 2004). Research from conversational analysis has also shown its

role in giving feed-back to the conversational partner (Poggi and Pelachaud, 2000), managing turn-taking and change of conversational topic (Norris and Drummond, 1998; Madden, Oelschlaeger, and Damico, 2002; Milford, 1977; O'Donnell-Trujillo and Adams, 1983). Thus, throughout linguistic and communicative development, laughter is an important component of interaction, requiring sophisticated pragmatic skills together with cognitive and emotional attunement to other people.

Laughter has been of interest to many scholars and has been studied from many different perspectives, but due to the very different methodologies, terminologies and classifications used it is a significant challenge to integrate all the results. Many authors have attempted to classify laughter functions (e.g. Poyatos (1993), Campbell, Kashioka, and Ohara (2005), Tanaka and Campbell (2014), Vettin and Todt (2004), and Jokinen and Hiovan (2016)), but it is tricky to come up with a comprehensive taxonomy also due to the multifaceted nature of laughter and the difficulty in discriminating triggers, meaning and functions.

2.3 Why different layers of analysis?

Our work builds on millennia of reflections by philosophers, linguists, and psychologists. The search for the nature of laughter indeed goes back at least as early as Aristotle (McKeon, 2009) and has also been discussed by Kant (Kant, 1790b), Hobbes (Hobbes, 1994), and Bergson (Bergson, 1901) among many others (see Morreall (1983) and Kozintsev (2011) for reviews), being often, not surprisingly, intertwined with the elaboration of theories about humour. Our approach is *dialogical*, in that it attempts to understand and account for all the occurrences of laughter in conversational interaction, whether humour is present or not. The following review is not intended to discredit previous work, but to highlight the limitations that the taxonomies proposed would have from a semantic perspective.

2.3.1 Existing taxonomies

In the literature of the last decades, many taxonomies for laughter has been proposed, from different disciplines and for very different aims. We believe that one reason for the lack of agreement, and even for inconsistency within systems themselves, is that there are several layers relevant to distinct types of laughter. Sometimes, discussions about distinct "types" of laughter have been in fact about different layers of analysis. Laughter classification encompasses at least three areas: sound, context, and function. Studies of the sound of laughter analyse phonetic, acoustic, paralinguistic, kinesic and anatomical features (e.g., Poyatos (1993), Urbain and Dutoit (2011b), Trouvain (2003a), and Provine and Yong (1991)) or propose constitutive elements of laughter (Kipper and Todt (2003), Trouvain (2003a), Bachorowski, Smoski, and Owren (2001), Campbell, Kashioka, and Ohara (2005), Tanaka and Campbell (2014), Nwokah and Fogel (1993), and Ruch and Ekman (2001)). Our focus here is on contextual and functional classifications.

Contextual classifications and unfunniness

Studies on the contexts where laughter occurs investigate the position of laughter in relation to the stimulus and the position of a laugh in relation to speech (both from the person laughing and the conversational partner) and others laughter. Studies of laughter stimuli generally distinguish those that are funny (though that in itself is a tricky matter to characterise) and those that are not. It has been suggested that contrary to "folk wisdom", most laughter, in fact, follow banal comments (Coates, 2007; Provine, 2004; Morreall, 1982).

The second level of contextual analysis concerns the position of laughter in relation to the laughter (or lack thereof) of a partner. With mildly differing parameters and timing thresholds, several authors distinguish between isolated laughter, i.e. laughter not shortly preceded by others laughter (Nwokah et al., 1994), reciprocal/antiphonal/chiming in laughter, i.e. laughter that occurs shortly after a partner's laughter (Nwokah et al., 1994; Smoski and Bachorowski, 2003; Hayakawa, 2003), and co-active/plural laughter (Nwokah et al. (1994) and Hayakawa (2003)). In Vettin and Todt (2004), a taxonomy based on a combined analysis of positioning in relation to others' speech, laughter, and turns, is proposed. They put forward an initial distinction between speaker and audience laughter. Subsequently, they characterise the event preceding the laughter as being a complete sentence, a short confirmation, or a laughter bout. Combining these parameters, they obtain 6 mutually exclusive contexts where laughter can occur (see Figure 2.1).

TABLE 2.1: Context classification in Vettin and Todt (2004)

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

Vettin and Todt (2004) therefore use exclusively timing parameters (i.e. what precedes and what follows) to support claims about laughter eliciting situations. However, their classification runs into problems in the way it deals with the referentiality of laughter, specifically with what in the rest of the current work, in line with Glenn (2003) I will call *laughables*, those events or states the laughter is related to. Laughter can concern both events that precede or follow it, but also events or

utterances with which it overlaps. Timing parameters are not optimal as a means for inferring laughables given that significant time misalignment can occur between the laughter and the laughable, namely their potential lack of adjacency (see Chapter 3 for a detailed corpus study about laughter positioning in relation to laughables). In my view also the distinction between speaker and audience can be problematic, indeed often a subject might laugh while speaking, but the laughter produced might be a response to the conversational partner's previous comment, rather than being a modification of her current contribution.

The proposal from Provine (1993) that most of the time laughter is related to rather banal comments is based on the assumption that a laugh refers to what immediately precedes it. However, as we have already pointed out, there is a rather free alignment between laughter and its laughable. Moreover, even if the laughable is the immediately preceding contribution, funniness rarely lies simply in the utterance itself, but is most frequently to be found in the relation between that utterance and the context or can reside in the enriched content of the utterance, not necessarily accessible to an overhearer. Therefore, it is misleading to come to any conclusion about what laughter is about by analysing merely what immediately precedes it. To see this, consider (1), where the expression 'du cours de sémantique de ce matin' is not humourous in itself. Nonetheless, we cannot assume that the laughter is not related to humour, since it is only the enriched denotation of 'the semantics class of this morning', accessible only to the interlocutors that should be judged as amusing (or not). PC is indeed sure that MA will remember the funny event that happened during the morning semantics class.

(1) *Example from Priego-Valverde et al. (2018)*
PC: t'aimerais parler de quoi?
MA: du....
PC: < smiling voice > du cours< /smiling voice > < laughter >de sémantique+de ce matin< /laughter >

PC: what would you like to speak about?;
MA: about...
PC: about < smiling voice > *the semantics class* < /smiling voice >< laughter > *of this morning* < /laughter >

Functional classifications

Regarding the functional classification of laughter, the debate is still quite unresolved. Many taxonomies have been proposed; some contain as few as two types, whereas others contain dozens. Szameitat et al. (2009b) distinguish between physical (tickling) and emotional laughter (including joy, taunts, and schadenfreude). Poyatos (1993) bases his classification on the social functions that laughter might have. He defines laughter as a paralinguistic differentiator (one that allows the differentiation

of physiological and emotional states and reactions among interlocutors). He distinguishes at least eight social functions: affiliation, aggression, social anxiety, fear, joy, comicality and ludicrousness, self-directedness, amusement, and social interaction. Shimizu, Sumitsuji, and Nakamura (1994) identify three types of laughter: laughter due to pleasant feeling, sociable laughter, and laughter for releasing tension. Hayakawa (2003) distinguishes three non-mutually-exclusive functions: laughter for joining a group, balancing laughter for releasing tension, laughter as a concealer (to soften or evade). A yet different classification comes from Campbell, Kashioka, and Ohara (2005) and Reuderink et al. (2008), where four laughter types are distinguished on the basis of their segmental composition: hearty, amused, satirical, social.

In some classifications confusion between form, appropriateness, trigger, and function can be observed. For example, in Jokinen and Hiovan (2016), 6 mutually exclusive kinds of laughter are proposed: *mirth, embarrassed, breath, polite, derision and relief*. Whereas *breath* is a formal characteristic of the form, *mirth* and *embarrassment* might be considered as triggers, *polite* is an attribute relative to the appropriateness of the context, and *derision* and *relief* might be viewed as social and psychological functions. We can indeed have a breathy embarrassed laughter that is also polite, or a mirthful derisive laughter, etc. It is clear therefore, that the types proposed are not an efficient classification, especially given the intended application for conversational annotation. Similarly, in Poyatos (1993)'s taxonomy, functions and triggers are confused, having, for example, in a mutually exclusive relationship, *affiliation* laughter (e.g., to agree) in opposition to *joy*. Here the former can be roughly defined as the illocutionary act performed by the laughter, whereas the latter can be considered as a feature of the laughter trigger. Once more we are confronted with overlaps, for instance, a joyful laugh that has an affiliative function.

Acoustically-based classification

Studies such as Campbell, Kashioka, and Ohara (2005) and Tanaka and Campbell (2014) classify the function of laughter using solely acoustic parameters. Tanaka and Campbell (2014) asked participants to listen to the laughter bouts played in isolation and judge whether it was *mirthful* or *polite*. While there is clearly value in studying affective laughter perception, one might point out that the names of the categories 'mirthful' and 'polite' do not belong to the same level of analysis: one can feel mirthful, but cannot feel polite; and the two categories are not mutually exclusive, making the classification inapplicable for dialogue annotation, i.e. one can politely laugh while feeling mirthful, and one can impolitely laugh without feeling mirthful. Moreover, we believe that laughs with similar acoustic features can have different functions in different contexts. We will partially test this hypothesis in Chapter 3, where we will explore whether in our corpus study laughter function can be predicted by context and form-based measurements (perceived arousal), and in Chapter 6, where we present a more detailed analysis of acoustic features of laughter serving different functions.

Necessity of different levels of analysis

We believe that in order to avoid confusion and overlapping types, it is useful to draw an analogy with the study of speech (e.g. Lewis (1970) [2]).

First, from a physical point of view, we can study the physiology and phonetics of laughter, the former regarding the human body and the latter regarding the acoustic features of the laughter itself. Then, one can study the phonology and the positioning of its smaller units: the building blocks of a laughter sequence and any combination rule there might be. It is only when we come to the meaning and function levels that things get unclear. By analogy with the study of speech, once again, we believe therefore that it is important to separate different objects of analysis and especially not to confound the physiological cause, the trigger, the meaning and the social function (Wierzbicka, 2000; Lewis, 1970). The goal of the current chapter is to understand what laughter can mean and how it can be used to affect our dialogues.

2.4 Multilayered Analysis

2.4.1 Form and contextual levels

The first aspects of laughter production that can be analysed are its phonetic and acoustic features (e.g. fundamental frequency, pitch, voice quality, exhalation, and inhalation phases and duration), and how its smallest discrete elements get combined in longer sequences. Extensive work is available on the topic: e.g. Petridis and Pantic (2011), Kipper and Todt (2003), Bachorowski, Smoski, and Owren (2001), Mowrer, LaPointe, and Case (1987), Ruch and Ekman (2001), Urbain and Dutoit (2011b), Truong and Van Leeuwen (2007), Poyatos (1993), Trouvain (2003b), Lavan, Scott, and McGettigan (2016), Nwokah and Fogel (1993), and Campbell, Kashioka, and Ohara (2005) (see 6 for more details).

Secondly, we can look at its positioning in relation to other parts of speech. In our current work, we are interested in exploring laughter ordering in relation to (1) linguistic material, (2) others' laughter and (3) its argument, the laughable (see section 2.4.4). Different orderings and combination of laughter and linguistic material can indeed affect the meaning conveyed (Nwokah et al., 1994; Jefferson, Sacks, and Schegloff, 1977).

1. A laugh can occur alone or can overlap with verbal production by the laugher her/himself, i.e. *stand alone* and *speech-laughter* (Nwokah et al., 1999; Trouvain, 2001).

[2] One helpful distinction comes from the theories of meaning. In "General Semantics", David Lewis wrote *"I distinguish two topics: first, the description of possible languages or grammars as abstract semantic systems whereby symbols are associated with aspects of the world; and, second, the description of the psychological and sociological facts whereby a particular one of these abstract semantic systems is the one used by a person or population. Only confusion comes of mixing these two topics."* (Lewis, 1970, p. 19)

2. A laugh can occur in isolation (i.e. laughter not preceded by any other laughter), follow (i.e. *antiphonal laughter*: starting during the partners laughter or within one second after its offset)[3]) or have the same onset time of another laughter from an interlocutor (i.e. *coactive laughter*) (Nwokah et al., 1994; Smoski and Bachorowski, 2003).

3. A laugh can occur after (more commonly), but also before or during its argument with a rather flexible alignment (see section 3.5.3 for results from a detailed corpus study about laughter-laughable alignment).

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

In speaking about the *meaning* of laughter we are broaching a long-standing debate about the use of non-verbal social signals (such as smiling, crying, sighing, etc.): does laughter reflect something about the emotional and cognitive state of the laugher or it is merely produced to influence the receiver? The most traditional approach is the representational one (e.g., Ekman and Friesen (1975) and Morreall (1983)), which argues that any emotional expression refers to some internal state and conveys such information to the receiver that will be able to decode it cognitively (Russell, 2003). Laughter emerges in infants around 3-4 months of age (Sroufe, 1997; Sroufe and Wunsch, 1972) and several researchers, endorsing the representational approach, have proposed to consider its first occurrences as a reflex of positive internal states (Ekman and Friesen, 1975; Darwin and Prodger, 1998; Van Hooff, 1972), the use of which, during development, becomes gradually much wider and more sophisticatedly intertwined with language.

The scepticism from some scholars stems from the fact that laughter can occur in so many different situations, being linked to so many different emotional states (e.g. amusement, embarrassment, nervousness, sadness, astonishment etc.), needing interlocutors to interpret it and respond to it in so many different ways that it would be unreasonable to assume that laughter could have a unique core meaning that passively reflects the internal state of the laugher. The Affect Induction Approach (AIP) (Owren and Bachorowski, 2003) therefore states, following the behavioural-ecology argument (Fridlund, 1994; Fridlund, 1997; Crivelli and Fridlund, 2019), that facial or vocal expressions in general, and laughter in particular, do not serve a representational function, i.e., by being informative about something such as internal states. Rather, according to the AIP, they are produced exclusively in order to influence the listener's attention, arousal and emotion, more or less unconsciously inducing positive affective responses in listeners, relying on the positive affect that laughter acoustic properties can have in themselves or by conditioning through experience (Owren and Bachorowski, 2003; Sander and Scheich, 2001).

[3]Agreeing with Smoski and Bachorowski (2003), we prefer to use the term antiphonal rather than the term contagious (Provine, 1993; Provine, 2001) or reactive (Nwokah et al., 1994) given that the first alludes to an automatic and reflex-like action and, the second, to a conscious deliberate one.

While acknowledging the fact that laughter, being extremely adaptive, can be produced in many different emotional states and that it can positively influence the interlocutor, we believe that this does not necessarily imply that it cannot have a core meaning (postulated in section 2) and that it is not informative about cognitive and emotional laugher's states (for more details see discussion in Chapter 2). While taking an agnostic position in the long-standing debate about the relation between emotion and facial/non-verbal expression (Crivelli and Fridlund, 2019), we believe that when an interlocutor hears a laughter s/he can attribute to it the general meaning that it is normally used to convey. Whether the expression is linked or not to emotion, it does not prevent the listener from deriving an inference about a core meaning/state intended to be conveyed. The fact indeed that facial/non-verbal "emotional" expression can be influenced by the presence of an observer (i.e. audience effect), has been used by Crivelli and Fridlund (2019) as an argument against the fact that those have a direct connection to internal emotion, and that are exclusively used to convey information to interlocutors and to affect them. For our aim is to investigate the meaning conveyed by laughter in interaction, this is further support to our proposal that laughter has propositional content. As stated in Bavelas and Chovil (2000), a signal being influenced by the presence of others is one of the criteria for considering a non-verbal behaviour, a visible/audible act of meaning.

We believe that the two approaches do not contradict each other. On the one hand, as argued in Wierzbicka (1995, p.209),"The fact that a given gesture can be used in a wide range of situations and relationships, and that it may receive different interpretations in different cases, does not mean that it does not have a constant semantic core. For example, a performer's bow, a greeting bow, and a bow performed by a priest or an altar boy in front of an altar can all be assigned the same semantic formula (that is, the same meaning) with the proviso that this formula will be flexible enough (or general enough) to lend itself to different interpretations in different contexts.". On the other hand, it is true that laughter as a positive emotional expression has important social effects: it is crucial in the management of affective states within interactions and in establishing and maintaining social bonds (but also marking boundaries and distancing people), it positively affects the interlocutor, as well as helping to deescalate negative emotional experiences, being linked to positive physiological effects that reduce stressful reactions characteristic of unpleasant emotions (e.g. fear, anger, disgust) (Scott, Sauter, and McGettigan, 2010). However, all these effects that laughter can have are not inconsistent with the fact that it can have a constant core meaning.

A large part of the literature on laughter is dedicated to the distinction between spontaneous and volitional laughter in terms of its acoustics (Vettin and Todt, 2004; Lavan, Scott, and McGettigan, 2016), physiology and neurological path (with respect to both production and perception) (Wild et al., 2003; Keltner and Bonanno, 1997; McGettigan et al., 2013). In our study, we will ignore this distinction because, in line with Wierzbicka (2000), we think that the actual psychological experience behind a

behaviour such as laughter, does not change the meaning conveyed and how it would interact with the linguistic material, focus of our interest. Nevertheless, that does not mean overlooking the fact that when a laughter is perceived as non–genuine by a conversational partner that can trigger additional mentalising and the derivation of relevant inferences according to the social context and the current interlocutors' mental and intentional states; the analysis of these hower goes beyond the aim of the current paper. Moreover, as noted by Gervais and Wilson (2005) and McComas (1923), in conversational laughter the boundary between spontaneous and volitional is much more blurred than in an experimental setting. Laughter becomes a learnt behaviour, which can reach a high level of automaticity as indicated by the significant tendency to under-report own laughter production by subjects (Vettin and Todt, 2004).

When not focusing on the physiological and psychological states underlying a laugh, most of the literature concentrates on some potential triggers for laughter, especially humour and tickling (by several scholars considered as a form of proto-humour, e.g. Provine (2001) and Weisfeld (1993) - see section 8.2 in Chapter 8). Traditionally humour theories have been divided into 3 branches: the ones taking a deep cognitive perspective and focusing on incongruity as a central aspect in the perception of humour (Schopenhauer, 1891; Kierkegaard, 1941; Raskin, 1985; Attardo and Raskin, 1991; Attardo, 1994; Attardo, Hempelmann, and Di Maio, 2002); theories of superiority, focusing on the relation that humour can have to hostility, criticism, and disparagement; and theories of release which, taking a psychoanalytic approach stemming from Freud (1960), consider humour as one of the substitution mechanisms available to humans to sublimate socially tabooed aggressive impulses to acceptable ones, therefore avoiding wasting additional mental energy to suppress them.

The material on the topic is immense and the debate about what is humour and why it triggers laughter is still very active and unresolved. We agree with Koestler (1964) in his pioneering observation that humour is a very complex and multifaceted phenomenon potentially impossible to frame into one theory. Nevertheless, nowadays, most scholars, despite supporting different theories, models, motivations and mechanisms (Martin, 2010; Oring, 2016) agree about the crucial role played by *incongruity* with respect to the perception of humour (Gervais and Wilson, 2005). We will not take any stance about humour theories apart from recognising a crucial role played by the recognition of (pleasant) incongruity, taking an agnostic stance with regards to the precise mechanisms underlying such positive evaluation.

2.4.3 Laughter Meaning: Laughables and Positively Increased Arousal

We propose that the core meaning of laughter involves a predication $P(l)$, where P is a predicate that relates to either *incongruity* or *friendliness/closeness* in senses we explain shortly and l is the laughable, an event or state referred to by an utterance or exophorically. This core meaning, when aligned with rich contextual reasoning, can yield a wide range of functions (in line with our proposal is Nikopoulos (2017)). We further

assume, in line with Wierzbicka (1995) and Morreall (1983) that this core meaning is, in turn, the argument of an emotive relation corresponding to *pleasure* or *enjoyment* by the laugher. This represents the *force* of the laughter. Following much recent literature in cognitive psychology, we can assume that pleasure/enjoyment arises as a consequence of an *appraisal process* (Oatley and Johnson-Laird, 2014; Scherer, 2009). We can summarize this view in the formula:

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

Such a shift can be triggered by different kinds of stimuli, where incongruity can be present or not, and its amplitude depends not only on the nature of the stimulus in itself, but can also be affected by social factors, contexts (Cundall Jr, 2007) and current emotional and physical state (Lowe and Taylor, 1997; Weaver et al., 1985), mood (Ruch, 1997) and personality traits (Ruch, 1993).

2.4.4 The laughable and its properties: the first dimension of laughter meaning

The first dimension is a categorical one, which relates to the kind of stimulus that the laughter takes as an argument, the one which "triggered" the arousal shift, and the type of appraisal. The laughables selected by laughter as arguments can be divided into two big classes: those involving incongruity and those that do not, being generally related to a sense of closeness. A more detailed classification of incongruities (and lack thereof) is presented below.

Laughable types

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

(3) a. Given that the route via Walnut street is shorter than the route via Alma, choose Walnut street.

b. Given two routes choose the shortest one.

c. A(1): Which route should I choose?
B(2): The route via Walnut street is shorter.
A(3): OK, so I will choose the route via Alma.

d. Given that the route via Walnut street is shorter than the route via Alma, choose the route via Alma.

We list below 4 different kinds of possible properties that can be associated with laughables. Examples of each, commented in detail, are presented in Section 2.5.

1. **Pleasant incongruity** With the term 'pleasant incongruity' we refer to any case in which a clash between the laughable and certain background information is perceived as witty, rewarding and/or somehow pleasant (Goel and Dolan, 2001; Shibata and Zhong, 2001; Iwase et al., 2002; Moran et al., 2004). Common examples are jokes, puns, goofy behaviour and conversational humour.

2. **Social incongruity** We identify as a 'social incongruity' a clash between social norms and/or comfort and the laughable. Examples of such instances might be, a moment of social discomfort (e.g. embarrassment or awkwardness), a violation of social norms (e.g., invasion of another's space, the asking of a favour), or an utterance that clashes with the interlocutor's expectations concerning one's behaviour (e.g., criticism) (Owren and Bachorowski, 2003; Caron, 2002; Fry Jr, 2013). We classify as social incongruity also those situations in which someone is speaking about something "painful" for him/herself for two reasons: the first is that speaking about unpleasantness can run counter to social norms and can make the interlocutor feel uncomfortable. Moreover, when a laugh is produced in such circumstances, it fulfils the same effect as a laugh produced during felt embarrassment, i.e., it helps to cope with the uneasy situation by giving the impression that we are taking the situation in the best way and that also the interlocutor should do so (Panksepp, 2000). Similar reflections have also been proposed in Devillers and Vidrascu (2007), Jefferson, Sacks, and Schegloff (1977) and West (1984).

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

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

Locations of laughables

Glenn (2003) is close to our position when stating that laughter works similarly to an indexical for which the hearer needs to find a referent in the context. He also stresses the fact that such a process presupposes important pragmatic abilities, in order to infer others' informational, attentional and intentional states, and context-based reasoning, because any utterance or action could draw laughter depending on the context. Based on preliminary observation we also hypothesise that laughter does not have to occur necessarily after, but it can also occur before or during the laughable it is related to; making an analogy with pronouns it can, therefore, have both an anaphoric or cataphoric relation to its argument (an extended investigation and discussion of the results is presented in Chapter 3).

The laughable can be constituted by the eventuality described by a verbal contribution (4), by an exophoric event (5), by a metalinguistic stimulus (e.g., a slip of the tongue, pun, violation of conversational rules, inappropriate speech act, etc.), as in (6) and (7) or by a dialogue act in itself as in (8) where the question is not incongruous in the semantic content itself, but it is the fact of asking the question per se which is appraised as incongruous.

(4) Laughable: **Linguistic denotation** (*From DUEL French 3_1: Dream apartment)*

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

B: so that's (the: + the) the first floor huh?
A: < laughter/ > *the ground floor; B: here it is!*
A: with a: + a parking like in Batman you know like you go under ground < laughter/ >;
B: < laughter/ >

(5) Laughable: **Exophoric event** (*Example from BNC - Interaction mum child home setting*)
Child looking cutely for something that is in front of him.
Mum: < laughter/ > There he is!!

(6) Laughable: **Metalinguistic** (*From DUEL French 3_2: Film Script)* - Speaker A and B saying the same thing at the same time.

Speaker A: Va pourrait mettre un truc dedans
Speaker B: On va pouvoir mettre des trucs de < laughter/ >

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

(7) Laughable: **Metalinguistic** (*Translated example from DUEL French 1_3: Border Control*) - Mispronunciation

Officer: Et tu tiens toujours des: contacts avec cet euh ce dit enfant?
Traveller: je le vois pas mais euh je je lui do ouais je lui d j'ai je (NV) je < laughter/ >

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

(8) Laughable: **Dialogue Act** (*Extract from Romaniuk (2013)*) David Gregory; interviewing Chuck Schumer:
DG: (1) Is Sarah Palin the future of the Republican party?
CS: (2) .hh hh=W(h)well(h)heh heh heh .hhuh, I guess I shouldn't judge and let them f(h)ight among themselves.

We also annotate for the origin of the laughable, i.e. if the laughable has been produced by the laugher him/herself (7) or by the other participant (4 - Speaker B last line), by something external to the conversation (e.g., someone making a weird noise in the next room) or whether the laughable has been jointly constructed by the conversational partners (e.g., an identical utterance simultaneously (6)).

2.4.5 Arousal: the second dimension of laughter meaning

The second dimension laughter is informative about is arousal, a continuous dimension: this can range from very low to extremely high, and different amplitudes in the shift can depend on the trigger/argument itself, on the individual current emotional state, and social context (Fridlund, 2014; Devereux and Ginsburg, 2001; Provine and Fischer, 1989)[4]. We emphasize that laughter does not signal that the speaker's current emotional state is positive, just that there was a *shift* which was positive. The speaker might have a very negative baseline emotional state (being very sad or angry), but the recognition of the incongruity in the laughable or the feeling of in-groupness can cause a positive arousal shift, which could be minor and very brief. Two striking examples, where laughter is triggered by two very different kinds of laughable in an extremely negative context, are offered in the video of an interview with the rock band "Eagles of Death Metal" a few days after the terrorist attack at the Bataclan Theatre in Paris.[5]

(9) Eagles of Death Metal Discuss Paris Terror Attacks - Pleasant incongruity in a negative circumstance.

[4]With the term arousal we refer to the state of activation or wakefulness as intended for example in the dimensional approach to emotion literature (e.g. Russell (1980), Barrett and Russell (1999), and Kuhbandner and Zehetleitner (2011))

[5]Eagles of Death Metal Discuss Paris Terror Attacks:
https://www.youtube.com/watch?v=n74HBrrFnIc

In (9) one member describes the scene that ensued after the gunshots broke out when he and several members of the audience ran to the dressing room. As they were looking for weapons to protect themselves, they found a bottle of champagne. The speaker laughs after saying "bottle of champagne". This laughter is probably triggered by the recognition of an incongruity at the time of utterance: the incongruence of the positive and festive association of a bottle of champagne, in contrast to the extremely sad events that had taken place. However minor, the incongruity caused a positive shift.

(10) Eagles of Death Metal Discuss Paris Terror Attacks - Friendliness in negative circumstance

The second example, presented in (10), relates to a totally different kind of laughable. One of the singers, while speaking about a particularly intense moment, receives a friendly pat on the shoulder from one of the band-mates and produces a little laughter. Also, in this case, the laughter signals that the friendly pat and the feeling of having a close mate supporting him in the difficult moment of telling about that terrible night gave the laugher a positive shift in arousal. The distinction between the overall emotional state and the direction of the shift explains why laughter can be produced when one is experiencing a state of sadness or anger. We often do not have physiological measures that can guarantee that a positive emotional shift actually took place. However, whether it actually occurred or whether the laughter was produced only to simulate it, does not fundamentally change what the laughter communicates (Wierzbicka, 1995). It is simple to imagine the very same interactions with no laughter produced, and it is easy to see how the production of laughter from the speaker yields extra information about his cognitive and emotional state which suddenly has a slight and possibly very temporary improvement, whether real or simulated, by comparison with the continuing sadness that otherwise characterises the interview.

Basis arousal dimension

We ground the proposal that part of the meaning conveyed by laughter is about arousal on the results from several studies. Researchers found a correlation between acoustic features of the laughter and the level of arousal/intensity of emotion perceived (Chaspari et al., 2012) or perceived amusement (Petridis and Pantic, 2009). Also, from a neuro-psychological perspective, Scott, Sauter, and McGettigan (2010) found activation of the pre-supplementary motor areas to be correlated with the perceived arousal of the non-verbal emotional vocalisations, while the bilateral premotor cortex activation was correlated both to valence and arousal perception. These results seem, therefore, to suggest that arousal is a type of information we extract from a non-verbal expression.

Laughter in negative situations

We are aware that in some occurrences of laughter (e.g., in an embarrassing situation, when speaking about current serious problems to a doctor, etc.) (Jefferson, 1984; Potter and Hepburn, 2010; Glenn and Holt, 2013; Haakana, 2001; Khudyakova and Bergelson, 2015) it is hard to think that the laugher is actually feeling a positive shift in arousal (Morreall, 1983; James, 1884). In such cases, it is important to distinguish between (i) the actual physiological state, (ii) the content of the laughter, namely the predication $P(l)$, where P in such cases is social incongruity, and (iii) the possible physiological effects that can arise, given the conditioned positive reaction that laughter can elicit (Neuhoff and Schaefer, 2002; Panksepp and Burgdorf, 2003).

There is no dearth of work focussing on the analysis of laughter in patient-doctor interaction (Haakana, 1999; Haakana, 2001; Haakana, 2002; Jefferson, Sacks, and Schegloff, 1977; West, 1984). In these situations it is not rare for the patient to produce laughter while explaining her/his problems to the doctor. Nonetheless, the laughs that take place in such cases are never reciprocated by the doctor. We hypothesize that in such cases the positive shift is either felt/simulated by the laugher him/herself, in order to help to cope with the trouble-telling, or intended to be felt by the addressee of the laughter. This is plausible also given that the acoustics of laughter in itself can positively affect the listener (Owren and Bachorowski, 2003).

As also discussed in Morreall (1983), the production of laughter in uncomfortable situations can be related to the Facial Feedback Hypothesis, i.e. facial emotional expressions can affect or induce the emotion they normally are associated to (Strack, Martin, and Stepper, 1988; Foley, Matheis, and Schaefer, 2002; Neuhoff and Schaefer, 2002)[6]. The phenomenon might be described as a loop where laughter, expressing a pleasant feeling, over time becomes associated with those and pleasant in itself, inducing positive and pleasant feelings in the laugher herself. Thus, laughter in embarrassing situations, despite seeming to constitute a case that contrasts with the core laughter meaning postulated in the current section (i.e., "the laughable l having property P triggered a positive shift in arousal of value d in the laugher"), can still be a valid account of two possible mechanisms: on the one hand, one can laugh aiming to show that is taking the situation (i.e., the laughable) in the best possible way, potentially causing an improvement in the current cognitive and emotional appraisal of the situation; conversely, considering the effects that laughter acoustics in itself can have (Owren and Bachorowski, 2003), together with its powerful contagiousness (Provine, 1992), the laugher can aim to affect the interlocutor positively and induce her to appraise the situation in a positive way. Moreover, as proposed in Norrick (1993) and Norrick (2010), in such situations a laugh can signal resistance to taking

[6]Although Facial Feedback Hypothesis is one of those theories within psychology that has failed to be replicated with consistency in the psychology replication crisis, recent studies suggest that the failure of the replications can be attributed to slight modifications of the design (Noah, Schul, and Mayo, 2018). Specifically: the fact that participants knew they were going to be filmed, which reduces reliance on internal cues in making judgements. Recent studies seem to confirming the hypothesis (Söderkvist, Ohlén, and Dimberg, 2018; Kuehne et al., 2019; Coles et al., 2019).

something too seriously. Finally, laughter is linked to several physiological positive effects, both psychological and physical (Panksepp, 2004; Berk, 2001; Mora-Ripoll, 2010), helping to reduce negative affective reactions to stressful situations (Keltner and Bonanno, 1997; Kuiper and Martin, 1998; Führ, 2002).

2.4.6 Ironic uses of laughter

As with speech, laughter can be used ironically, produced with the intention of conveying some aspect that is incompatible with (sometimes the reverse of) its semantics or pragmatics (Bryant, 2011). For laughter, this could involve either the imputation of *non*-incongruity to a laughable or the failure of the incongruity to trigger a positive shift of arousal. Examples of such uses are the laughs produced after an unfunny joke where the intent is to convey that the joke uttered is banal and/or did not provoke a positive shift in the listener.[7] In extract (11) Nicola uses laughter ironically[8] to mark the fact that the incongruity between doing the hoovering and having a nice day does not in any way provoke a positive shift in her. Nicola's contribution "< laughter/ > Doing the hoovering < laughter/ >" could be verbalized as an ironic comment like "Oh yeah! What a nice day I will have! Doing the hoovering all day! Amazing!".

(11) *Example from informal conversation mums at the park (BNC, KDE)*
Nicola: Thank you! It's very nice of you!
Linda: Have a nice day!
Nicola: < laughter/ > Doing the hoovering < laughter/ >
L: < laughter/ >
N: < laughter/ > Thanks Lyn I'll see you on Wednesday.

It is at this point important to distinguish between ironic laughter, laughter to mark irony, and laughter which shows enjoyment of the incongruity contained in an ironic comment, all of which are offered in (11). The first laugh produced by Nicola, as previously stated, is an ironic laugh, where the speaker reverses the normal meaning of the laughter itself. The second laugh produced by Nicola is, on the other hand, a laugh to mark the irony of the preceding contribution, while the laugh from Linda is used to show enjoyment of Nicola's ironic comment. (Further examples will be discussed in Section 4.2.2).

2.5 A Taxonomy for laughter functions

On the base of conversational data and anecdotal reports, we developed a semantically and pragmatically grounded taxonomy of laughter function.

In our approach, the crucial elements used to categorise the function of a laughter are the laughable (i.e. the argument of the laughter) together with cues about others'

[7] Maybe even a negative shift because the positive expectation was deflated.

[8] It is possible to hypothesise, even though work of the subject is lacking, that ironic laughter might have specific acoustic features which stress its faked and voluntary production, similarly to ironic verbal comments (Bryant and Fox Tree, 2002; Cheang and Pell, 2009; Bryant, 2010).

informational, attentional and intentional states indispensable for its identification, the acoustic features of the laughter itself, and the prosodic contour of the speech in which it is embedded (Hay, 2000). In order to guide the process of function classification, we postulated a binary Decision Tree (Fig. 2.1)[9].

In what follows, we present some examples of the functions observed in our data. For all these examples unanimous agreement in function annotation was achieved by our coders (see Chapter 3 for details about the application of the current taxonomy for a corpus study).

2.5.1 Laughter referring to an incongruity

In the current section we present examples (extracted from natural conversations) of the laughable classes postulated in section 2.4.4.

Pleasant incongruity

1. **Showing enjoyment of pleasant incongruity**

   (12) *Example from politics lecture (BNC, JSM)*
   Lecturer: The other announcement erm is er Dr *** has asked me to address some delinquents, no that's not fair, some er hard working but misguided students
   Audience: < laughter/ >

   (13) *Example from politics lecture (BNC, JSM)*
   Lecturer: and so the Korean war started and the United Nations' forces were commanded by one General Douglas MacArthur, General Douglas MacArthur, in case you don't know, won the second world war single handedly.
   Audience: < laughter/ >
   L: er < laughter/ > it's not funny, he believed it!

   Both examples (12) and (13) contain laughter used to show enjoyment of a pleasant incongruity: in (12) the students' laugh appreciating the lecturer's joke in which students are incongruously compared to delinquents; while in (13) students laugh recognizing the sarcastic tone of their professor stating

[9]Laughter evolution is without any doubt of significant interest to all research on laughter. However, it falls outwith the scope of our current chapter. Nonetheless, we believe that our classification is not incompatible with the most common hypothesis of laughter having evolved as a play signal where incongruities, unexpected and potentially threatening behaviours are often present. In this way, it marks especially harmless intentions (Vettin and Todt, 2005; Gervais and Wilson, 2005; Ross, Owren, and Zimmermann, 2010). We believe that these roots are reflected in our framework and can be found in its finer detail, where both the aspect of signalling playfulness (e.g. marking pleasant incongruity) and enjoyment of the activity (e.g.show enjoyment of incongruity), harmless intentions (e.g. softening a criticism) and promoting bonding (in all of its occurrences and emblematically in the *friendliness/closeness branch* of the DT (Fig. 2.1) are present. In Section 8.7.8 (Chapter 8) we sketch hypothesis about the co-option process laughter underwent to serve diverse functions in human interactions.

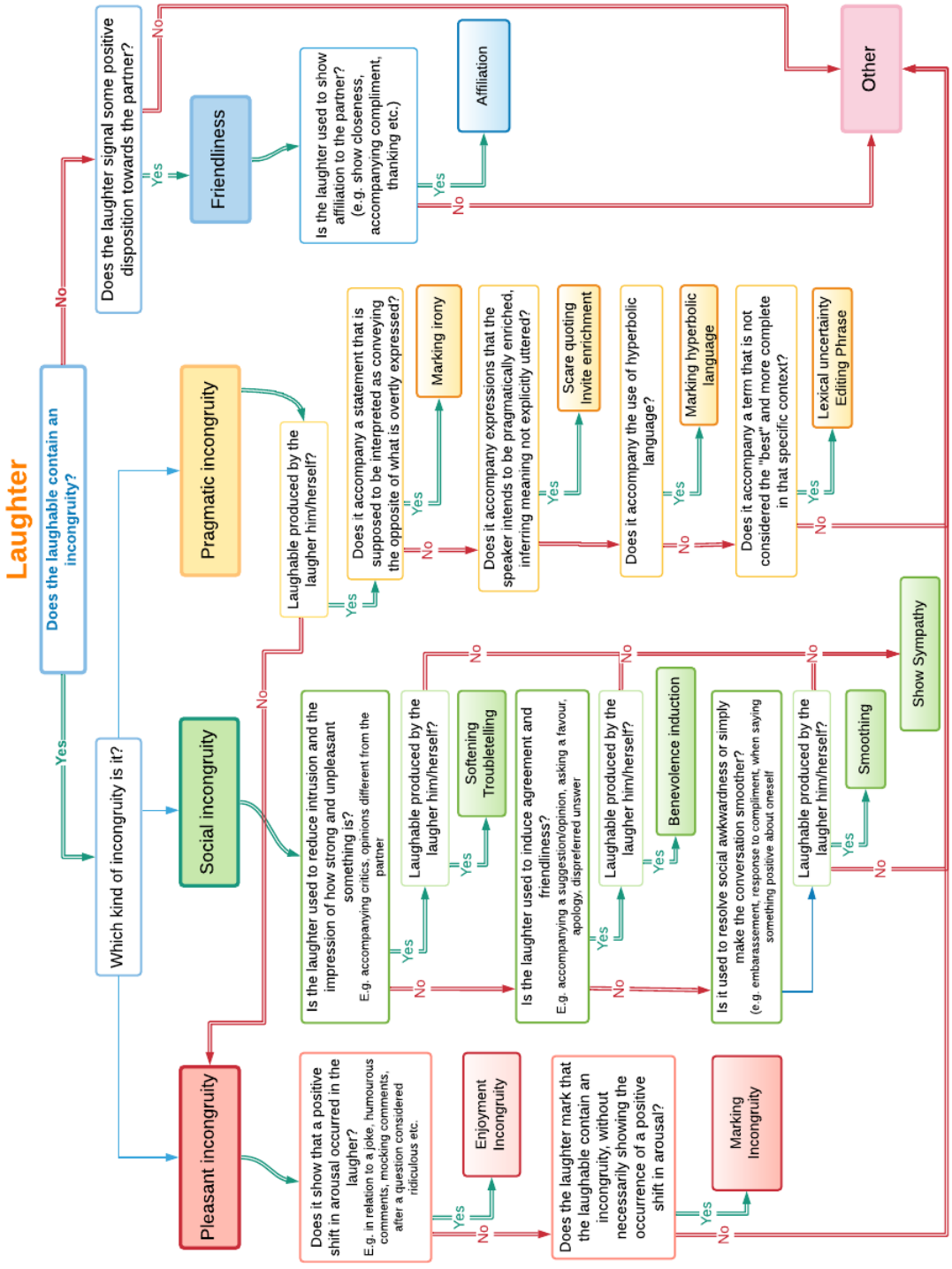


FIGURE 2.1: Decision tree for classifying the pragmatic functions of laughter

that General Douglas MacArthur won the second world war single-handedly, therefore recognizing and enjoying the incongruity between what was said and what was meant in addition to appreciating the incongruous pretence and impossible eventuality that a man could win a war alone.

2. **Marking[10] Incongruity**

(14) *Example from job interview (BNC, JNW)*
Ian: with a ... with a er client then ... we appreciate the business ... comes first .
John: Mm ... it it may it may not be in that nature because the nature of of supply teaching work of course is that I: Yes.
J: there tends to be a phone call
I: Can you make it? we're desperate < laughter/ >
J: Can you make it in half an hour's time, you know < laughter/ >
I: Yeah, yeah , yeah. It's a [...]

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

Social incongruity

1. **Softening and Trouble-telling**

(15) *Translated example from DUEL French video Fr2_1*
(While drawing the apartment they designed)
Speaker B: ah t'as pas mis les trucs dans la salle de bain < laughter/ >

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

In (15) Speaker B uses laughter to soften the criticism addressed towards her partner concerning her drawing, in this way she tries to make the remark as less aggressive and impolite as possible, signalling the interlocutor to do not take it too seriously.

2. **Benevolence Induction**

[10]Especially in this kind of use laughter functions as a contextualization cue (Gumperz, 1982), signalling the presence of some incongruity to the interlocutor .

(16) *Example from a job interview (BNC, JNV)*
Interv.: Do you play in the cathedral yourself or..?
John: I have done it in the past, not recently. There have been other things < laughter > occupying me recently < /laughter >.
Interv.: Right. Yeah.

In (16) John, in the context of a job interview, uses laughter while saying something that might be slightly negative about himself: he confesses that he has not played very often in cathedrals lately; the laughter may serve the function of ingratiating the interviewer, inducing him to avoid a harsh evaluation of the statement; at the same time the laughter helps him to avoid explaining what "other things" have been occupying him recently.

3. **Smoothing**

(17) *Example from a job interview (BNC, JNV)*
Interviewer: ... [cough] Right, you seem to be pretty well qualified.
John: I hope so < laughter > yes < /laughter >

In (17) the laughter is used to smooth the response to a compliment. Normally it is culturally frowned upon to speak well of oneself. Here the little laugh helps to avoid being viewed as presumptuous and arrogant, thereby helping to minimize potential social discomfort.

4. **Show Sympathy**

(18) *Example from Interview to Michael Heseltine after heart attack (BNC, K6A)*
Michael Heseltine: One of the things they have to do is to get your uric acid I think it's called erm content correct. And it it so they give you some m medicine for that. A side effect of which can be that you can develop gout. And so the what what what that...
Interviewer: Ah, that explains
MH: ..everybody saw was not the
John: Mhm.
MH: fit strapping Heseltine which I wished
John: You looked terrible.
MH: which I wished to portray.
John: < laughter/ >

(19) *Translated example from DUEL French video 3_1 - Dream Apartment Task)*
A: c'est a l'escalier? ..on va faire a comme a ...je met escaliers parce que j'ai mal dessin
B: < laughter/ >

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

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

In order to clarify the difference between softening and benevolence induction it is useful to refer to Brown and Levinson (1987)'s politeness theory, i.e. we call *softening* the uses whose aim is to reduce intrusion (e.g. accompanying criticism, opinion different from the partner and answering inconveniently to a question - as in (12)), while we classify in the *benevolence induction* function class all laughter that accompanies suggestions, opinions or the asking of a favour looking for agreement and friendliness, with the aim of inducing agreement and benevolence (as in (13)). In the same class, i.e. *social incongruity*, we also include laughter used to *show sympathy* that occur as a response to such acts (i.e. softening, benevolence induction, smoothing) both antiphonally (laughter in response to a laughter of that class) or as a response to the act in itself from the partner (as in (15) and (16)). Note that laughter used to "show sympathy" can sometimes seem very similar to the one that we categorise as laughter to "show affiliation" (in the non-incongruity part of the decision tree - see section 3.5.2), but the context and the laughable are generally different and constitute the discriminants between the two.
On the other hand, laughter serving a *smoothing* function is the one used in order to resolve social awkwardness in general (e.g. embarrassment) or simply helping the flow of the conversation when for example the conversational partner does not react as the speaker expected.

Pragmatic incongruity: Uttered vs Intended Incongruity

1. **Marking Irony**

(20) *Example from Politics Lecture (BNC, JSM)*
Lecturer: ... And then of course you've got Ronald Reagan ... and < laughter/ > history ended with Ronald Reagan.

Laughter can be used in order to signal to one's interlocutor that what is going to be said or that has just been said is not to be taken literally, but rather should be interpreted as an ironic comment. This signals an incongruity between what is said and what is meant, blurring the real opinion of the laugher. In (20) the Professor's laughter indicates that the upcoming statement is not to be taken seriously, but ironically.

2. **Scare quoting/Invite Enrichment**

(21) *Example from Trial Court (BNC, F7X)*
A: I don't know if you can help that man or not.
B: I'll have < laughter > a word < /laughter > with him Terry
A: [...] Because Mr had represented him

This extract is taken from a recording just after a trial court session between lawyers. The laughter is here used in order to signal that the expression "a word" is used in a way that deviates slightly from the most standard understanding (see e.g., Predelli (2003) on scare quoting).

3. **Lexical Uncertainty/Editing Phrase**

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

Here the laughter is used as an *editing phrase* (Tian et al., 2015), signalling the speaker's need to reformulate and correct his previous contribution. Khudyakova and Bergelson (2015) report examples of this kind of use in aphasic patients when not sure about some lexicon or construction used.

Laughter not referring to any incongruity

Friendliness

1. **Affiliation**

(23) *Extract from DUEL French 1_1 - Dream Apartment Task*
A: (et +) ah si il faut faut un meuble chaussures
B: ouais.
A: ce serait bien a, parce que moi euh: j'aime bien F euh
B: ouais ouais je comprends ouais
A: laisser les chaussures et demander aux invits de laisser les chaussures l'entre
B: en plus tu sais t'sais
A: parce que: c'est crade sinon
B: pour peu qu'il y en ait que y'en a un qui marche n'importe o dehors euh il vient il laisse des traces
A: < laughter > exactement < /laughter >

B: < laughter/ >

A: (and +) ah yes We need a shoe rack
B: yes.
A: It's going to be good, because I euh I really prefer euh
B: Yes yes I understand yes
A: Leave the shoes and ask guests to leave the shoes at the entrance
B: moreover you know y'know
A: because: it's dirty otherwise
B: if there's going to be someone that walks anywhere ouside euh he comes he leaves marks
A: < laughter > *exactly* < /laughter >
B: < laughter/ >

(24) *Extract from DUEL French 3_1 - Dream Apartment Task*
A: euhm ensuite on a le canap euh ..en cuir.. norme.
B: Bleu
A: si tu veux..
B: < laughter/ >

A: euhm and then we have the couch euh ..leather.. huge.
B: Blue
A: If you want
B:< laughter/ >

(25) *Example from bar conversations (BNC, KDP)*
Richard: Right, thanks Fred. You're on holiday after today?
B: Lovely. < laughter/ >

In (23)–(25) laughter does not refer to the appreciation of any incongruity, neither pleasant neither social or linguistic, but rather to the appreciation of some action from the partner and is performed to show closeness and friendliness: in 23 A shows affiliation while agreeing with B's statement, in 24 show appreciation and closeness with a little laughter used to thank and show appreciation of A's offer and in 25 Richard show closeness to his client for the good news.

2.6 Beyond functions

In the previous section, we presented a taxonomy for laughter function classification. It is important to stress again that with the term 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, etc.

Moreover, on another level of analysis, this can have a cooperative or a non-cooperative goal (e.g. mocking). Particularly interesting is the fact that the very same laughter with a specific function can have both connotations at the same time. This stress furthermore the fact of encompassing different levels of analysis. For example, a laugh produced provocatively toward a subject, might, on the other hand, have a positive connotation, functioning as a very important bonding means, for other subjects present in the interaction, especially when the laughter is joined in by other parts of the group. In example (26) we can observe how a laugh produced to *show enjoyment* is used provocatively with a mocking attitude towards the professor meaning ("You are so old!!"), therefore distancing in a way the professor and the student, while on the other hand, it bonds the student to his mates that join the laughter (Boxer and Cortés-Conde, 1997). The same analysis can be applied similarly also to a much more famous example in (27).

(26) Example chemistry lecture (BNC, FLY)
Professor: The reason is that in fact I acquired this ... on the thirteenth of August 1972.
Student: < laughter > I wasnt even born then. < /laughter >
Other Students: < laughter/ >

(27) *Laughter to show enjoyment of pleasant incongruity - Non-cooperative*
The Simpsons: Nelson Laughs at the Very Tall, Season 7, episode 21: "22 Short Films About Springfield"

This distinction, therefore, allows to easily account for what in the literature has been often referred to as "superiority laughter". In our framework, such a case would be simply analysed as a laughter referring to a laughable appraised as incongruous and pleasant (someone's misfortune in this case), with a hostile attitude towards the interlocutor.

In the current work, I am not going to focus on the last aspects mentioned, I will rather concentrate on the semantics and functions of laughter.

2.7 Summary Multi-layered framework for laughter analysis

In Table 2.2 a summary of the different layers proposed to be relevant for the analysis of laughter, making an analogy with the study of language (Lewis, 1970), is presented.

2.8 Conclusions

In the current chapter, I presented a multi-layered semantic and pragmatic framework for laughter analysis. The crucial assumption at the base of the framework is that laughter has propositional content, which needs to be integrated into any framework aiming to model dialogue from a semantic and pragmatic perspective. Building on

TABLE 2.2: Levels relevant to the analysis of laughter

Form
Acoustic features, phonology
Positioning
Ordering in relation to speech, others' laughter and laughable
Semantics
Predication of incongruity/pleasantness causing a positive shift in arousal
Functions
Effect that the laugher intends her own laughter to have
Social aspects
Dialogue act performed, intentions, response from context

earlier work by Ginzburg et al. (2015), I proposed laughter to have a core semantic meaning, similar to a predicate of type P(l), that when aligned with rich contextual reasoning can generate a wide range of functions.

Making an analogy with the study of language, I believe that there are different levels pertaining to laughter analysis: form (e.g. phonetics, acoustics, phonology), positioning, semantics, and pragmatics (effect on dialogue and dialogue act performed).

I presented what I think could be a useful method to observe laughter behaviour and gain insightful data about its semantic and pragmatic import in our conversation.

In the next Chapter (3) I present the first applications of the framework in a corpus study aimed at characterising the variety of uses laughter has in adult dialogue.

Chapter 3

Laughing Adults

3.1 Why this Chapter?

In the current chapter I present a multi-corpora study looking at adult laughter use in conversation in 3 languages (French, Chinese and English). The aim of the current work[1] is three-fold.

1. In the first place, I wanted to deepen our understanding of the semantic and pragmatic contribution of laughter in our conversations. For this aim, I wanted to test whether the multi-layered framework (presented in Chapter 2) proposed in order to account for the semantic and pragmatic meaning of laughter was a viable and reliable method for the analysis of laughter in interaction. The framework and the taxonomy were indeed constructed on the base of anecdotal examples together with the analysis of very few conversations, and its applicability needed to be experimented in a systematic fashion in a broader range of genres and contexts.

2. Secondly, my interests were also exploratory. I wanted to explore in general how laughter is used in adult dialogues: What does laughter predicate about? Which effects does laughter have on dialogue? Also, do laughter patterns of use change across languages and contexts?

3. And lastly, I had specific questions about the positioning of laughter in relation to its argument (i.e. the laughable) and in relation to speech, both from the laugher herself and the interlocutor. Our account suggests indeed that resolving the *laughable* is crucial for deriving the content of a laughter event. I hypothesize, on the base of preliminary observations, that laughter is not always adjacent to its laughable. Rather, the sequential distribution between laughter and laughable might be somewhat free. I hypothesize that laughter can occur before, during and after the laughable, and that intervening material can occur between a laughter event and its laughable.

In what follows I firstly start stating explicitly the research questions motivating my work and I then present the corpora used (Section 3.2.1). In sections 3.2.2, 3.2.3

[1]The work presented in the current chapter has been conducted in collaboration with Ye Tian and Jonathan Ginzburg (Mazzocconi, Tian, and Ginzburg, 2016; Mazzocconi, Tian, and Ginzburg, 2019).

and 3.2.4 I explain the method used for the annotation of the laughter, the laughable and the laughter functions respectively. The main body of the chapter is constituted by data and discussions of results in relation to my research questions: in sections 3.3, section 3.4 and section 3.5. In order to facilitate reading, discussions will follow the presentation of the results for each feature analysed.

I conclude the chapter with a general discussion of the main observations collected, the theoretical and practical implications for linguistics, psychology and the implementation of dialogue systems (section 3.7).

3.2 Corpus study and Research questions

In the current study, we present some application of the framework presented in Chapter 2. Our aim is generally to test whether the framework can be an interesting, viable, and reliable way to structure laughter behaviour observation and whether it is able to capture most of its uses. The questions we are trying to address are: 'How is laughter used in adult conversation? How does it contribute to the semantics and pragmatics of the messages conveyed? How does it interact with the linguistic material? Do patterns of laughter use change across languages?'. More specific questions are introduced in the body of the chapter, as results get presented.

3.2.1 Materials

The work presented in the current chapter is based on the analysis of natural adult conversation data consisting of 1072 instances of laughter. The data are taken from two different corpora: the DUEL corpus (Hough et al., 2016) and the British National Corpus (BNC) (Burnard, 2000).

- DUEL Corpus data

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

1. **Dream Apartment**: the participants are told that they are to share a large open-plan apartment, and will receive a large amount of money to furnish and decorate it. They discuss the layout, furnishing and decoration decisions.

2. **Film Script**: The participants spend 15 minutes creating a scene for a film in which something embarrassing happens to the main character.

3. **Border control**: one participant plays the role of a traveller attempting to pass through the border control of a fictional country, who is being interviewed by an officer, who happens to be a parent-in-law of the traveller.

The corpus was transcribed in the target language and translated into English. Disfluencies, laughter, and exclamations were annotated. MINT tools (Kousidis, Pfeiffer, and Schlangen, 2013), a toolkit for multi-modal recording was used for the recordings to ensure synchronization of the various data sources, which included high-quality audio, video and body tracking data. The video data was filmed using two cameras to capture the gesture space and face of both participants. The dialogues were recorded with two Sennheiser Omnidirectional Lapel microphones (one clipped on each participant) with a sampling rate of 44,100 Hz on an Avid Mbox pro sound card, in a sound-proofed room (French and Chinse: at Université Paris Diderot; German: at Bielefeld University). The corpus was transcribed in the target language and translated into English. Disfluencies, laughter, and exclamations were annotated. The data I will present are based on the analysis of laughter in three dyads in French and two in Chinese[2] (3 tasks x 5 pairs) for a total of 210 minutes and 897 instances of laughter.

- British National Corpus (BNC) data

In order to balance the friendly, extremely cooperative and task-oriented bias of the first set of data, recorded in a structured setting, we integrated the analysis with the use of data from the spoken part of the BNC. The corpus covers British English conversations audio-recorded between 1991 and 1994 in a wide range of contexts. The subset of audio-recorded conversations was selected in order to cover as wide a range as possible of interaction settings, varying in genre, register, level of familiarity between the interlocutors, number of conversational participants, topic and goal of interaction.[3] Overall, 21 conversations (604 minutes) were analysed, for a total of 289 laughs.

3.2.2 *Audio-video* coding of laughter

Coding was conducted by the first and the second authors and by three postgraduate students. We made sure that at least once (whether in the first phase or in the agreement testing) the material had been annotated by a native speaker of the language investigated. Whenever possible as far as the DUEL corpus goes, laughter was identified and marked by examining the audiovisual signal, a method that has been shown to be the best condition for laughter recognition and detection (Petridis and Pantic, 2011; Jordan and Abedipour, 2010). For the BNC we had to rely exclusively

[2]It is important to mention, given the cultural influences on laughter behaviour (Soury and Devillers, 2014), that the recording of the Chinese conversations took place in Paris, recruiting native Mandarin Chinese speakers who were living in France either studying or working at university.

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

on audio-based detection and coding of laughter. When a laugh occurred, the coder stopped the videotape, detected the exact onset and offset using the software ELAN (Brugman and Russel, 2004) for DUEL and Praat (Boersma, 2002) for the BNC, and conducted a detailed analysis using the "multi-layered framework" presented in the previous chapter and summarized in Figure 3.1.

It is to be noted therefore that for the DUEL corpus, thanks to the availability of video-recordings, we have more precise information about the duration of laughs (having marked exact start and end time of each laugh), which in turn made possible for us to perform more fine-grained analysis about laughter positioning in the speech-stream and in relation to the laughable (section 3.5), which were not possible for the BNC.

Laughter was coded relying on multimodal signal. A formal description of the vocalization and facial expression most typical of laughter, but not always realised, are proposed in Apte (1985) and Ekman and Friesen (1975). Here I report a summary as elaborated by Nwokah et al. (1994, p. 26):

> *"The facial expression has the following characteristics: the mouth is open widely or narrowly with its corners drawn backwards and a little upward. The upper lip is somewhat raised and in older children and adults, the teeth bared. The eyes are partially closed and may sparkle due to increased secretion of the lacrimal glands. The eyebrows are generally lowered. The cheeks are drawn upward and wrinkles may appear under the eyes. A nasolabial fold is formed that runs from the outside of each nostril to the comers of the mouth. Laugh vocalizations have the following characteristics: There is a deep inspiration followed by a short interrupted expiration. A vowel sound is produced with either a glottal stop [?] consonant or a voiceless or voiced glottal fricative consonant [h] often interrupting several times so that there is an abrupt and sharp cut in the flow of air to the mouth, usually by a sudden and complete closure and quick separation of the vocal cords. Laughter can also consist of a brief or extended uninterrupted single vowel."*

Following Urbain and Dutoit (2011b) we consider the laughter offset (final laughter in-breath inhalation) as part of the laughter event itself, thus resulting in an average laughter duration longer than other authors (e.g., Bachorowski, Smoski, and Owren (2001) Rothgänger et al. (1998)). Occurrences of laughter from each participant, together with their laughables, were marked and coded. Coding criteria were elaborated in order to capture the differences stressed in Chapter 2 between form, meaning, function and effect of laughter production in dialogical interaction (Figure 3.1).

We captured some features related to the form of laughter in marking whether the laughter co-occurs with speech (i.e., speech laughter or standalone laughter) and coding the level of arousal communicated which, despite being a crucial tier in the semantic analysis in our framework, is inevitably and intrinsically related to

TABLE 3.1: Laughter coding parameters

Form and context	
Duration	Start-Time, End-Time
L. in relation to speech	Stand-alone laughter
	Speech-laughter
L. in relation to others' laughter	Isolated
	Dyadic: Antiphonal and Coactive
L. in relation to the laughable	Before
	During
	After
Semantics	
Arousal	Low
	Medium
	High
Laughable	
Predication	Incongruity
	Friendliness
Type of laughable	Denotation utterance
	Meta-linguistic
	Non-verbal
	Dialogue act
	Exophoric
Origin of laughter	Self
	Partner
	Collaborative
	External
Pragmatics	
Function	Show enjoyment of pleasant incongruity, Marking incongruity, Softening, Benevolence induction, Smoothing, Meaning modification (marking irony, scare quoting, editing phrase etc.), agree, thank, affiliation [Refer to Decision tree, Figure2.1]
Goal	Cooperative
	Non-Cooperative
Dialogue-act/Move	e.g. statement opinion, answer etc. (Stolcke et al., 2000)
Response from partner	e.g. Laugh, smile, look, question etc.

the acoustic features of the laughter. Such an assumption is justified by results from neuro-imaging studies (Scott, Sauter, and McGettigan, 2010; Warren et al., 2006; Sauter et al., 2010), where vocalizations presented in isolation and exclusively in audio form activated proportionally different areas of the brain according to the perceived arousal, namely the pre-supplementary motor areas and the bilateral pre-motor cortex. For this measure we relied on the natural expertise of the coders, who have acquired long training in perceiving and producing laughter over years of ecological interactions (McKeown, 2016; Curran et al., 2017). The classification of arousal (or intensity of the laughter) is therefore based on a qualitative judgement expressed on a 3 point scale: Low, Medium and High. A detailed consideration of phonetic or facial features is beyond the scope of the current thesis, although we intend to address this in future work (see Chapter 6 for a preliminary study about acoustic features of laughter related to different laughables).[4]

3.2.3 Audio-video coding of laughable

We define the laughable as the argument selected by the laughter, i.e., the event laughter predicates about. Every time a laugh was identified, coders would mark the laughable the laugh would refer to, based on their personal judgement. The temporal boundaries were marked, the content (whether verbal or not) was annotated and an index was assigned in order to map each laughter to the respective laughable. Laughables were then classified according to the type (or absence) of incongruity, according to their source (linguistic denotation, meta-linguistic and exophoric event – see Section 2.4.4 for definitions), and the origin of the laughable (the laugher her/himself, the partner or external - see Section 2.4.1 for details). In this process, all coders took an approach very similar to the one presented in Hay (2000): all the videos were carefully observed in order to extract maximum background information and understanding of the social dynamics between the speakers. A multimodal approach has been taken in order to rely on all the richness occurring in conversation (Iedema, 2007; Jones and LeBaron, 2002; Kress and Van Leeuwen, 2001; Streeck, Goodwin, and LeBaron, 2011; Wierzbicka, 2000), without relying exclusively on linguistic import. An important feature of our classification involves inferring speakers/laughers' intentions, which of course is prone to issues of subjectivity and indeterminacy. We therefore embrace such limitations and used agreement between coders as a measure of the level of possible objectivity according to our classification (see Section 3.3 for inter-annotator agreement). The annotation relies heavily on context, together with

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

tone of voice, prosody, pace, pauses (Crystal, 1976) and in the DUEL corpus (where videos were available) also on facial expressions, posture and gestures.

3.2.4 Audio-video coding of laughter function

The classification of the laughter functions is based on rich pragmatic and contextual reasoning, taking account of the form and contextual features of the laughter, the kind of laughable identified, together with the relationship between the interlocutors and their intentions, and performed by the coders using the binary decision tree presented in Chapter 2 and re-proposed in Figure 3.1 to ease consultation.

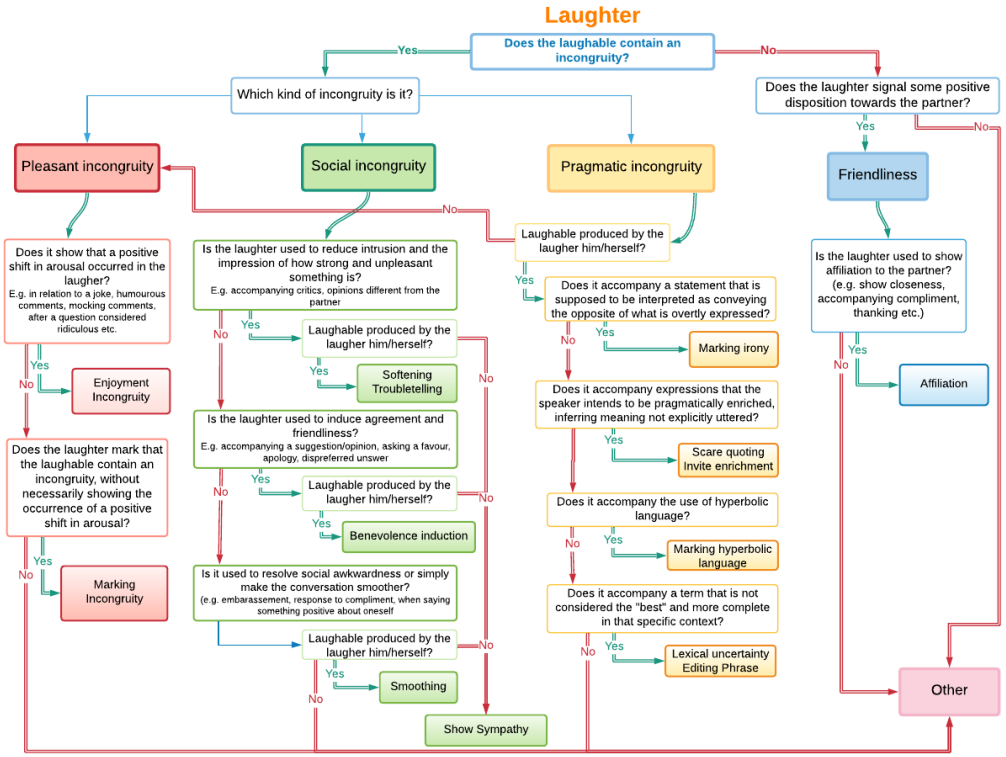


FIGURE 3.1: Binary decision tree for laughter classification

Results and Discussions

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

The reliability of the framework and the taxonomy was assessed by having 20% of each corpus analysed by three coders: the first, the second author and three postgraduate students (one for each language). The three postgraduate students (a native Chinese speaker, a native English speaker and native French speaker) were naïve to

the aims of the study and proceeded to the annotation after a brief explanation about the framework and the decision tree. An *Other function* category was offered to all the coders, whenever specific instances of laughter could not be fitted in the functional taxonomy proposed. The results in terms of percentage agreement and Krippendorff's α (Krippendorff, 2012) are given in Table 3.2[5]. Despite the apparently complex framework proposed, entailing as it does multiple components, our annotation scheme attains a high rate of agreement, even when applied by naive coders. At the same time, although there is a high percentage of agreement between coders, the Krippendorff's alpha results are negatively affected by the instances in which a value is present in only one of the coder's annotations while being absent in the others'. That can happen especially for the rarest categories, e.g. absence of incongruity in the laughable (i.e. friendliness/closeness), etc. The slightly lower percentages of agreement reported for the BNC might be attributable to the fact that the classification was exclusively based on audio data, therefore lacking a lot of multimodal and visual cues available for the DUEL corpus. This explanation is also based on results from studies showing that the audio-visual signal is the best condition for laughter detection (Petridis and Pantic, 2011; Jordan and Abedipour, 2010), and probably also for its analysis. Slightly lower percentages of agreement are reported across languages for the classification of the specific functions (i.e., terminal nodes of the decision tree - Figure 3.1) especially *show enjoyment of incongruity*; occasionally the boundary between *show enjoyment of incongruity* and *mark incongruity* can be quite blurred. Moreover, since *show enjoyment of incongruity* is the most basic use of laughter, it can sometimes be more subtle to distinguish when the laughter is actually there to serve another function for which laughter has been co-opted.

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

3.4.1 How often do we use laughter in our interactions?

Laughter was, in general, very frequent (Table 3.3). Substantial differences were observed depending on the setting of the conversation. In the DUEL corpus, both in French and Chinese, laughter was much more frequent than in the BNC. For the DUEL corpus, one can compute more specifically that laughter constitutes 17% of the conversation duration in French and 7.2% in Chinese. Although some cross-gender differences have been found in other works (e.g. Bachorowski and Owren (2002), Provine (1993), and Jefferson (2004)), we did not conduct any cross-gender analysis because the sample was not balanced and not sufficiently large.

The discrepancy in laughter frequency reported across corpora, and especially between the BNC and the DUEL overall, could be related to the very friendly and

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

TABLE 3.2: Inter-coder annotation agreement

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

cooperative nature of the DUEL corpus, ideal circumstances for laughter to occur frequently. The different nature of the data analysed should not be considered as a weakness of the study presented. One of the goals of the current study was to develop a classification of laughter based on a variety of settings. Our central aim, hence, was to characterise the use of laughter in as broad a range of situations as possible.

TABLE 3.3: Laughter occurrences and frequencies in different datasets

Corpus	Dur	N' laughs	/10 m
DUEL Fr.	125 m	562	45
DUEL Ch.	85 m	221	26
BNC	603 m	289	5

3.4.2 Can laughter production communicate about different levels of arousal?

The arousal level communicated was qualitatively assessed by the coders on the basis of perceived acoustic and respiratory features[6]. Across all corpora, low arousal

TABLE 3.4: Level of arousal displayed by the laughter

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

laughter is the most frequent regardless of the types of laughable and function, followed in frequency by medium and high arousal laughter in all languages. Interestingly a more significant proportion of high arousal laughter has been found in the more natural and spontaneous data (BNC), in comparison to the more structured and controlled data available from DUEL. We can speculate that this is due to the specific context in which the DUEL conversations were recorded: being observed is a condition in which the occurrence of an intense display of emotional expressions might be inhibited (Chapman and Wright, 1976); moreover, the interaction was restricted to specific tasks, which in turn can affect the intensity and especially the interest and the emotional involvement of participants. Especially in the DUEL corpus subjects are required to have close and friendly dialogues where humour is likely to be involved, sometimes with people that are not even acquaintances. Displays of humour appreciation or humour production in these kinds of situations can become a risky

[6]Although one could cast doubts about some aspects of our methodology due to certain subjective aspects it relies on, the agreement was quite high. Moreover, arousal is quite a complex phenomenon to judge quantitatively. For example, when considering only loudness and frequency, one can indeed miss the classification of some very aroused laughter where several silent segments are produced as shown by Rychlowska et al. (2018). We defer to further studies a deeper investigation of objective measures of arousal, which will definitely entail a multimodal approach taking into account acoustic features, respiration, quality of voice, but also posture and body movements, as already considered in Urbain et al. (2013) for laughter detection.

matter (McKeown, 2016), because the level of familiarity does not enable one to know enough about the other's cultural norms and boundaries. The risk of offending or overreacting and thereby producing embarrassment or resentment is high. In this type of situation, consequently, a low aroused laughter is always a more ambiguous, and therefore safer option. As observed also by McKeown (2016), low arousal laughter can serve all the pragmatic functions listed, therefore opening several options as to its interpretation (see also Tables 3.7).

3.4.3 What is laughter related to? Types and origins of laughables.

In the dialogical interactions analysed, over 90% of the laughter involves a laughable contained in the linguistic denotation of the speakers' verbal contributions (see subsection 2.4.4 for an explanation of the classification of laughables). Much lower percentages (3% in French, 1% in Chinese and 3% in English) had a metalinguistic referent or referred to something external to the conversation (7% in French, 8% in Chinese and 4% in English)—see Table 3.5. Quite surprisingly we find exactly the same pattern in French and Chinese concerning the producer/origin of the laughable: 57% of the laughables are produced by the laugher him/herself, 34% by the interlocutor of the laugher, 2% simultaneously by the interlocutors and 7% are not produced by any of the interlocutors (exophoric).

Significant differences can be observed in comparison to the BNC corpus regarding the origin of the laughable. Firstly, laughables produced jointly are totally absent in the BNC. Their presence in the DUEL corpus can indeed be attributed to the particularly controlled setting where the content of the dialogue is more easily predicted by the interlocutors. Secondly, and perhaps more surprisingly, the BNC is the only corpus, in which the percentage of laughables produced by the laugher herself is lower than 50% (46%). An often replicated result has shown that speakers laugh more than the audience (Provine, 1993; Vettin and Todt, 2004; LaGreca et al., 1996). The idiosyncrasy of the BNC in this respect can be due to the wide variety of genres compared with the materials usually used in this kind of studies, which privilege cooperative and friendly talk. It is, however, worth noting when comparing our results to other works, that our definition of 'speaker/self' is crucially different from a theoretical point of view and might lead to slightly different percentages from the one adopted in other papers. We do not make reference to 'speaker' vs 'audience', but rather distinguish between laughter predicating of a laughable produced by the laugher herself or by the partner. It is indeed not always the case that the person speaking and laughing is actually laughing about the thing s/he is currently saying.

3.4.4 What does laughter predicate about?

In Table 3.6 we report the exact numbers and percentages of the type/absence of incongruity contained in the laughable, i.e., the second branch of the decision tree - Figure 3.1. In each corpus, a small percentage of the laughter produced could not

TABLE 3.5: Laughable distributions: type and origin

Laughable type	DUEL Fr	DUEL Ch	BNC
Denotation	501 (90%)	202 (91%)	267 (92%)
Meta-Ling	19 (3%)	2 (1%)	9 (3%)
Exophoric	42 (7%)	17 (8%)	13 (4%)
Self	320 (57%)	125 (57%)	134 (46%)
Par	193 (34%)	76 (34%)	152 (52%)
Collab	13 (2%)	5 (2%)	0 (0%)
External	36 (7%)	15 (7%)	3 (1%)

be classified according to our framework and was therefore assigned to the "Other" category (0.6% in French; 0.4% in Chinese and 0.6% in BNC) and excluded from further analysis. In Chinese, we observe a higher proportion of laughter referring to a social incongruity. Laughter that relates to linguistic incongruity is sporadic, almost absent in Chinese. Laughter that does not refer to any incongruity is quite rare in DUEL and almost absent in the BNC.

TABLE 3.6: Occurences and percentages of laughter according to the type/absence of incongruity in the laughable

Corpus	Incong. Pleasant	Incong. Social	Incong. Ling.	No incong. Friendl.	Other
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%)

The vast majority of the laughs observed in our data involve *pleasant incongruity*, having a pragmatic function of either *show enjoyment of incongruity* or *mark incongruity* (74% in DUEL French, 67% in DUEL Chinese and 75% in BNC - Section 3.4.5). Such data disconfirm Provine's proposal (Provine, 1993; Provine, 1996) that laughter is very rarely about something humourous and that it is most of the time related to "banal comments", functioning almost exclusively as a "social lubricant". We should emphasize that our distinction between *pleasant* and *social* applies exclusively to the type of incongruity contained in the laughable; we are not by any means trying to argue that around 70% of the laughter produced in natural conversation have no social effect or are not influenced by social context. We are naturally enough aware of the critical role humour and laughter have for social bonding, managing relationships, and conversation (Lipovsky, 2012; Glenn, 2003; O'Donnell-Trujillo and Adams, 1983; Ellis, 1997). However, the investigation of such effects goes beyond the scope of this work, which is to analyse the use of laughter in dialogue characterising its use, way of predication, reference and effects on the meanings conveyed. Our conclusion is therefore intended to be valid only in relation to the laughable: most of the time laughter predicates *pleasant incongruity* in the argument and in order to be grasped very often requires a rich interpretation of the context, in terms of

situational and cultural information, and of personal experience (Apte, 1985). Very often laughter makes reference to comments or events that do not overtly involve a pleasant incongruity when considered in isolation, but are amusing only when the enriched denotation of the event is accessible to the listener. This is valid not only for pleasant incongruity but also for social incongruity: context, past events, intentions, expectations and desires of other people are always crucial for incongruity detection. In (28), repeated from (1) in the previous chapter, we propose an example in which pleasant incongruity is perceivable only by the interlocutors, who are able to access the enriched denotation of *this morning's semantics class*. According to Provine (1993) we should classify PC's utterance as not containing a humourous comment (in our terminology–constituting a pleasant incongruity). In fact, it is quite clear that PC, relying on the ability of MA to remember and infer the incongruous object of reference, is hoping to have her interlocutor positively appreciate the incongruity she recalls and laugh back.

(28) *Example from Priego-Valverde et al. (2018)*
PC: t'aimerais parler de quoi?
MA: du....
PC: < smiling voice > du cours< /smiling voice > < laughter >de sémantique+de ce matin< /laughter >

PC: what would you like to speak about?;
MA: about...
PC: about < smiling voice > *the semantics class* < /smiling voice >< laughter > *of this morning* < /laughter >

3.4.5 Which are the functions laughter is used for?

In Figure 3.2.a we report frequencies of the more detailed functions (i.e., the terminal nodes of the decision tree - Figure 3.1)[7]. The vast majority of laughter refers to a laughable containing a *pleasant incongruity* in all the corpora analysed: 74% in DUEL French, 67% in DUEL Chinese and 75% in BNC (see Table 3.6). In order to make the graph easier to inspect concerning the other detailed function, in Figure 3.2.b we present the same results excluding the laughter whose laughable contained a pleasant incongruity (i.e. laughter with the function of *showing enjoyment of an incongruity* or *marking an incongruity*).

Between languages, there are surprising similarities in the proportion of functions laughter is used for. The striking higher percentage of laughter produced with the function of *show enjoyment of pleasant incongruity* in all languages can be justified by the fact of being the function closer to its phylogenetic origin (Ross, Owren, and Zimmermann, 2010; Van Hooff and Preuschoft, 2003). In order of frequency we see

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

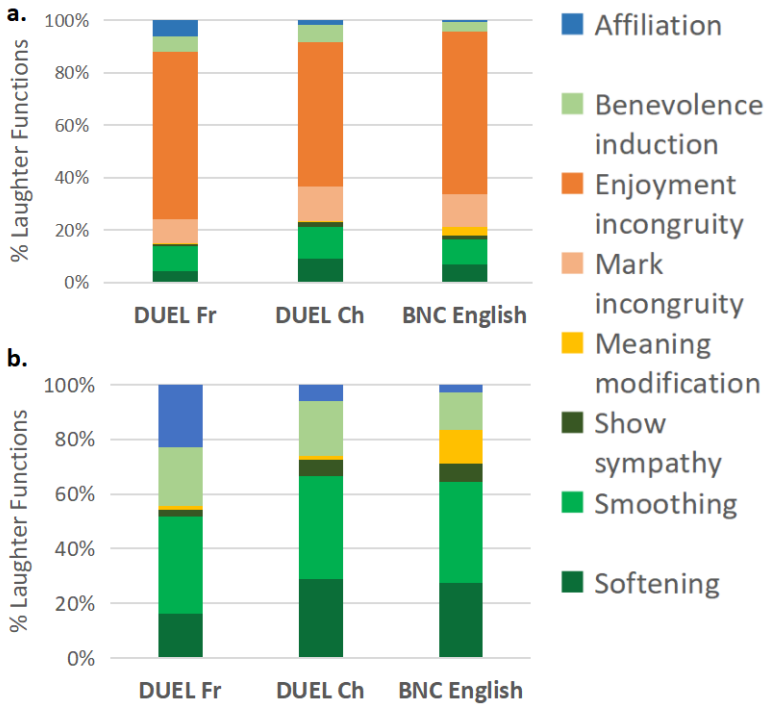


FIGURE 3.2: Laughter functions distribution(a); Laughter functions distribution excluding those related to laughables containing pleasant incongruities (b) - Percentages

then *smoothing*, *softening*, *benevolence induction*. Which can be considered as the first co-option of the original meaning, still communicating "this bad thing is not bad, I hope you'll like me". The use of laughter in relation to pragmatic incongruities, effecting meaning modification of utterances, is the more sophisticated use of laughter, the furthest from its origin and the rarest in the conversations considered in the current work (though extremely interesting from a linguistic perspective). Nevertheless we observe a higher proportion of this type of functions in the more natural and ecological corpus, the BNC, meaning that maybe the extremely friendly, task-oriented and cooperative DUEL corpus, in both languages, might offer a less complex and more explicit environment for communication.

3.4.6 Is the level of arousal communicated influenced by some feature of the laughable?

Previous studies, using different laughter classifications, found differences in the acoustic and perceptual features of different types of laughter (e.g. Szameitat et al. (2011a) and Tanaka and Campbell (2014)). The laughter analysed though were most typically recorded in isolation in response to funny videos or recorded by actors asked to produce laughter with diverse emotional valences. Inspired by this work, we wanted to check whether laughs predicating of different kinds of incongruity would differ in the level of arousal perceived. We therefore performed a Fisher Exact test to explore the distribution of the level of arousal coded (low, medium, high)

across laughter related to different kinds of laughable according to our taxonomy scheme.

The level of arousal coded is extremely dependent on the type of incongruity present in the laughable both for French (DUEL) and English (BNC) (two-tailed Fisher's Exact Test, p-value of 2.137e-10 and 1.828e-11). While in Chinese, such dependency is not observable (two-tailed Fisher's Exact Test, p-value = 0.3205). See Table 3.7 for actual numbers. The level of arousal is also significantly different across specific functions. For example, a significant difference in the level of arousal coded has been found between the laughter used to *show enjoyment of incongruity* and the ones used to *mark incongruity* in French and English, but not in Chinese (two-tailed Fisher's Exact Test: DUEL French p-value= 0.0025; DUEL Chinese p-value= 0.706; BNC p-value= 1.628e-09).

TABLE 3.7: Contingency table arousal × type/absence of incongruity

Corpus	Arousal	Pleasant	Social	Ling.	Friendl.
BNC	High	38	0	0	0
	Medium	103	11	0	0
	Low	77	50	6	2
DUEL French	High	5	0	0	0
	Medium	192	16	1	6
	Low	216	96	1	25
DUEL Chinese	High	1	2	0	0
	Medium	36	13	0	0
	Low	111	51	0	6

Perhaps unsurprisingly, high arousal laughter is exclusively related to laughables containing pleasant incongruities. Conversely, laughter in relation to linguistic incongruity is mostly low arousal and never high. We can speculate that this is the case because of the more controlled nature of laughs used to mark pragmatic incongruity, being more carefully and consciously positioned as markers for meaning modification. Laughter unrelated to any incongruity, but produced with the intent to show friendliness is typically low arousal. It is interesting to note that low arousal laughs are in any case the most common across all functions. McKeown's statement that "the intensity of a laugh most strongly distinguishes the function to which laughter is oriented" (McKeown, 2016, p. 14) does not apply to our data. In a way, intensity can give some hints, especially when dealing with high arousal laughter (which is generally classified as a laughter to show enjoyment of incongruity), but in most other cases it would be hard to determine which function the laughter is serving considering exclusively arousal. We find this data a convincing argument for the conclusion that any function classification based exclusively on laughter arousal cannot be fully reliable. We therefore claim that any computational dialogue system aiming to integrate laughter and language cannot rely exclusively on laughter acoustic form for its interpretation. On the other hand, as far as production is concerned, a discrete low arousal laughter might always be a safer and more acceptable option for a dialogue

system, because of its ambiguity and multi-functionality (discussed more in detail also in Section 3.4.2).

3.4.7 How often do we respond to other's laughter with laughter?

Over 60% of all the laughter in all corpora is isolated laughter, resulting therefore in percentages of dyadic laughter (i.e. antiphonal and coactive) ranging between 26% and 39%. We found very similar percentages between the two languages explored in the DUEL corpus, while in the BNC we observed lower percentages (see Table 3.8). In the DUEL corpus we had enough data from the same couples to calculate the transitional probability of a speaker to laugh antiphonally and coactively in response to the partner's laughs (i.e., the number of dyadic laughs produced by one speaker given the total number of laughter occurrences from the partner). In French, we found an overall transitional probability of 21.9% (sd 10.84) for antiphonal laughter and 20% (sd 8.9) for coactive laughter, for an overall transitional probability of dyadic laughter of 42.18% (sd 15.07). While in the Chinese data, we observed an overall transitional probability of 16.18% (sd 5.6) for antiphonal laughter and of 25.94% for coactive laughter, for an overall transitional probability of dyadic laughter of 42.13% (sd 17.47)[8].

TABLE 3.8: Dyadic laughter: occurrences, percentages and transitional probability (TP)

Corpus	Antiphonal	Coactive	Dyadic	Isolated	TP Dyadic
DUEL Fr.	121 (21%)	97 (18%)	218 (39%)	344 (61%)	42.18% (sd 15.07)
DUEL Ch.	40 (18%)	41 (18%)	81 (37%)	140 (63%)	42.13% (sd 17.47)
BNC	33 (11%)	42 (15%)	75 (26%)	214 (74%)	–

The occurrence of dyadic laughter (i.e. antiphonal and coactive) is very similar in the two languages examined in the DUEL corpus, while it is less frequent in the BNC. Again, maybe not surprisingly, the result can be explained by the very specific setting of the DUEL corpus, which makes it highly conducive for antiphonal laughter: the interactions are all good-natured, cooperative (cf. the facilitating value of the *chameleon effect* for cooperation - Lakin et al. (2003)), and require participants to come to an agreement on some proposals (Banning and Nelson, 1987; Vinton, 1989). It should be noted that the observation of antiphonal laughter is hugely dependent on setting, context, and goal of the interaction (Smoski and Bachorowski, 2003; Smoski, 2004). As pointed out in previous works (Laskowski and Burger, 2007; Smoski and Bachorowski, 2003; Trouvain and Truong, 2012), laughter represents an optimal opportunity for joint vocalisation. In comparison to linguistic contributions, where usually only smaller overlaps are tolerated, laughter overlap is common and can last for several seconds and even in cases where the laughs did not have the same onset, temporal vicinity (e.g. antiphonal laughter) often leads to overlap. A detailed study

[8]I have to specify that this calculation is based on the total of laughter produced by the partner and not exclusively on what have been called inviting or initiated laughter West (1984) and Haakana (2002) occurring specifically at the end of a turn inviting the partner to join the laughter.

of the acoustic features of laughter overlapping others' laughter and isolated laughter has been conducted by Truong and Trouvain (2014), showing that non-overlapping laughs are very distinctive from initiating laughs, and that responding laughs (what we call antiphonal in our annotation) seem to have intermediate-level features. Also, in the corpora examined, as already reported in other studies (e.g., Vettin and Todt (2004)), laughter from one speaker can often overlap with the conversational partner's speech turn. These phenomena constitute another argument in support of the idea that laughter be considered an interacting but parallel and separated channel from speech, where different alignment rules apply (see 3.5.3 for further argumentations). Like Trouvain and Truong (2012), we did not find the familiarity effect observed by Smoski and Bachorowski (2003) in the occurrence of dyadic laughter (either antiphonal or coactive). What we did observe, though, despite not having enough statistical power to assert this firmly, is that most of the variance is due to the couples where the participants are not close friends. In those couples there seems to be always a "dominant" participant and a more submissive one with a discrepancy of almost 20% of transitional probability to laugh antiphonally between them (having the less dominant laughing antiphonally more often). Moreover in the data we have, such phenomena do not seem to be gender-related. Nevertheless, our results have to be considered with significant caution due to the limited number of dyads analysed in DUEL. In the BNC, such analysis could not be performed due to the lack of information about the people involved in interactions and the lack of standardised environment for comparisons.

3.5 Positioning of laughter

3.5.1 How is laughter positioned in the speech stream?

Does laughter overlap with speech?

Speech laughter, i.e. laughter co-occurring with speech from the laugher herself, was frequent in all the corpora analysed (see an example from the Chinese corpus in (29)). We observed higher proportions of speech laughter in Chinese (47%) compared to French and English, where a very similar pattern has been found (respectively 31% and 30%) . Frequencies of speech-laughter across the 3 datasets are significantly different: χ^2 (1)= 23.63, p= <0.00001.

Can laughter interrupt one's own utterances?

We found 14 laughter bouts (5%) in French and 12 (8.6%) in Chinese that occurred in utterance-medial positions. These proportions are statistically higher than zero: French $\chi^2(1)$=12.3, p=.0004; Chinese $\chi^2(1)$=10.5, p=.001. Most of these interruptions do not occur at phrase boundaries. For example:

(29) *Example from DUEL Chinese 2_3*
那你之前有没有啊:.有过什么... < laughter/ > < laughter >犯罪记录吗?

Do you have, uh, have any < laughter/ > *criminal records?*

Such analysis is not available for the BNC: this is due to the absence of video data and the more impoverished annotation of the data in that no exact timing of the onset and offset of laughs have been marked.

Does laughter overlap with partner's utterances?

We found that 51.8% of laughter bouts in French and 56.7% of laughter bouts in Chinese start during the partner's utterances (not necessarily laughables), as in (30):

(30) *Example from DUEL French 1_1*
B: pour faire un mur de son quoi < laughter > en fait c'est une < english > rave < /english > notre appartement < /laughter >
A: < laughter/ >

B: to create a sound barrier which < laughter > *in fact it is a rave, our apartment* < /laughter >
A:< laughter/ >

3.5.2 Does laughter punctuate speech? Does it have a lower priority on speech?

In our analysis we observe rather high percentages of speech-laughter over the total of laughter produced, both in Chinese (47%), French (31%) and English (30%). Moreover, when considering exclusively stand-alone laughter, we found that 5% in French and 8.6% in Chinese occurred in utterance-medial position, rather than at phrase boundaries. Our data together with results from Nwokah et al. (1999), Trouvain (2001), O'Connell and Kowal (2005) and Devillers and Vidrascu (2007), who found percentages of speech-laughter even higher than ours (respectively 50%, 60% and 58%), definitively refute the old hypothesis of laughter punctuating speech occurring exclusively at phrase boundaries (Provine, 1993).

Our results also seem to contradict the argument proposed in conversational analysis that laughter has lower priority than speech in conversation (Glenn, 2003): they propose that while it is acceptable to start speaking while someone is laughing, it is not acceptable to start laughing while someone is speaking. Our data, however, show that this happens quite often, and laughter can overlap both with laugher's speech, but also with the interlocutor's speech. It is possible that there might be limitations as to the amount of overlap allowed, but again, in line with Nwokah et al. (1999) and Crystal (1976) our data seem to show that laughter and its meaning are not secondary or subordinated to speech, but rather that speech and laughter seem to interact being on independent parallel channels allowing frequent overlap.

What about sign language?

Provine has defended for many years the 'laughter-as-punctuation-of-speech' hypothesis, suggesting that laughter bouts seldom (0.1%) disrupt phrases but punctuate them, occurring exclusively at phrase boundaries (Provine, 1993; Provine, 1996; Provine, 2001). Despite the considerable evidence for the frequent production of speech-laughter, it is interesting to consider Provine's argument, because it triggers some interesting research question when compared with recent data. Provine explains his finding on the basis of an organic constraint: laughter and speech share the same vocal apparatus and speech has "priority access". Curiously enough, Provine has always excluded speech-laughs from his investigations, without any justification. A more recent study on laughter in deaf American Sign Language (ASL) signers (Provine and Emmorey, 2006) showed that signers rarely laugh during their own utterances, where no competition for the same channel of expression is present. Provine and Emmorey (2006) conclude that the punctuation effect of laughter holds even for signers and, possibly, it is not a simple physical constraint that determines the placement of laughter in dialogues, but it could be due to a higher-order linguistic structure.

On the surface, their findings in speakers and signers are similar: speakers do not stop mid-sentence to insert a laugh, and signers do not laugh while signing a sentence. However, this "similarity" may be a difference in disguise. We have shown that laughter and speech overlap is frequent in speakers. If it were indeed true that signers do not laugh while signing, it would raise the question of why speech-laughter is common for speakers but rare for signers. Provine and Emmorey (2006) hypothesised that the placement of laughter in dialogue is controlled by higher-order linguistic structure, where laughter is secondary to language. Therefore, even when the two do not occur in competing channels (e.g. for signers), laughter still only occurs at phrase boundaries.

I argue for a different explanation (assuming speech-laughter data -laughter that overlaps utterances- were not excluded in the ASL study as they were in spoken dialogue studies): in deaf signers, since the laughter is perceived only visually and involves marked facial movements, it would interfere with the perception of the message conveyed by language. In sign languages, body and face movements constitute important communicative elements at all linguistic levels from phonology to morphology, semantics, syntax and prosody (Grammatical Facial Movements) (Liddell, 1978; Campbell, 1999). Despite the fact that emotional facial expressions can overlap with linguistic facial movements (Dachkovsky and Sandler, 2009), a laugh, implying a significant alteration of facial configuration (see identification of a laughter episode in Section 3.2.2) could be excessively disruptive for the message aimed to be conveyed. In contrast, in verbal language, the laughter signal can be fused entirely in the speech (Crystal, 1976) and used in a sophisticated manner to enrich and facilitate communication. Nwokah et al. (1999) report that not even from an acoustic perspective is laughter secondary to speech: when co-occurring the laugh

indeed does not resemble the spectral speech patterns nor does the speech resembles the laughter ones, but together they create a new idiosyncratic pattern. Laughter is fully meaningful and communicative in itself, universally across cultures, and the emotional components that it carries are not secondary to speech or trivial.

3.5.3 How is laughter positioned in relation to the laughable? Does laughter always follow the laughable?

As anticipated in section 3.2.1, DUEL data allowed us to conduct fine-grained exploration about the positioning of laughter in relation to its laughable. One particularly interesting datum is that there is no one to one relationship between laughs and laughables: each laughable is "laughed about" more than once (1.7 times in French and 1.4 times in Chinese). In order to investigate the time alignment between laughter and laughable, we calculated "start of laughter minus start of laughable", "end of laughter minus end of laughable", and "start of laughter minus end of laughable". If laughter always follows the laughable, all three measurements should be above zero.

Misalignment	Fr			Ch		
(in seconds)	mean	sd	range	mean	sd	range
start.L-start.LB	2.2	2.4	-9.4 -13.7	1.3	2.3	-19.6 - 9.6
end.L-end.LB	1.4	2.3	-12.8 - 11.6	0.5	2.6	-24.6 - 5.2
start.L-end.LB	-0.5	2.3	-13.9 - 8.4	-0.9	2.6	-25.1 - 3.0

TABLE 3.9: Time alignment of laughter ("L") and laughable ("LB")

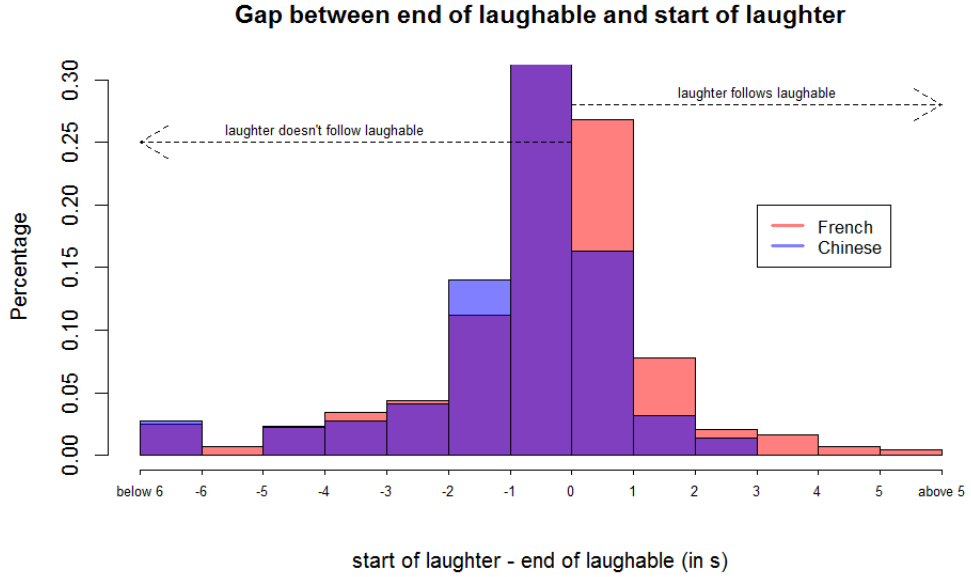


FIGURE 3.3: Time gap between laughable and laughter

This was not the case. In both Chinese and French, on average, laughter starts *during* rather than after the laughable, and finishes after the laughable. In general, laughs in Chinese are more likely to overlap with the laughable than in French.

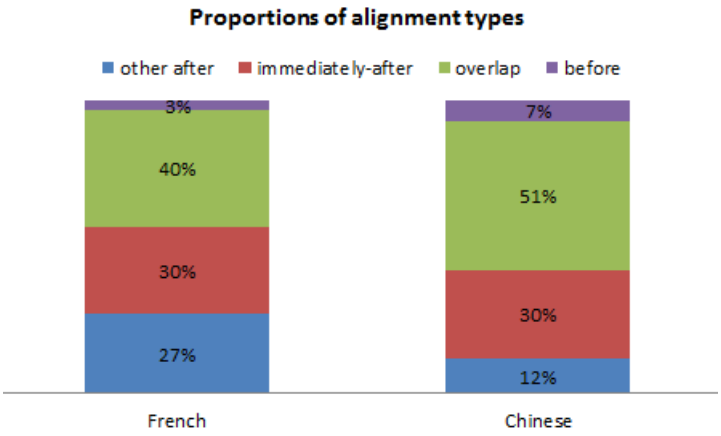


FIGURE 3.4: Laughter positioning in relation to the laughable: before, during or after.

The distribution varies over a wide range. Table 3.9 summarizes the gaps between the boundaries of laughter and laughable, and figure 3.3 plots specifically the gap between the end of the laughable and the start of laughter. They show that it is common for laughs to start before, during and after the laughable. When a laugh has no overlap with its laughable, they are not always adjacent to each other (average utterance duration is under 2 seconds while the gap can be up to 10 seconds). In example (31), the first two instances of speech-laugh refer to a laughable in a later utterance. (Laughable underlined.)

(31) 那个老师(要他+要求小诗) 用"不约而同"造句子, 后来小明< laughter >就想了一想< /laughter >, 然后说呃说呃这样吧? < laughter >(我就+小诗) < /laughter > 就想了想说, 呃:呃:我在路上碰见一个美女, 然后我就问她,约吗? < laughter > 然后美女说, 滚,我们不约儿童< /laughter >.

B: The teacher asked Xiaoshi to make a sentence with "bu yue er tong" (coincidentally together). Xiaoshi < laughter > *then* < laughter/ > *thought about it, and said, uh,* < laughter > *(I + Xiaoshi)* < laughter/ > *thought about it and said, uh, uh I saw a pretty girl in the street, and I asked her "shall we go for a date?", and* < laughter > *the girl said "shouldn't date children"* < laughter/ >.

(Note: "shouldn't date children" is phonologically identical to "incidentally together")

Based on whether laughter occurs entirely outside or overlapping with the laughable, we grouped laughter into four alignment categories: "before", "overlap", "immediately after" and "other after" (see figure 3.4). We found that in both languages, laughs that immediately follow (within 0.3s) the laughable constitute 30%. There are more overlapping laughter in Chinese than in French ($\chi^2(1)=6.9$, $p= .008$).

Despite the lower precision of BNC location of laughter information, we annotated whether the laughter occurred before, during or after the laughable (we do

not have information about the exact distance in terms of timing though). This is therefore the only level of accuracy we have to compare laughter positioning in relation to the laughable in the three languages. We observe significantly different patterns regarding the positioning of laughter in relation to its laughable in the three corpora ($\chi^2(4)$=46.612, p=1.837e-09) - see Table 3.10. Interestingly, in all the corpora analysed there is a relatively high percentage of speech laughter that does not refer to the co-occurring speech it overlaps with (BNC: 34.48%; DUEL French 60.89%; DUEL Chinese 41.90%).

TABLE 3.10: Laughter - Laughable alignment

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

The majority of laughter occurs after the respective laughable, as might be expected; however, as observed just before, laughs can also occur before or during the laughable they refer to. These results, together with the interesting relatively high proportion of speech-laughter not related to the overlapping speech (BNC: 34.48%; DUEL French 60.89%; DUEL Chinese 41.90% - Section 3.5.1) and the data reported in the previous section about overlap with speech from the partner, confirm the proposal of the existence of a rather free alignment between laughter and the respective laughable. This resembles the alignment of manual gesture and speech, as discussed in Rieser (2015) and Alahverdzhieva, Lascarides, and Flickinger (2018). In such a case, as with laughter, the speech and gesture interact to multimodally convey rich meaningful messages, but do not constitute a single channel. A graphic illustration of the pattern observed is presented in Figure 3.5.

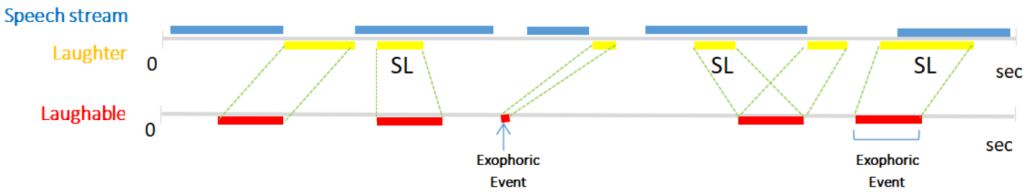


FIGURE 3.5: Temporal misalignment of speech stream, laughter and laughable (SL stands for 'speech-laughter').

Comparing results across the three languages, we observe a higher percentage of laughter produced during or before the production of the laughable in Chinese (see Table 3.10) which does not seem to be dependent on the function performed. As a result of a more detailed investigation concerning the alignment of laughter and laughables, we observe different patterns across different functions and languages. Cross-linguistic differences are observed even when comparing the positioning of laughter serving the very same functions. Consequently, we suggest, very tentatively,

that some features of laughter positioning might be influenced by language and culture and not shared universally.

3.5.4 Does laughter-laughable alignment differ depending on the producer of the laughable

In the DUEL corpus, we found that laughter related to a partner-produced laughable start later than those related to a self-produced laughable, but still the average starting time is before the end of the laughable. With partner-produced laughables, the average gap between the end of laughable and the start of laughter is -0.02s in French and -0.3s in Chinese, while with self-produced laughables, the average gap is -0.7s in French and -1.3s in Chinese.

3.5.5 Does laughter-laughable alignment differ depending on the form of the laughter?

Laughter frequently overlaps with speech (see Section 3.5.1). 36% of laughter events in French and 47% of laughter events in Chinese contain speech-laughter. Speech-laughter is on average 0.3 seconds longer than stand-alone laughter bouts. Speech-laughs overlap with the laughable more than laughter bouts. 52% of speech-laughter in French and 70% in Chinese overlap with the laughables. In comparison, 33% of laughter bouts in French and 34% in Chinese overlap with the laughable. The reason why speech-laughter overlaps more often with the laughables is likely to do with the difference in function between speech-laugh and stand-alone laughter. Laughter that marks an upcoming laughable most frequently overlaps with speech, and these laughter events are also ones that tend to stretch until the middle or the end of the laughable.

Notice that not all speech laughs overlap with the laughable, suggesting that often, laughter that co-occurs with speech is not about the co-occurring speech (47.8% in French and 30% in Chinese). In the following example (32), speaker B says that she will take the bigger bedroom, and laughs. Speaker A joins the laughter, related to the partener's utterance, but at the same time starts a new utterance[9].

(32) *Example from DUEL French video 1_1*
B: okay. les chambres maintenant
A:alo:rs F euh: bon évidemment F euh:
B: je prends la plus grande < laughter/ >
A: c'est là < laughter > où il y a un problème t'vois < /laughter >

B: okay. the bedrooms now A: well euh: well obviously euh:
B: I take the bigger one < laughter/ >

[9]Another clear example of a speech-laughter not co-occurring with its laughable, is observable in this extract from mother-child interaction (Demuth, Culbertson, and Alter, 2006): where the speech-laugh constituting the utterance "Who is hiding among the flowers?" is clearly related to a laughable which occurs before, i.e. the child mislabelling the picture of a bee (zee).

A: It's there < laughter > where there is a problem you see < /laughter >

3.5.6 Is the position of laughter in relation to the laughable influenced by the effect laughter is aimed to have on the dialogue?

We conducted Fisher exact tests to investigate whether laughter serving different functions would significantly differ in its position of occurrence in relation to the laughable. Within the *social incongruity* class (i.e. benevolence induction, smoothing, softening and show sympathy) we did not find any significant difference regarding the context of occurrence in any of the corpora analysed. On the other hand, within the laughter predicating about *pleasant incongruities*, we found a significant discrepancy in their alignment in relation to the laughable between the laughs used to *show enjoyment of incongruity* and the ones used to *mark incongruities* both in French and Chinese, but not in English (two-tailed Fischer's Exact Test: DUEL Chinese p-value= 7.13e-09; DUEL French p-value=0.006; BNC p-value= 0.06). Comparing then the context of occurrence between laughter predicating about *social incongruities* and laughter referring to *pleasant incongruities* we did not find the same patterns across languages. In Chinese and in English the context of occurrence is significantly different between laughter referring to *social incongruities* and laughter serving a *show enjoyment of incongruity* function, but no significant difference is observed in French (two-tailed Fisher's Exact test: Chinese p-value= 0.017; BNC p-value= 0.0002; French p-value= 0.3). On the other hand, significant differences are observed between laughter predicating *social incongruities* and laughter used to *mark pleasant incongruities* in Chinese and French, but not in English (two-tailed Fisher's Exact Test: Chinese p-value=0.0005; French p-value= 0.02; BNC p-value= 0.417). Interestingly, in a cross-linguistic comparison we found different patterns of laughter positioning, both for laughter predicating *social incongruities* (two-tailed Fisher's exact test: p-value= 0.003127) and for laughter that signals *pleasant incongruities* (p-value= 3.53e-06), while no significant difference has been found across languages in relation to the laughter related to the *friendliness* class (after Bonferroni correction level of significance = .016).

3.6 Can the type of laughter predication be predicted on the base of lower-level features?

Given the results from previous sections, we wanted to test whether the different patterns of laughter use observed, in terms of form, positioning and origin and type of laughable, could be predictive of the function the laughter is aimed to have on the dialogue. We therefore performed a Multinomial Logistic Regression in order to explore whether specific features could predict functions from "lower" layers. In particular we tried to predict the first branching of functions, the one related to

the type (or absence) of incongruity contained in the laughable.[10] The analysis was conducted using the library *nnet* (Ripley, Venables, and Ripley, 2016). The formula is reported in (33) while coefficients are reported in Tables 3.11 and 3.12.

(33) multinom(function ∼ origin + Positioning + Antiphonal + Arousal + Speech-laughter, data = data)

We ran the analysis independently for the different corpora and languages, using positioning of laughter in relation to speech production (speech-laughter or standalone laughter), to the laughable (before, during or after) and to others' laughter (antiphonal, coactive or isolated), the producer of the laughable (whether the laugher herself or the partner) and the level of arousal perceived (low, medium, high) as features to predict the laughable type branching (pleasant, social or linguistic incongruity or friendliness - see Figure 3.1). Specifically, we explored the odds ratio of one type of laughable over another.

For the French data from the DUEL corpus, the model manages to predict correctly 75.09% of the laughable type classification. The result is slightly improved when adding duration as a supplementary feature, having the model being able to predict 75.63% of the branching correctly. For the Chinese data from DUEL, the model manages to predict 73,4% of the classification of the laughable type and when adding duration as a predictor 73,86%. For the BNC data, the results were even better with an overall accuracy of 80.36% even without the inclusion of duration as supplementary factor. Duration could not be added to the model for the BNC data since the availability of only audio files did not offer precise enough conditions to mark exact laughter onsets and offsets.

The results obtained from our multinomial logistic regression are encouraging. It is to be noted though that in all the languages investigated the models are weaker at predicting *friendliness* and *pragmatic incongruities* (in order of error rate). This is probably due to the scarcity of the data available for these classes, which are much rarer than social and pleasant incongruities in our corpora. Echoing the results presented above regarding laughter positioning and function cross-linguistically (see Section 3.5.6), we found a specific cluster of relevant features both for the different languages and for the specific functions: classes cannot be predicted on the base of a single feature, but each of these is characterised by a specific cluster. We believe that our model can be improved by having a larger set of data for the rarer branches and will definitely benefit from implementation with methods similar to the ones used in Tanaka and Campbell (2011), i.e., Classification Trees and Support Vector Machines applied using the most relevant acoustic features of laughter.

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

TABLE 3.11: DUEL corpus: Multinomial logistic regression results: coefficients of log odds and *p*-values (adjusted for multiple comparisons) comparing each feature analysed across pair of laughable types.

Tiers	value	Social/ Funny	Ling/ Funny	Friendl./ Funny	Ling/ Social	Friendl./ Social
DUEL - Chinese						
speech-laugh	coeffcnt	-1.05	/	-9.00	/	-13.82
	p-adjst	0.01	/	0.88	/	0.00
antiphonal/ isolated	coeffcnt	0.03	/	1.22	/	1.18
	p-adjst	0.95	/	0.49	/	0.51
coactive/ isolated	coeffcnt	0.36	/	1.93	/	1.56
	p-adjst	0.14	/	0.41	/	0.23
mid/low-arousal	coeffcnt	-0.08	/	-18.67	/	-38.26
	p-adjst	0.87	/	0.00	/	0.00
laughable-par/self	coeffcnt	-0.68	/	-0.58	/	0.10
	p-adjst	0.66	/	0.10	/	0.93
laughable-ex/self	coeffcnt	3.46	/	2.38	/	-11.50
	p-adjst	0.00	/	0.98	/	0.00
Bef/aft	coeffcnt	0.04	/	-41.24	/	-46.30
	p-adjst	0.93	/	0.00	/	0.00
Dur/aft	coeffcnt	0.36	/	-6.50	/	-15.26
	p-adjst	0.42	/	0.86	/	0.00
duration	coeffcnt	-0.44	/	-1.60	/	-1.16
	p-adjst	0.07	/	0.25	/	0.41
DUEL - French						
speech-laugh	coeffcnt	-0.35	/	0.03	/	0.39
	p-adjst	0.27	/	0.93	/	0.46
antiphonal/ isolated	coeffcnt	-1.00	/	-0.27	/	0.73
	p-adjst	0.003	/	0.57	/	0.003
coactive/ isolated	coeffcnt	-1.46	/	0.49	/	1.96
	p-adjst	0.003	/	0.31	/	0.003
medium/low arousal	coeffcnt	-1.40	/	-1.17	/	0.23
	p-adjst	5.22e-06	/	1.76e-02	/	0.68
laughable-par/self	coeffcnt	-1.28	/	0.61	/	1.9
	p-adjst	4.30e-05	/	0.14	/	1.27e-04
laughable-ex/self	coeffcnt	0.53	/	1.62	/	1.08
	p-adjst	0.20	/	0.01	/	0.12
Bef/aft	coeffcnt	-0.41	/	-0.03	/	0.38
	p-adjst	0.56	/	0.97	/	0.75
Dur/aft	coeffcnt	0.21	/	-0.89	/	-1.11
	p-adjst	0.54	/	0.54	/	-0.21
duration	coeffcnt	-0.19	/	-0.40	/	-0.20
	p-adjst	0.14	/	0.11	/	0.46

TABLE 3.12: BNC corpus - Multinomial logistic regression results: coefficients of log odds and *p*-values (adjusted for multiple comparison) comparing each pair of laughable types.

Tiers	value	Social/ Funny	Ling/ Funny	Friendl./ Funny	Ling./ Social	Friendl./ Social
BNC - English						
speech-laugh	coeffcnt	0.43	-0.90	/	-1.33	/
	p-adjst	0.40	0.50	/	0.32	/
antiphonal/ isolated	coeffcnt	-0.79	-8.40	/	-12.73	/
	p-adjst	0.15	0.92	/	0.00	/
coactive/ isolated	coeffcnt	-28.33	11.75	/	33.97	/
	p-adjst	0	0.00	/	0	/
low/high-arousal	coeffcnt	24.32	35.43	/	-0.78	/
	p-adjst	0.00	0	/	0	/
mid/high-arousal	coeffcnt	22.94	6.06	/	-19.86	/
	p-adjst	0	0	/	0	/
laughable-par/self	coeffcnt	-1.2	-31.04	/	-19.46	/
	p-adjst	0.00	0.00	/	0.00	/
laughable-ex/self	coeffcnt	-0.39	-40.40	/	-19.54	/
	p-adjst	0.76	NaN	/	0.00	/
Bef/aft	coeffcnt	-0.83	1.86	/	2.70	/
	p-adjst	0.28	0.16	/	0.05	/
Dur/aft	coeffcnt	-0.18	1.70	/	1.89	/
	p-adjst	0.73	0.29	/	0.24	/

3.7 General Discussion and Conclusion

The aim of the work presented in this chapter was to contribute to the little research available on the relation between laughter, laughable and speech in natural conversation, starting from the observation of their temporal sequence and alignment. This goal offered us the possibility to test the applicability, efficiency and reliability of the multi-layered framework proposed in Chapter 2 for the analysis of laughter.

Among our findings we highlight the following:

Multi-layered analysis of laughter and laughter propositional content The framework adopted, where laughter is crucially considered as a visible and audible act of meaning (Bavelas and Chovil, 2000; Wierzbicka, 1995; Wierzbicka, 2000) which needs to be integrated with linguistic import, has been shown to be reliably applicable by naive coders and able to give interesting insights about the semantic and pragmatic dynamics of laughter use. The framework is based on the idea that, as for the study of language, it is crucial to distinguish different levels of analysis in the study of laughter, i.e. form, positioning, meaning and pragmatic function. The annotation scheme is set out in concrete terms in the form of a binary decision tree, which supported the annotation process efficiently. Our corpus study uses two corpora, the multilingual DUEL corpus (French and Chinese) and the BNC (English), involving three languages and a variety of different situational contexts. Interesting similarities and differences have been observed, which need further investigations.

Laughter alignment with laughable We observe that the alignment of laughter in relation to its laughable can be rather free—preceding, co-occurring or following it. This observation invalidates the common sequential adjacency assumption, showing instead patterns resembling those observed for manual gesture in relation to speech (Rieser, 2015; Alahverdzhieva, Lascarides, and Flickinger, 2018). Our study provides the first systematic analysis of laughables, using data from the DUEL corpus (Hough et al., 2016), in which less than a third of the laughs immediately follow their referents. Instead, the laugh can occur before, during or after the laughable with wide time ranges. In addition, laughter *does* "interrupt" speech: we frequently start laughing in the middle of an utterance of the interlocutor or of ourselves (often speech-laugh). Our results challenge the assumption that what laughter follows is what it is about, and thus question previous claims based on this assumption.

Laughter placement relative to speech Our data, together with Nwokah et al. (1999), Trouvain (2001), and Devillers and Vidrascu (2007), demonstrate that laughter does not occur exclusively during pauses at phrase boundaries (Provine, 1993), but it can overlap with speech from the laugher herself, can interrupt her own utterances and can frequently overlap with the conversational partner's speech turn. Laughter seems therefore not to be secondary to speech, but to interact with it on a parallel and independent channel, allowing frequent overlap both with laugher's speech and with partner's speech.

These observations, concerning the positioning of laughter in relation to laughable and speech, favour the view that laughter belongs to a parallel independent channel from speech, though the two channels interact multimodally to convey meaning.

Laughter functions In our data 90% of laughter instances involve an incongruity, 70% of these constitute what we call a *pleasant incongruity* while approximately 20% a *social* one. Given the differences between DUEL and the BNC and even within distinct parts of these corpora, it seems clear that such distributions are highly setting dependent and, hence, cannot be used to make domain-independent claims about the nature of laughter. Nonetheless, they do call into question previous such general claims that laughter is very rarely about something humorous and that it is most of the time related to "banal comments", functioning almost exclusively as a "social lubricant" (Provine, 1993; Provine, 1996).

Our statistical analysis suggests that none of the functions can be reliably predicted from a single factor of our analysis, but is rather a specific cluster of features that characterises different functions in the different languages analysed. In addition, some similarities observed across languages, especially when context was held constant (i.e. DUEL corpus), allow us to tentatively suggest that some laughter features are not heavily influenced by the language spoken and the culture of origin.

Chapter 4

Why did you laugh?

4.1 Why this chapter?

In the current chapter I argue for the claim that laughter has propositional content using reaction to laughter from the part of interlocutors, namely clarification requests, as diagnostics for the propositional import of laughter[1].

This chapter will be divided into two main parts:

- In the first part, I provide evidence that laughter has propositional content given its stand-alone uses as a response or follow up to questions and assertions, and its intra-utterance use to signal irony and scare quoting.
- In the second part, I show how laughter, having propositional content, can be the object of clarification requests, i.e. questions used to point out a difficulty in understanding a previous utterance by another interlocutor, as other content–bearing words and phrases. I will use the range of potential clarifications found in corpora of natural conversation as diagnostics to identify some of the constituents of laughter meaning.

4.2 Laughter as language

Laughter is widespread in our daily interactions: in the British National Corpus we find 1 laughter every 14 turns, in Vettin and Todt (2004) up to 15.4/10 mins (median 5.8, sd 2.5), in the French part of the DUEL corpus presented in Chapter 3 45/10min, in the ICSI meeting corpus (Laskowski and Burger, 2007) laughter to occupies 9.5% of the total verbalising time Gilmartin et al. (2013); and it has the power to modify the meaning of our utterances Chapter 2. Although laughter has been of interest to philosophers for millennia and in recent times studied extensively by psychologists, neuroscientists, and phoneticians, it has been assumed since Kant (Kant, 1790a) to lack propositional content (e.g. Hayakawa (2003)). A recent explicit statement in that direction is for example the one presented in Hepburn and Varney (2013, p.25):

[1]The work presented in the current Chapter is the result of joint work with Vlad Maraev (University of Gothenburg) and Jonathan Ginzburg (Mazzocconi, Maraev, and Ginzburg, 2018).

> *"Laughter does not have propositional content—it cannot be unpacked into a set of discrete words or phrases; rather it is something that is treated as accompanying talk or even as "flooding out" in response to "humor"."*

I will here present several examples, some extracted from actual conversations and some constructed, refuting this position and providing evidence for the fact that laughter has propositional meaning and needs to be considered when computing utterance meaning, both in its stand-alone and intra-utterance uses.

4.2.1 Negation of laughter propositional content

In (34) we observe an audience of students bursting into laughter after their professor's statement in the context of a lecture. The rebuttal from the professor can be justified and understood only if we assume the students' laughter to have propositional content that can be negated, i.e. "It's not funny".

(34) *Example from politics lecture (BNC, JSM)*
Lecturer: so the Korean war started and the United Nations' forces were commanded by one General Douglas MacArthur, General Douglas MacArthur, in case you don't know, won the second world war single handedly
Audience: < laughter/ >
Lecturer : er < laughter/ > it's not funny, he believed it! (BNC)

4.2.2 Ironic use of laughter propositional content

An easy to imagine example in which laughter is used with the intention of conveying the opposite of its conventional meaning, is the occasion in which a friend of ours tells a joke which we do not really appreciate and we produce a voluntary laughter with, even though there are no studies available in that regard, a marked prosodic contour. In this case, therefore, the laughter actually communicates something like "The joke that you just told me absolutely did not trigger in me any positive arousal shift" (see Chapter 2 for more details). The fact that laughter communicates the opposite of its conventional meaning should be considered as evidence of the fact that it brings semantic content to our conversation.

(35) *Constructed example*
Friend A: [Unfunny pun]
Friend B: AH-AH!
Friend A: Don't you like it?!? I think it is great!!!! < laughter/ >

(36) *Example from Providence Corpus (Demuth, Culbertson, and Alter, 2006), Lily 030010*
Mum: Yeah
Child: Maybe we will take the car!

Mum: Oh yes!
Child: Maybe you can come with us!
Mum: Well maybe I can but I might have to work on my homework < laughter/ >.
Child: Maybe you can do that later.
Mum: Oh great! okay!
Child: And then come with us to the children's museum and then we'll get back to our house. And then you can do your homework.
Mum: Oh wow!

(37) *Example from Providence corpus (Demuth, Culbertson, and Alter, 2006), Lily 030010*
Child: Who's this from? Mum: Um... that is from the swim club .
Child: What is it?
Mum: It says we havta have to pay them. < laughter/ >
Child: We have to pay them?
Mum: Yeah.
Child: What .. what do you havta have to pay ?
Child: What do you havta pay what do you have to pay mommy ?
Mum: Well we have to pay so we can go to the swim club this summer.

4.2.3 Scare quotating – Different laughter positioning affect the sentence meaning

Strikingly, and fascinatingly for linguists, laughter not only conveys propositional content, but it can modify utterance meanings. In the cases where laughter is used to mark scare quoting then, its positioning is particularly crucial. Different positioning in the utterance indeed would determine different instances of laughter predication and therefore affect in a potentially different way the meaning conveyed. Two examples are proposed in what follows: while in (38.1) the speaker is sweetly amused by realising for how long "She" has been Josh's friend, in (38.2) the speaker is modifying only the word "friend" meaning that probably there is something more than just friendship between the two. Laughables are underlined.

(38) *Constructed example*

1. She is John's, hehe, long-term friend;
2. She is John's long-term, hehe, friend.

In example (39) we offer a constructed manipulation of laughter positioning in a sentence to show the complexity of its predication. We compare the exact same sentence with the addition of laughter serving different functions in different positioning, resulting in a totally different semantics of the meaning conveyed. Laughables (i.e. *areas* of predication) are underlined.

(39) *Constructed example*
I love working on holiday! Ahah! → marking irony
I love working on ahah holidays! → scare quoting
I love ahah working on holidays! → scare quoting
I ahah love working on holidays! → scare quoting

4.2.4 Our proposal in brief - see Chapter 2

Our framework has been presented in detail in Chapter 2. We here present only a very brief summary to recap our proposal.

We propose that the core meaning of laughter involves a predication $P(l)$, where P is a predicate that relates to *incongruity* and/or *pleasure* and l is the laughable, an event or state referred to by an utterance or exophorically. Informally, the laughter's force can be construed as: the laughable l having property P triggers a positive shift of arousal of value d within A's emotional state e. We therefore consider laughter as an event predicate, the meaning of which is constituted by two main dimensions: the laughable and the arousal (see Chapter 2 for details). Different kinds of laughables can be distinguished firstly based on whether they contain an incongruity or not (friendliness) and secondly depending on which kind of incongruity it is (pleasant, social and pragmatic), being therefore a categorical variable. Arousal, on the contrary, is a continuous one: going from very low (e.g. little giggle, quiet laughter) to very high (e.g. loud uncontrollable laughter).

This core meaning, when aligned with rich contextual reasoning, can yield a wide range of functions, the classification of which can be guided by a binary decision tree presented in Figure 2.1. A detailed discussion of specific functions is presented in Chapter 2.

4.3 Laughter Clarification Requests corpus study

The proposal that laughter has propositional content leads to the expectation that, as with other content–bearing words and phrases (Ginzburg and Cooper, 2004b; Purver and Ginzburg, 2004), laughter can be the object of clarifications requests (CRs), i.e. questions used to point out a difficulty in understanding a previous utterance by another interlocutor. In the following, I show that this expectation is met and the range of clarifications found in corpora is used as diagnostics to identify some of the constituents of laughter meaning, indirectly informative about the elements needed for a correct laughter interpretation.

4.3.1 Clarification Request Data

The data analysed are taken from 2 corpora: the British National Corpus (BNC) (Burnard, 2000) (both spoken and written) and the Switchboard corpus (SWBD) (Godfrey, Holliman, and McDaniel, 1992), searched using the SCoRE search engine

(Purver, 2001). Despite the very high number of laughter occurrences (see Table 4.1) observed both in the SWBD (26,861) and BNC (30,598) corpora, we found very few explicit Clarification Requests (CRs) for laughter (0 in SWBD and 13 in BNC; 0.04% of all the laughs produced)[2] (see Table 4.1 for detailed search and results). This frequency is significantly smaller than that found for nominals in Purver (2004) (46 CRs over a total of 24,310 common nouns produced (0.18%)), but is of a similar order to the frequency found for verbs (3 CRs over a total of 30,060 verb occurrences (0.09%)).

A possible, purely speculative, explanation of the discrepancy between CRs about verbs and nouns might be based on the fact that verbs are morphologically richer than nouns (Conroy, Sage, and Lambon Ralph, 2006) and therefore potentially a listener might have more redundant information to rely on. It is known from studies on aphasics that impairment in verb retrieval is more disruptive for sentence construction and production than nouns or phonological impairments (Marshall, Pring, and Chiat, 1998; Marshall, 2009; Berndt et al., 1997). It might be therefore that a common listener, being the verb the core of any sentences can rely on more information to infer verb meaning being therefore more stable. For additional possible explanation, see Purver (2014).

In addition then, we found regular occurrences of participants spontaneously providing explicit justifications of their laughter productions to make sure the interlocutors interpret their contribution correctly, providing information about the elements necessary for laughter to occur.

Corpus	**SWBD**		**Wr.**	**BNC**	**Sp.**	**BNC**
Expressions	**N.**	**Dir. CRs**	**N.**	**Dir. CRs**	**N.**	**Dir. CRs.**
What's funny	5		5	3	5	4
What's so funny	3		17	12	3	1
What was so funny	2		4	3	1	
What are you laughing about	0		2	2	5	4
What are you laughing at	0		3	3	2	2
What you laughing for	0		1	1	2	2
Why are you laughing	0		4	4	0	
That's not funny	1		5		4	
Why do you laugh	0		1	1	0	
Laugh because	7		7		3	
Laughing at	4		307		55	
Total Direct CRs		0		29		13
Tot. Laughter occurrences		26861				30598

TABLE 4.1: Laughter direct Clarification Requests: Switch-Board (SWBD) and British National Corpus (BNC), written (Wr.) and spoken (Sp) data.

[2]The same percentages are not available for the written BNC analysed because of the difficulty in identify all the laughter occurrences in the text. In the written BNC laughs are indeed not tokenised and therefore hard to be spotted in their occurrences/descriptions.

4.3.2 Sources

The first question we consider is—What are the causes of a problematic interpretation of a laugh? We found that the most frequently clarified element is the *laughable*, i.e., the argument of the laughter predication.

Laughable

The highest number of CRs relating to laughter seems to involve a presumption that the predication involves *funniness* i.e., predication of the presence of a pleasant incongruity in the laughable, which could be paraphrased as "This is funny!". Therefore typical CRs related to a laughter are "What's funny?", "What's so funny?". This can be explained given data from the previous Chapter 3, which show, regardless of the language investigated and context, a high frequency of laughter predicating about pleasant incongruities used to show enjoyment of those, in comparison to the other types of laughables and functions; this is consistent also with the fact that this use of laughter is the more ancient and basic both phylogenetically (Ross, Owren, and Zimmermann, 2010; Vettin and Todt, 2005) and ontogenetically (Sroufe and Wunsch, 1972; Nwokah et al., 1994).

1. **Argument - pleasant incongruity**: In (40) the CR about the argument of the laughter is met by pointing at what we classify as a metalinguistic laughable (e.g., a slip of the tongue, pun, violation of conversational rules, inappropriate speech act, etc.) (see Chapter 2 for more details). This relates not to the content of Andrew's utterance, but to its form. While in (41) the laughable is clarified by describing verbally the gossip considered to be incongruous and funny by Daniel and the Unknown speaker.

   (40) *Extract from BNC, KBW*
   Tim: I don't want chocolate.
   Dorothy: Shh. Shh.< unclear >
   Andrew: Tim. If you don't want to finish it just put it down there and keep quiet.
   Dorothy: < laughter/ >
   Andrew: **What are you laughing at?**
   Dorothy: < laughter > the way you said it < /laughter >.

   (41) *Extract from BNC, KNY*
   Alex: I can't get this right.
   Unknown: < laughter/ >
   Marc: What was that you said?
   Alex: Nothing.
   Marc: James, **who's he laughing at?** What have you been saying?
   Emma: James.

Unknown: Alex please < unclear >.
Daniel: James [last or full name] fancies Zoe.
Emma: Does he?

2. **Argument - retracting funniness assumption**: In (42) it seems that the default interpretation of the laughter production "my partner has perceived something funny", justifies the question "what's funny?"; when the expected answer is not provided, this is then retracted in "What are you laughing at then?", Angela becoming open to the other possible laughter functions and laughable types.

   (42) *Extract from BNC, KSS*
   Richard: < laughter/ > Angela: **What's funny?** < pause > What you doing?
   Richard: I'm not doing a thing. You're doing it.
   Angela: **What you laughing at then?**
   Arthur: < unclear >.< laughter/ >
   Angela: You're waiting for what? What you waiting for?

3. **Argument - pragmatic incongruity** We did not find CRs related to pragmatic incongruity (i.e. when there is a clash between what is said and what is intended). However, this absence, we think, can be explained by the scarcity of this kind of laughable in the corpora we used (in Chapter 3 over 1072 laughs only 1% were related to a pragmatic incongruity). We can nevertheless construct contexts in which a CR for this type of laughable could be quite natural:

   (43) *Constructed example*
   A: She is John's long-term, heh friend.
   B: < laughter/ > **Why the snigger?** < laughter/ > Is there something more than friendship?

4. **Topoi and enthymemes**: In (44) and (45) the person asking for clarification does not have any issues identifying the laughable in itself, it is very clear for them what the interlocutor is *laughing about*; the objects of their CRs are, we argue, the topos and the enthymeme implicated in the incongruity. In (44) probably Geoff even understood which topos and enthymeme his mum is considering, but, still, he does not appreciate the pleasant incongruity and asks critically for further explanations. While in (45) the Anonymous speaker explains very clearly the reason for his/her pleasant incongruity appraisal stating that he would not expect (this other person) to do that, thereby pointing at a clash between expectations and reality.

   (44) *Extract from BNC, KD6*
   Geoff: ah
   Lynn: < laughter/ >

Geoff: I like that
Lynn: Gosh
Geoff: **What you laughing for?, I wouldn't laugh**
Lynn: Oh
Geoff: Silly mummy < pause > oh dear table's wobbling

(45) *Extract from BNC, KST*
Margaret: Yes, but pretend she's not watching and he looks over the top of his paper.
Anonymous: And grins!
Margaret: Oh it's stupid! I mean if anybody else just got up on the stage like he does < pause > and kicks his leg, kick like their leg like er like that they'd boo him off!
Anonymous: It's quite funny though < pause > when he kicks his legs and he went< unclear > he goes < pause > ooh wah!
Margaret: **What's funny about it**?
Anonymous: **Well that's funny! You're not expecting him to do that.**

Arousal

The second dimension of laughter meaning proposed in Chapter 2 is arousal. Two things can be questioned about the shift in arousal a laughter signals: the direction (i.e. positive – pleasure) and the amplitude of such a shift. In (46), Danny asks a CR about the pleasure (positive shift in arousal) felt by Mark, inferred from his laughter.

(46) *Extract from BNC, F7U*
Danny: < pause > Yes, that's what it means, it means weighing scales. < pause > What he meant was a balance.
Mark: < laughter/ >
Danny: Erm < pause > right if this < pause > < laughter/ > **you're enjoying this Mark aren't you?** < pause > Dunno why, they'll start me off now!

On the other hand, it is possible for a CR to be posed when the arousal perceived clashes with our evaluation of the laughable, questioning therefore the amplitude of the shift. We can imagine a situation as in (47), in which A is puzzled about the extremely highly aroused laughter produced by B when looking at the vignette she is showing her and when asking for clarification she's implicitly asking for the topos and enthymeme utilised, because according to the ones A considered such highly aroused laughter would be inappropriate.

(47) *Constructed example*
A: Look at this vignette! Isn't it nice? < laughter/ > [=little giggle]
B: < laughter/ > < laughter/ > [=bursting out laughing very loudly and uncontrollably]

A: **Why** *such* **loud laughter?**
B: < laughter > It made me think about what happened that day with my friend... < laughter/ > etc.

4.3.3 Form

The second aspect of our interest is the form CRs related to laughter can have. With nouns and verbs it is indeed possible to ask for clarification in different ways: from full sentences which echo or reprise the source; via non-sentential, elliptical fragments containing only noun phrases or wh-phrases; to highly conventionalised particles like "Eh?" (Purver, 2004). Examples are provided in Table 4.2 taken from Purver (2006).

TABLE 4.2: Possible CR forms - from Purver, 2006

Form	Example
Conventional	A:"Did Bo leave?" B:"Eh?/What?/Pardon?"
Non-reprise	A:"Did Bo leave?" B:"What did you say?/Did you say 'Bo'?"
Literal reprise	A:"Did Bo leave?" B:"Did BO leave?"/"Did Bo LEAVE?"
WH-substituted Repr.	A:"Did Bo leave?" B:"Did WHO leave?"/"Did Bo WHAT?"
Reprise sluice	A:"Did Bo leave?" B:"Who?/What?"
Reprise fragment	A:"Did Bo leave?" B:"Bo?/Leave?"
Reprise gap	A:"Did Bo leave?" B:"Did Bo ...?"

Based on our corpus analysis it appears that not all of these forms are viable when asking for laughter clarification.

1. **Direct CRs**
   In our exploration most of the direct CRs we could find were wh-phrases (see (40), (41), (42), (44), (45) above) directed either at the argument or the arousal of the laughter produced. While in (46) we have a confirmation clausal question (Ginzburg and Cooper, 2004b).

2. **Echoing-reprising the source**
   We did not find any of this occurrence in our corpora investigation. We can nevertheless imagine other contexts in which a reprise (or a non-reprise (Purver, 2004)) of the source is used to construct a CR (48a). Indeed we have come across an example in a spontaneous conversation presented in (48a):

   (48) a. *Constructed example*
   A: So you know... now there are gonna be important political consequences after yesterday's demonstration.
   B: < laughter/ >
   A: **Ha ha? / What do you mean "ha ha"? / "ha ha" What?**
   B: Well, you know! Do you really expect something good?? What are they gonna do! As usual some useless declaration on tv and that's all.

b. *Attested example*
A: I hear you're busy < laughter/ > [=little giggle]
B: What's the *hehe*?

One should emphasize that the latter kinds of CR probably work only with *low* arousal laughter with sufficient numbers of harmonic elements, given the need to modulate the prosodic contour into a question-like intonation. Therefore a question here arises about whether different kinds of laughter allow different forms of CRs.

3. **Indirect CRs**
It is possible also to use very indirect ways of asking for clarification which are much harder to spot in a large corpus. Here is an example from the St. Louis Post-Dispatch:

(49) *Example from St. Louis Post-Dispatch - 11 May 2018*
The defense objected and Burlison sustained the objection. Sullivan laughed.
"Is there something about my ruling that strikes your fancy?" Burlison said.
"No," Sullivan replied, "I'm laughing to myself about something else."

4.3.4 Spontaneous Clarifications

Topoi and Enthymemes

From a theoretical perspective, especially in order to understand the (conscious) cognitive processes behind laughter production, it is also very useful to look at instances where people spontaneously clarify the reason for their laughter. In the current work we have observed this kind of practice only for laughter related to pleasant incongruities, where people very carefully explain the topos and the contrasting enthymeme they considered. More specifically, in (50) A describes the different frames of reference (topoi) considered by him and his friend with regards to the amplitude of the movement needed to hit the golf ball correctly, stressing the clash between the two. (51), on the other hand, offer two interesting points of reflection. The first is A's correction after B's laughter "I'm serious", showing therefore that A interpreted B's laughter as "This is funny!"/"That's a good joke!", which could be elaborated in "My comment was not intended to be funny, it is not a joke, I really mean it! Parts of Lubbock actually come to Dallas in the form of enormous clouds of sand or dust." It is then B who clarifies again, explicating the actual reason of his/her laughter referring to a joke she used to tell in the past, where the topos implicated is "The bigger a country is, the more opportunities there are for it to be rich and powerful. Therefore countries try to keep as much land as possible.", while the enthymeme presented in the old joke is an instance of the opposite behaviour "The bigger a country is the

more opportunities there are for it to be rich and powerful. Therefore countries, if you conquer a bit of land, will give you more."

(50) *Extract from SWBD, sw2388*

A: yeah what's funny is the idea that uh you know what I consider you know like a three-quarter backswing or even a half backswing uh my friend says that's you know that's a full backswing and you don't want to go any further than that so i mean it's a now it's a matter of trying to convince myself that that's right < laughter/ >
B: yeah
A: < laughter/ > so I don't know it's going to be interesting
B: well you have to prove it to yourself just by doing it a few times
A: um that's probably true

(51) *Extract from SWBD, sw4445*

B: does does Dallas sits sit in any kind of uh uh 've been there but I don't remember if you sit in any kind of a trough that uh where you get temperature inversions that that capture air pollutants or anything like that
A: we have we yes we occasionally have them not if they're not, not not too significant, but they do occasionally occasionally occur uh one source of < laughter/ > pollution for us is the dust and sand in uh west Texas
B: sure
A: in the spring time we'll have parts of Lubbock coming to Dallas
B: < **laughter/** >
A: I'm serious these enormous clouds of sand or dust or whatever you wanna call it
B: **I laugh because I made the journey once from El Paso to Dallas and then continuing east uh to the Eastern Coast of the United States and uh I joked that uh all of the settlers**
A: uh-huh
B: **settled in Eastern Texas where the green rolling hills are and and when they finally beat the Mexicans the Mexicans said fine you can have East Texas but as long as long only as long as you take west Texas too** < laughter/ >
A: yeah < laughter/ >, < laughter/ > okay
B: < laughter/ >

4.3.5 Relation between laughter and smiling

An additional issue raised by the clarification data here concerns the semantic relation between smiling and laughter. Smiling can indeed be the source of the very same CRs that we have found for laughter, as in (52) extracted from the written part of the BNC.

(52) *Extract from written BNC, The five gates of hell. Thomson, Rupert. London: Bloomsbury Pub. Ltd, 1991.*

'You look like nobody else,' he said, 'same as always.' He held her again, then he looked round. 'Where's George?' 'She's going to be late,' Yvonne said. Harriet handed him a glass of wine. 'She said she'd come and wake you up when she got back.' 'You must be hungry,' Yvonne said. She made him a sandwich and brought it to the table. He looked down at it, smiling. **'What's so funny?'** she said. He held the sandwich up.' It's the first sandwich you've ever made me that hasn't got any paint on it.'

Such data support the idea that smiling and laughter, at least in some of their occurrences—without overlooking the possibility that they might have a completely different evolutionary origin (Van Hooff, 1972; Lockard et al., 1977)— could have been co-opted to convey a similar meaning different only in intensity, on a continuum of graded signals. In support of this hypothesis, Ruch (1993) found that in laughter we observe the activation of the same action units activated in smiling, but with stronger intensity and with longer activations, and Pollio, Mers, and Lucchesi (1972) observed how often laughter emerges and fades in smiling. This view seems to be strengthened by (53), where the signal on the low extreme of the continuum, smiling, *gave way* to laughter as soon as the intensity of the emotion increased. Another example of this is given in (54), where we can see a nice crescendo from smiling to laughter.

(53) *All the sweet promises. Elgin, Elizabeth. London: Grafton Books, 1991*

'She'll have to go without, then – or paint her legs, as it suggested in the magazine. Gravy-browning is supposed to be good.' 'Good grief!' Mama bare-legged! Lucinda shook with silent joy. Gravy-browning? But it really wasn't funny, come to think of it, since poor Pa would be the whipping boy for the silk stocking shortage. One thing was certain, though. Worrying about clothing coupons would at least make Mama forget the invasion for a while. **'What's so funny?'** Vi demanded. 'My mother. Having to paint her legs.' Lucinda's smile gave way to a throaty laugh. 'But she'll find a way round it.' She would, too.

(54) *Example extracted from the Providence Corpus (Demuth, Culbertson, and Alter, 2006) - William 020012*

Child: < laughter/ >
Mum: < laughter/ >
Mum: What're you doing you silly goosie?
Mum: You silly goosie.
(Facial movements imitation play)
Child: < smile/ > < laughter/ >
Mum:< laughter/ >

4.3.6 Discussion

The data presented raises a variety of questions. We will focus mainly on two:

1. Why are few occurrences of laughter CRs found?
2. Why are they all related to laughs concerning pleasant incongruities and none concerning social, pragmatic incongruities or friendliness/closeness.

The answers to these questions might be correlated. On the one hand, it is possible that a more refined exploration of the corpus will allow the detection of more indirect forms of CRs. On the other hand, we think that a laughter CR is potentially rude or aggressive. That might explain, given its exclusive reliance on phone conversations between strangers, why in SWBD we do not find any direct laughter CRs. Issues related to politeness and social conventions might also explain the absence of laughter CRs related to social incongruities (e.g. embarrassment, asking a favour, criticising). In these kinds of situations the request for clarification would indeed have the contrary effect to the one aimed by the laugher, making the situation very uncomfortable for the parties involved. These kinds of laughter usually involve very low arousal, and people are often not even aware of producing them (Vettin and Todt, 2004), therefore asking for clarifications about something we were not even aware of having produced might lead to embarrassment and to a temporary breakdown of the conversation. We can speculate therefore that CRs about laughs related to social incongruities do not arise (at least in the contexts analysed) because of the more straightforward nature of this kind of laughs used to smooth conversation and soften specific comments. Conversely, the laughables constituting pleasant incongruity are a much more varied and significant collection, also given the judgemental, moral, and cognitive aspects related to laughter production (e.g., not everything can a subject for laughter, it is silly to laugh at some things, some laughter can be offensive for someone, etc.). Moreover, cultural, personal and emotional experiences, as well as "cognitive styles", can influence and affect the perception of pleasant incongruities, creating potential for discrepancies in the common ground (and topoi) considered by the interlocutors and leading to the need for clarification requests. In a friendly but not intimate context (e.g., SWBD), the best option is always to produce a small antiphonal laughter, even when the laughable is not shared, and either pursue the conversation regardless or attempt to seek clarification concerning the laughable in more indirect ways.

4.4 Conclusion

In this chapter I have presented evidence that supports the proposal that laughter has propositional content (Chapter 2), analysing both the clarification requests raised after some laughter occurrences and the corrections after an interlocutor's laughter, which signal a wrong interpretation of the previous contribution. Using clarification

requests as diagnostics, we distinguished different elements constitutive of laughter meaning and necessary for its interpretation, namely the laughable (with its components) and the arousal. The type of clarification requests found in the corpora therefore supports the basic structure of our modelling of laughter meaning. We hypothesize that there are restrictions on the form CRs can take depending on the kind of laughter that is subject to clarification. This hypothesis needs to be investigated experimentally. I also offer tentative hypotheses concerning how the social context might affect the occurrences of CRs relating to laughter. Data about the relation between smiling and laughter is also provided, suggesting the possibility that in some uses the two are non-verbal social signals that can convey the same meaning on a graded scale according to intensity. This, in turn, suggests the need to investigate the cases when such graded difference of meaning is not evinced. Moreover, the fact that in both corpora analysed one can find CRs related to smiling such as "What are you smiling about/at?", "Why are you smiling?" suggests that our claims about laughter having propositional content and functioning as an event predicate that selects for a contextual argument, can be generalised also to other kinds of non-verbal social signals (e.g. smiling and frowning).

Chapter 5

Formal laughter

5.1 Modelling laughter meaning

In this chapter we offer a detailed formal proposal for a semantic and pragmatic analysis of laughter[1]. We will show that many of the semantic/pragmatic properties of laughter can be captured in a straightforward fashion with an existing formal approach to dialogue semantics/pragmatics, namely the framework KoS (Ginzburg, 2012), though this involves adopting independently motivated assumptions about the nature of input to semantics/pragmatics that are not assumed in most other semantic/pragmatic frameworks. At the same time, as we discuss in section 5.2, in order to capture certain additional features of laughter one has to integrate emotional reasoning into semantics/pragmatics, building on existing work in cognitive psychology and artificial intelligence (Scherer, 2009; Marsella, Gratch, and Petta, 2010).

5.1.1 Background on KoS and TTR

Cognitive States in dialogue

We formulate our account within the framework of KoS (Ginzburg, 1994; Ginzburg and Cooper, 2004a; Larsson, 2002; Purver, 2006; Fernández, 2006; Ginzburg and Fernández, 2010; Ginzburg, 2012).

KoS is a theory that combines an approach to semantics inspired by situation semantics and dynamic semantics with a view of interaction influenced by Conversation Analysis (CA). On the approach developed in KoS the analysis is formulated at a level of cognitive states, one per conversational participant. Each cognitive state consists of two 'parts', a private part and the dialogue gameboard, which represents information that arises from publicized interactions (similar to the concept of common ground).

In our formalization we will mainly focus on the public part, i.e. the Dialogue Gameboard (DGB), recurring to the private part only when needed to illustrate the affective import of laughter use on the interaction.

[1]The work presented in the current chapter is the result of joint work with Jonathan Ginzburg (Université Paris Diderot) and Ye Tian (Cambridge Amazon Research) (Ginzburg, Mazzocconi, and Tian, subm).

The structure of the dialogue gameboard is given in (55a) — the *spkr, addr* fields allow one to track turn ownership, *Facts* represents conversationally shared assumptions, *VisSit* keeps track of the visual situation including the focus of visual attention, *Pending* and *Moves* represent respectively moves that are in the process of being or have been grounded, *QUD* tracks the questions currently under discussion:

(55) a. DGBType (provisional definition) $=_{def}$

$$\begin{bmatrix} \text{spkr} : \text{Ind} \\ \text{addr} : \text{Ind} \\ \text{utt-time} : \text{Time} \\ \text{c-utt} : \text{addressing(spkr,addr,utt-time)} \\ \text{Facts} : \text{Set(Proposition)} \\ \text{VisSit} : \text{RecType} \\ \text{Pending} : \text{list(locutionary Proposition)} \\ \text{Moves} : \text{list(illocutionaryProposition)} \\ \text{QUD} : \text{poset(Question)} \end{bmatrix}$$

To understand better the specification in (55), we offer a short discussion concerning the logical underpinnings of KoS. KoS is formulated within the framework of Type Theory with Records (Cooper, 2005; Cooper, 2012; Cooper and Ginzburg, 2015), a model–theoretic descendant of Martin-Löf Type Theory (Ranta, 1994) and situation semantics (Barwise and Perry, 1983; Cooper and Poesio, 1994; Seligman and Moss, 1997; Ginzburg and Sag, 2000). TTR enables one to develop a semantic ontology, including entities such as events, propositions, and questions, whence types characterizing questions and propositions, in (55). As we will see shortly, with the same means TTR enables the construction of a *grammatical* ontology consisting of utterance types and tokens and of an interactional domain in which agents utilize utterances to talk about the semantic universe. For current purposes, the key notions of TTR are the notion of a *judgement* and the notion of a *record*.

- **The typing** *judgement*: $a : T$ classifying an object a as being of type T. Examples are given in (56). (56a,b) involve *basic* "atomic" types IND(ividual) and TIME. In (56c) $run(b, t)$ is a *p(redicate)–type*, that arises by assigning the entities b, t, respectively to the argument roles of *run*; $arg1_{IND}$ requires its fillers to be *of type* IND, whereas $arg2_{TIME}$ requires its fillers to be *of type* TIME. Ranta (1994) proposed that elements such as s in (56c) be viewed as events or situations.

  (56) a. b : IND
  b. t : TIME
  c. s : run$(arg1_{IND} : b, arg2_{TIME} : t)$

- **Records**: A record is a set of fields assigning entities to labels of the form (57a), partially ordered by a notion of *dependence* between the fields—dependent fields must follow fields on which their values depend. A concrete instance is exemplified in (57b). Records are used here to model events and states, including utterances, and dialogue gameboards.

(57) a. $\begin{bmatrix} l_1 = val_1 \\ l_2 = val_2 \\ \dots \\ l_n = val_n \end{bmatrix}$

b. $\begin{bmatrix} \text{x} & = & \text{-28} \\ \text{e-time} & = & \text{2AM, Feb 17, 2019} \\ \text{e-loc} & = & \text{Nome} \\ \text{c}_{temp-at-in} & = & \text{o1} \end{bmatrix}$

- **Record Types**: a record type is a record where each field represents a judgement rather than an assignment, as in (58a). The basic relationship between records and record types is that a record r is of type RT if each value in r assigned to a given label l_i satisfies the typing constraints imposed by RT on l_i. More precisely, as in (58b):

(58) a. $\begin{bmatrix} l_1 : T_1 \\ l_2 : T_2 \\ \dots \\ l_n : T_n \end{bmatrix}$ b.The record

$\begin{bmatrix} l_1 & = & a_1 \\ l_2 & = & a_2 \\ \dots & & \\ l_n & = & a_n \end{bmatrix}$ is of type: $\begin{bmatrix} l_1 & : & T_1 \\ l_2 & : & T_2 \\ \dots & & \\ l_n & : & T_n \end{bmatrix}$

iff $a_1 : T_1, a_2 : T_2, \dots, a_n : T_n$

c. Type inclusion:[2] $T_1 \sqsubseteq T_2$ iff for all assignments to basic types it is the case that if $a : T_1$ then $a : T_2$

To exemplify this, (59a) is a possible type for (57b), assuming the conditions in (59b) hold. Records types are used to model utterance types (aka as *signs*) and to express rules of conversational interaction.

(59) a. $\begin{bmatrix} \text{x} & : & \text{Ind} \\ \text{e-time} & : & \text{Time} \\ \text{e-loc} & : & \text{Loc} \\ \text{c}_{temp-at-in} & : & \text{temp\_at\_in(e-time,e-location,x)} \end{bmatrix}$

b. -28 : Ind; 2:00AM, Feb 17, 2019 : Time; Nome : Loc; o1 : temp_at_in(2:00AM, Feb 17, 2019, Nome, -28)

[2]For detailed discussion concerning systems of types and type assignments, see (Cooper, 2012; Cooper, 2016).

Conversational Rules

Contextual reasoning will be important for us in two ways. First, we characterize dialogue regularities (e.g., A's assertion p gives rise to the possibility that B accepts p or alternatively that B initiates discussion of the question p?) in terms of *conversational rules*, mappings between two dialogue gameboards the *precond(ition)s* and the *effects*. We will eventually suggest that laughter *inter alia* serves to signal that a more marked conversational option has been selected. Some basic conversational rules that will be needed to analyze the dialogues we consider are given in (60):

(60) a. Ask QUD-incrementation: given a question q and ASK(A,B,q) being the LatestMove, one can update QUD with q as MaxQUD.

$$\begin{bmatrix} \text{pre} & : & \begin{bmatrix} \text{q} & : & \text{Question} \\ \text{LatestMove = Ask(spkr,addr,q)} & : & \text{IllocProp} \end{bmatrix} \\ \text{effects} & : & \left[\text{QUD} = \left\langle \text{q,pre.QUD} \right\rangle \ : \ \text{poset(Question)}\right] \end{bmatrix}$$

b. QSPEC: this rule characterizes the contextual background of reactive queries and assertions—if q is MaxQUD, then subsequent to this either conversational participant may make a move constrained to be q-specific (i.e., either About or Influencing q).

$$\begin{bmatrix} \text{pre} & : & \left[\text{QUD} = \left\langle \text{q, Q} \right\rangle \text{: poset(Question)}\right] \\ \text{effects} & : & \begin{bmatrix} \text{r : Question} \vee \text{Prop} \\ \text{R: IllocRel} \\ \text{LatestMove = R(spkr,addr,r) : IllocProp} \\ \text{c1 : Qspecific(r,q)} \end{bmatrix} \end{bmatrix}$$

c. Assert QUD-incrementation: a straightforward analogue for assertion of (60a): given a proposition p and ASSERT(A,B,p) being the LatestMove, one can update QUD with p? as MaxQUD.

$$\begin{bmatrix} \text{pre} & : & \begin{bmatrix} \text{p} & : & \text{Prop} \\ \text{LatestMove = Assert(spkr,addr,p)} & : & \text{IllocProp} \end{bmatrix} \\ \text{effects} & : & \left[\text{QUD} = \left\langle \text{p?,pre.QUD} \right\rangle \ : \ \text{poset(Question)}\right] \end{bmatrix}$$

d. Accept move: specifies that the background for an acceptance move by B is an assertion by A and the effect is to modify LatestMove.

$$\begin{bmatrix} \text{pre} & : & \begin{bmatrix} \text{spkr} & : & \text{Ind} \\ \text{addr} & : & \text{Ind} \\ \text{p} & : & \text{Prop} \\ \text{LatestMove = Assert(spkr,addr,p)} & : & \text{IllocProp} \\ \text{QUD} = \left\langle \text{p?,pre.QUD} \right\rangle & : & \text{poset(Question)} \end{bmatrix} \\ \text{effects} & : & \begin{bmatrix} \text{spkr = pre.addr} & : & \text{Ind} \\ \text{addr = pre.spkr} & : & \text{Ind} \\ \text{LatestMove = Accept(spkr,addr,p)} & : & \text{IllocProp} \end{bmatrix} \end{bmatrix}$$

e. Fact Update/ QUD Downdate: given an acceptance of p by B, p can be unioned into FACTS, whereas QUD is modified by the function NonResolve. NonResolve is a function that maps a partially ordered set of questions $poset(q)$ and a set of propositions P to a partially ordered set of questions $poset'(q)$ which is identical to $poset(q)$ modulo those questions in $poset(q)$

resolved by members of P.

$$\begin{bmatrix} \text{pre} & : & \begin{bmatrix} \text{p} & : & \text{Prop} \\ \text{LatestMove = Accept(spkr,addr,p)} & : & \text{IllocProp} \\ \text{QUD} = \left\langle \text{p?,pre.QUD} \right\rangle & : & \text{poset(Question)} \end{bmatrix} \\ \text{effects} & : & \begin{bmatrix} \text{FACTS} = \text{pre.FACTS} \cup \left\{ \text{p} \right\} & : & \text{Set(Prop)} \\ \text{QUD = NonResolve(pre.QUD,FACTS)} & : & \text{poset(Question)} \end{bmatrix} \end{bmatrix}$$

We exemplify how these rules work in (61), which involves discussion and disagreement at the illocutionary level. A poses a query, which via *Ask QUD-incrementation* updates Moves and via *QSPEC* licences B's assertion, which in turn updates Moves via *Assertion QUD-incrementation*. A rejects B's assertion, and then offers her own proposal, which B accepts. This licences acceptance, incrementation of FACTS and downdating of QUD via *Accept* and *Fact update/QUD downdate*, respectively:

(61) a. A(1): Who's a good candidate?

B(2): Petra.

A(3): (3a) No, (3b) Pauline is.

B(4): OK.

b.

Utt.	DGB Update (Conditions)	Rule
initial	MOVES = $\langle\rangle$ QUD = $\langle\rangle$ FACTS = cg1	
1	LatestMove := Ask(A,B,q0) QUD : = $\langle q0 \rangle$	 Ask QUD-incrementation
2	LatestMove := Assert(B,A,p1) (About(p1,q0)) QUD : = $\langle p1?, q0 \rangle$	QSPEC Assert QUD-incrementation
3a	LatestMove := Assert(A,B, $\neg$ p1) (About($\neg$p1,p1?)) QUD : = $\langle \neg p1?, p1?, q0 \rangle$	QSPEC Assert QUD-incrementation
3b	LatestMove := Assert(A,B, p2) (About($\neg$p2,q0)) QUD : = $\langle p2?, \neg p1?, p1?, q0 \rangle$	QSPEC Assert QUD-incrementation
4	LatestMove := Accept(A,B, p2) QUD := $\langle q0 \rangle$ FACTS := cg1 $\cup \{p2\} \cup \{\neg p1\}$	Accept Fact update/QUD downdate

Topoi and Enthymemes

Conversational reasoning is important for us also because one of the relata of incongruity is in some sense an inference rule that represents "congruity" (what is expected). As presented in detail in Chapter 2 (Section 2.4.4), in order to capture this we use the Aristotelian notions of *topos* and *enthymeme* introduced into TTR in

work by Breitholz and Cooper (Breitholtz and Cooper, 2011; Breitholtz, 2014). Topoi represent general inferential patterns (e.g., *given two routes choose the shortest one*). *Enthymemes* are the actual arguments conveyed in dialogue or other discourse which are drawing on topoi. In other words, they are applications of topoi in particular cases, e.g., *given that the route via Walnut street is shorter than the route via Alma, choose Walnut street*. We adopt the formalization of Breitholtz and Cooper (2011) and Breitholtz (2014) in which topoi and enthymemes are functions from records (the context) to record types (the conclusion). (62) is a simplified illustration of the route choice topos, discussed in detail in (Breitholtz, 2014).

(62) a. λr: $\begin{bmatrix} \text{x:}Ind \\ \text{y:}Ind \\ \text{c}_{\text{route}}\text{:route(x)} \\ \text{c}_{\text{route}_1}\text{:route(y)} \\ \text{c}_{\text{shorter\_than}}\text{:shorter\_than(x, y)} \end{bmatrix} . \left[\text{c}_{\text{choose}}\text{:choose}(r.\text{x})\right]$

b. λr: $\begin{bmatrix} \text{x=Walnut Street:}Ind \\ \text{y=Alma:}Ind \\ \text{c}_{\text{route}}\text{:route(x)} \\ \text{c}_{\text{route}_1}\text{:route(y)} \\ \text{c}_{\text{shorter\_than}}\text{:shorter\_than(x, y)} \end{bmatrix} . \left[\text{c}_{\text{choose}}\text{:choose}(r.\text{x})\right]$

The basic relationship between enthymemes and topoi on this view is given in (63):

(63) a. An enthymeme $E = \lambda e : D1.R1(e)$ belongs to a topos $\tau = \lambda e : D.R(e)$ if:

b. $D1 \sqsubseteq D$, and

c. for any, $e : D1$, $E(e) \sqsubseteq \tau(e)$.

Propositions

The final logical notion we introduce is the situation semantics notion of an Austinian proposition (Barwise and Etchemendy, 1987). Deriving from Austin's theory of truth (a true assertion involving a situation token matching a situation type), they were originally proposed to explicate assertions and relatedly beliefs. In TTR they are identified with records of the form (64a) whose truth conditions are defined in (64b):

(64) a. $\begin{bmatrix} \text{sit} & = & s \\ \text{sit-type} & = & T \end{bmatrix}$ $s_0 : ST_0$ b. A proposition $p = \begin{bmatrix} \text{sit} & = & s_0 \\ \text{sit-type} & = & ST_0 \end{bmatrix}$ is true iff

Subsequently, such propositions been used in modelling utterance processing (Ginzburg, 2012). Ginzburg (2012) proposes that dialogue interaction is, to a large extent, structured by a series of branching points where an utterance is either grounded

(Clark, 1996) or gives rise to clarification interaction or repair[3]. Ginzburg (2012) show that the specific conditions for grounding and possibilities for repair of an utterance u can be read off the *locutionary proposition* defined by u and a grammatical type T_u, intuitively the *sign* (in the Saussaurean sense) associated with u. That the locutionary proposition involves the entire sign and not merely its semantic components is motivated, in part, by the fact that this enables the locutionary proposition to serve as the means for characterizing the forms that are possible means to ground or request clarification about u and these exhibit significant syntactic and phonological parallelism with u (Ginzburg and Cooper, 2004a), as exemplified in (65b,c). (65d) exemplifies lexical entries we will posit below for laughter. Here it is a somewhat simplified lexical entry for the particle 'mmh' used to acknowledge understanding of a prior utterance. It has fields for phonological and syntactic types, as well as for the *contextual parameters* of the utterance (DGB-PARAMS) needed to resolve the content of an utterance of 'mmh' on a given use. In this case the contextual parameters are an utterance token and the conversational participants:

(65) a. A locutionary proposition $\begin{bmatrix} \text{sit} & = & u_0 \\ \text{sit-type} & = & T_{u_0} \end{bmatrix}$ is true iff $u_0 : T_{u_0}$, in other words iff the sign fully classifies the utterance; otherwise, repair interaction ensues.

b. (i) A: Do you fear him? B: Fear? (=What do you mean by 'fear' or Are you asking if I *fear* him) / #Afraid?;
(ii) A: Are you afraid of him? B: Afraid? (=What do you mean by 'afraid' or Are you asking if I am *afraid* of him) / #Fear?

c. A: She is an advocate. B: What do you mean an advocate/#an attorney?

d. $$\begin{bmatrix} \text{phon} : \texttt{mmh} \\ \text{syncat} : \textit{interjection} \\ \text{dgb-params} : \begin{bmatrix} \text{spkr} : \text{Ind} \\ \text{addr} : \text{Ind} \\ \text{u} : \text{sign} \\ \text{c1} : \text{address(spkr,addr,u)} \end{bmatrix} \\ \text{cont} = \text{Acknowledge(u,spkr)} : \text{IllocProp} \end{bmatrix}$$

5.1.2 A minimal theory of laughter: laughables and incogruity

We propose to view laughables as Austinian propositions, comprising the laughable event and its description, a record type. (66) offers some examples: in (66a) the laughable is simply a perceived event of a man slipping over a banana peel; in (66b)

[3]We assume these two latter terms are synonymous, the former often used in the dialogue community, the latter among CA researchers.

the laughable is the utterance by A 'Bill is absurd', whereas in (66c) the laughable is the utterance 'friend':

(66) a. exophoric: man slips over banana peel $\mapsto$
$$\begin{bmatrix} \text{sit} = l \\ \text{sit-type} = \begin{bmatrix} \text{x: Ind} \\ \text{c1: Man(x)} \\ \text{y: Ind} \\ \text{c2: b-peel(y)} \\ \text{c3: slip-over(x,y)} \end{bmatrix} \end{bmatrix}$$

b. utterance: A: Bill is absurd. $\mapsto$
$$\begin{bmatrix} \text{sit} = l \\ \text{sit-type} = \begin{bmatrix} \text{x: Ind} \\ \text{c2: utter(x,'Bill is absurd')} \end{bmatrix} \end{bmatrix}$$

c. utterance medial: A: He's her heh friend. $\mapsto$
$$\begin{bmatrix} \text{sit} = l \\ \text{sit-type} = \begin{bmatrix} \text{x: Ind} \\ \text{c2: utter(x,'friend')} \end{bmatrix} \end{bmatrix}$$

The formalization we propose is grounded in the laughter meaning proposed in Chapter 2:

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

The core meaning of laughter imply therefore two dimensions: one related to the laughable (i.e. incongruity or friendliness/pleasantness) and arousal. To ease the presentation we will discuss possible representations of the predication of incongruity and then of pleasantness independently. Maybe a bit counter-intuitively we will therefore start from the rarer cases, i.e. pragmatic incongruity (Section 5.1.2) and, after having implement the necessary elements in the framework of reference (Section 5.2), friendliness (Section 5.2.3) (Figure 2.1). In the final part we will then explain how in the most common cases those predications get actually combined (Section 5.2.4).

Laughter to mark pragmatic incongruity

Like Raskin we think that *incongruity* needs to be explicated in terms of a *clash*. For Raskin the clash is between two objects (scripts) at the level of types. However, given that incongruity in conversation must apply to laughables (real world events), we refine slightly a proposal by Ginzburg et al. (2015) to yield a view of incongruity as a clash between (an enthymeme triggered by) the laughable and a topos that represents 'congruity', i.e., the much more probable course of action[4]. That is, the laughable l

[4]The definition proposed by Ginzburg et al. (2015) had the enthymeme as an additional independent argument, whereas we abstract away from the latter, which seems somewhat more parsimonious. For some initial discussion of this issue as it relates to clarification questions about laughter, see Chapter 4.

satisfies the domain type of an enthymeme, but there is a clash between the range of this enthymeme and that of a topos which would instantiate an enthymeme more expected in the circumstances. In (68), p is a proposition comprised of l, the laughable event, and L a type that classifies l, E is the triggered enthymeme, and τ is the clashing topos—E's domain is a subtype of τ, but its range (L_1) is incompatible with τ's range:

(68) Incongruous (p, τ) iff for $p = \begin{bmatrix} \text{sit} = \text{l} \\ \text{sit-type} = \text{L} \end{bmatrix} : \mathit{TrueProp}$, $\tau = \lambda r : T_1 \,.\, T_2 :$ (*Rec*→*RecType*), there exists $E = \lambda r : L \,.\, L_1 :$ (*Rec*→*RecType*) such that $L \sqsubseteq T_1$ and $L_1 \perp T_2$

We exemplify this definition with several distinct types of effects we have seen before:

1. Irony marking of an assertion:

   (69) Lecturer: ... And then of course you've got Ronald Reagan ... and <u>< laughter/ ></u> history ended with Ronald Reagan. (BNC, JSM)

   This relies on the enthymeme 'If A says that history ended with Ronald Reagan, then A means that in fact it did not.' This clashes with the sincerity topos 'If A says p, then A means p'. Hence it conveys the content in (70):

   (70) Content: Incongruous(laughable:Lecturer's utterance that history ended with Ronald Reagan, topos: If A says p, A intends p)

   How does this arise in context? We do not offer here a precise account of topos resolution, but sketch a hypothesis based on markedness. Whenever a declarative utterance is made by A which involves a proposition p there are (inter alia) two possible understandings available: A *asserts* p or A intends to convey a content incompatible with p. *A priori*, the former is far likelier, so a laugh can be viewed as a means of signalling the choice of the much less likely possibility.

2. Scare quotation

   (71) *Example extracted from the London Lund Corpus*
   B: Paul you're are you interested in modern drama. I mean is it one of your things, it won't come round next year, but it'll come the year after.
   A: well I I'm interested in it in a (pause, laughs) <u>comfortably relaxed way</u>

   In (71) we have an interaction between laughter and self communication management[5]. Here the laughable is A's upcoming speech event u. The pause

[5]Also known as 'self-repair' or 'disfluency'.

potentially indicates that A is not entirely sure how to express the next word or phrase. A chooses a particular sub-utterance but uses the laugh to signal that this choice deviates from the standard use of this phrase. In light of semantic work such as Ginzburg, Fernández, and Schlangen (2014) and psycholinguistic work such as Lowder and Ferreira (2018), we assume that a hesitation by A means that the immediately subsequent utterance addresses the issue of *What does A mean to say after* u_0*?*. The laugh in this case signals that A does not quite mean "comfortably relaxed" as the utterance to follow '[in] a'. The default, unmarked alternative would be for this utterance to represent exactly what A meant to say after '[in] a'. This is the same mechanism as for irony marking of a statement, but via incremental processing applied to word/phrase choice, as a consequence of self communication management.

Hence it conveys the content in (72), to which in previous chapters we have referred to with the term 'Pragmatic Incongruity':

(72) Content: Incongruous(laughable: DG's utterance 'comfortably relaxed', topos: if A utters u, A means $\mu(u)$, u's conventional meaning)

As noted in Chapter 2, note that different placements of a laugh within the same utterance type will result in potentially different contents being conveyed, given that which sub-utterance is the one in focus alters the issue raised and the scope of the scare quotation. Moreover, as with focus marking, the exact target of the scare quoted laughter is potentially ambiguous.

(73) A: well I I'm (pause) $<$ laughter/ $>$ <u>interested</u> in it in a comfortably relaxed way, you know. $\mapsto$ Content: Incongruous(laughable: DG's utterance 'interested' , topos: if A utters u, A means $\mu(u)$, u's conventional meaning)

5.1.3 A lexical entry for laughter predicating incongruity

We can now offer a lexical entry for a laugh that expresses incongruity. This lexical entry indicates about the signal whose phonological type is $lphontype$, on which more shortly, given a context that supplies a laughable p and topos τ, has as content the proposition that p is incongruous relative to τ. Moreover, the laughable is incongruous to a contextually given degree δ, constrained by a relation whose other argument is the arousal encoded in the laughter's phonetics.

(74) Laughter predicating incongruity

$$\begin{bmatrix} \text{phon} : \texttt{lphontype} \\ \text{dgb-params} : \begin{bmatrix} \text{spkr} : \text{Ind} \\ \text{addr} : \text{Ind} \\ \text{t} : \text{TIME} \\ \text{c1} : \text{addressing(spkr,addr,t)} \\ \delta : \text{Int} \\ \text{c2} : \text{Arousal}(\delta, phon) \\ \text{p} = \begin{bmatrix} \text{sit} = \text{l} \\ \text{sit-type} = \text{L} \end{bmatrix} : \text{Prop} \\ \tau = \lambda r : (T1)T2 : \text{(Rec)RecType} \\ \text{c2: SubType(L, T1)} \end{bmatrix} \\ \text{content} = \begin{bmatrix} \text{sit} = \text{s} \\ \text{sit-type} = \begin{bmatrix} \text{c3} : \text{Incongr(p,}\delta\text{,}\tau\text{)} \end{bmatrix} \end{bmatrix} : \text{Prop} \end{bmatrix}$$

A number of key aspects remain underspecified in this entry for reasons we explain now:

- **Form**: we have mentioned above that the arousal associated with a laugh is a significant parameter. First, it distinguishes different words for laughs: a snigger represents a low arousal laugh, whereas a cackle represents a high arousal laugh; second, a high arousal laugh is inappropriate for intra-utterance scare quotation and for empathetic acknowledgement, whereas a low arousal laugh to a joke communicates a scalar implicature that the laugher does not find the joke particularly funny. Arousal is encoded by a number of parameters, including intensity and duration, but in the absence of a clear account, we will simply assume this as a scalar value readable off the phonetic representation of a laugh; this value for current purposes we restrict to three subtypes: H(igh arousal), M(edium arousal), and L(ow arousal). The phonological representation of a laugh is known to be subject to both large inter–subject and intra-subject variation (Urbain and Dutoit, 2011a), and so we leave that unanalyzed as a type `lphonetype`[6]. To the extent we need to specify laughs that have specific arousal profiles we can add restrictions on the arousal, exemplified in (75):[7]

(75) a. $\begin{bmatrix} \delta : \text{Int} \\ \text{c2} : \text{Arousal}(\delta, phon) \\ \text{c}_{arousal} : \delta \geq \text{Higharousal} \end{bmatrix}$ b. $\begin{bmatrix} \delta : \text{Int} \\ \text{c2} : \text{Arousal}(\delta, phon) \\ \text{c}_{arousal} : \delta \leq \text{Lowarousal} \end{bmatrix}$

[6]Bachorowski, Smoski, and Owren (2001) suggest that voiced laughter ('song'-like) is viewed more positively than unvoiced laughter ('snort'-like and 'grunt'-like). Whether this distinction, deriving from a study under laboratory conditions, has semantic-pragmatic effects in interaction remains unstudied as far as we are aware. We will try to tackle this question is Chapter 6

[7]We make here the simplifying assumption of absolute thresholds for arousal, rather than relative ones in terms of average phonetic properties. For some discussion on arousal and valence see Kuhbandner and Zehetleitner (2011).

- **Contextual parameters** Both the laughable and the topos that are the relata of the incongruity relation are specified here as contextual parameters to be resolved from information from the DGB. We have seen that laughables can originate from the content of the latest move made[8] (example (76)), from the ongoing utterance (examples (77)), from the visual situation (example (76a)). These can be both anaphoric and cataphoric (for the latter: examples (77), (78)), so we defer attempting to formulate a precise theory of resolution to future work (see Chapter 3 for some discussion of laughter placement, in relation to speech and the laughable.). A similar point applies to the resolution of the topos—as we have illustrated above, resolutions can be topoi that are conversational rules. But, as for instance example (78) shows ('Today's semantics class (laugh)') the resolution can be any commonly known topos, analogously to definite reference.

(76) A: I will take care of your savings.
B: < laughter/ >
$\rightsquigarrow$ I don't think you will take care of my savings!

(77) a. (i) A: Jill is John's, (laugh) long-term friend.
(ii) A: She is John's long-term (laugh) friend.

b. (i) A: You need to press on the (laugh) red button.
(ii) A: You need to press on the red (laugh) button.

(78) *Example from Priego Valverde, 2018*
PC: t'aimerais parler de quoi?
MA: du....
PC: < smiling voice > du cours< /smiling voice >< laughter >de sémantique de ce matin< /laughter >

PC: what would you like to speak about?;
MA: about...
PC: about < smiling voice > the semantics class < /smiling voice >< laughter > of this morning < /laughter >

5.2 Appraisal and Laughter

As stated in (67), we propose laughter to have a core meaning constituted by two different dimension: the laughable and arousal.

In the previous section, we showed how laughter can give rise to a variety of conversational effects, mostly via a use of laughter that imputes incongruity to a

[8]Note that the following example involve predication of incongruity, but also enjoyment of the laughable from the interlocutor's part.

laughable. In this section we offer some explication of certain emotive aspects of laughter—we need to capture the fact that, with some arguable exceptions, laughter is associated with pleasure experienced by the laugher and, potentially though certainly not invariably, the other interlocutors.

5.2.1 Cognitive and Computational models of emotion

There are a variety of cognitive theories of emotion at the moment (for a recent survey see Oatley and Johnson-Laird (2014)), but despite the variation in outlook and approach among them, there seems to be a reasonable consensus that can be summarized as in (79):

(79) a. Emotions are caused by appraising events in relation to concerns.

b. An initial automatic appraisal takes place that does not require conscious processing.

c. This is followed by a secondary appraisal that often includes conscious reflection and that can lead to new intentions.

d. A third phase of appraisal is social, when emotions are verbally confided to others.

We will follow most closely the Component Process Model of appraisal developed by Klaus Scherer (see e.g., Scherer (2009)). On this view, appraisal of an event and its consequences can be structured on the basis of a number of criteria or *stimulus evaluation checks*, each of which has certain physiological correlates:[9]

(80) a. Does the event have consequences for my needs or goals?
Physiological correlates include:[10]
EEG alpha changes, modulation of the P3a in ERPs; heart rate deceleration, vasomotor contraction, increased skin conductance responses, pupillary dilatation, local muscle tonus changes . . .

b. Is the event intrinsically pleasant or unpleasant, independently of my current motivational state?
Physiological correlates:
Pleasant: inhalation, heart rate deceleration, salivation, pupillary dilatation; lids up, open mouth and nostrils, lips part and corners pulled upwards, gaze directed; . . .

[9]The CPM does not assume the existence of a limited set of discrete emotions ('basic emotions') or affect programmes as assumed in some other theories (Oatley and Johnson-Laird, 2014), but considers the possibility of an infinite number of different types of emotion episode. The nature of the emotion episode is exclusively determined by the pattern of appraisal results and the specific patterning over time driven by the recursively generated appraisal results. At the same time the CPM does recognize the existence of *modal emotions*—modal outcomes that occur more frequently due to event contingencies and psychobiological prewiring.

[10]All the physiological correlates listed here are taken from Table 1 in Scherer (2009).

Unpleasant: Defence response, heart rate acceleration, increase in skin conductance level, decrease in salivation, pupillary constriction; slight muscle tonus increase; brow lowering, lid tightening, eye closing, nose wrinkling, upper lip raising,. . .

c. Who was responsible and what was the reason?

d. Do I have sufficient power to exert control if possible?
Physiological correlates:
High control/High power: Shift toward ergotropic, trophotropic balance; increase in depth of respiration, slight heart rate decrease, increase in systolic and diastolic blood pressure, changes in regional blood flow, increased flow to head, . . .
Low power: Protection/Submission Extreme ergotropic dominance; faster and more irregular respiration, strong increase in heart rate and heart stroke volume, increase in systolic and decrease in diastolic blood pressure, increase in pulse volume amplitude),

The computational framework EMA (EMotion and Adaptation) (Gratch and Marsella, 2004; Marsella, Gratch, and Petta, 2010; Traum et al., 2008) implements a view of appraisal quite close to that of the Component Process Model. There are some significant differences, nonetheless. Thus, EMA does not subscribe to the assumption that the stimulus evaluation checks are strictly ordered, and we follow EMA in this respect. EMA treats appraisal as a set of feature detectors that map features of the agent's current view of the agent-environment relationship into appraisal variables.

5.2.2 Adding *Emotion* to the DGB

In order to integrate emotion–related information into the Dialogue Gameboard, we posit an additional field we will dub *Mood*. Mood represents the publicly accessible emotional aspect of an agent that arises by publicly visible/audible actions (such as non-verbal social signals). This can but need not diverge from the private emotional state—as with insincere illocutionary acts, one manifestation of a "fake" laugh/smile is a laugh/smile that does not reflect genuine pleasure; it can also involve the lack of a genuine belief that the laughable is pleasantly incongruous, incongruous or pleasant (depending on the predication at issue).

We view Mood as a complex entity built from appraisal values. More specifically, we assume that it is a weighted sum of appraisals[11]. We treat each appraisal as being a record of the type Appraisal, given in (81). We posit this type to be, following

[11]One could, in principle, keep track of a list of appraisals (as is the case for MOVES). But this goes counter to some indications in the psychological literature:

> *An individual with talent for introspection might be able to specify current goals and ongoing activities, the present state of physical comfort and discomfort, mental content and many subtle aspects of subjective experience, of which valence is only one. What happens to these moments? The answer is straightforward: with very few exceptions, they simply disappear.* (Kahneman and Riis, 2005)

the Component Process Model and EMA, a record type with three fields *pleasant, responsible, power*, each field corresponding to an answer to a stimulus evaluation check. We restrict attention here to these dimensions, which seem needed for the purposes of this paper. Pleasantness is specified via a scalar predicate *Pleasant* which can be positively aroused or negatively aroused or both; the latter case corresponds to the case of mixed emotions (Minsky, 2007), which in practice are relatively common (Oatley and Duncan, 1994). Specifically for our current interest, this can be exemplified by the case of a funny but offensive joke, that we appreciate but reject at the same time. Power is specified in terms of a scalar predicate *Powerful* whose lower bound arises when the arousal value is zero.

(81) a. $\text{Appraisal} = \begin{bmatrix} \text{pleasant} : \text{Pleasure} \\ \text{responsible} : \text{RecType} \\ \text{power} : \text{Power} \end{bmatrix}$

b. $\text{Pleasure} = \begin{bmatrix} \text{Pred} = \text{Pleasant} : \text{EmotivePred} \\ \text{arousal} : \begin{bmatrix} \text{pve} : \mathbb{N} \\ \text{nve} : \mathbb{N} \end{bmatrix} \end{bmatrix}$

$\text{Power} = \begin{bmatrix} \text{Pred} = \text{Powerful} : \text{EmotivePred} \\ \text{arousal} : \mathbb{N} \end{bmatrix}$

As mentioned above, this leads to the postulation of a modified type for the dialogue gameboard, with a field for Mood:

(82) $\text{DGBType} \mapsto \begin{bmatrix} \text{spkr: Ind} \\ \text{addr: Ind} \\ \text{utt-time} : \text{Time} \\ \text{c-utt} : \text{addressing(spkr,addr,utt-time)} \\ \text{Facts} : \text{Set(Prop)} \\ \text{Pending} : \text{list(LocProp)} \\ \text{Moves} : \text{list(LocProp)} \\ \text{QUD} : \text{poset(Question)} \\ \text{Mood} : \text{Appraisal} \end{bmatrix}$

We do not offer here a general theory of how appraisals arise—we will restrict attention below to the effect laughter can have on the parameters of appraisal. Nonetheless, we make a number of assumptions concerning how Mood gets updated and introduce one abbreviation for two recurring operations. We assume that the most recent arousal value should be given a stronger weight than the current value of Mood, which itself represents some combination of the earlier ones. Therefore we postulate a weighting between the contribution of the new appraisal and the current

value of a field of Mood. If this field also has a non-zero negative value, the weighting will attenuate it, otherwise it will have no effect.

Thus, an update rule that increments the positive pleasantness recorded in Mood to an extent given by the weight ϵ is given in (83a), whereas the converse operation of incrementing the negative pleasantness is given in (83b). We exemplify the application of positive pleasantness update for $\delta = 12, \epsilon = .25$ in (83c):

(83) a. $\text{PositivePleasantnessIncr}(\delta, \epsilon) =_{def}$

$$\begin{bmatrix} \text{preconditions: } \left[\text{LatestMove.cont : IllocProp}\right] \\ \text{effect : } \begin{bmatrix} \text{Mood.pleasant.arousal.pve =} \\ \epsilon(\text{preconds.Mood.pleasant.arousal.pve}) + (1-\epsilon)\delta : \text{Real} \\ \text{Mood.pleasant.arousal.nve} = \epsilon(\text{preconds.Mood.pleasant.arousal.nve}) : \text{Real} \end{bmatrix} \end{bmatrix}$$

b. $\text{NegativePleasantnessIncr}(\delta, \epsilon) =_{def}$

$$\begin{bmatrix} \text{preconditions: } \left[\text{LatestMove.cont : IllocProp}\right] \\ \text{effect : } \begin{bmatrix} \text{Mood.pleasant.arousal.nve =} \\ \epsilon(\text{preconds.Mood.pleasant.arousal.nve}) + (1-\epsilon)\delta : \text{Real} \\ \text{Mood.pleasant.arousal.pve} = \epsilon(\text{preconds.Mood.pleasant.arousal.pve}) : \text{Real} \end{bmatrix} \end{bmatrix}$$

c. $\text{PositivePleasantnessIncr}(\delta = 12, \epsilon = .25)($

$$\begin{bmatrix} \text{pleasant} = \left\langle \text{pleasant}, \begin{bmatrix} \text{pve} = 4 \\ \text{nve} = 2 \end{bmatrix} \right\rangle \\ \text{responsible} = \left[\text{x} = \text{b}\right] \\ \text{power} = \left\langle \text{powerful}, 2 \right\rangle \end{bmatrix})$$

$$= \begin{bmatrix} \text{pleasant} = \left\langle \text{pleasant}, \begin{bmatrix} \text{pve} = 10 \\ \text{nve} = .5 \end{bmatrix} \right\rangle \\ \text{responsible} = \left[\text{x} = \text{b}\right] \\ \text{power} = \left\langle \text{powerful}, 2 \right\rangle \end{bmatrix}$$

We will assume for simplicity that the weighting ϵ has a fixed value for any given agent and will not—as we formally should—specify it each time as a parameter of an agent's private cognitive state.

5.2.3 Laughter related to laughables without incongruity

We can now formulate a lexical entry for cases in which laughter predicate exclusively about pleasantness, when no incongruity can be appraised (i.e. what in previous Chapter has been termed friendliness (Figure 3.1)) as in (84a): the content we posit is that the laughable is pleasant for the speaker to a contextually given degree δ. The *effect* of such laughter on the speaker is captured in terms of an update rule that

increments the (positive) pleasantness recorded in Mood to an extent given by the weight ϵ, as described earlier[12].

(84) a.
$$\begin{bmatrix} \text{phon} : \texttt{laughterphontype} \\ \text{dgb-params} : \begin{bmatrix} \text{spkr} : \text{Ind} \\ \text{addr} : \text{Ind} \\ \text{t} : \text{TIME} \\ \text{c1} : \text{addressing(spkr,addr,t)} \\ \delta : \text{Int} \\ \text{c2} : \text{Arousal}(\delta, phon) \\ \text{s} : \text{Rec} \\ \text{p} = \begin{bmatrix} \text{sit} = \text{l} \\ \text{sit-type} = \text{L} \end{bmatrix} : \text{prop} \end{bmatrix} \\ \text{content} = \begin{bmatrix} \text{sit} = \text{s} \\ \text{sit-type} = \begin{bmatrix} \text{c4: Pleasant}(p, \delta, spkr) \end{bmatrix} \end{bmatrix} : \text{Prop} \end{bmatrix}$$

b.
$$\begin{bmatrix} \text{preconditions: } \begin{bmatrix} \text{LatestMove.cont} = \text{Assert(spkr, Pleasant}(p, \delta, spkr)) : \text{IllocProp} \end{bmatrix} \\ \text{effect} : \begin{bmatrix} \text{PositivePleasantnessIncr}(\delta, \epsilon) \end{bmatrix} \end{bmatrix}$$

From pleasantness (i.e. friendliness), we can derive two functions of laughter: affiliation, thanking and empathetic acknowledgement.

5.2.4 Core laughter meaning

But what about the most common occurrences of laughter? When laughter relates to the appreciation of a pleasant incongruity? This can be captured by a simple refinement of (84)—adding as a disjunct that the trigger for the Mood update can also be an incongruity content, as in (74). This means that incongruous laughter will communicate (i) that the laughable is incongruous relative to some topos τ and (ii) that this appraisal trigger a positive (pleasant) shift in arousal in the laugher.

Thus, (85b) which denies the pleasure but not the incongruity seems a more natural reaction than (85c), which denies the latter:

(85) a. (Strange scene: A tiger dressed in a soldier's uniform licks the hand of a military strongman). A: (laughs).

[12]The formulation of the update rule in (84) assumes that the force of pleasant laughter is assertoric, justified in part by data on this score from section **??**. This is more debatable for pleasant laughter than incongruous laughter, since the former—on the content postulated here—represents a first person statement about her emotional state and so is less obviously up for discussion. Nothing very much rides on this decision, which could be modified if there is a clear motivation for postulating a distinct force.

b. B: What's funny? (It's weird, but not pleasure causing)
¬ Pleasant (Incongr(l)): seeing a tiger dressed in a soldier's uniform licking the hand of a military strongman is not enjoyable.

c. What's the big deal? (I don't see what's weird)
¬ Incongr: I don't see what's strange;

One way of capturing this additional inference is by positing a topos that finding an entity incongruous involves that fact itself being pleasant:

(86) If l is incongruous, then l's being incongruous is pleasant for A.

Antiphonal laughter: sharing incongruous judgement

Armed with the lexical entry in the previous subsection, we can now consider the dialogue in (87a), for which we assume the laughable can be represented as in (87b). We view the sharing of the incongruity judgement concerning Roger's statement, as akin to the sharing of a "normal" linguistically expressed proposition, as in (87c):

(87) a. Roger: you are what dey refer to in rougher circles as a chickn shit.
Roger: hhhhehh
Ken: heh:heh:heh

b. p0= $\begin{bmatrix} \text{sit} = \text{l} \\ \text{sit-type} = \begin{bmatrix} \text{x: Ind} \\ \text{y: Ind} \\ \text{c2: Assert(x,chicken-shit(y))} \end{bmatrix} \end{bmatrix}$

c. A: Bill is annoying. B: Bill *is* annoying / Yes!

Assume the laughter proposition has a similar force to a normal assertion. This yields a QUD update, as in step 4 below. This enables B to express the same proposition and share in incongruity classification of l:[13]

Utt.	DGB Update (Conditions)	Rule
4	LatestMove := Assert(B,A,Incongruous(p0, e1,τ_1))	
	QUD : = $\langle Incongruous(p0, \tau_1)?\rangle$	Assert QUD–incrementation
5	LatestMove := Accept(A,B,Incongruous(p0, e1,τ_1)))	Accept
	QUD := $\langle\rangle$	Fact update/QUD downdate
	FACTS := cg1 $\cup\{Incongruous(p0, e1, \tau_1)\}$	

[13]Whether the incongruity here is irony ('I don't really mean to say you're a chicken shit.') or of a more social nature (saying something crude to one's interlocutor violates politeness), we will not try to resolve here.

Laughter deflection.

Now consider

(88) Ginny: Don't back up will you else you'll slice my head off.
Dinda: (laugh)
Ginny: Well what's so funny about mum having her head sliced off? (BNC 648-9)

In this case, the pleasant incongruity signalled by Dinda's laugh is rejected by Ginny in a way any proposition in dialogue can be rejected: by the conversational rule QSPEC whenever p? is MaxQUD, one can react with an utterance that addresses p?, in particular one undermining p. So this dialogue evolves like the dialogue in (61). (See Chapter 4 for further examples about laughter clarification requests.)

5.3 Conclusion

In the current chapter we have shown how to develop a formal semantic and pragmatic account of laughter embedded in a general theory of conversational interaction. This view of laughter enables us to capture in a unified and rigorous manner previous insights concerning laughter, including those from Conversation Analysis and those emanating from linguists working on humour. We also showed how to incorporate emotion in cognitive states to capture emotional effects of laughter.

Chapter 6

How do we laugh?

6.1 Why this chapter?

Some scholars proposed the possibility of an acoustic form-function mapping in the interpretation of laughter. In the current chapter I will try to investigate whether this hypothesis holds true when different levels of analysis are distinguished and confounding variables eliminated. To this aim, in collaboration with Maud Pelissier[1], I performed acoustic analysis on a subset of the laughs extracted from natural conversations analysed in Chapter 3. We wanted to investigate whether the two larger categories of laughter found in the corpus study, classified on the base of the kind of laughable they are related to, i.e. *pleasant incongruity* and *social incongruity*, would differ in terms of acoustic features. In order to avoid confounding factors and have enough statistical power I had many limitations on the amount of data I could analyse: [1] I used only laughs taken from the DUEL corpus, for which a higher quality of audio recording was available; [2] I analysed only laughs produced by females, because we lacked a gender-balanced set of data and because due to the known difference in vocal production acoustic profiles we could not collapse the two groups; [3] to avoid confounding features, I analysed exclusively laughter occurring in isolation, i.e. not overlapping with other's laughter and speech, both from the laugher and from the partner; [4] in order to avoid the confounding factor of arousal, being unevenly distributed between the two classes, the analysis focuses exclusively on low arousal laughter. The main aim is to investigate, at least in a preliminary fashion, whether a laughter acoustic form-function mapping could apply in our taxonomy and could be reliable when controlling for confounding variables. We expect the acoustic form of laughter not to be highly and reliably predictive of functions. In both cases, whether a correlation will be found or not, this first step would be important firstly because of the attempt to study distinct types of laughter occurring in spontaneous conversation rather than recorded in isolation, and secondly it will have important implications for the building of a dialogue system able to extract and convey information from natural speech were linguistic and non verbal material needs to be incrementally processed to derive the right interpretation of utterances.

[1]Laboratoire de Phonétique et Phonologie - UMR7018 - CNRS/Sorbonne Nouvelle

In the first section (6.2) I briefly review the literature, motivating the question at issue; in section 6.3 I present the analysis conducted in order to investigate the potentiality of a form-function mapping; in section 6.3.5 I present reflections on the data obtained and critically present them in relation to previous studies; finally, in section 6.4, I consider the practical and theoretical implications of our results and conclusions. .

6.2 Introduction

There is extensive literature on the acoustic and physiological features of laughter. This applies both to the analysis of laughter produced in isolation as a reaction to humorous stimuli and to the analysis of laughter extracted from recordings of natural interaction among adults (Bryant and Aktipis, 2014; Poyatos, 1993; Urbain and Dutoit, 2011b; Truong and Van Leeuwen, 2007; Lavan, Scott, and McGettigan, 2016; Lavan and McGettigan, 2016; Lavan et al., 2017; Provine and Yong, 1991; Kipper and Todt, 2003; Trouvain, 2003a; Bachorowski, Smoski, and Owren, 2001; Campbell, Kashioka, and Ohara, 2005; Tanaka and Campbell, 2014; Nwokah and Fogel, 1993; Ruch and Ekman, 2001; Truong and Trouvain, 2012), among typically developing children (Nwokah and Fogel, 1993; Nwokah et al., 1994; Nwokah et al., 1999; Nwokah et al., 1993), and among autistic children (Hudenko, 2004; Hudenko, Stone, and Bachorowski, 2009). A parallel strand of research has developed regarding the function of laughter in conversation. Many taxonomies have been proposed whose aim is to classify our adaptive and variable laughter behaviour (e.g. Poyatos (1993), Campbell, Kashioka, and Ohara (2005), Tanaka and Campbell (2014), Vettin and Todt (2004), and Jokinen and Hiovan (2016)). Some scholars have also tried to explore a possible correlation between acoustic features and kinds of laughter according to their proposed taxonomy, using either data from natural conversations (e.g. Tanaka and Campbell (2011) and Campbell, Kashioka, and Ohara (2005)) or laughter voluntarily produced by actors (Szameitat et al., 2009b). All the proposed classifications are very hard to integrate given the diverse perspectives taken by scholars from different fields and the multifaceted nature of laughter, which often makes it arduous to discriminate between trigger, social context, meaning and function performed. As argued in detail in Chapter 2, I believe that a common issue with most taxonomies is that, even within the same system, they contain types that relate to different layers of analysis, confounding very often physiological and psychological causes, meaning, and social functions in interaction. The solution proposed in Chapter 2 is to distinguish, similarly to the study of speech, between phonetics and acoustics, semantics and pragmatics of laughter. In the current chapter, we present the acoustic analysis of laughs produced in natural conversation which, in our framework, are assigned to different classes. The aim is to contribute to the debate about a possible laughter acoustic form-function mapping.

6.3 Methods

6.3.1 Materials

The laughs analysed in the current study constitute a subset of those analysed in Chapter 3, together with two additional conversations in Mandarine Chinese extracted from conversation from the DUEL corpus (Hough et al., 2016). The current work presents the analysis of laughter from the conversations of three dyads in French and four in Chinese (3 tasks x 7 pairs), part of which already analysed for semantic and pragmatic features in Chapter 3.

The dialogues were recorded with two Sennheiser Omnidirectional Lapel microphones (one clipped on each participant) with a sampling rate of 44,100 Hz on an Avid Mbox pro sound card, in a sound-proofed room at Université Paris Diderot[2].

Laughable and laughter function annotation

All the laughs occurring in the dialogues had been previously annotated by 3 coders (a PhD student, a post-doc and a Master's student), two of which were always native speakers of the language investigated, using both audio and video data (which have been shown to be the best condition for laughter recognition and detection (Petridis and Pantic, 2008; Petridis and Pantic, 2011; Jordan and Abedipour, 2010; Reuderink et al., 2008)). The annotation has been conducted following the framework proposed in Chapter 2: for each laugh, annotators were asked to identify the laughable, classify it and mark the laughter arousal and the pragmatic function performed.

Data selection

In the current study, given our focus on the analysis of laughter acoustic features, only the laughs not co-occurring with speech (either from the laugher or the partner) and not overlapping with others' laughter have been analysed. Truong and Trouvain (2012) have indeed observed significant differences between the acoustic features of overlapping and non-overlapping laughter. Given the lack of a gender-balanced corpus and the known cross-gender differences in vocal productions acoustic profiles, all the stimuli analysed are laughs produced by female participants (Bachorowski, Smoski, and Owren, 2001; Szameitat et al., 2011b). In order to have enough statistical power, for the current study we considered only the kinds of laughter that we observed more frequently in our corpus study presented in Chapter 3: laughs referring to pleasant (71%) and social (25%) incongruities, excluding therefore the laughter referring to pragmatic incongruities (0.2%) or to a laughable containing no incongruity at all (4%). The material analysed amount therefore to 57 laughs in Chinese (31 of which refer to pleasant incongruities and 26 to social incongruity) and to 97 laughs in French (65 of which refer to pleasant incongruities and 31 to social incongruity).

[2]Detail of the corpus have been presented in Chapter 3. Here it will be specified only the recording instrumentation given the importance for the audio quality.

In order to avoid the confounding variable of arousal, given the uneven distribution especially of high and medium arousal laughter between the two groups considered, we included in our analysis only the laughter unanimously annotated to be low arousal. In Chapter 3 (section 3.4.6) it has been shown that most laughter related to a social incongruity is low arousal and never high, while the higher number of high arousal laughter is found in relation to a pleasant incongruity. Moreover, arousal judgements have often been reported to be correlated with several acoustic features, both in term of pitch, rhythm and intensity, both in emotional vocalizations (Szameitat et al., 2010; Nwokah et al., 1993; McKeown and Curran, 2015) and in speech (Schröder et al., 2001; Pereira, 2000; Laukka, Juslin, and Bresin, 2005). Including therefore all the levels of arousal would have negatively affected the reliability of our analysis due to the significantly unbalanced representation in the two classes.

6.3.2 Measures for acoustic analysis

Using the software PRAAT (Boersma, 2002), we explored 9 acoustic features that have been previously found to be predictive of affective ratings and categorization judgements for laughter (e.g. Bachorowski and Owren (2001)) and emotional vocalizations in general (Sauter et al., 2010; Scott et al., 1997). The acoustic analysis carried out includes measures of the fundamental frequency, spectral measures and measures of amplitude, thus covering a broad range of acoustic features. Similar features have been analysed in Lavan, Scott, and McGettigan (2016) when comparing spontaneous (laughter elicited while watching a funny video) and volitional (laughter produced on demand in the absence of any situational context) laughs produced in isolation, i.e. out of conversational context.

- **Total duration**: Interval between the first zero-crossing of the onset to the final zero crossing after the offset of the laugh. Measures are given in seconds.
- **F0 mean**: F0 mean in Hz was computed using the auto-correlation method in PRAAT. Pitch floor was set at 75 Hz and the pitch ceiling at 1000 Hz, due to laughs being high-pitched. The frame duration was selected automatically by the autocorrelation algorithm, resulting in a frame duration of .08 s.
- **F0 variability**: Standard deviation of the F0 mean in Hz, divided by the total duration of the laugh.
- **F0 minimum and F0 maximum**: F0 minimum and maximum are defined as the highest and lowest F0 measurement and were manually labelled to reduce the impact of doubling/halving errors on these measures.
- **F0 Range (Hz)**: F0 maximum –F0 minimum.
- **Percentage of Unvoiced Segments**: Percentage of frames lacking harmonic structure.

- **Mean harmonics-to-noise ratio (HNR)**: Mean ratio of quasi-periodic to non-period signal across time segments.
- **Intensity**: Mean intensity in dB relative to the auditory threshold–determined after the stimuli were normalized for peak amplitude.
- **Spectral centre of gravity (COG)**: Measure for the mean height of the frequencies for each laugh, in Hz, which captures the weighting of energy in the sound across the frequency range.

		French					Chinese				
Acoustic features	Type	Mean	SD	t	df	Sig. (2-tailed)	Mean	SD	t	df	Sig. (2-tailed)
Duration	Enj inc	1,29	0,62	2,836	27,54	0,008	1,50	0,99	0,432	2,68	0,698
	Mar inc	0,85	0,47				1,28	0,82			
F0_Mean	Enj inc	228,09	29,52	-1,136	20,28	0,269	224,83	27,73	-1,303	3,01	0,283
	Mar inc	239,07	32,20				241,24	19,67			
F0_Variability	Enj inc	24,85	18,85	-0,650	16,17	0,525	26,21	22,29	-1,067	3,16	0,361
	Mar inc	30,48	30,68				36,49	14,86			
F0_Min	Enj inc	177,50	53,17	-1,278	22,54	0,214	178,59	44,59	0,414	2,23	0,715
	Mar inc	197,63	50,93				162,85	64,03			
F0_Max	Enj inc	280,71	33,20	0,504	23,32	0,619	276,17	30,86	-0,820	3,34	0,467
	Mar inc	275,90	30,63				286,55	19,25			
F0_Range	Enj inc	103,21	65,87	1,286	22,71	0,211	97,59	56,41	-0,738	2,46	0,525
	Mar inc	78,27	62,60				123,70	58,19			
UnvoicedSegments	Enj inc	0,60	0,14	1,142	17,67	0,269	0,65	0,17	1,265	2,14	0,326
	Mar inc	0,54	0,18				0,43	0,30			
MeanHNR	Enj inc	6,01	2,05	-0,690	19,36	0,499	4816,86	2,37	-0,366	2,86	0,740
	Mar inc	6,50	2,39				5326,33	2,20			
Intensity	Enj inc	51,02	9,86	0,967	23,63	0,343	49,81	11,28	-2,664	6,73	0,033
	Mar inc	48,38	8,71				58,24	3,99			
SpectralCOG	Enj inc	351,55	451,63	0,349	37,75	0,729	297,23	272,25	1,029	3,04	0,378
	Mar inc	318,28	260,53				173,88	186,77			

FIGURE 6.1: Comparison of the acoustic features of laughter used to *show enjoyment* of pleasant incongruity and to *mark* incongruity. Results Student t-test.

6.3.3 Statistical analysis

Preliminary analysis

Before proceeding to the models testing, we wanted to be sure that the class of laughter related to a *pleasant incongruity* was a homogeneous one. This class includes laughter serving very different functions: *show enjoyment* of pleasant incongruity and *marking* pleasant incongruity (see Figure 2.1). In comparison to the ones used to *show enjoyment*, laughter used to *mark* pleasant incongruity does not show an actual appreciation or enjoyment of an incongruity, but it is rather used to signal the presence (or anyway the awareness) of an incongruity to the interlocutor, being typically a more controlled, low arousal and carefully positioned kind of laughter. Given its more controlled and restrained nature, this kind of laugh might in a way seem more similar, at least in the acoustic form, to the ones used to signal social incongruity. In Figure 6.1 we report the results of the Student independent t-tests performed in order to compare the different acoustic features of laughs serving the function of *show enjoyment* of a pleasant incongruity and it is rather used to *mark* the

presence of a pleasant incongruity, i.e. referring to the same kind of laughable but serving different functions. The only significant difference was observed in duration, exclusively in the French corpus. In neither of the languages investigated were significant differences observed in terms of acoustic parameters. Once reassured that no significant differences were present in the class, we kept considering it as a pretty homogeneous group.

Linear mixed-effects models

All data were analysed with linear mixed-effects models, which present a number of advantages compared to traditional repeated-measures ANOVAs: among other things, they can adjust better for missing data and for repeated measures across participants and items (Linck and Cunnings, 2015). Analyses were performed in R version 3.3.2 with packages lme4 version 1.1.10 (Bates et al., 2015a), lmerTest version 2.0-33 (Kuznetsova, Brockhoff, and Christensen, 2015) and lsmeans version 2.25 (Lenth, 2016). According to recent recommendations (Barr et al., 2013; Bates et al., 2015b; Linck and Cunnings, 2015), the following procedure was followed to fit the models:

1. An initial model was built with the maximal fixed-effects structure and the maximal random-effects structure: the acoustic measure of interest was used as a dependent variable, and Language (Chinese / French) and Laughable Type (Social Incongruity / Pleasant incongruity) were included as fixed effects. The maximal random effects structure thus included a random slope by Language, Laughable Type and the Language $\times$ Laughable Type interaction, as well as a random intercept by Participant. The following syntax was used in R: *Acoustic measure* $\sim$ *Language * LaughableType + (Language*LaughableType|Participant)*

2. If the model did not converge, it was simplified as follows:

   (a) Correlations between intercept and slope were removed;

   (b) The higher order interaction was removed from the random slope;

   (c) Parameters were removed from the random slope individually, and if two models with equivalent parameters converged, those models were compared with an ANOVA to determine which one was a better fit to the data.

3. The model was submitted to a Type III ANOVA with a Satterwaithe approximation of degrees of freedom (lmerTest::anova) to estimate the *p*-values.

4. Higher order interactions were followed up by pairwise comparisons adjusted for multiple comparisons with Tukey's honest significant difference (lsmeans::lsmeans).

Language	**French**				**Chinese**			
Laughable	**Pleasant**		**Social**		**Pleasant**		**Social**	
Stats	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dur	1.03	0.51	0.96	0.41	1.34	1.07	0.70	0.42
F0 M	243.05	25.62	222.06	44.38	223.59	27.20	211.63	32.62
F0 Var	24.39	23.69	20.93	22.62	33.18	25.45	46.33	38.69
F0 Min	206.15	50.38	196.88	46.40	175.87	44.15	156.88	35.58
F0 Max	277.54	24.48	251.23	57.20	270.84	30.73	258.82	50.12
F0 range	71.39	57.93	54.35	53.11	94.97	52.25	101.94	70.94
Unv Seg	0.62	0.15	0.61	0.14	0.63	0.20	0.64	0.27
M HNR	5.99	2.15	6.22	2.40	4.72	2.73	6.43	4.36
Int	45.70	7.89	43.68	8.22	46.85	11.66	61.16	10.00
Sp COG	327.38	505.24	250.28	202.05	297.79	228.84	611.37	403.62

TABLE 6.1: Descriptive statistics according to language and incongruity type in the laughable. Duration, F0 Mean, F0 Variability, F0 Min: Minimum F0, F0 Max: Maximum F0, F0 Range, Unvoiced Segments, Mean HNR: Harmonics to Noise Ratio, Intensity, Spectral COG: Spectral Center of Gravity

6.3.4 Results

Descriptive statistics

In table 6.1 we report the descriptive statistics of the features analysed.

Linear mixed-effects models results

In Table 6.2 we report the results of all the linear mixed-effects models analyses. Below, only significant or marginally significant effects are reported and discussed.

F0 Mean Analyses revealed a main effect of Laughable type: the mean F0 was higher for laughter related to pleasant incongruities (M=236.69 Hz, SD=27.45 Hz) than for laughter related to social incongruities (M=218.12 Hz, SD=40.18). There was also a marginally significant effect of Language: the mean F0 was higher in the French data (M=234.43 Hz, SD=35.75 Hz) than in the Chinese one (M=218.01 Hz, SD=29.94 Hz).

F0 Max We found a main effect of Laughable type on F0 max: it was higher for laughter related to pleasant incongruity (M=275.35 Hz, SD=26.54 Hz) than social incongruities (M=254.10 Hz, SD=54.04 Hz).

Mean HNR There was a main effect of Laughable type on the HNR, which was higher for laughter related to social incongruity (M=6.93, SD=3.08) than laughter related to pleasant incongruity (M=5.76, SD=2.16). For this parameter, the Language $\times$ Laughable type interaction was marginally significant (p=.08) and was therefore

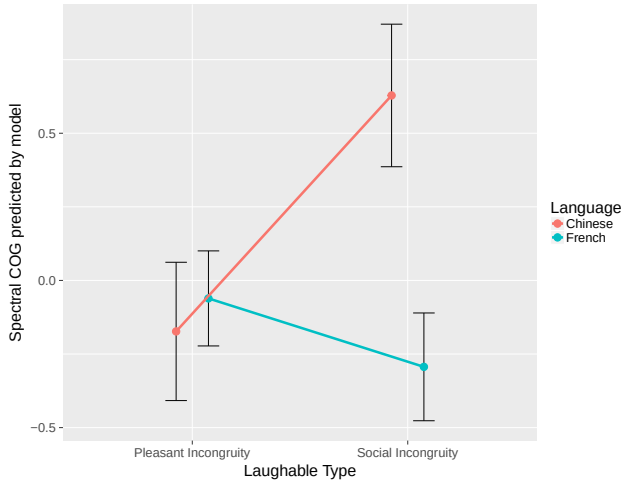


FIGURE 6.2: Language × type of laughable interaction on spectral COG.

further examined, although the results of these analyses have to be taken with caution. Post-hoc tests revealed that the Laughable type effect was in fact restricted to Chinese participants ($\text{Mean}_{Social-Funny}$=2.42, SE=1.05, t(18)=2.30, p=.03).

Spectral COG The Language × Laughable type interaction had a significant effect on spectral COG: the COG was higher for Chinese than French participants for social laughter only ($\text{Mean}_{Chinese-French}$=0.92 Hz, SE=0.30, t(59)=3.04, p=.004). Besides, the spectral COG was significantly higher for laughter related to social than pleasant incongruities only for Chinese participants ($\text{Mean}_{Social-Funny}$=0.80 Hz, SE=0.35, t(21)=2.28, p=.033).

6.3.5 Discussion

One of the main laughter characteristics that emerges even after a quick inspection of the descriptive statistics reported in Table 6.1, is the distinctive high variability in all the parameters analysed. Our results therefore confirm a well-established finding that laughter, despite being a somewhat stereotypical vocal signal recognised universally cross-culturally (Sauter et al., 2009; Sauter et al., 2010), is characterised by extreme variability in its phonetic and acoustic features; Bachorowski, Smoski, and Owren (2001), Ruch and Ekman (2001), Kipper and Todt (2003), and Vettin and Todt (2004) reported it to be much higher intra- rather than inter-individually. Urbain and Dutoit (2011b) conducted a detailed phonetic investigation reporting that, even within the same laughter, it is possible to have a surprisingly high variability of phones used which range from 2 to 59 (mean = 32, sd = 14.4). The laughter episode durations observed are consistent with previous data reported in Bachorowski, Smoski, and Owren (2001) and Rothgänger et al. (1998): mean duration is between 1s to 2s. The fact that some of the laughter analysed in our corpus might go beyond such a threshold is likely due to the fact that we chose, similarly to Urbain and Dutoit (2011b), to consider the final offset inhalation phase as part of the laughter event in

Variable	Factor	Sum Sq	Mean Sq	*dF*	*F*	*p*
Duration	Language	0.23	0.23	1,4.43	0.76	0.43
	Laughable type	0.37	0.37	1,3.69	1.26	0.33
	Language:Lb Type	0.03	0.03	1,3.69	0.11	0.76
F0 Variability	Language	1361.22	1361.22	1,4.14	2.26	0.20
	Laughable type	86.80	86.80	1,4.52	0.14	0.72
	Language:Lb Type	350.48	350.48	1,4.52	0.58	0.48
F0 Mean	Language	4300.60	4300.60	1,82.00	3.95	0.05.
	Laughable type	5223.8	5223.8	1,82.00	4.80	**0.03***
	Language:Lb Type	392.5	392.5	1,82.00	0.36	0.55
F0 Min	Language	7602.7	7602.7	1,4.83	3.96	0.11
	Laughable type	1533.5	1533.5	1,8.12	0.80	0.40
	Language:Lb Type	1021.1	1021.1	1,8.12	0.53	0.49
F0 Max	Language	167.5	167.5	1,3.50	0.11	0.76
	Laughable type	6991.2	6991.2	1,47.85	4.54	**0.04***
	Language:Lb Type	284.7	284.7	1,47.85	0.18	0.67
F0 Range	Language	2471.2	2471.2	1,4.96	0.89	0.39
	Laughable type	384.3	384.3	1,65.19	0.14	0.71
	Language:Lb Type	2098.2	2098.2	1,65.19	0.75	0.39
Unvoiced segments	Language	25.72	25.72	1,3.25	0.08	0.80
	Laughable type	20.43	20.43	1,6.10	0.06	0.81
	Language:Lb Type	40.30	40.30	1,6.10	0.12	0.74
HNR	Language	3.32	3.32	1,2.54	0.54	0.53
	Laughable type	26.48	26.48	1,31.97	4.28	**0.047***
	Language:Lb Type	19.89	19.89	1,31.97	3.21	0.08.
Intensity	Language	204.89	204.89	1,4.56	3.56	0.12
	Laughable type	8.34	8.34	1,77.94	0.14	0.70
	Language:Lb Type	136.61	136.61	1,77.94	2.38	0.13
Spectral COG	Language	2.99	2.99	1,7.28	3.22	0.11
	Laughable type	1.57	1.57	1,12.46	1.69	0.22
	Language:Lb Type	5.18	5.18	1,12.46	5.58	**0.04***

TABLE 6.2: Results of analyses with linear mixed effects model for each variable. Lb type: Laughable type, F0 Min: Minimum F0, F0 Max: Maximum F0, HNR: Harmonics to Noise Ratio, Spectral COG: Spectral Center of Gravity

itself, resulting therefore in slightly longer durations compared to ones reported in Bachorowski, Smoski, and Owren (2001) and Rothgänger et al. (1998). It also has to be considered that we excluded all speech-laughter (i.e., laughter co-occurring with speech from the laugher herself) and the coactive laughter (i.e., simultaneous laughing from both participants) typically longer in duration (Truong and Trouvain, 2012). The mean F0 reported falls within the range individuated by other scholars (e.g. Bachorowski, Smoski, and Owren (2001), Rothgänger et al. (1998), Truong and Van Leeuwen (2007), Truong and Trouvain (2012), and Szameitat et al. (2011b)), i.e. for females between 160 and 533Hz. It is worth noting though, comparing the descriptive statistics of our data to the one reported in Lavan, Scott, and McGettigan (2016), that the characteristics of the laughs analysed in our corpus are much closer to the ones they reported for volitional rather than spontaneous laughter. Research has shown the existence of physiologically and neurologically different pathways for spontaneous and volitional laughter, both in production Wild et al. (2003) and perception McGettigan et al. (2013). We are nevertheless reluctant to consider all the laughter occurring in conversation as *volitional*. They are very often much less intense, explosive and loud that laughter produced while watching an extremely funny video, however we believe that their production is in any case not fully controlled and strategic (at least not for all of them). As noted by Gervais and Wilson (2005) and McComas (1923) indeed, in conversational laughter, the boundary between spontaneous and volitional is much more blurred than in experimental settings. During development, laughter becomes a learnt behaviour, which can reach a high level of automaticity, as indicated by the significant tendency to under-report own laughter production by subjects (Vettin and Todt, 2004). It is for this reason that we think that for laughter produced in conversation, it might be not useful to distinguish between volitional and spontaneous laughter. At least if the goal of the work is to infer laughter functions. On the contrary, it might be interesting when the focus is specifically perceptual features of laughter (e.g. (Shochi et al., 2017))
Taking this as given, we discuss our results also in the light of data from studies where the focus of the analysis was the contrast between spontaneous and volitional laughter acoustic features.

The main effect of laughable type over F0 Mean and F0 Max observed and its direction, i.e. being higher for laughter related to pleasant than social incongruity, is consistent with the literature that distinguishes between spontaneous and volitional laughter: Higher F0 mean and F0 maximum have indeed been found in spontaneous laughter in comparison to volitional laughter (Lavan, Scott, and McGettigan, 2016; Bryant and Aktipis, 2014; McKeown and Curran, 2015). We can indeed speculate that while laughter related to pleasant incongruities might have a more spontaneous nature, and be more related to the phylogenetic origin of laughter (Ross, Owren, and Zimmermann, 2009), laughter related to social incongruity might be more learned and potentially more shaped by culture and language, being in a way more controlled and similar in form to a voluntarily produced laughter.

The same reflection also applies to the significant effect of Laughable type over the Mean HNR. Despite not being a significantly different feature in the acoustic comparison between spontaneous and volitional laughter (Lavan, Scott, and McGettigan, 2016), it has been found to correlate with the spontaneous ratings of participants when asked to judge based exclusively on acoustics whether laughter was spontaneous or volitional. Interestingly increased HNR has been found to correlate with some physiological features, i.e. lower level of breathiness, more closed mouth and higher level of nasality (Lavan, Scott, and McGettigan, 2016).
The most interesting result that emerges from our analysis is the two-way interaction of Language and Laughable type over Spectral COG graphically represented in Figure 3. We found higher Spectral COG in Chinese laughter related to social rather than pleasant incongruities, while the effect of language is evident only for the laughter related to social incongruity (having higher spectral centre of gravity in Chinese rather than in French). It has to be also noted that the effects observed are based on the analysis of exclusively low arousal laughter (see Section 6.3), excluding therefore any confounding effect related to Arousal and the unbalanced distribution of its levels across laughter related to different laughable types. COG is usually used to describe fricatives. It is possible that our Chinese participants somehow marked the quality of their unvoiced parts differently from the French participants. We are planning to conduct further analysis in order to test this hypothesis[3].

While we do argue for the view that conversational laughter cannot be considered as volitional in all of its occurrences, conversely, based on our data and especially on the significant interaction of Language $\times$ Laughable type over spectral COG, we are pushed to speculate as follows: there are some forms of laughter that might be more similar across languages and cultures, in as much as being closer to their phylogenetic origin, whereas other types, more pragmatically sophisticated, might be more influenced by the cultural and language environments. This applies not only to their occurrences but even in their form, as also reported for emotional facial expressions (Hess, Beaupré, and Cheung, 2002; Lim, 2016; Gelder and Veld, 2016; Hareli, Kafetsios, and Hess, 2015). Consistent with such a conclusion is, for example, the study conducted by Lavan et al. (2018) where it has been found that laughter produced while watching a funny video contains acoustic features that make it harder for a listener to discriminate identities compared to other laughs produced voluntarily in absence of any context. This is probably due to the involvement of phylogenetically older physical structures in the hearty, genuine and uncontrolled kind of laughter, i.e., not involving the use of supra-laryngeal structures.

The main aim of our exploratory investigation is the potential existence of an acoustic form-function mapping. While acknowledging that our results have to be viewed cautiously because of the limited number of laughs, subjects and languages analysed, we agree with other scholars (e.g. Russell (2003) and Curran et al. (2017)), that a straightforward mapping between acoustic form and function is not possible.

[3]I owe heartfelt thanks to Jürgen Trouvain for his valuable feedback on this point.

Laughter is extremely variable in its acoustic features, even within the same laughable class or function (see Table 6.1 and 6.1). Despite having found significant main effects of three features (F0 Mean, F0 Max and Harmonic to Noise Ration) in the comparison between laughter related to pleasant and social incongruities, we nevertheless reiterate our earlier claim (Chapter 2) concerning the fact that an automatic classification exclusively based on acoustic features of laughter would not be able to identify the function performed reliably. On the contrary, we believe that laughable characteristics, position, arousal and, additionally, acoustic information, when taken together could really inform and help the efficiency of an automatic laughter interpreter, drastically improving, for instance, the model presented in Chapter 3 (Section 3.6).

The idea of a lack of correlation between form and function in laughter is also supported by scholars sustaining the Affection Induction Approach and the Behavioral Ecology View (Owren and Bachorowski, 2003; Frijda and Tcherkassof, 1997; Fridlund, 1997). While agreeing on this point, we disagree with the conclusion they derive from this. Since laughter can occur in many different contexts and situations being linked to very different emotional states, they conclude that therefore laughter cannot have a representational function, i.e. be about something, signalling some internal or external state, but that it is rather produced exclusively to affectively influence the listener. Although acknowledging the fact that laughter, being extremely adaptive, can be produced in many different emotional states and that it can positively influence the interlocutor, we believe that this does not necessarily imply that it cannot have a core meaning and that it is not informative about cognitive and emotional laugher's states (for more details see discussion in Chapter 2). After all, we can attribute multiple meanings also to many linguistic expressions depending on the context, but nobody would argue that the words uttered do not have referential meaning. While taking an agnostic position in the long-standing debate about the relation between emotion and facial/non-verbal expression (Crivelli and Fridlund, 2019), we believe that when an interlocutor hears/sees a laughter she can attribute to it the general meaning that it is normally used to convey, i.e. (in our proposal): *The event (laughable) l having property P (incongruity and/or pleasantness) has triggered a positive shift of arousal of value d within A's emotional state e.* Whether the expression is linked or not to emotion, it doesn't prevent the listener inference about a core meaning/state intended to be conveyed. The fact indeed that facial/non-verbal "emotional" expressions can be influenced by the presence of an observer (i.e. audience effect), has been used by (Crivelli and Fridlund, 2019) as an argument against the fact that those have a direct connection to internal emotion, and that are exclusively used to convey information to interlocutors and to affect them. For our aim is to investigate the meaning conveyed by laughter in interaction, this is further support to our proposal of laughter having propositional content. As stated in Bavelas and Chovil (2000), the fact of a signal being influenced by the presence of others is one of the criteria for considering a non-verbal behaviour a visible/audible act of meaning.

6.4 Conclusion

In the current chapter, I attempted a preliminary exploration of the acoustic features of laughter related to different kinds of laughables, according to the framework proposed in Chapter 2, thereby contributing to the debate about a potential laughter acoustic form-function mapping. After consideration of the descriptive statistics, we explored the influence of Laughable type and Language (French and Chinese) on the acoustic features of laughter. The variable Laughable type included two levels: pleasant incongruities (e.g., humourous comments) and social incongruities (e.g., a moment of embarrassment, asking a favour, criticising, etc). Our data confirm previously reported data about the high variability in laughter acoustic form (Bachorowski, Smoski, and Owren, 2001; Ruch and Ekman, 2001; Kipper and Todt, 2003; Vettin and Todt, 2004) even within the same functional class. The results from our analyses show some tendencies of laughter related to social incongruity to be more controlled in its acoustic form. We found indeed that acoustic profiles of laughter related to social incongruity are similar to the ones observed in volitional laughter (lower F0 mean, lower F0 Max and lower Harmonic to Noise Ratio). We highlight an interesting significant effect of the interaction Language×Laughable type only over the spectral COG. The most relevant reflections and tentative conclusions that emerge from our study can be briefly summarised in two main points:

1. Despite the observation of significant differences in few features (F0, F Max and HNR), we claim that a straightforward acoustic form-function mapping is not fully reliable, therefore in order to predict function multiple factors have to be taken in account.

2. When considering exclusively laughter occurring in conversation, there appear to be some forms of laughter which might be more similar across languages, in as much as being closer to their phylogenetic origin. Other forms, more pragmatically sophisticated, despite not being produced deceptively or strategically, might be more influenced by cultural and language environments, not only in their occurrences but even in their form.

Our conclusions should be taken cautiously. Much more investigation is needed, both in terms of the laughter sample size analysed and in terms of the variety of languages investigated. We believe that this type of research might be useful for the development of dialogue systems able to interpret laughter and produce it naturally in dialogical interactions. From our data, it emerges the possibility that a culturally specific calibration might be needed even regarding the acoustic form of the laughter. Our exploration also opens the way to further research into the acoustic characteristics of laughs relating to different kinds of laughable in populations where pragmatic impairment is involved; as discussed in Hudenko, Stone, and Bachorowski (2009) and Hudenko (2004) it has been shown that acoustic laughter features differ between typically developing children and children within the autistic spectrum. Investigation

of such laughter behaviour, implying highly sophisticated skills could indeed give us important insights into the cognitive processes behind laughter serving different functions, the specific impairments involved, and the potentially compensative strategies to adopt.

Chapter 7

Your laugh in my brain

7.1 Why this chapter?

Many scholars have investigated neuro-correlates of laughter in very controlled conditions, looking at activations in response to tickling, perception of humour (e.g. jokes) or while listening to laughs pre-recorded presented in isolation (spontaneously produced while watching a funny video, volitionally produced on demand or acted). Despite the important role that laughter has in our interactions and the sophisticated pragmatic skills involved in its production and comprehension, much smaller attention has been devoted to the investigation of laughter in conversation.

In this chapter, I will present what is, to our knowledge, one of the first attempts to explore neuro-correlates of laughter perception when embedded in natural dialogue using functional Near-Infrared Spectroscopy (fNIRS). The study discussed has been conducted at the University College London (UCL) and is the result of joint work with Gulun Jin[1], Judit Gervain[2] and Sophie Scott[3] (Mazzocconi et al., 2018).

We investigate whether the perception of laughter related to different laughables can trigger different cortical activations by reason of entailing different levels of mentalising, i.e. reasoning about others' intentional and emotional states. We believe that the investigation of laughter perception and production neuro-correlates in more ecological contexts could provide important insights for the functions of laughter in dialogue and stress its importance both from a linguistic, psycholinguistic and socio-pragmatic point of view. Moreover, it will be a concrete means to test some part of the theoretical semantic and pragmatic framework presented and discussed in Chapter 2.

This chapter is constituted of four main parts: I first provide a brief background to our study, putting forward and motivating our hypothesis (Section 7.2); I then present the procedure and results from our fNIRS pilot experiment (Section 7.3), and the methodology and results of the behavioural study all of the participants from the first experiment participated in (Section 7.4); and lastly I will present a general discussion of our data and conclusions (Section 7.5).

[1]Institute of Cognitive Neuroscience, University College London (UCL)
[2]Laboratoire Psychologie de la Perception - UMR 8242- CNRS/Universit'e Paris Descartes
[3]Institute of Cognitive Neuroscience, University College London (UCL)

7.2 Background and Hypothesis

Our hypothesis is based on the assumption that laughter has propositional content and functions as an event predicate. When a listener hears laughter, she derives inferences about the level of arousal experienced by the laugher and needs to resolve the argument of the predication, i.e. the laughable (Chapter 2). Different kinds of laughables can be distinguished firstly based on whether they contain an incongruity or not and secondly depending on which kind of incongruity it is (detailed definitions of incongruity and how it arises are offered in Chapter 2 and 5). Arousal, on the other hand, is a continuous variable which can go from very low to very high.

In our study, we focused specifically on two of the laughable classes laughter can relate to: pleasant incongruity and social incongruity. In previous corpus studies (Chapter 3) they have indeed been found to be the most frequent, and they are probably also the most different in terms of mentalising processes involved. While a detailed discussion has been presented in Chapter 2, I will here propose only a brief definition of the two classes of interest.

- **Pleasant incongruity**: when a clash between the laughable and certain background information (*topoi* in our formalization) is perceived as witty, rewarding and/or somehow pleasant (e.g., jokes, puns, goofy behaviour and conversational humour).
- **Social incongruity**: when a clash between social norms and/or comfort and the laughable can be perceived. Examples might be, a moment of social discomfort (e.g., embarrassment or awkwardness), a violation of social norms (e.g., invasion of another's space, the asking of a favour), or an utterance that clashes with the interlocutor's expectations concerning one's behaviour (e.g., criticism).

McGettigan et al. (2013) and Lavan et al. (2017) have shown that areas proven to be related to mentalising and social reasoning correlate with the perceived authenticity of isolated laughter. Based on such work we expect to see greater activation in the medial Prefrontal Cortex (mPFC) and in the pre-Supplemetary Motor Area (pre-SMA), when the laughable is constituted by a *social incongruity* compared to the cases where the laughter relates to a *pleasant incongruity*. We acknowledge results from several studies (e.g. Iidaka (2016) and Wild et al. (2006)) pointing at the involvement of Prefrontal areas also in the perception of humour, but nevertheless we expect a significant difference in the processing of more "socially oriented" laughter. This hypothesis is also based on results from studies looking at neuro-correlates of the perception of embarrassment and violation of social norms in others, which found activation in areas implicated in the complex Theory of Mind (ToM) system and social cognition (i.e. in the medial and dorsolateral Prefrontal Cortex, temporal regions, orbito-frontal cortex, posterior Cingulate cortex and in the sensorimotor cortex) (Bastin et al., 2016; Berthoz et al., 2002). We hypothesise therefore a higher

need for mentalising in cases when a positive non-verbal vocalization is produced in relation to a potentially uncomfortable event, in order to resolve the argument and the motives of such production.

7.3 Study1: fNIRS pilot study

We asked participants to passively watch video-clips, extracted from recordings of natural conversation, containing different types of laughter while wearing an fNIRS cap.

7.3.1 Functional Near-Infrared Spectroscopy (fNIRS)

fNIRS is a relatively non-invasive, safe, portable, and low-cost neuro-imagining technique which exploits the different light absorbance of oxy- and deoxy- haemoglobin (different absorption spectra) in order to monitor haemodynamic response to brain activation. The technique, therefore, similarly to the fMRI (functional Magnetic Resonance Imaging), relies importantly on the basis that neural activation and vascular response are tightly coupled, i.e. neurovascular coupling (Arthurs and Boniface, 2003; Logothetis et al., 2001). For the current study, we choose to use the fNIRS because, in comparison to the fMRI, it offers the advantage of not producing noise and of a better temporal resolution (Huppert et al., 2006); while in comparison to the EEG, it offers a better spatial resolution (slightly less than 1 cm), but slower responses. fNIRS in comparison to EEG is indeed much slower because relying on physiological and mechanical measures, rather than on electrical signals which travel much faster. The compromise though for the current study is that we could not look at very deep structures (e.g. Nucleus Accumbens); fNIRS indeed can record signal only from the superficial layer of the cortex (about 1,5-2 cm from the scalp).

The participants wore an in-house fNIRS cap while watching some video-clips and were tested using the Hitachi Optical Topography System ETG-4000. This system uses two continuous wavelengths of source light at 695 and 830 nm, 10Hz sampling frequency, and source-detector separations around 3 cm. We used two probes 3x5 (16 sources and 14 detectors) for a total of 44 channels. They were positioned in order to record signal from part of the prefrontal areas (especially the medial) and the supplementary motor area (SMA).

7.3.2 Participants

10 neuro-typical Mandarin Chinese native speakers (5 females and 5 males) took part in our pilot study. All the participants were attending universities in England. The mean age of the participants was 23.91 years (SD = 2.944 years, range 21-32 years old). They were compensated a minimum of 15 pounds for their participation (which lasted around 1.5 hours). This study was approved by the UCL Research

Ethics Committee (Project ID Number: ICN-PWB-13-12-13a), and written informed consent was obtained from all participants.

7.3.3 Stimuli

The video-clips were extracted from the Mandarin Chinese subsection of the DUEL corpus (Hough et al., 2016) and all the occurring laughs were annotated manually following the framework proposed in Chapter 2 and 3, using the ELAN software (Brugman and Russel, 2004).

Our stimuli consisted of 60 video-clips taken from the same dyadic conversation: 20 containing laughter related to a pleasant incongruity, 20 containing laughter related to a social incongruity and 20 where no laughter would occur (conversation without laughter), used as the control condition. Each video-clip included enough contextual information to understand the argument of the laughter and its pragmatic function. The mean length of the video clips with laughter was 12.094 seconds with a standard deviation of 3.453s. The laughter occurred on average 6.416 (SD=3.215) seconds after the beginning of the video clip.

Selection of stimuli

The video-clips selection for the experiment consisted of two steps. In the first one, 2 expert Chinese annotators labelled each laugh according to the laughable it was related to, watching the full video. Laughs related to *pragmatic incongruity* or *friendliness* were excluded. In the second one, in order to avoid any bias due to background information, six Chinese volunteers were invited to classify the same laughs based on the short video-clips cut out from the full conversation, presented in random order. After watching each video-clip, the volunteers, naive to our multi-layered framework, were asked "Why do you think the laughter was produced?" and they were given six options to choose from:

1. Because the laugher was experiencing embarrassment;
2. Because the laugher was afraid to seem impolite (accompanying criticism, difference of opinion to their partner);
3. Because something very sad or bad was being said — to reduce the strength and the degree of unpleasantness;
4. Because the laugher was trying to induce agreement and friendliness in their partner (e.g. accompanying a suggestion, asking a favour, apology);
5. Because something funny was said/had happened;
6. I cannot choose because I need more background information.

These items were constructed in order to be a simplified description of the most common laughter arguments and functions, as described in our framework (Chapter

2) and corpus study (Chapter 3). The first four options represent instances in which laughter predicates about a social incongruity and the fifth pleasant incongruity. The sixth option was added in order to understand whether the contextual information provided was sufficient for laughter interpretation.

The video-clips with a higher percentage of agreement (at least 4 coders) in the classification were included in the stimuli set. We ended up with a selection of 40 video-clips containing laughter related to social incongruity and 40 video-clips containing laughter related to pleasant incongruity. Due to the time-constraints imposed by the use of fNIRS[4], we reduced our stimuli to 20 video-clips containing a laugh relating to social incongruity and 20 containing a laugh relating to pleasant incongruity. In order to avoid any confounding effect related to the perception of different persons in the videos, we decided to use only extracts from the same conversation: a dyad of a male and a female unfamiliar to each-other.

7.3.4 Design

fNIRS records the Haemodynamic Response Function (HRF) which is a metabolic and slow correlate of brain activity, with peak response several seconds after the stimulus onset, with a plateau of several seconds. Considering the characteristics of the signal fNIRS relies on, we opted for a block design. This allows superposition of the HRF triggered by each of the repeated stimuli, increasing the strength and the reliability of the signal. Each block was constituted of 2 video-clips of the same type, i.e. containing laughter related to the same type of laughable: either social or pleasant incongruity. Videos within block had an 1,5s interval between them, and each block was followed by a 20s break, allowing the signal to return to the baseline. A graphic illustration of our design is presented in Figure 7.1.

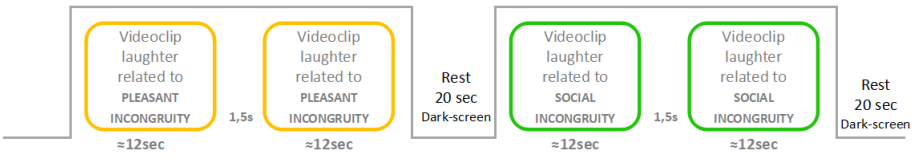


FIGURE 7.1: Graphic representation of the experimental design of Study 1: fNIRS

7.3.5 Procedure

Participants were briefly introduced to the fNIRS technique and the experimenters checked that there was no metal or electronics equipment carried by the participant. The fNIRS cap (2 probes 3x5, Hitachi ETG-4000 Optical Topography System) was then set in place, the position of the optodes was digitalised and participants were asked

[4]The advisable time for fNIRS recording is around 20-25 minutes, because of the discomfort that wearing a tight cap with optodes adherent to the scalp causes to the subjects.

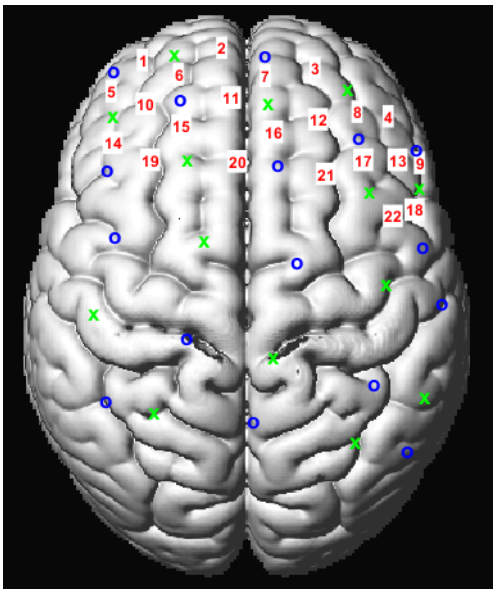


FIGURE 7.2: Localization of Probe 1

to passively watch the video-clips presented on a screen. The videos constituting the blocks were randomised according to type, i.e. videos constituting blocks of type social or pleasant incongruity would vary across participants, and the order of blocks as well was randomised. The script was built party using PsychoPy2 (Peirce et al., 2019) and partly compiled manually in Python. Participants were uninformed about our research interest in laughter. The video-clips presentation and fNIRS recording lasted around 21 minutes. After removing the fNIRS equipment, the participants were given a short break and then asked to take part in the behavioural experiment (Section 7.4).

7.3.6 Analysis

Data were analysed using a Matlab (Mathworks) custom script (Gervain et al., 2011) looking at differences in concentration of oxy- and deoxy-haemoglobin across the cortex, correcting for artefacts (e.g. heartbeat, noise, systemic blood flow variations). Data were band-pass filtered between .01 and .7 Hz. Parts of the recorded signal where quick (within 0.2 seconds) and large shifts in concentration ($>$ 0.1 mmol) where observed, were excluded from the analysis because considered as important artefact due to movement. For each block, a baseline was established by linearly fitting the 5s preceding the onset of the block and the 5s occurring 10s after the end of the block, allowing the hemodynamic response to return to baseline.

Due to the presence of extreme noise in the data 3 participants were excluded, as well as the second probe for all participants. Only data from probe 1 have been analysed (Figure 7.2).

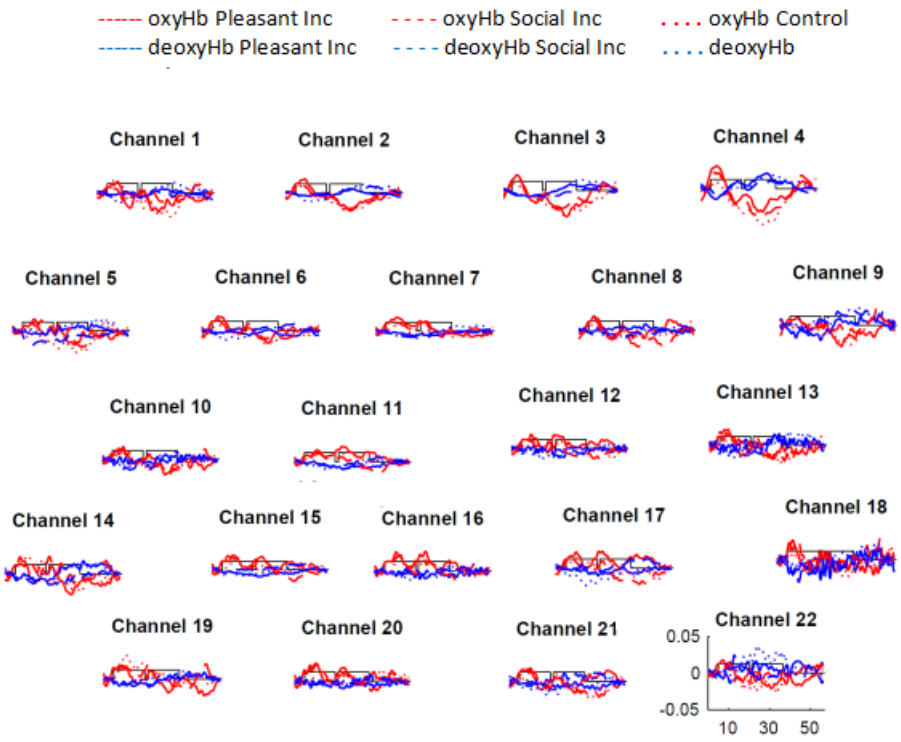


FIGURE 7.3: Grand average of signal recorded from Probe 1

7.3.7 Results: Study 1

Our data were unfortunately quite noisy (as shown in Figure 7.3), which makes it hard to interpret the overall averages of the changes in the different haemoglobin types between conditions and the significant differences found in the statistical analysis. In red are represented the concentrations of the oxy-haemoglobin while in blue the concentrations of the deoxy-haemoglobin. We used a continuous line to represent the pleasant incongruity condition, a dashed line for the social incongruity condition and a dotted line for the control condition.

Despite the fact that no definitive conclusion could be drawn, both due to artefacts and the small sample size, we got encouraging results from the cleanest data-sets, possibly confirming our hypothesis (Figure 7.4): at a visual inspection a greater concentration of oxy-haemoglobin in the dorsomedial-PFC as well as in the pre-SMA. The main goal of our study was indeed to test the technique, the design and the feasibility of the study. In Section 7.5 I will discuss the improvements planned for further studies.

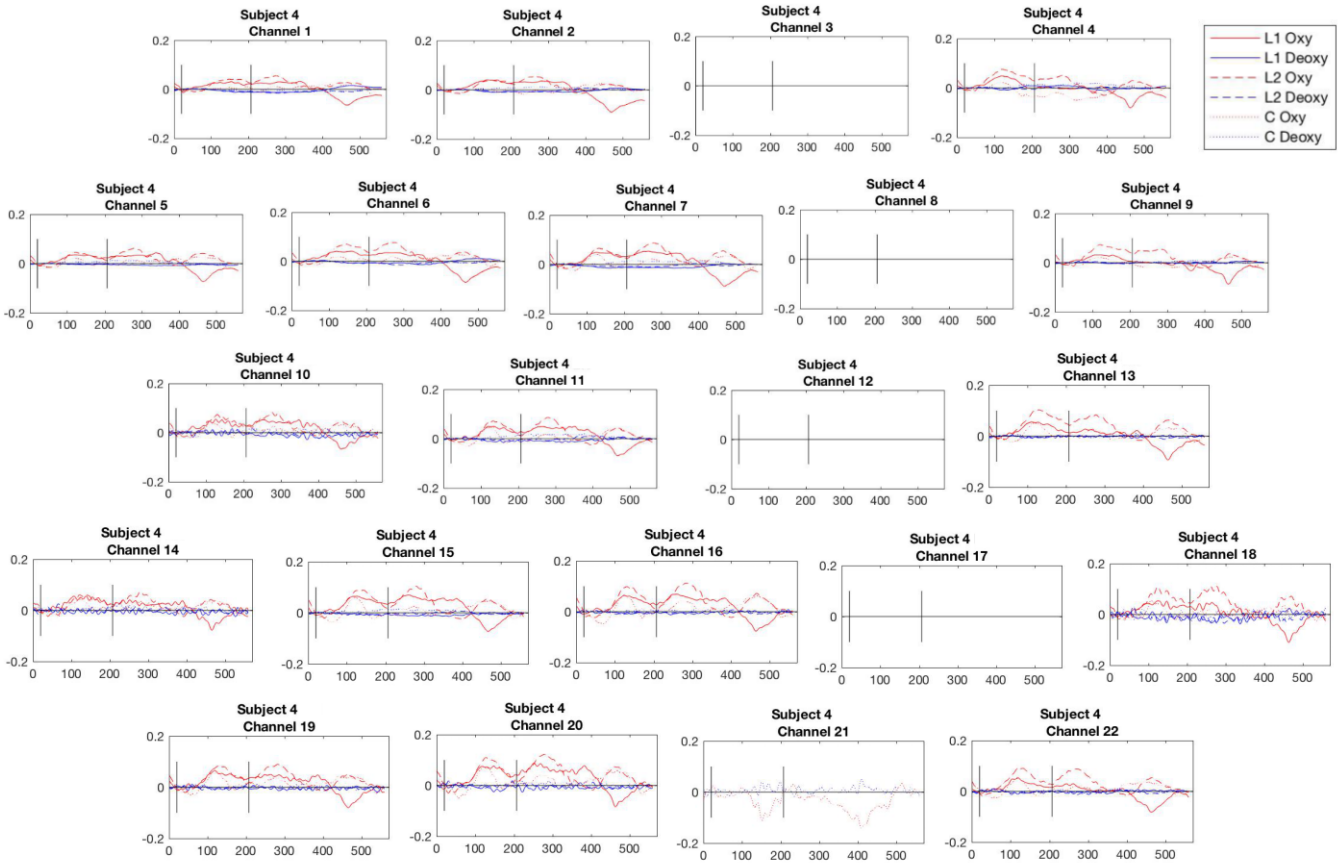


FIGURE 7.4: Example of clean data-set from Participant 4 - White channels have been excluded because of quick shift in concentrations in short time signaling an important artefact due to movement.

TABLE 7.1: Significant contrasts between conditions ($p<.05$): Pleasant incongruity (Pl), Social Incongruity (So), Control(C) and Baseline (b); n= channels.

H-Type	Pl/So	Pl/C	Pl/b	So/b	C/b
Oxy			7		11, 16, 17
Deoxy		12, 17	1, 7, 9, 18, 19	5, 13, 14, 19, 20	10, 11, 15, 16, 17, 19, 20, 21
Total	14	5			23

7.4 Study 2: Behavioural study

In the behavioural study, we asked participants to watch the same video-clips presented in the fNIRS experiment asking them to classify the laughter according to the type of laughable they were related to and to rate them in terms of arousal and valence perceived.

7.4.1 Participants

The same participants of Study 1 took part in the behavioural study.

7.4.2 Materials

Video clips

The same set of video-clips used in Study 1, were used for Study 2 expect for the ones where the conversation did not contain any laughter (used as control condition for the fNIRS pilot study). For the behavioural study, we therefore used a total of 40 video-clips: 20 video-clips containing a laughter related to a social incongruity and 20 related to a pleasant incongruity.

Laughter questionnaire

A week after the behavioural study, participants were asked to fill the Chinese version of the 'Questionnaire on people's experiences of their own laughter production and perception' (Müller, 2017; Jin, 2018). In Figure 7.5 we report the English version (Chinese version reported in Appendix C).

7.4.3 Behavioural study procedure

The 40 video clips with laughter were presented individually in random order using the MatLab Psychtoolbox (Brainard and Vision, 1997). After each video, the participants were asked to classify laughables choosing between the two most frequent classes: pleasant incongruity and social incongruity. As the aim of the study was to

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

FIGURE 7.5: Questionnaire on people's experiences of their own laughter production and perception (Müller, 2017)

investigate how people totally naive to the framework would respond, we 'translated' these categories into more explicit options: "What were they laughing about?" A1: A moment of social discomfort; A2: Something funny. Participant where then asked to classify the laughter on a Likert scale from 1 to 7 in terms of Valence (having 4 as neutral value) and in terms of Arousal (where 1 was very low and 7 very high). All the questions were written in Chinese and the participants were given 5 seconds to answer each question. In addition, as a catch question, every five video-clips, the participants would be asked which of the two persons in the video produced the laughter, the "Male" or the "Female". A graphic illustration of a trial is presented in Figure 7.6.

Before starting the actual data collection, participants were briefly introduced to the classification and rating tasks. To ensure that they understood the task correctly, test trials with six video-clips, not included in the stimuli set, were completed.

Furthermore, to investigate whether participants' ratings were influenced by their perception, experience and production of laughter in everyday life, participants were asked to complete the questionnaire about their own laughter production and perception one week after the study. This was to decrease the influence of the experiment and the meta-laughter reasoning required for the behavioural task.

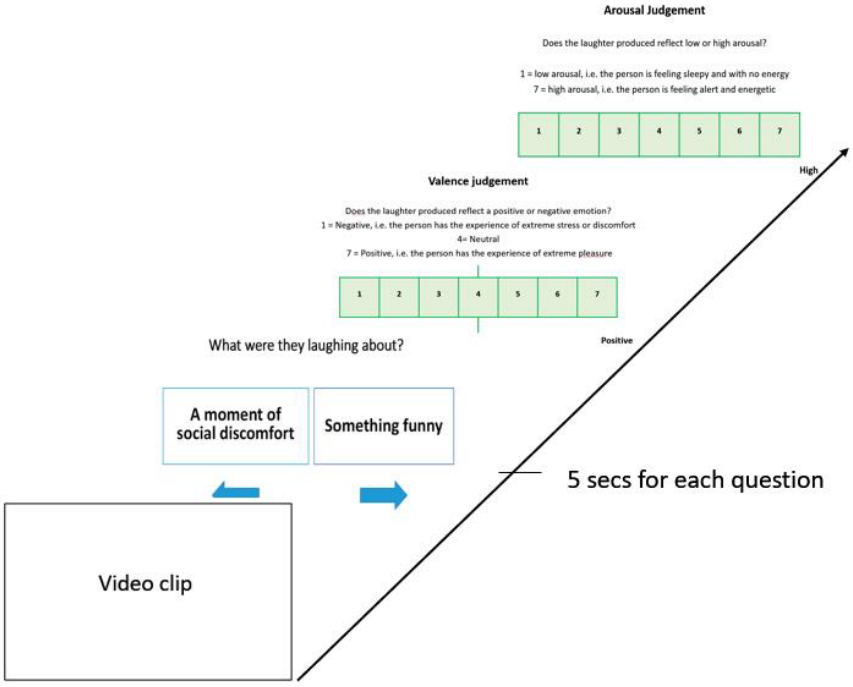


FIGURE 7.6: Trial Behavioural experiment (translated from Chinese)

7.4.4 Results: Study 2

Classifications of laughables

The classifications of laughables were coded into categorical variables (1=related to a pleasant incongruity; 2=related to a social incongruity).

The average pairwise percentage agreement between subjects was quite high, amounting to 70.45%, which defines the amount of agreement on the classification of laughter in the video clip, as the proportion of agreeing judgement pairs out of the total number for the classifications (Artstein and Poesio, 2008); while we observed a Krippendorff's α of 0.425. However, when the classification from experts annotators (based on the framework in Chapter 3) was added to the calculation, the average pairwise percentage agreement decreased to 66.51%, and the Krippendorff's α to 0.332.

The overall mean percentage of matching between participants and expert annotators was at chance level: 47.04% (SD=6.3%). Both for pleasant (45.91%; SD=12.00%)) and social (48.18%; SD=11.89%) incongruity.

Valence and arousal ratings of laughter predicating about pleasant and social incongruity

We used a Cumulative Link Mixed Model to compare ratings of valence and arousal between laughter related to pleasant or social incongruity using the *clmm2* function of the (*ordinal*) library in R. Firstly, the ratings were compared between the two classes as defined by the experimenters. The results indicated that there was no significant difference ($e = 0.2822, se = 0.1700, z = 1.6600, p = 0.09691097$) for the mean ratings of valence between laughter related to pleasant ($M = 4.18$) and social ($M = 4.42$) incongruity. Similarly there was no significant difference ($e = -0.0957, se = 0.1680, z = -0.5699, p = 0.56873827$) for the mean ratings of arousal between the laughter related to pleasant ($M = 4.03$) and social ($M = 3.92$) incongruity.

Then, we reran the analysis according to the participants' laughable categorisation. The results indicated that the mean rating of laughter valence when the laughable was classified as a pleasant incongruity ($M = 5.07$) was significantly higher than when it was classified as a social incongruity ($M = 3.56$) ($e = -2.3484$, $se = 0.2076$, $z = -11.3105$, $p < 2.22e-16$). On the other hand, the mean rating of laughter arousal when related to a pleasant incongruity ($M = 4.57$) was also significantly higher than that predicating of social incongruity ($M = 3.40$) ($e = -1.4143$, $se = 0.1811$, $z = -7.8110$, $p = 5.6747e-15$).

This suggests that even if they are not aware of it, participants may use perception of valence and arousal of the laughter in order to categorise the type of laughable the laughter is related to, rather than features of the laughable itself (see section 7.5 for discussion).

Individual differences

Results from the 'Questionnaire on People's Experiences of Their Own Laughter Production and Perception' (Müller, 2017; Jin, 2018) were analysed and scores for the four components ("I like laughter", "I do not understand others' laughter", "I laugh

TABLE 7.2: Numeric expressions of the four factors of the laughter perception questionnaire (Müller, 2017).

Factor	**Numeric Expression**
1 "I like laughter"	$(Q_{19} + Q_{16} + Q_{20} + Q_{18} + Q_{11} + Q_{21} + Q_8 - Q_3)/8$
2 "I do not understand others' laughter"	$(Q_{23} + Q_{24} + Q_{22} + Q_{28} + Q_{26} - Q_{17} - Q_{30})/7$
3 "I laugh a little"	$(Q_6 + Q_5 + Q_2 + Q_9 + Q_1 + Q_4 - Q_7 - Q_{10})/8$
4 "I use laughter as a social tool"	$(Q_{25} + Q_{15} + Q_{29} + Q_{14} + Q_{27} + Q_{13} + Q_{12})/7$

little" and "I use laughter as a social tool") extracted (Jin, 2018). The factors were computed as follows: the ratings of items which were positively correlated with the factor were added together, while the ratings of items which were negatively correlated with the factor were subtracted. The total value was then divided by the number of items. The calculation process of the four factors is shown in Table 7.2 (see Figure 7.5 to see which questions loaded on each factor).

In order to investigate whether people's experience, both in perception and production of laughter in everyday life would influence their valence/arousal ratings of laughter, non-parametric (Spearman) correlations were conducted between mean valence/arousal ratings for laughter related to social and pleasant incongruity and the four components. Despite the fact that results of our correlations have to be taken cautiously because of the small sample size, compared to the one commonly advised for analysis of correlation (n=25, David (1938)), we decided to report our results. We think it is good practice to accompany experiments about laughter perception with some measures of laughter perception in daily life that could account for individual differences. We know indeed that laughter perception (especially in terms of valence and arousal) can vary across the population, and be importantly affected by the presence of gelotophobic traits, i.e., fear of being laughed at, (Chan et al., 2016; Papousek et al., 2009; Hofmann et al., 2015; Papousek et al., 2014).

We found a significant negative correlation between the mean arousal rating of social laughter and the factor "I like laughter": the participants who perceived themselves as liking laughter more in daily life generally rated laughter related to social incongruity as lower arousal. Although a significant positive correlation ($r(11) = 0.618$, $p = 0.043$) was found between the mean arousal rating of social laughter and the mean valence rating of social laughter, there was no significant correlation between the mean valence rating of social laughter and "I like laughter". On the contrary, no correlations between perceptual features and individual laughter experiences (questionnaire factors) were found for laughter related to pleasant incongruity.

7.5 Discussion and Conclusion

The studies reported in this chapter were undoubtedly preliminary, intended as pilots for future investigations, and succeeded in giving us useful indications for the design of future experiments. The combination of our pilot fNIRS study together with the results from the behavioural classification, notably, opened interesting research questions. I start the discussion commenting on the results of our behavioural study, to then proceed to reflections about how to improve further neural investigations of laughter perception in conversational interactions.

7.5.1 Behavioural study

The aim of the second experiment was to investigate whether participants, when asked to pay attention to the argument of the laughter rather than the laughter itself, could classify laughables and whether that classification would be influenced by their experience in perception and production of laughter in everyday life. We found that participants' classification matched the expert annotators' only by chance, both for the social and the pleasant incongruity classes. While on the other hand, the agreement between participants was much higher (70.45% overall average pairwise agreement). In Chapter 3 though, percentages of agreement and Krippendorff's α with naive coders introduced briefly to the framework, were much higher (Section 3.3).

The results suggest that without an explicit presentation of the framework for laughter analysis adopted (differentiating distinct layers pertinent to laughter analysis), other factors prevail on the classification of the laughable type. We attribute the disagreement on the laughable classification to two main factors: confusion between levels of laughter analysis and important reliance on the perceptual features of the laughter (authenticity and spontaneity), rather than on the features of the laughable itself.

Some participants informally reported that they had classified as social incongruity, cases when the laughter was produced in response to a humorous remark which they did not find very funny. This indicates confusing *the argument* (which was a humorous comment, therefore containing a pleasant incongruity) and the fact that probably the laughter was produced with *the main intention* of pleasing the interlocutor (which relates to the social function of laughter). While we do not deny the social effect and motivation that influence each laughter production, being a communicative signal, we believe that, at least from a semantic perspective, it is important to distinguish that from the argument the laughter relates to (Chapter 2).

Apart from the justifiable confusion between layers of analysis, perceptual features of the laughter seemed to be a significant factor in the classification of laughables. We indeed find significant differences in arousal and valence ratings that we did not find in the expert annotators classification. The patterns observed in the participants' classification and ratings are indeed similar to the ones found in the

literature when comparing volitional and spontaneous laughter (e.g. Lavan, Scott, and McGettigan, 2016; Bekinschtein et al., 2011). These means that if a low arousal and quite posed laughter is produced in response to a joke, participants are more likely to classify it as a laughter predicating about a social incongruity rather than predicating of a pleasant incongruity; while in the framework we applied, regardless of the spontaneity, valence and the arousal, the argument would still be classified as a pleasant incongruity.

We think that our results should not be taken as to discredit the classification used by the experimenters. The classification proposed in Chapter 3 is indeed aimed to model laughter use from a semantic perspective, while this might not be the priority in social interaction. Or rather it might be that resolving the laughable is so easy for expert communicators, that they can focus directly on the perceptual feature of the laughter and evaluate its sincerity.

The encouraging results from some of the participants in the fNIRS study, despite being preliminary, seem to suggest though that in terms of neuro-correlates there might actually be differences in the perception of laughter related to different types of laughables.

7.5.2 Improving neural investigation about laughter processing in conversation

The first obvious improvement for our investigation will be to consider a larger sample size which will allow our statistical analysis to be more reliable, especially given the complexity of the fNIRS signal. Secondly, the consideration of results from the behavioural study has important implications for the designing of further neural investigations of laughter processing in conversation. The fact for example that participants judgements did not match the experimenters' classification, suggested that maybe for the future a design where each block is constituted only by one video could be more appropriate. That would indeed allow comparison of neuro-correlates both according to the experimenters' and the participants' classification of laughable, following a similar procedure to the one used in McGettigan et al. (2013) with regard to the perception of spontaneous and volitional laughter.

Moreover, the observation that participants seem to rely more importantly on the perceptual features of the laughter for the classification of the laughable, rather than focusing on the features of the latter would make interesting to operate a manipulation on the video-clips similar to the one operated in Curran et al. (2017). This would mean extracting the laughs from the original context of occurrence, to switch it in a context where it would relate to another kind of laughable. A manipulation of this kind might allow us to see whether the classification of the laughable was affected by changing the laughter associated with it and vice-versa. For the application of such manipulation, we would though need a new set of stimuli carefully selected. In our video-clips indeed, we had both laughter overlapping with speech, and laughter overlapping with others' speech. For the same reason, we

indeed could not ask participants to rate laughter in isolation without presenting the full video-clip in order to explore the influence of context on the perceptual features of laughter and vice-versa.

On the other hand, in order to explore whether the two classes of laughables we postulated do actually imply different types of processing in perception, it could be interesting to conduct an fMRI experiment, enabling us to look at deeper brain structures, taking in account the drawbacks of fMRI (noise and lower temporal resolution). Previous studies have indeed observed involvement of areas related to the reward circuit (Nucleus Accumbens and right midbrain) in humour perception (Elliott, Friston, and Dolan, 2000; Berridge and Robinson, 2003; Everitt and Robbins, 2013; Chan et al., 2016). We might therefore explore whether laughter occurring in natural conversation in relation to pleasant incongruity might elicit the same activation, in contrast to cases when laughter is related to social incongruity. While reward is a crucial component in the appreciation of humour, i.e. pleasant incongruity, it is reasonable to imagine that such factor is not present in contexts where we are embarrassed, are apologising, are proposing critics without willing to sound rude or are asking for a favour. In these contexts, we expect reward to be absent, while discomfort might have a major role. Studies about the perception of embarrassment and violation of social norms in others found rather an activation in areas implicated in the complex ToM system and social cognition (i.e. medial and dorsolateral Prefrontal Cortex, temporal regions and orbitofrontal cortex, in the posterior Cingulate cortex and in the sensorimotor cortex) (Bastin et al., 2016; Berthoz et al., 2002).

An fMRI investigation might allow to us to explore whether, in the cases when participants classified pleasant incongruity as social incongruity because, despite recognising the pleasant incongruity, they did not appreciate it, specific activations could be found in contrast to the cases when they actually appreciated it. In the fMRI study conducted by Campbell et al. (2015), they indeed found specific areas to be involved in the detection/comprehension of the incongruity (Temporal Parietal Junction) while other (Superior Frontal Gyrus) to be specifically active when the incongruity was appreciated as funny (pleasant in our framework). Lastly, the experiment will definitely benefit from a more careful selection of the control conditions, it would be ideal indeed to have two subsets of video-clips: one in which embarrassment or social discomfort is present in the absence of laughter and another one in which the interaction is just generally positive without the occurrence of laughter. This would allow a cross-paradigm more specifically informative about the role of laughter in the processing of the two situations.

We believe that a deeper investigation of the neuro-correlates of laughter use in interaction could provide important insights for the pragmatic functions it can serve in dialogue. A principal aim for the future is to exploit also the advantages of fNIRS, and its relative robustness to motion artefact (Pinti et al., 2015; Noah et al., 2015), for recording brain activity in real interaction (Cannizzaro et al., 2016). Such strands of investigation in neuro-typical subjects will constitute an important basis for further

studies in clinical populations where pragmatic reasoning might be affected, with particular interest for autism.

Chapter 8

Laughter in development

8.1 Why this chapter?

Laughter, both in its production and perception, offers us a special window into children's neuro-psychological development from very early on, emerging long before gesture, language or walking, and slowly developing to reach adult competency. Until now though, little attention has been devoted to exploring laughter development.

In the current chapter I am going to present an investigation on the development of laughter behaviour during the second and third year of life (from 12 to 36 months), based on observations collected in a longitudinal corpus study looking at the laughter of four babies while engaged with their mothers in natural interaction at their home. I am particularly interested in how laughter can be informative about cognitive and communicative development: how it emerges and is used in the earliest interactions, the first events it predicates about, its functions, and how those change over time. The interactional context with the mother will also give us the opportunity to look at how child behaviour in relation to others' laughter changes over time and how the mother's laughter behaviour also evolves, attuning to the child's development. The laughter analysis and annotation is based on a semantically and pragmatically grounded framework elaborated and tested for adult interaction (presented in Chapter 3). The corpus study presented in the current chapter will therefore also serve to test its adequacy for different developmental stages and generalizability to different interactional contexts.

The chapter is structured as follows: I start by presenting a literature review justifying my interest in laughter as a sign of cognitive and communicative development (Section 8.2), both when laughter occurs as a response to humorous stimuli and when it does not. In Section 8.3 I present some data from ethological studies looking at the origins of laughter in evolution, which may help in understanding human development of laughter use. The last part of the literature review is dedicated to research looking at laughter behaviour in clinical populations and in particular in subjects within the Autism Spectrum Disorder (Section 8.4). These studies are central to my motivation in conducting my own investigation, and show that laughter behaviour differs depending on the neuro-diversities observed. This suggests that a deeper knowledge of neurotypical laughter development could be a useful

additional means for early detection of delays in cognitive and/or communicative development.

I then move on to the presentation of the longitudinal corpus study I conducted (Section 8.6), presenting and discussing results for each of the feature analysed in Section 8.7, taking both an ontogenetic and phylogenetic perspective. I close the chapter with a general discussion (Section 8.8), summarising conclusions and proposing lines of research for further work in Section 8.9.

8.2 Why look at laughter in young children?

8.2.1 Laughter and humour

Laughter does not occur exclusively in relation to humour, but is certainly one of the most reliable indicators of humour appreciation. This is the first way in which laughter can be informative about cognitive development. Humour, both in its perception and production, is indeed a much more complex process than it seems. From a semantic and cognitive perspective it is still complicated to formalise what makes something humorous, and interesting debates are still open in the humour studies community (Ritchie, 2018)[1]; 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 appreciation indeed evolves over time, together with our cognitive abilities, giving us important insights into what children are directing their attention to, what children are learning about the world, the development of personality, bonding and attachment, as well as providing insights into infants' and children's understanding of others' minds (their mentalising ability) and the evolution of laughter itself (Mireault and Reddy, 2016).

By studying laughter in relation to humour in the early years of life, we can learn a lot about laughter itself, about children and about adulthood.

Why do babies laugh?: theories and data "in development"

The topic of laughter developmentwas long neglected, until the appearance of Developmental Psychology in the 20th century. Interestingly, in humour development studies, contrary to what happens in adult humour studies, incongruity appears to have an undisputed role. Before then, only Charles Darwin seems to have paid attention to laughter behaviour in development. In his notes about his son Doddy's development (Darwin, 1877), he reports the first laughter emerging at 110 days in the context of a peek-a-boo game, and three weeks later he describes the following: "*He received a little pinch on his nose and cheeks as a good joke. I was at first surprised at*

[1]In the current work, while embracing the importance of incongruity as an argument for laughter, I will take an agnostic stance with respect to theories about humour/funniness. I will focus mainly on laughter itself and on describing its arguments with as much detail as possible.

humour being appreciated by an infant only a little above three months old, but we should remember how very early puppies and kittens begin to play." Darwin, 1877, p. 289.

Laughter: a sign of cognitive mastery

Piaget (1945) proposes one of the first theories to explain laughter in relation to humour in children, on the basis of observations of his own children's development. He considers smiling and laughter to be a sign of cognitive mastery. In Piagetian theory (Piaget, 1945), when a child perceives information that does not fit with her existing schema about a particular object or event, she 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 capabilitiesare expanded. A baby in a phase of assimilation would laugh and smile at her newfound skill, and typically would find 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 (not too easy, but not too hard) (McGhee and Pistolesi, 1979). Surprisingly though, Piaget was never especially interested in humour and laughter, and never tried to explore in more depth the hypothesis that laughter could accompany cognitive mastery, despite the fact that laughter seemed to always be present in his observations of pretend play. His work was nevertheless the basis for many of the successive studies conducted on laughter and humour around 1970s.

Shultz and Zigler (1970) were the first to try and test the hypothesis that laughter/humour appreciation could genuinely be a sign of cognitive achievement. They observed children between 8 and 18 weeks of age and their reaction to stationary or moving stimuli, in an experiment based on the assumption that the moving version of the stimulus would be more difficult to assimilate than the stationary version due to the increased difficulty in following the contours. The results showed that infants were more likely and quicker to laugh while watching a static puppet than a moving one, needing a period of accommodation to the moving contours. This result was then supported by similar observations reported by McCall (1972), Zelazo (1971), and Zelazo (1972).

In order to account for the decrements in the amount of positive expressions elicited over sessions, Shultz and Zigler (1970) proposed a refinement of the Piaget model of cognitive development introducing the concept of *Cognitive Satiation*.

In the same period Sroufe and Wunsch (1972) tested children below 1 year of age, 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 laughter over time: auditory and tactile stimulations 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 respectively (Sroufe and Wunsch, 1972;

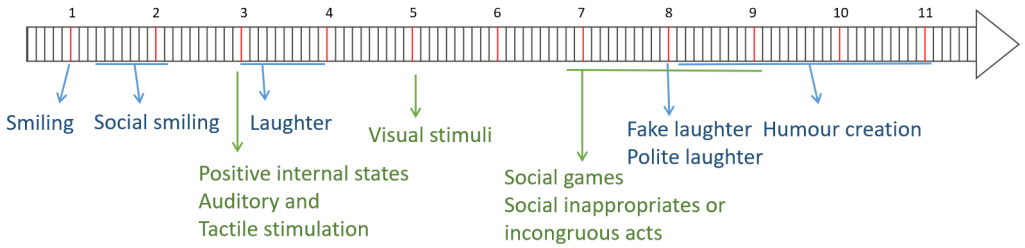


FIGURE 8.1: Stages of Laughter and Humour development in the first year. - Based on (Sroufe and Wunsch, 1972; Reddy, 2008)

Wolff, 1987) (see Figure 8.1 for a graphic illustration).

The stimuli used in those studies, however, contained important confounding factors which make it impossible to treat their conclusion as definitive. 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.

Shultz (1976) explored peek-a-boo reactions in 6 month to 12 month-old infants, showing that children 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 people/person engaged in play: children would not like 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 more recent study about peek-a-boo reactions in infants (2, 6, 7, 8 months old) (Parrott and Gleitman, 1989) highlights that the ability to predict what is going to happen has an important effect on the level of 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 preferred the condition in which the outcome was correctly predicted, the appreciation of the "switched condition" decreased with age, again supporting the hypothesis that surprise/incongruity has to be balanced with ability to predict, and therefore incongruity must be supported by knowledge in a fun environment.

Such a factor also seems to remain crucial later in development, including in adults. Zigler, Levine, and Gould (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 the fifth grade (as expected), but they observed an increase in appreciation only from the first until the fourth grade, and then a decrease in the 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): he presented children of different grades with jokes involving a violation of the principle of conservation of mass (as in (89)) and of the principle of class inclusion. Jokes were appreciated the most by children who had just learnt the specific principle, the jokes resulting therefore in an optimal level of challenge for their cognitive structures.

(89) *Example joke involving violation of the principle of mass conservation (from Martin (2010))*
Mr. Jones went into a restaurant and ordered a whole pizza for dinner. When the waiter asked him if he wanted it cut into six or eight pieces, Mr. Jones said: "Oh, you'd better make it six! I could never eat eight!"

The right level of complexity in the stimuli seems to be an important element for more than one researcher, despite the other differences between the theories. Researchers in the field, while agreeing on the development of humour appreciation as a sign of development in cognitive abilities, differ in the psychological and emotional functions of laughter production as a response to the appraisal of such incongruities (MacDonald and Silverman, 1978; Rothbart, 1973; Sroufe and Wunsch, 1972).

For example, Rothbart (1973) proposed an arousal safety model of humour, stressing the importance of the context and the need for precise calibration of the amusing/threatening elements in the stimuli in order to have the right amount of excitement without overwhelming and distressing the child. His model found support in the experiments conducted by MacDonald and Silverman (1978) where the reaction from the child in a peek-a-boo game was observed to be more intense if the mother was rapidly moving towards the child compared to when she was moving away from the child. Going further, Sroufe and Wunsch (1972) proposed laughter to be a "tension-discharge mechanism" (1972:1341) used when the level of incongruity builds up and the incongruity is explained. In a way, combining ideas based on some comments by Freud and Rief (1963) (Tension-Release Hypothesis) and humour incongruity theories almost results in a cognitive based-arousal theory of laughter in infants. When a child is confronted with a level of incongruity that is too difficult to resolve with respect to her current level of development, she may burst out crying for the same stimulus that a few months later will make her laugh uncontrollably.

Sroufe and Wunsch (1972) however, position themselves against the ambivalent view of laughter as the result of a mix of negative and positive feeling. Despite the fact that children might at first respond with some apprehension to stimuli that later will be appreciated as funny, as soon as they start to respond with laughter

we observe only purely positive and approaching behaviours, indicating that the incongruity is now perceived in a safe, playful and non threatening social context and that their cognitive abilities are sufficient to grasp it.

More recent studies on the topic have been conducted by, among others, Mireault and Reddy (2016) who stress, beside the cognitive aspects, the crucial role of the social environment. Reddy, Williams, and Vaughan, 2002 state that appreciation of humour emerges when newly discovered patterns and norms become the objects of violation and distortion in fun and exploration. They are also in line with the theory of humour appreciation as sign of cognitive mastery, in the sense that the most positive responses are in relation to stimuli/challenges that are just at the edge of their cognitive capacities. 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 indeed grounded on social referencing i.e. children's tendency to gather information from other individuals to regulate their own behaviour in ambiguous situation (Klinnert et al., 1983, see Fawcett and Liszkowski (2015) for a review).

Humour and play

There have been debates in the field about the distinction between play and humour. McGhee and Pistolesi (1979) argue that real humour cannot be appreciated until the age of 18 months when a child acquires the ability to engage in symbolic play (according to Piaget's theory achieved around 18 months). According to McGhee and Pistolesi (1979) it is only at this stage that the child, presented with an incongruous object or event, can distinguish between reality assimilation and fantasy assimilation. When presented with a humorous incongruous object or event the child has to treat it playfully without integrating it into her cognitive schemas. On the other hand, Pien and Rothbart (1980) argue that symbolic play capacities and fantasy assimilation are not necessary for humour appreciation. All that is needed is appraisal of the incongruity in a playful context, allowing playful interpretation. From very early on children start developing schemas and expectations about reality, and the only important thing for humour to occur is the recognition of the incongruity in relation to their mental schemas (which would correspond to *topoi* in our formalisation of incongruity sketched in Chapter 2, Section 2.4.4). As known by researchers working with violation of expectation paradigms (e.g. Baillargeon, Spelke, and Wasserman (1985)), infants are attuned to and are particularly interested in unexpected events from the first weeks of life (e.g. Cashon and Cohen (2000)). All that is needed to respond in a playful way to an incongruity is a safe and non-threatening environment.

In Pien and Rothbart (1980)'s view, therefore, a 6-month-old baby engaged in a peek-a-boo game is already experiencing humour.

The continued debate and disagreement may also result from different definitions of humour, and the debate in that case may be impossible to solve. The most that might be said, as stated by Martin (2010), is that humour originates in play and gradually becomes differentiated from other forms of play as the child's cognitive abilities develop (Bergen, 2003). If we take as a definition of humour the ability to appraise an incongruity as pleasant, I espouse the view that humour appreciation emerges during the first year of life, especially on the basis of more recent studies which have analysed in detail the first experiences of pleasant incongruity appreciation and production (see also section 8.2.3 and 8.2.4). Hall et al. (2013) demonstrated the correlation between pretend play and gesture, which in turn is correlated to language development. Laughter facilitating the first shared playful interactions might therefore have an important role to play. Laughter provides a baby with a means to direct a play partner's attention, and may serve the crucial purpose of honing and interlinking new abilities.

Tickling

It is worth taking some time here to discuss tickling, which is probably the first thing that comes to mind when thinking about laughter, and is the best known and one of the first stimuli to which laughter is related (especially for children). Tickling evokes laughter not only in humans, but also in primates (Ross, Owren, and Zimmermann, 2009) and possibly even rats (Panksepp, 2000). 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), research shows that it is not quite so simple as that. Tickling does indeed involve stimulation of body parts, typically those which are very 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) in his pioneering work collected in *The Expression of emotions in men and animals* and Hecker (1873), proposed a close parallelism and equivalence between tickling and humour, relying on a common underlying mechanism (the Darwin-Hecker Hypothesis).

> *"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)

Along the same lines, Panksepp (2000) and Wattendorf et al. (2012) proposed that laughter in response to tickling and laughter in response to humour might

share the same neurological activation. Some research using different experimental approaches seems to support the hypothesis. Fridlund and Loftis (1990), in a questionnaire-based study, found a positive correlation between reports of being very sensitive to tickling and reports of having the tendency to laugh frequently in response to humorous stimuli; similarly, Harris and Christenfeld (1997) found a positive correlation between the amount of laughs produced by their participants in response to tickling and in response to humorous stimuli.

In a more recent study, Harris and Alvarado (2005) have argued against the Darwin-Hecker hypothesis on the basis of results from their own observations. They applied the Facial Action Coding System (FACS) (Ekman, 1997) to annotate facial expressions during laughter in response to tickling and laughter in response to humorous stimuli. They found that during tickling additional Action Units also related to expressions of pain and distress were activated. From my point of view, this is not a strong argument against the Darwin-Hecker hypothesis: enjoying tickling in its humorous aspects, by reason of it being a kind of mock attack occurring in a playful context, does not cancel out the fact that the "attack component" is still present, and that being touched in vulnerable parts triggers discomfort and distress[2]. Indeed, I 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.

We know from studies on babies that tickling, reflecting phylogenetic patterns in the ontogenetic development, is one of the first stimuli that can elicit laughter in infants. Leuba (1941), observing the development of his two sons, observed that the typical response to tickling (smiling, chuckling and laughter) undergoes maturation, emerging in its full-fledged form around 6-7 months of age, without exposure to concomitant laughter from the partner[3]. Leuba 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 may fit with the idea that in order to be appreciated, humour needs a perfect calibration of arousal (Rothbart, 1973), being incongruous and discomforting, but not too much (Sroufe and Wunsch, 1972). In addition, the tickling stimulation will elicit 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 8.2.1), and the laughter produced would serve the communicative functions of showing affection and getting attention (Provine, 2004). In the case where it is a stranger who tickles vulnerable body parts, there is an absence of the clash between a potentially threatening stimulation and the pleasantness of the play, that clash being grounded in the awareness that the familiar person is unlikely to truly attack.

[2]See Minsky (2007) and Oatley and Duncan (1994) regarding mixed emotion.

[3]Leuba ensured that his children were never exposed to laughter or positive emotional expressions during tickling: Leuba and his wife made sure that their children were never exposed to tickling outside of the experimental procedures, and always covered their own faces with cardboard (with a small slit for eyes) during the tickling sessions.

Moreover, 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, Flanagan, and Wolpert, 2006; Claxton, 1975; Weiskrantz, Elliott, and Darlington, 1971; Wolpert and Flanagan, 2001). Provine (2001) proposes that the mechanism which underlies the recognition of non-self identities could bethe same as that which sustains the development of the sense of self and personhood crucial in infant development. Blakemore, Wolpert, and Frith (1998) conducted an fMRI experiment and observed lower cerebellum activity in relation to hand self-tickling compared to experimenter-tickling. Interestingly, Lemaitre, Luyat, and Lafargue (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, Wolpert, and Frith, 1998; Blakemore, Wolpert, and Frith, 2000; Shergill et al., 2005).

Concerning the evolution of play, long-standing debate has raged between researchers arguing for a fitness-motivated evolution, viewing tickling as a learning opportunity for fighting and the protection of vulnerable body parts (Harris, 1999; Gregory, 1924; Van Leeuwen, Zimmermann, and Ross, 2010), and researchers arguing for its evolution as a way to promote bonding in the context of play (Panksepp, 2000; Panksepp, 2004). With regards to humour, where both cognitive-competitive and social-affiliative motivations have been proposed to explain its evolution (Gervais and Wilson, 2005), I do not think that the two positions are mutually exclusive. The fact that play in general is extremely advantageous for the individual, thanks to the huge opportunities for learning and ability-testing, does not exclude the fact that it is also an extremely powerful means to create social bonding and group cohesion (aspects that in turn are also advantageous for the individual).

The relation between tickling and laughter is at least partly determined by cognitive, social and psychological factors, and looking at this relationship can therefore be informative about these elements. It can also give us insight into development in the case of children, and internal cognitive processes in the case of adults.

8.2.2 Laughter: a valuable vocalization for early interactions

According to Ekman and Friesen (1975), laughter emerges as an unconscious vocalisation reflex to a positive inner-state and, through the modelling and influence of the environment (Argyle, 1988), it becomes an important and varied form of non-verbal communication, one that is, crucially, social in its nature (Kohler, 2008). Infants, contrary to their use of other non-verbal vocalisations, such as crying, laugh only when the caregiver is present (Bowlby, 1969; Nelson, 2005). Reddy nicely describes this as a second-person phenomenon: for "*laughter to occur needs an "I" and a "you"; an "it" is not sufficient*" (Reddy, 2008, p. 184).Indeed, adults are more likely to laugh when they are not alone, even if not amused, than when they are amused but alone (Provine and

Fischer, 1989). The same results have been replicated both in school-aged children (Chapman, 1975) and in preschoolers (Addyman et al., 2018).

Stevenson et al. (1986) analysed in depth the early patterns of mother-infant vocalisations and responsiveness. Carrying out a micro-analytic analysis, they found similarities between the earliest vocalisation exchanges and adult conversation, especially with regards to turn-taking. Examining visual attentional contexts of occurrence, the authors observed two different functions that vocalisations can have in mother-infant interaction. When visual attention by the partner is present, vocalisations represent episodes of proto-conversation, while when visual attention by the partner is absent, they serve as an attention-getting device.This makes laughter, depending on the context of occurrence, informative about different pragmatic skills: conversational turn-taking intuitions, and the infant's ability to direct others' attention to the self (laughter as an attention-getting device) before being able to direct it towards external targets establishing joint attention.

Laughter moreover is one of the first media for children to actively take part in the conversation, contributing in the vocal interaction with a signal shared with the adult, and which they can use with the same level of proficiency as the adult. Mothers tend to "interpret" infant sounds as communication, and voiced sounds like laughter are important transmitters of changes in affective status that have a crucial role in the elicitation and maintenance of social play interactions (Fogel, 1982; Fogel, 1990). From this perspective laughter emergence in children is also an important signal for the adult, who will begin to feel notably more engaged and prone to engage in interaction, and to maintain the interaction (Wilkie and Saxton, 2010).

One of the first studies to look at laughter longitudinally, observing occurrences and sequential patterns, is that conducted by Nwokah et al. (1994). They observed laughter in mother-infant interaction during the first and second year of life (from 12 to 24 months of age), analysing frequency, duration and the correlation of children's parameters with those of the mothers. They found relatively constant timing parameters in mothers, but clear changes in children during the first year, and observed correlation in the rate of laughter between mother and child from the second year.

They also observed the production of laughter in response (Reciprocal) or concomitant (Coactive) to a partner's laughter. They observed changes both in the first and in the second year, with mothers most commonly laughing before the child during the first year, but, by contrast, most commonly laughing after the child during the second year.

Laughter, emerging around the third month of life, is therefore one of the first means available to children to attract attention, contribute to the conversation, respond, express meaning, and create a frame in the interaction that assures the partner of recognition of his or her behaviours (Apte, 1985; Collis, 1985), allowing children to have their first equitable exchanges with adults.

8.2.3 Laughter and others' minds

Laughter can enable the first non-verbal social interactions and 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.

Both mind-reading and social abilities have often been referred to with the umbrella term Theory of Mind (ToM). Here we will use this term (ToM) to refer to a complex system of processes that enables us to understand others' mental states, whether on an attentional, emotional, informational or intentional level. While a detailed discussion of the different theories of ToM development (Nativism (Chomsky, 1980; Fodor, 1992), Connectionism (Elman, Bates, and Johnson, 1998) and Theory-theory (Gopnik, Meltzoff, and Kuhl, 1999)) is out of the scope of the current work, since all of them envisage the gradual development/emergence of sophisticated social skills (Westra and Carruthers, 2017), I do agree with Schaafsma et al. (2015) on the need to try to disentangle and distinguish the different cognitive processes that constitute the building blocks of the dynamic system that allows mentalising, mind-reading, mind perception and pragmatic abilities to take place. The current work is largely motivated by the hypothesis, grounded in experimental data (e.g. Hoicka and Gattis (2008)), that laughter couldbe crucial in the development of one of the ToM building-blocks, as well as informing us about the gradual evolution of such complex social abilities.

Laughter emerges very early on (around 3-4 months of age) (Sroufe and Wunsch, 1972), and can be quickly used to direct others' attention, first toward the self (as a gestural attractor, (Tomasello, Gust, and Frost, 1989; Tomasello et al., 1994)) and then towards external targets. Making an analogy with gesture, we can therefore speculate that the first use is 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. In this respect laughter seems to work in a similar way to an "indexical" (Glenn, 2003) and in its use it implies an early awareness of others' attentional states (Tomasello, 1995; Baron-Cohen, 1989; Baron-Cohen, 1997; Charman et al., 2000; Camaioni, 1992). Many researchers have argued that the ability to direct others' attention in order to establish shared attention is the first stage of ToM abilities.In order to have the intention to direct others' attention (10-13 months, Bates, Camaioni, and Volterra (1975)) it is indeed necessary to have an awareness that others might have different attentional states from our own, and the intention to help them focus on the object of our own attention (Camaioni, 1992; Baron-Cohen, 1991).

In alignment with pragmatic theories, which state that for communication to happen there is need for an "ability to represent in your own mind the mental representations of others" (meta-representation) (Sperber, 1995), a positive longitudinal correlation has been found between joint attention abilities (use of indexicals, following gaze and pointing) and language abilities in the second year (Carpenter, Akhtar, and Tomasello, 1998; Mundy and Gomes, 1998; O'Reilly, Painter, and Bornstein, 1997;

Tomasello and Farrar, 1986). Despite the need for direct evidence, a concurrent and longitudinal correlation between language and ToM measures has been observed both in neurotypical (Charman et al., 2000; Astington and Jenkins, 1999) and autistic populations (Buitelaar et al., 1999; Happé, 1995).

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 ToM milestones.

An example of this is the emergence of "artificial" laughs around the eighth month of life (Reddy, 2001) produced in order to join others' laughter without understanding the eliciting stimulus, to elicit laughter in the other, or to appease the adults' expectations and enthusiasm in playful contexts even when the baby is not actually amused or is already bored by the game (i.e. polite laughter). These laughs show the growing attention that children start to pay very early on to others' attentional, emotional and intentional states.

In addition, the attempt to elicit laughter in others through clowning and teasing, emergent between 8-11 months (Reddy, 2001; Reddy, 2008), shows an increasing interest in others' emotional reactions, a desire to elicit them and the ability to perceive causal links between one's behaviour and others' reactions, as well as signalling an increasing cultural attunement to the environment (see Section 8.2.5).

8.2.4 Laughter as a socio-emotional resource: cue for intentions and information for learning

Hoicka and her colleagues have conducted extensive work on the development of the ability to recognise humorous intentions, i.e. understanding that someone might do the wrong thing with the intention to amuse. Their work collocates the ability to recognise humorous intentions around 25 months (Hoicka and Gattis, 2008): later than distinguishing intentional actions from mistakes (14–18 months, Carpenter, Akhtar, and Tomasello (1998)), but earlier than discriminating intentions to pretend from sincere intentions (36 months (Rakoczy, Tomasello, and Striano, 2004)), and intentions to lie and joke (over 5 years (Sullivan, Winner, and Hopfield, 1995)) (see Figure 8.2 for a graphic representation). Based on Hoicka and Gattis (2008)'s results it seems that understanding humorous intentions might be the first step in understanding that one can intend to do the wrong thing.

Their work also gave us important insights into children's use of laughter as a cue for disambiguating stimuli and inferring intentions. In Hoicka and Gattis (2008) they show how 18-month-old children are already able to clearly distinguish unambiguous jokes from unambiguous mistakes. When they are given the opportunity to repeat the action they have been shown, they indeed tend to copy the jokes and correct the mistakes, producing the complete and exact action. These results are consistent with data from Meltzoff (1995), showing that 18-month-old babies are able to complete mistakes and with McGhee and Pistolesi (1979) who postulated that children start to play incongruous actions as jokes from 18 months of age. But

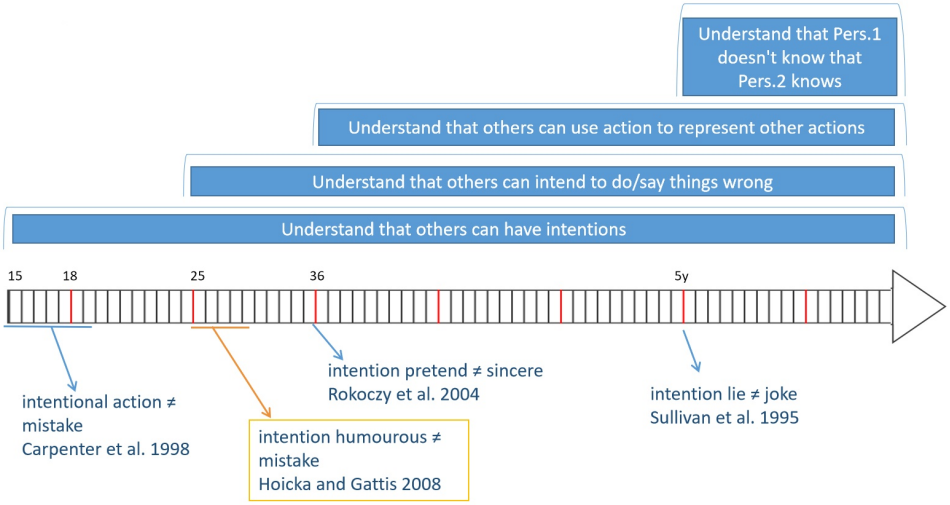


FIGURE 8.2: Development of cognitive abilities needed to differentiate reasons for doing the wrong thing.

it is only when they are 25 months old that they learn to discriminate ambiguous jokes and mistakes exploiting non-verbal cues informative about intention. Children would therefore copy ambiguous jokes/mistakes marked by laughter as humorous and correct the very same ambiguous jokes/mistakes marked by "Whoops!" as accidental. In a follow up study, Hoicka and Wang (2011) showed that children do not copy the ambiguous joke just because it is accompanied by a positive vocalization (laughter, in comparison to a negatively valenced exclamation "Whoops!"). They tested 15-month-old babieswho showed the ability to discriminate between positive vocalizations ('sweet' vocal cues versus humorous cues) and consequently expected the related actions. Along the same line of investigation, they conducted a further study (Hoicka and Akhtar, 2011) to explore whether 30- to 36-month-old babies were actually just relying on the verbal or non-verbal interpretation cues and their valence, or whether they were actually able to infer others' intentional (and in this case also informational) states. Children where more likely to imitate 'wrong actions' (in the case of this experiment: mislabelling) if the intention was humorous rather than sincere, especially in the case of competent speakers rather than less competent speakers, i.e. foreigners.

Interesting results about the importance of framing humour and about the role of laughter as cue for intentions come from studies on parents in interaction with their children. Parents appear to be very careful in marking whether something is intended as a joke or not. In comparison to positively valenced pretence for example, when joking, parents tend to exaggerate Infant Directed Speech (higher F0 mean, range and standard deviation; greater intensity mean, range and standard deviation; slower speech rate) and sometimes smiling (Hoicka and Gattis, 2012; Hoicka, 2016). Especially in comparison to sweet sincerity, parents cueing for humour use a rising linear contour, almost questioning the joke; they also tend to significantly increase

gaze and smiling towards the child, while reducing gaze to the objects, especially with younger toddlers. This difference might be explained by the parents wanting to be sure that the humorous intentions are grasped, and wanting to avoid generalisation of jokes' false information (Hoicka, 2016).

Westra and Carruthers (2017) argue that one of the reasons that children fail the False Belief Task[4] until quite a late age (in the larger part of the literature, in its most classical version, around 4 years) is not a matter of language complexity or perspective taking, but rather the fact that for children it may be hard to interpret the task just in terms of the Question Under Discussion (Ginzburg, 2012; Roberts, 1996). On the basis of children's experience it might indeed be quite unlikely that the topic of conversation (and in this case the question they are asked) is the mental state of the characters, since mental states and beliefs are very rarely the object of conversation in their daily life (Westra, 2017). Our ordinary explanations and descriptions of behaviour generally leave beliefs implicit. Usually we simply refer to agents' desires, leaving the inference of the belief state to interlocutors (Papafragou, Cassidy, and Gleitman, 2007; Steglich-Petersen and Michael, 2015). If that hypothesis is true, than laughter could be one means to express mental states (e.g. humorous intentions) that are generally left implicit. Laughter could therefore genuinely be considered a special tool to get the first insights into others' beliefs.

Humour, of course, is not the only situation for which special attunement to others' mental states and rich pragmatic reasoning is needed. What is special about humour is its early emergence and, in its first forms, its relative simplicity and motivating accessibility (Hoicka, Jutsum, and Gattis, 2008). Indeed, it has three important features in comparison to other complex non-literal meanings acquired much later such as pretence (24 months (McCune-Nicolich, 1981; Rakoczy, Tomasello, and Striano, 2004)), irony (4-10 years (Pexman and Glenwright, 2007; Recchia et al., 2010; Filippova, 2014)) and metaphors (3-10 years (Gottfried, 1997; Pearson, 1990; Pouscoulous, 2014)).

1. Humour can take non-verbal and physical forms, therefore being accessible to the child even before acquiring solid verbal skills, allowing pragmatic development before other aspects of language (Hoicka, 2014);

2. Compared to other forms of non-literal meaning, it is relatively simple from a pragmatic point of view: the only thing needed is to grasp the literal ambiguity, or the wrongness of the act together with the intention to amuse (Hoicka and Gattis, 2008). In contrast, in the case of pretence one must also consider imagination (Nichols and Stich, 2003); in the case of irony one must be able to understand complex mental states (e.g., Pexman and Glenwright (2007)), while

[4]Many different versions of the False Belief Task have been constructed and proposed in the literature. What they all have in common is the setting up of a situation in which a child is led to believe something about a current set of circumstances, but this belief is different from a belief that should/could be held by others. At the end of the task the child is usually interrogated about the belief held by the other individual (either a character or person).

grasping metaphor involves noticing literal overlaps between two concepts (e.g., Andrews et al. (1986)).

3. Thanks to its simpler nature, it is relatively easy for the child to engage in successful and equitable humorous exchanges even during the first year of life.

4. Humour is a form of interaction that is exceptionally socially and emotionally rewarding[5]. In humour there might be therefore a motivational component not present in other types of non-literal meanings.

Humour may thus be the first context in which the child is motivated to learn about pragmatic meaning, possibly constituting the basis for later and more complex forms of non-literal meaning.

In conclusion, the studies reviewed suggest that humour implies the first steps towards the understanding of others' intentions and informational states. Laughter plays an important role in helping children discriminate between intentions and, when laughter is produced as a response to humorous stimuli, it informs us that those stimuli have been grasped. Therefore as put forward by Reddy (1991) and Reddy (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.

8.2.5 Clowning and Teasing

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 the 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). Hoicka and Akhtar (2012), Bainum, Lounsbury, and Pollio (1984), and Hoicka and Akhtar (2011) observed that 2- and 3-year-olds, when producing incongruous versus conventional actions and utterances, were significantly more likely to laugh while clowning, either with or without looking for a reaction, and significantly more likely to smile while looking for a reaction. Thus early on, children signal their jokes with laughter, smiling, and looking for a reaction, suggesting they are communicating their act as

[5]Neuro-imaging studies about humour appreciation indeed show an important positive activation of the reward system and the amygdala (e.g. Bekinschtein et al. (2011)).

humorous to their audience, demonstrating an awareness of the need to contextualise their jokes and cue their intentions.

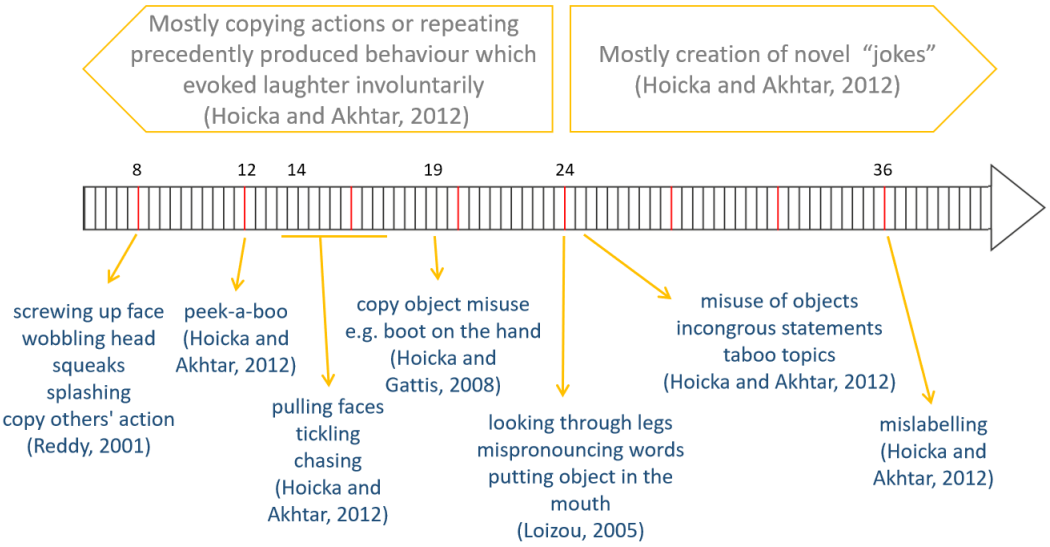


FIGURE 8.3: Clowning development. Based on Reddy (2001), Hoicka and Akhtar (2012), Hoicka and Gattis (2008), and Loizou (2005)

As anticipated in Section 8.2.3, engaging in clowning signals an early awareness and interest in others' emotional states, as well as showing awareness of conventions, social rules and expectations. Even more fascinating is the emergence of teasing, when clowning actually becomes a sort of provocation and occasion to test boundaries. Even more-so than in clowning, in teasing the child shows understanding of others' emotional attitudes, expectations, and 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 faked 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, Williams, and Vaughan, 2002, p. 230). Again therefore, we stress how humour and laughter, in the context of clowning and teasing can be extremely informative about cognitive, emotional, social and pragmatic development.

8.3 Laughter in evolution

For long time it has been thought that humans were the only laughing animals (Stearns, 1972); a conviction stemming from Aristotle, who wrote in his essay *On parts of animals* that humans were the *"only living things that laugh"* (Lennox, 2002). But nowadays there is good evidence for the idea that homologous behaviours can

be observed in other mammals, especially in our closest cousins, the non-human primates and monkeys. I believe that for theorists and semanticists of laughter it is extremely important to consider primate use of laughter. The fact that laughter emerges so early on in ontogeny reflects the fact that it is a rather "old" behaviour, and the understanding of its original contexts of use can help us frame it in the best way, a way that accounts for all of its occurrences, from tickling to the most complex pragmatic uses. Indeed, accounts of laughter use have often failed to include its most basic and primitive use. In adult humans laughter has been co-opted to serve a variety of functions, and for researchers it seems hard to reach agreement on a general framework able to integrate all the data.

I will therefore give a very brief review of what we share and what we do not share with our ancestors with regards to laughter, believing it will be of help in understanding the development of laughter use in children.

8.3.1 Play Face

Van Hooff and his colleagues propose that laughter has its most ancient homologous behaviour in the *'play face'* displayed in primates and monkeys (Preuschoft and Hooff, 1997; Van Hooff, 1972; Van Hooff and Preuschoft, 2003). The term *play face* refers to a facial expression characterised by wide opening of the mouth, most typically without retraction of the lips which still cover the teeth. It usually, as the name suggests, occurs in the context of play, and is often accompanied by play chuckles (rythmic breathing) and by energetic but supple movements. Young primates spend long hours playing. Play typically involves energetic physical activities: chasing each other, attacking, rough-and-tumble (a kind of wrestling) and tickling. It is possible that this kind of physical play, in addition to being crucial for bonding and social cohesion (De Waal, 1986), has the function of training juveniles for serious tasks they will have to undertake later in adult life like hunting, fighting, mating, fleeing and simple locomotion (Gervais and Wilson, 2005; Panksepp, 1998). Play face in this context therefore seems to be needed to signal that the attack is a mock attack, that the chase is a mock chase, that the fight is mock fight, etc.

This display is extremely interesting and seems to suggest that primates, and some monkeys, therefore do have the ability to distinguish between reality and pretence, seriousness from play, which is arguably one of the basic conditions for humour to occur (Martin, 2010). In this regard it is intriguing to mention results reviewed in Gamble (2001) where primates closer to us (chimpanzees and gorillas) exposed to sign language training have been observed using it in playful ways e.g. punning, incongruous word use and humorous insults, suggesting the possibility of a rudimentary form of humour. Moreover such humoristic uses were always produced together with the display of play face, giving further support for the hypothesis that humour and play are closely connected (Martin, 2010). Similar relaxed open-mouth displays have been observed also in other species, e.g. canidae and ursinae have a gape-mouthed play face (where upper teeth remain covered) accompanied by

energetic movements and rapid panting very similar to the one observed in primates (Van Hooff and Preuschoft, 2003). It seems therefore that the origin of the ancestors of laughter may be dated millions of years ago.

8.3.2 Laughter

The first to draw a parallel between this pantingand the energetic exhalations observed in chimpanzees in association with the play face was Darwin (1872). The same behaviour was also subsequently observed in other primates (Van Hooff and Preuschoft, 2003; Ross, Owren, and Zimmermann, 2009). Despite the claims that they are homologous, important differences can be observed in the respiration and acoustics patterns between primate and human laughter, which sound quite dissimilar as a result (Provine, 2001; Gervais and Wilson, 2005; Owren and Bachorowski, 2001). In order to test the hypothesis that the expression of laughter has evolved from non-human displays, Ross, Owren, and Zimmermann (2010) and Ross, Owren, and Zimmermann (2009) conducted a fascinating study comparing the acoustic features of tickle-induced laughter in orangutangs, gorillas, chimpanzees, bonobos and humans. They found similarities and differences, which when used to generate a phylogenetic tree based on the acoustics features observed, reflected exactly the well-established genetic relationships of great apes and humans. This study supports therefore the claim of a phylogenetic continuity in positive expressions between apes and humans, and so validates the use of the term 'laughter' to refer to the vocalisation observed in the 5 species. Laughter and play face occur in the context of play, especially rough-and-tumble play and chasing, and seem to be important signals for displaying affiliation and for action coordination (Van Hooff and Preuschoft, 2003; Bard, 2007; Byrne, 2003; Hatfield, Cacioppo, and Rapson, 1994), and when observed in captivity non-human primates also display them in the context of tickling and peek-a-boo play. All of this data seems to go against 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 insteadsupports positions that view laughter as crucially linked to the joy of play, incongruity and friendly interactions (Darwin, 1872; Panksepp, 1998).

Some authors propose smiling to have a very different evolutionary origin in the silent bare-teeth display generally used to show submissiveness (Van Hooff and Preuschoft, 2003). The debate is still open on whether laughter and smiling should be considered as having a different or similar evolution.Van Hooff and Preuschoft (2003) proposed the two to have very distinct phylogenetic origins and different original functions that were only later co-opted to share the same meaning on different levels of the same scale (Ruch, 1993), as reflected in the lexicon used in some languages (e.g. in French *rire*, *sourire*).

While the idea that laughter is shared with our ancestors is now generally accepted, the debate on whether or not the 50Hz chirping observed in rats when tickled can also be considered homologous (Panksepp and Burgdorf, 2000; Panksepp, 2000; Panksepp and Burgdorf, 2003) is still open (Gervais and Wilson, 2005). This strand

of research, nevertheless, has already started to help shed light on the neural basis of positive emotions (e.g. Carré et al. (2015)).

8.4 Laughter in exceptional development

Given the highly sophisticated pragmatic and cognitive skills involved in laughter use and in humour appreciation and production, it is interesting to look at their patterns of use in different cases of exceptional development. Preliminary research has indeed shown that different laughter behaviour and humour appreciation can be observed across clinical conditions with particular neuro-psychological difficulties (e.g. Reddy, Williams, and Vaughan (2002), Krishan, Batchelor, and Porter (2017), and Adams et al. (2015)). In what follows I will present a brief review of studies on laughter and humour in autistic populations, which sparked my interest and motivated the detailed study of laughter behaviour in typically developing children presented in the remainder of this chapter.

8.4.1 Autism

Autistic Spectrum Disorder (ASD) is generally described as being characterised by poor communication skills, poor social cognition, and a poor understanding of pragmatics (e.g., Baron-Cohen, Leslie, and Frith (1985) and Perner et al. (1989)). As humour relies on understanding pragmatics, and resides particularly in the situational and cultural context, making implicit reference to subtle sociocultural rules, it is not surprising that children on the autistic spectrum have difficulty in appreciating and producing humour, specifically in a social and communicative context.

Some studies on humour appreciation and production in ASD adults are available and have produced interesting results (e.g. (Silva et al., 2017; Lyons and Fitzgerald, 2004; Emerich et al., 2003). Research on adults with Asperger Syndrome found that they were just as likely to appreciate jokes based on visual puns as neurotypical adults (Samson and Hegenloh, 2010). However they were less likely than neurotypical adults to appreciate semantic jokes, and jokes which relied on the recognition of false beliefs in others. A factor that might affect the appreciation of humour in interaction is the difficulty in recognising others' humorous intentions. Zalla et al. (2009) showed how in Asperger subjects there are difficulties in discriminating between voluntary and involuntary actions, which, as discussed in Section 8.2.4, is the first step to understanding why others might do the wrong thing, a precondition for grasping humorous intentions.

The first study, to my knowledge, looking at laughter and humour in ASD children is the one conducted by Reddy, Williams, and Vaughan (2002).They looked at a group of ASD children (36-65 months old) in comparison to a group of children with Down Syndrome (DS) (18-65 months old) in order to highlight the differences between and particularities of the two conditions: while in ASD the core of the difficulties are social and pragmatic abilities, in DS the social sphere of competence is rather

intact and the weakness usually resides in the cognitive abilities. They did not find any significant difference in the amount of laughter produced in a day, and they found similar appreciation of tactile and slapstick humour both in ASD and DS children (a piece of data going against the theory proposed by Jung (2003) that deep mind reading abilities are needed for any kind of humour). The differences arise rather in the interest in others' laughter, i.e. in the ASD group they observed very low orienting response to others' laughter and significantly fewer attempts to elicit others' laughter. The ASD group also displayed a lack of appreciation for socially inappropriate acts and funny faces, and fewer shared laughs. Rather, ASD children often laughed on their own, and parents report that it is often hard to understand the object of their laughter.This un-sharedness of laughables seems to reflect a lack of social and cultural attunement to the environment (Reddy, 2008). In addition, the lack of clowning and teasing, likely signalling a lack of interest in others' emotional expressions and reactions, could be explained on the basis of a limited ability to engage in shared attention (Paparella et al., 2011), and difficulties in grasping acts and their consequences, and in understanding and sharing emotions.

Laughter as pointing

Considering the data collected by Reddy, Williams, and Vaughan (2002), I think it would be useful to draw a parallel with gesture, and more specifically in this case pointing. When speaking about pointing we can distinguish two types: imperative and declarative pointing. In ASD children pointing itself is not compromised, and indeed they use imperative pointing and pointing for the self (i.e. pointing as a self-directed attentional device, e.g. when identifying different objects in an image (Goodhart and Baron-Cohen, 1993)).What is compromised, generally absent or with a late emergence and sporadic use is declarative pointing (Camaioni, 1992). Similarly, in laughter it is not laughter behaviour itself that is compromised. Children later diagnosed as autistic are often found to smile, laugh, babble and be engaged in social routines like peek-a-boo similar to neurotypical developing children (Lösche, 1990), and Reddy, Williams, and Vaughan (2002) found equal occurrences of laughter in both ASD and neurotypical children: what differs is the use of this laughter and the context of its use. Making an analogy with the study of pointing, I think it would be extremely useful and informative to analyse laughter-use in typical children in detail, in order to better understand the source of the differences in other populations.

A recent study by Cai, White, and Scott (2019) found that the perception of laughter per se and the social effects it might have are not completely impaired, at least in Asperger adults. When asked to evaluate bad jokes, Asperger participants are affected by the presence of accompanying laughter in a similar way to neurotypical adults. Moreover the lack of understanding of laughter in social interaction is often associated with gelotophobia (i.e. the fear of being laughed at) in the ASD population (Samson, Huber, and Ruch, 2011), which constitutes an additional difficulty in facing daily social interactions.

In summary, the data above suggests that observation of laughter at very early stages of development could prove informative, along with other non-verbal behaviours (Luyster et al., 2008; Nadel and Camaioni, 2017; Mundy et al., 1986), about difficulties or delays in different areas of cognition and social development.

8.5 What is missing?

The literature presented shows with little doubt that laughter can be informative about development, and that it is vital in helping to scaffold abilities which form the basis for further complex mentalising processes. What is missing is a longitudinal detailed investigation looking at not only at the occurrence of laughter, but also its semantic and pragmatic use – how laughter is used by children, whether in relation to humour or not. Laughter is highly informative when produced in relation to humour, but it is also informative when produced for other reasons, because the underlying motivations behind these cases of production are far more socially grounded and pragmatically complex. While there is some literature on the development of laughter in response to humorous stimuli, almost none to my knowledge addresses the development of laughter-use in moments of embarrassment, when there is need to soften a statement, to induce agreement and benevolence from the other or to show affiliation.

8.6 Corpus Study

The nature of the current study is in the first instance exploratory, aiming to observe the development of laughter behaviours in mother-child interaction from 12 to 36 months of age from a semantic and pragmatic perspective. Laughter behaviours were measured by analysing video-recordings of interaction between mother and child in familiar contexts, and applying the annotation framework proposed in Chapter 2.

8.6.1 Motivating Questions

More specifically, my research questions are:

1. Can laughter be used as a marker of cognitive and communicative development during the second and third year of life?
    - Is child laughter behaviour like adult laughter behaviour? Does it evolve over time?
    - Does children reaction to others' laughter change over time? Do they display more explicit responses to others' laughter?
    - Do children produce laughter related to different kinds of laughables as they grow older?
    - Is laughter used to serve different functions as the child grows older?

2. Is there something special about laughter use in mother-child interaction?
    - Is mothers' laughter behaviour similar to the one displayed in adult-adult interaction?
    - Do mothers adapt their laughter behaviour to the cognitive and language development of their child?

8.6.2 The corpus

Laughter is a non-verbal vocalisation which affects our facial expressions, and our body movements and posture. In interpreting laughter, it is very important to take a multimodal approach both to its identification (laughter can be silent) and its comprehension in order to identify laughables, infer intentions, observe gaze direction and attentional states, and take into account other non-verbal social signals (Griffin et al., 2013; Cosentino, Sessa, and Takanishi, 2016). 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 corpus for which video data was available: the Providence corpus (Demuth, Culbertson, and Alter, 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 home. All the interactions have been orthographically transcribed using CHAT conventions (cf. MacWhinney (2000)). All transcriptions of the mothers' and children's speech, as well as audio/video files, can be found on the CHILDES database (https://phonbank.talkbank.org/access/Eng-NA/Providence.html).

8.6.3 Our data

Our corpus study focuses on a subset of the Providence Corpus (Demuth, Culbertson, and Alter, 2006), looking at laughter behaviour development in 4 children: Alex, Lily, Naima and William. We analysed 30 minutes of spontaneous interaction with the mother at intervals of every 6 months from the age of 12 to 36 months, for a total of 5 time points per child (see Table 8.1 for more precise information), and ultimately annotating 297 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

Child	Time	Age	Video	Transcript	Minutes
Alex	1	01;04.27	010427	010427	30
	2	01;06.14	010614	010614	30
	3	02;01.02	020102	020102	30
	4	02;06.06	020606	020606	26.5
	5	03;01.03	030103	030103	30
Lily	1	01;01.02	010102	010102	31
	2	01;06.11	010611	010611	30
	3	02;00.04	020004	020004	30
	4	02;06.04	020604	020604	30
	5	03;00.03	030003	030003	20.12
	5	03;00.10	030010	030010	6.15
	5	sum	–	–	26.27
Naima	1	01;00.14	010014	010014	30
	2	01;06.04	010604	010604	30
	3	02;00.04	020004	020004	30
	4	02;06.11	020611	020611	30
	5	02;11.23	021123	021123	15.66
	5	03;01.01	030101	030101	15
	5	sum	–	–	30.66
William	1	01;04.12	010412	010412	26.08
	2	01;06.05	010605	010605	28
	3	02;00.12	020012	020012	30.04
	4	02;06.12	020612	020612	30.18
	5	03;00.11	030011	030011	27.73

TABLE 8.1: Information about videos analysed - Age, links and transcripts

started from the very beginning of the recording session. Parts of the video with no interaction (e.g. child and mother in different rooms) or in the presence of third persons were excluded from further analysis, and subtracted from the total duration of the video, in order to focus exclusively on mother-child interaction patterns. I indeed observed impressionistically that the presence of a third person particularly influences the mothers' laughter behaviour, who immediately produce significantly more laughter than when interacting whit the child alone[6]. For 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 8.1). 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).

[6]This observation is in line with data collected in the BNC (presented in Chapter 3) where I noted that in conversations where children were present fewer laughs were produced.

TABLE 8.2: Laughter Annotation Scheme for Interactions with Children

Form and context	
Duration	Start-Time, End-Time
L. in relation	Stand-alone laughter
to speech	Speech-laughter
L. in relation to	Isolated
others' laughter	Dyadic: Antiphonal and Coactive
L. in relation	Before
to the laughable	During
	After
Semantics	
Arousal	Low, Medium, High
Laughable	
Predication	Incongruity: Pleasant, Social, Pragmatic
	No Incongruity: Friendliness
Type of laughable	Denotation utterance
	Meta-linguistic
	Non-verbal
	Dialogue act
	Exophoric
Origin of laughter	Self
	Partner
	Collaborative
	External
Laughable Media	Auditory; Visual; Physical; Language;
	(any combination of those)
Pragmatics	
Function	Show enjoyment of pleasant incongruity,
	Marking incongruity, Softening,
	Benevolence induction, Smoothing,
	Meaning modification
	(marking irony, scare quoting, editing phrase etc.),
	Affiliation
	[Refer to Decision tree, Figure2.1]
Level of Engagement	Interaction/No Interaction
	Shared attention/No shared attention
Partner's Response	Explicit (Laugh; Smile; Look)
	Implicit (keep activity)
	None
Clowning/Teasing	Clowning (c); Teasing (t)
Incongruent Mood	Yes; No
Goal	Cooperative
	Non-Cooperative
Dialogue-act/Move	e.g. statement opinion, answer, comfort, hedge etc.
	(Stolcke et al., 2000) (Appendix D)
Activity	e.g. reading, pretend play, singing, eating etc.

8.6.4 Our annotation

All of our annotations have been conducted using the software ELAN (Brugman and Russel, 2004), which is ideal for multimodal annotation. This was viable thanks to the availability of the videos and of the corresponding CHAT files with transcriptions.

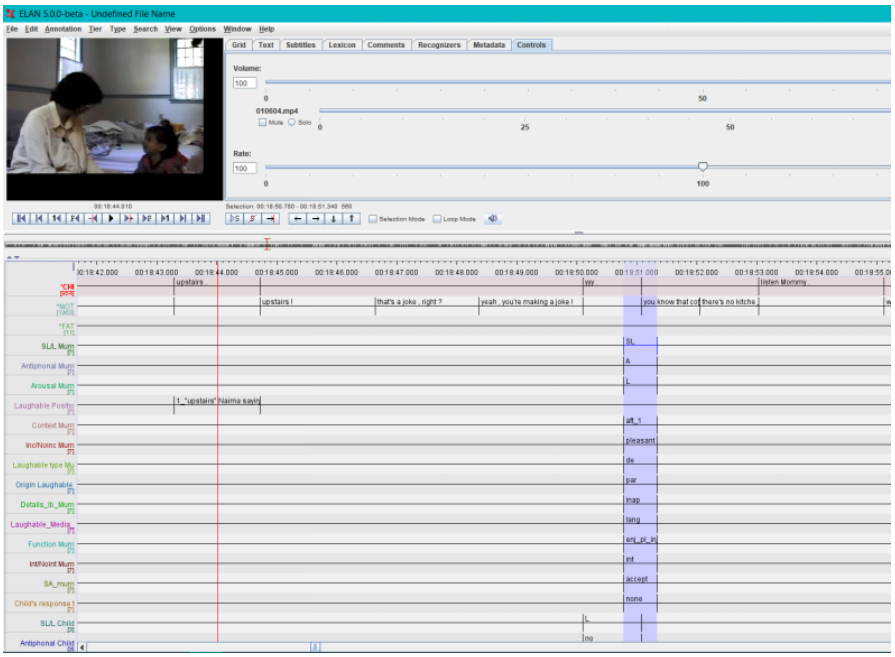


FIGURE 8.4: Screenshot ELAN software for Multimodal annotation

Coding was conducted by the author herself 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 function following the annotation scheme reported in Table 8.2. This constitutes a slightly modified version of the annotation scheme proposed in Chapter 3. Modifications were made in order to capture particularly interesting features specific to mother-infant interaction (e.g. responses to other's laughter). Moreover, additional characterisation of the laughables was inserted. This was motivated by the fact that in development, laughable features appreciated by infants change over time and are indicative of the cognitive and socio-emotional development of the child (see Section 8.2)[7]. The same procedure for laughter annotation was applied both for children and mothers[8].

[7]The no_visible category was included in the classification scheme due to limitations of the videos analysed: the use of a single camera in a familiar environment, where children and mothers were free to move wherever they wanted, often without the presence of a camera operator able to follow their movements, resulted in moments in which the participants are out of shot, or the faces and the objects of attention are not visible to the annotator.

[8]Verifying the inter-annotator agreement on this classification is planned for the near future.

8.7 Results and specific discussions

In what follows I will present the results from the variables observed, following the same scheme adopted in Chapter 3. I will discuss the results in relation to our research questions presented in Section 8.6.1, comparing patterns observed in mothers and children, overall and over time, as well as commenting on mother laughter behaviour in interaction with the child, in comparison to adult-adult behaviour. All the statistical analyses reported in the following sections have been conducted using the statistical software R (Team, 2016).

8.7.1 Information about children's language development

We use the Mean Length of Utterances (MLU) as an indicator of children's language development independent of their age (Brown and Levinson, 1987; De Villiers and De Villiers, 1973), measuring the mean number of morphemes produced for each utterance. This measure has been attested as a good indicator of language development (Brown, 1973; Bernstein, Tiegerman-Farber, and Tiegerman-Farber, 1993) until the age of 36 months (Parker and Brorson, 2005).

Figure 8.5 shows MLU in morphemes for each participant observed in the videos analysed, while in figure 8.6 the averaged MLU for mothers and for children overall is presented. These were computed using the MLU program in CLAN (MacWhinney, 2000), taking into consideration the full duration of the videos used for the laughter analysis (see Table 8.1 for details about the videos analysed)[9]. We see that the children all have typical language development, with Naima standing out for her faster language development.

8.7.2 Laughter Occurrences and Frequency

In order to give an impression of our data overall, in Figure 8.7 I report data from each dyad analysed separately. Each dot represents a laugh, blue for children and red for mothers. In each smaller graph, the y axis indicates the time of the video analysed, divided into 10 windows of 3 minutes.

Given that the videos analysed had a slightly variable duration (see Table 8.1) we decided to compute frequency as rate of laughter over 10 minutes. We report the observed frequency of laughter for each video, means, and standard deviations for children and mothers in Table 8.3. We observe a high variability both in children and in mothers as shown by the error bars in Figure 8.8[10] and as visible in Figure 8.7.

We ran a logistic regression, using the *glm* function from the *lme4* package (Bates et al., 2015a), in order to explore whether time had an effect on the number of laughs produced by children and mothers, treating therefore laughter occurrence as

[9]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.

[10]The particularly large error bars observed both at the first and at the last point represent the effect of two extreme values: William's mother when the child is 12 months old (9.97 laughs over 10 minutes) and Alex at 36 months (11.88 laughs over 10 min).

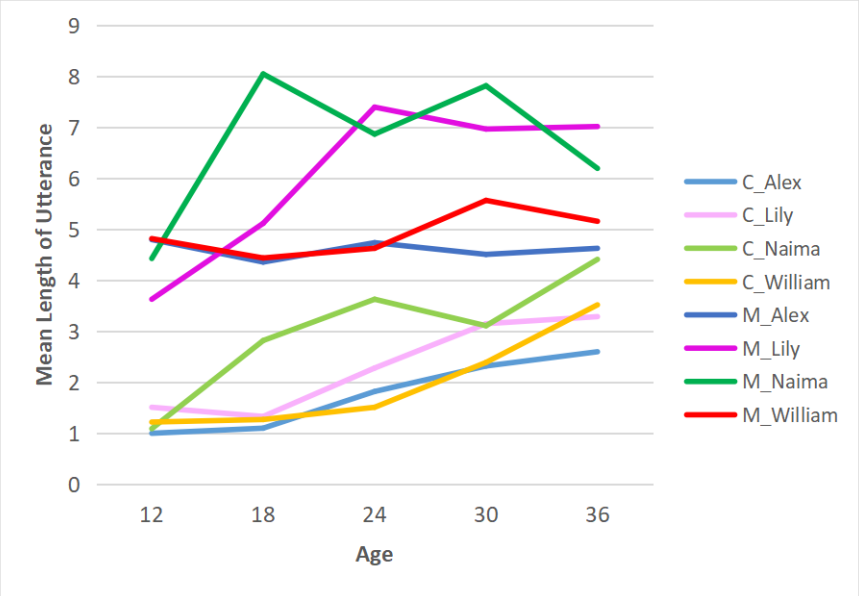


FIGURE 8.5: Mean Length of Utterances (MLU) of children and mothers over time

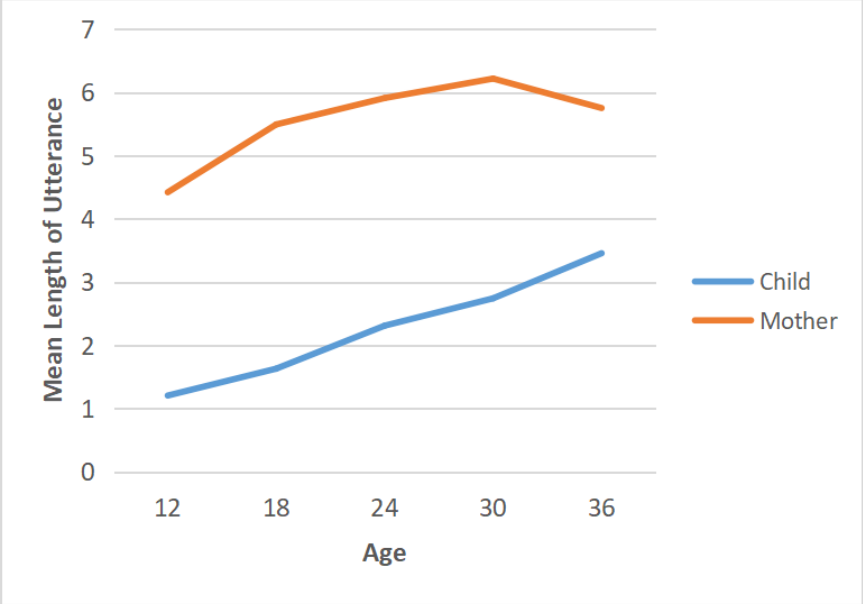


FIGURE 8.6: Mean of MLU for children and mothers over time

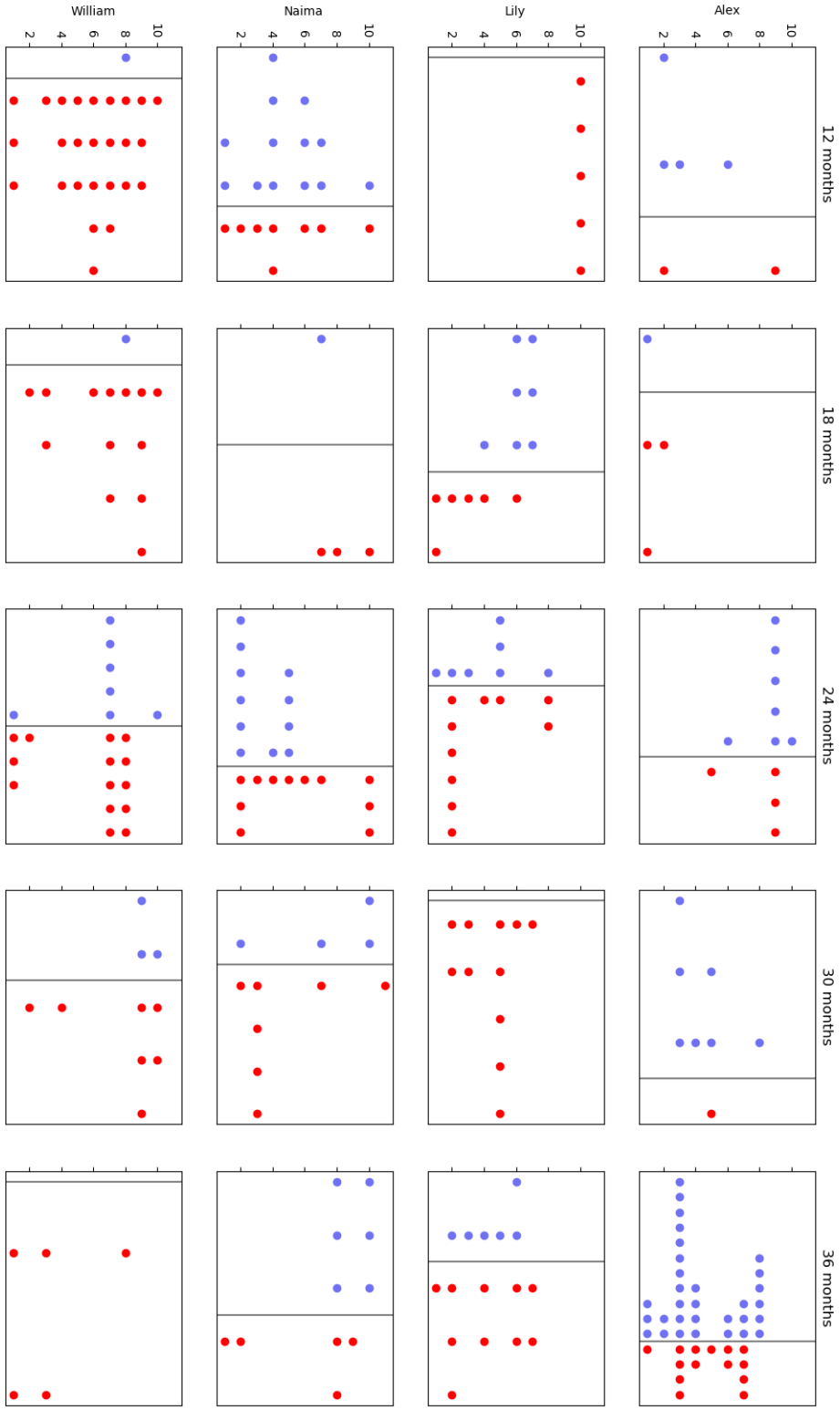


FIGURE 8.7: Individual laughter occurrences over time

Child	**12m**	**18m**	**24m**	**30m**	**36m**	**M**	**sd**
Alex	1,53	0,39	2,58	2,68	11,88	3,81	4,61
Lily	0	2,33	2,49	0	2,27	1,42	1,3
Naima	4,33	0,33	3,67	2,06	1,96	2,47	1,57
William	0,38	0,36	2,33	0,99	0	0,81	0,92
M	1,56	0,85	2,77	1,44	4,03	2,13	1,27
sd	1,96	0,99	0,61	1,18	5,33	2,01	1,92
Mum	**12m**	**18m**	**24m**	**30m**	**36m**	**M**	**sd**
Alex	0,77	1,15	1,48	0,38	5,37	1,83	2,02
Lily	1,64	2	3,56	3,9	3,78	2,98	1,07
Naima	2,67	1	3,67	1,81	1,63	2,15	1,03
William	9,97	4,64	4,66	2,32	2,02	4,72	3,19
M	3,76	2,2	3,34	2,10	3,2	2,92	0,73
sd	4,21	1,69	1,34	1,45	1,72	2,08	1,20

TABLE 8.3: Frequency of laughter over 10 minutes in children and mums

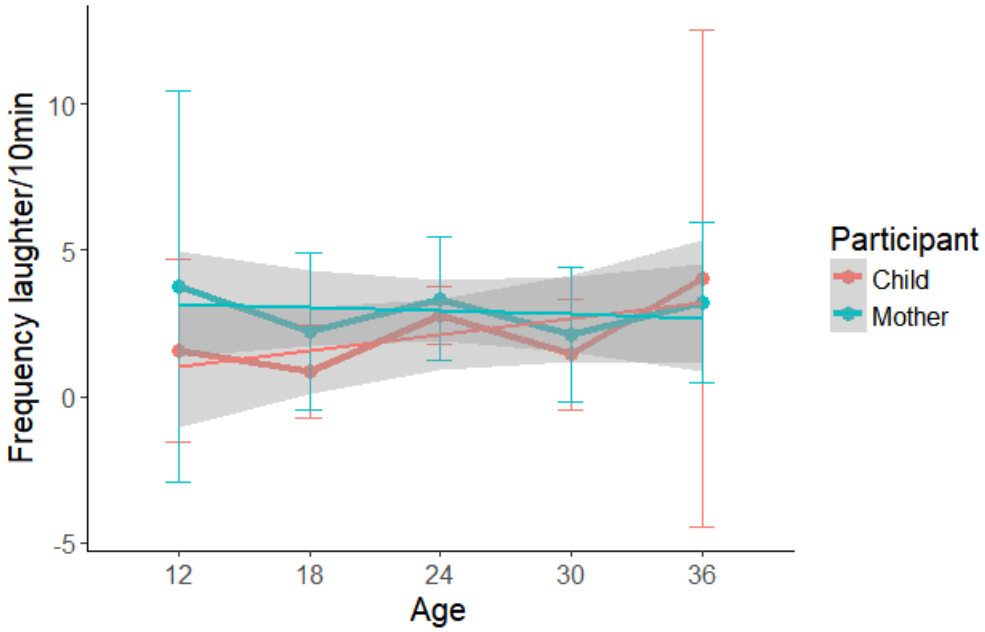


FIGURE 8.8: Frequency of laughter over time

Contrast	Estimate	Std. Error	z value	Pr(>|z|)
(1) 18vs12	-0.27146	0.11739	-2.312	0.020758 *
(2) 24vs(12+18/2)	0.17832	0.05585	3.193	0.001409 **
(3) 30vs(12+18+24/3)	-0.03391	0.04422	-0.767	0.443141
(4) 36vs(12+18+24+30/4)	0.09693	0.02745	3.531	0.000414 ***
MumvsChild	0.42109	0.13024	3.233	0.001224 **
(1):MumvsChild	0.04599	0.23479	0.196	0.844720
(2):MumvsChild	-0.22453	0.11170	-2.010	0.044422 *
(3):MumvsChild	-0.06976	0.08844	-0.789	0.430269
(4):MumvsChild	-0.15702	0.05490	-2.860	0.004237 **

TABLE 8.4: Results of the Logistic Regression with Helmert contrast - In the first part of the table we report the coefficients relative to each factor and contrast singularly, while in the second part we report the interactions between each of the contrasts and participant (Mother vs Child)

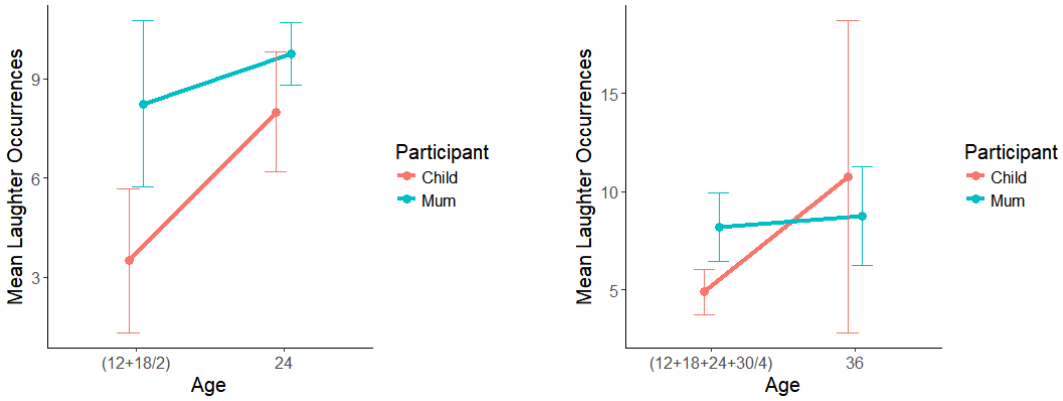
a dichotomous dependent variable for each second of the video analysed (laughter present / laughter not present)[11]. We applied the Helmert contrast which allowed us to compare each time point to the average of the previous ones. The formula is reported in (90), while coefficients are reported in Table 8.4.

(90) (glm(Laughter ∼ Age * Participant, data=data, family=binomial))

We observe a significant difference in the amount of laughter produced by children and mothers overall (MumvsChild: p=.0012), in that mothers are more likely to laugh than their children independently of the time-point analysed; we also see that laughter production undergoes a significant development over time and when comparing the last time point to the average of the previous ones (36vs(12+18+24+30/4)) we observe a significant difference (p<.001). We also observe an interaction of time and participant, particularly significant in the contrasts (2) and (4), with respective p-values of: <.05 and .004. Both interactions indicate that with time, as children get older their laughter productions become as frequent as their mothers'. Figure 8.9a and Figure 8.9b graphically represent the significant interactions observed.

Interestingly, we observe that the frequency of laughs produced by the mother in interaction with her child over 10 minutes (M=2.13, sd=2.01) is much lower than the one observed in adult-adult interaction (Table 8.3): Vettin and Todt (2004) 5.8 (sd=2.5)/10 mins; speed-dating 21(sd=9.28)/5 min (Fuchs and Rathcke, 2018); DUEL French 45/10m, DUEL Chinese 26/10m, BNC 5/10m (Chapter 3).

[11] A mixed-effect logistic model was not a viable option given the limited amount of data available.



(A) Laughter production at 24months in contrast to earlier time-points - (Contrast 2).

(B) Laughter production at 36 months in contrast to earlier time-points - (Contrast 4).

FIGURE 8.9: Number of laughter occurrences in mothers and children over time: each time-point illustrated on the right of the x-axis is compared to all the preceding time-points analysed.

8.7.3 Laughter form

Arousal

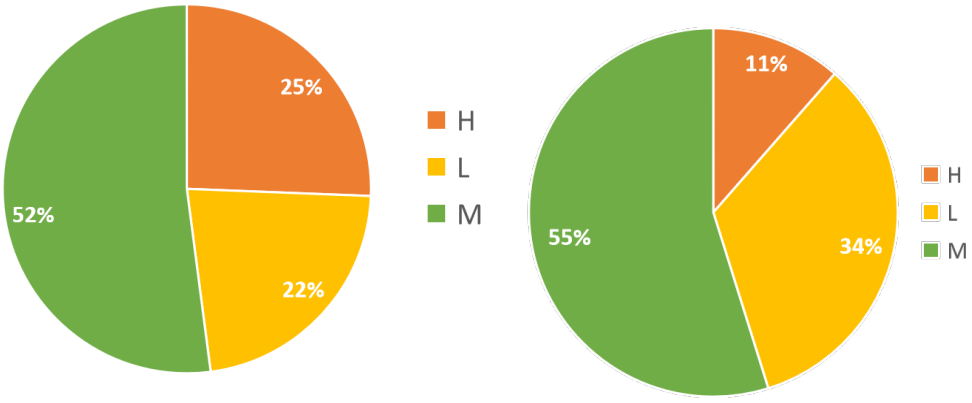
The pie charts 8.10a and 8.10b show the arousal level displayed in laughter over all time points by children and mothers. Children produced significantly more high arousal laughter than their mothers (McNemar's Chi-squared test with continuity correction: McNemar's chi-squared = 72.864, df = 1, p-value < 2.2e-16)[12], while mothers produced significantly more low arousal laughter (McNemar's chi-squared = 23.141, df = 1, p-value = 1.505e-06).

It is interesting to observe that the percentage of high arousal laughter produced by the mothers (11%) is not very different to that reported in natural adult interactions (BNC: 13.15% - see Chapter 3), even though low arousal laughter is more frequent in adult-adult (BNC: 47.06% - cfr. Chapter 3) conversations than in mother-child (34%) interactions. On the other hand, high arousal laughter is much more frequent in children (25%) both compared to mothers (11%) and to adults in general (13.15%).

Duration

We observed a mean laughter duration of 2,31s (sd=1,62) in children and of 1,65 (sd=1,01) in mothers. We then performed a two-tailed ANOVA to investigate whether the difference observed could be attributed to the fact that children produce more high arousal laughter, generally longer in duration. We observe main effects of both arousal $[F(2, 281) = 82.101, p = 2e - 16]$ and Participant (Child or Mother) $[F(1, 281)$

[12]We decided to preform a McNemar's Chi-squared test by reason of being a good non-parametric alternative of the Pearson's Chi-squared test, best suited for small paired samples (2x2 contingency table) compared to the Fisher's Exact Test.



(A) Children. (B) Mothers.

FIGURE 8.10: Percentages of level of arousal displayed in laughter

$= 7.814, p = 0.0055$] on laughter duration, while the interaction between the two factors is not significant. Laughs tend therefore to be longer when the level of arousal increases, and children tend to produce longer laughs than mothers regardless of the level of arousal. We then performed another two-tailed ANOVA to investigate whether the age of the child had an effect on laughter duration in children, but that was found not to be significant.

Discussion: Laughter form

The discrepancy observed in the production of high arousal laughter between mothers and children can be probably justified on the basis of the activities they were involved in, being clearly calibrated for children and for the level of their cognitive development, therefore triggering more enthusiasm in them compared to the adult they were playing with. Regarding laughter duration, we found a higher mean in comparison to Nwokah et al. (1994). Such data might be traced back to the fact that in our corpus children were playing with their mothers in a very familiar environment (their home), where children probably feel more at ease, playful, and free to choose familiar and preferred activities,which are more likely to provoke excitement, compared to the environment in which Nwokah et al. (1994)'s data was collected (i.e. laboratory room, controlled situation, controlled selection of toys, unfamiliar environment and only a short time to get used to it: 10 minutes). We did not find any effect of child age on the duration of laughter in children, which is in line with results from Nwokah et al. (1994), observing increase in duration only during the first year, stabilising around the age of 12 months (around 1 second).

The finding that children produce significantly longer laughter regardless of the level of arousal is interesting when considered together with data about laughter production in aphasic patients. Norris and Drummond (1998) found patients to produce significantly longer laughter compared to their healthy controls. The authors

Children	**12m**	**18m**	**24m**	**30m**	**36m**	**Total**
Laughter	18	10	32	16	34	110
Speech-laughter				2	9	11
Mothers	**12m**	**18m**	**24m**	**30m**	**36m**	**Total**
Laughter	25	12	29	17	25	108
Speech-laughter	16	13	10	9	10	58

TABLE 8.5: Laughter and speech-laughter over time in children and mothers

suggested therefore that when language is impaired, laughter might be a means for patients to prolong their role as speakers in the conversation and contribute meaningfully to the interaction. We can speculate that the same might apply to children. When language is not fully developed, laughter might be an early means, in its already fully available expressiveness, to hold the conversational turn and allow meaningful vocal contribution in interaction at the same level of the interlocutor.

8.7.4 Laughter Positioning

Position in relation to speech

Quite different percentages of speech-laughter over the total laughter produced are observed in children (11; 9%) and mothers (58; 35%) (in Figure 8.11 we report the actual occurrences observed), which result in a significant difference between children and mothers (McNemar's Chi-squared test with continuity correction: McNemar's chi-squared = 77.445, df = 1, p-value < 2.2e-16). While all mothers frequently produce speech-laughter, we observe its use only in two children: in Naima from the age of 30 months and in Alex from the age of 36 months. While in children we obviously see a significant change over time (Fisher's Exact Test: p-value = 0.008714), we do not observe any significant change in the production of speech-laughter over time in mothers (Fisher's Exact Test: p-value = 0.2404). This suggests that for the production of speech-laughter there is a need for quite advanced language abilities, as a matter either of vocal control and coordination, or of the development of laughter's pragmatic use to shape verbal contributions.

In line with Nwokah et al. (1994) we found speech-laughter to occur both on content and on function words. In (91) we report an example of speech-laughter from the mother, while in (92) one of the first examples of speech-laughter produced by a child.

(91) Example from the Providence Corpus - William 010412 - Mother speech-laughter
Mum: who's hiding in the honeycomb ?
Mum: huh , what's that ?
Child: a zee.

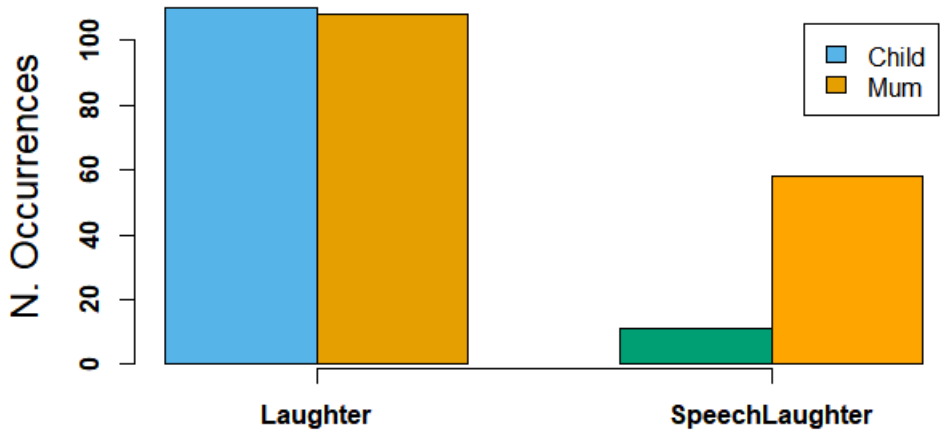


FIGURE 8.11: Laughter and speech-laughter occurrences in children and mothers

Mum: < laughter > bee! < /laughter >, that's right!
Mum: zzzzz a bee. < laughter/ >
Mum: < laughter > (a)n(d) who is hiding among the flowers ? < laughter/ >

(92) Example from Providence Corpus - Alex 020606 - Child speech-laughter
Child: < laughter >Upside< /laughter >
Mum: What's that?
Child: That's ...
Mum: An apple!
Child: < laughter >Apple< /laughter >
Mum: An apple
Child: < laughter >An apple< /laughter >
Mum: How about...

Looking at the dialogue acts the speech-laughter was used to accompany/perform, we found speech-laughter to be more likely in statements than in questions or exclamations (as reported also in Nwokah et al. (1999)), but especially we found speech-laughter to be more frequent than isolated laughter in the case of hedging and encouraging (data about laughter dialogue acts are reported in Appendix D). We found speech-laughter to be more frequent than isolated laughter when the laughable constituted a social incongruity both in mothers and in children (McNemar's chi-squared = 16.488, df = 1, p-value = 4.896e-05), similar to what we found in adult corpora (e.g. BNC: McNemar's chi-squared = 4.4024, df = 1, p-value = 0.03589). Interestingly the percentage of speech-laughter in mothers (35%) is not that different from

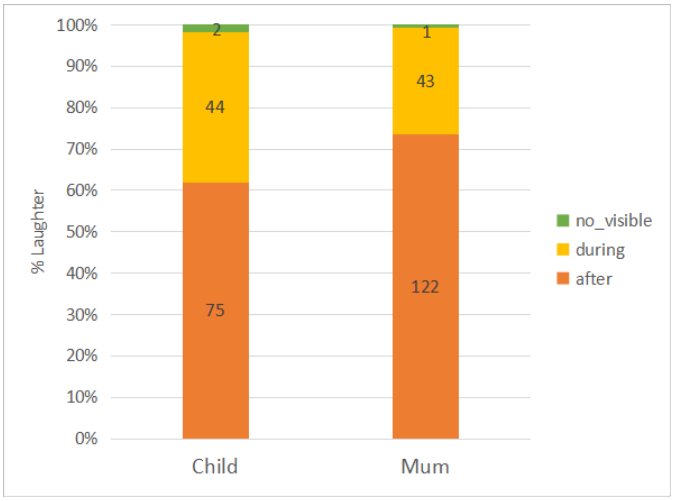


FIGURE 8.12: Position of laughter in relation to the laughable

the one reported in adult dyadic conversation (DUEL French: 31%, DUEL Chinese: 47%, BNC: 30%, see Chapter 3). The overall percentage we observed is notably higher than the mean of speech-laughter observed in mothers as reported in Nwokah et al. (1999): 18.6%, even though they also found a very high variability ranging from 5.1 to 50.2%.

Positioning in relation to laughable

Percentages of positioning of laughter in relation to the laughable (before, during and after) are shown in Figure 8.12. In (91) we have an example of laughter occurring after the laughable, while (93) provides an example of laughter occurring during the laughable.

(93) *Example from Providence Corpus - William 020012* - Laughter during laughable
Child: We go up and down!
Mum: We go up and down?
Child: Yeah
Mum: Yeah
Child: Up...
Mum: and down
Child: Down
Mum: Up and down
Child: < laughter/ >
Mum: < laughter/ >

Surprisingly, no cataphoric laughter, i.e. laughter produced before the laughable, was observed in either children or mothers. Even if with lower frequency compared to other positions (i.e. after and during), cataphoric laughter was observed in our other corpus studies of adult interaction in all corpora regardless of language (DUEL

French 2.67%; DUEL Chinese 7%; BNC: 5.54% - see Chapter 3 for more details). To explain this piece of data, we can tentatively suggest that cataphoric laughter may require more complex pragmatic abilities in order to resolve the argument, and that mothers instinctively do not use it with their very young children. Despite the obvious need for more research on the topic, we can at least speculate that this could be one of the modifications adults adopt when speaking to language-beginner listeners, i.e. Child Directed Speech (Ratner, 2013; Soderstrom, 2007). It may be one of the fine-tuning adjustments to the child's perceived comprehension abilities (Snow, 2017; Snow, 1989; Sokolov, 1993) – in this case, possibly of a syntactic and pragmatic type.

8.7.5 Sequential laughter pattern and response to other's laughter

Dyadic Laughter

Since we had only 3 instances of coactive laughter, we decided to collapse antiphonal and coactive laughter into the same class: dyadic laughter. We observe an overall significant difference in the production of dyadic laughter in mothers (31 dyadic laughs over a total of 166 laughs, 19%) and children (14 dyadic laughs over a total of 121 laughs, 12%) (McNemar's Chi-squared test with continuity correction: McNemar's chi-squared = 40.761, df = 1, p-value = 1.72e-10). In (94), (95). (96) and (97) we report different examples of antiphonal laughter from the mother. Interesting in the example (97) is the particularly posed laughter production from the mother.

(94) Example from Providence Corpus - Naima 010014 - Mother Antiphonal laughter
Mum: I'm gonna lie down here . is that okay with you ?
Child: yyy .
Mum: ah , lying down .
Child: down .
Child:< laughter/ >
Mum: < laughter/ >

(95) Example from Providence Corpus - Naima 010014 - Mother Antiphonal laughter
Mum: ring around the rosies .
Mum: a pocket full of posies .
Mum: ashes , ashes .
Mum: we all go down .
Child: < laughter/ >
Mum: < laughter/ >

(96) *Example from Providence Corpus - William 020012* - Mother Antiphonal laughter
Child: We go up and down!

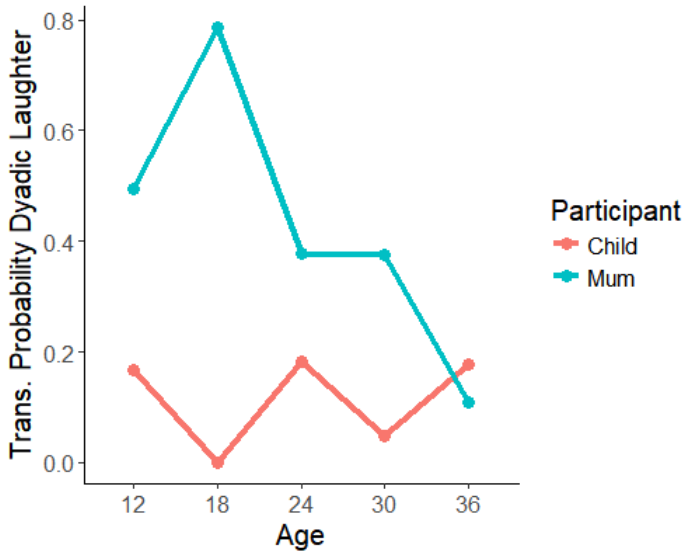


FIGURE 8.13: Dyadic laughter over time for children and mothers: Transitional probability.

Mum: We go up and down?
Child: Yeah
Mum: Yeah
Child: Up...
Mum: and down
Child: Down
Mum: Up and down
Child: < laughter/ >
Mum: < laughter/ >

(97) Example from Providence Corpus - William 010605 - Mother Antiphonal laughter
Mum: now everybody was beautiful .
Child: < laughter/ >
Mum: < laughter/ >

Because at some time-points children laughed much less than mothers, we thought that a more reliable measure of the production of dyadic laughter would be the transitional probability, the probability of dyadic laughter occurring from one participant over the total of the laughs produced by her partner (i.e. the amount of dyadic laughter of child X over the total of laughter produced by X's mother – and vice-versa).This transitional probability is overall higher in mothers (41%) than in children (9%) (McNemar's chi-squared with continuity correction = 17.905, df = 1, p-value = 2.322e-05) - Figure 8.13.

In order to explore whether a developmental trend in dyadic laughter behaviour could be observed, both in children and mothers, we divided our time-points of

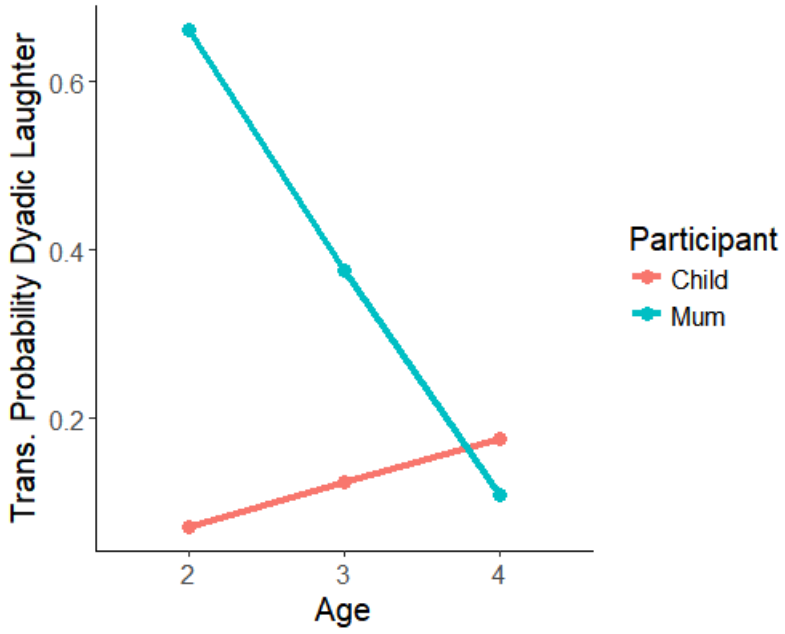


FIGURE 8.14: Trajectory of transitional probability of dyadic laughter over three time windows (second year, third year and beginning fourth year) for children and mothers

interest (12, 18, 24, 30, 36 months) into 3 periods: 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. The patterns observed over the three time-windows are shown in Graph 8.14. We conducted a Wilcoxon test at each of the 3 time-windows comparing mothers' and children's transitional probability of laughing in response to the partner's laughter. Results show a significant difference in the window relative to the second year (W = 3, p-value = 0.004703), which disappears in the third year (W = 16, p-value = 0.2953) and the fourth year (W = 4.5, p-value = 1). This is also visible in more detail in graph 8.13, where at the last time point children and mothers come to very similar values, respectively 13.2% and 10.9%. While in children we do not observe a significant difference in the transitional probability of laughing antiphonally in response to the mother over time, we see a marked decrease in the production of antiphonal laughter from the mothers (Figure 8.13), even though the statistical analysis did not show a significant difference (W = 19, p-value = 0.059).

For mothers, the overall transitional probability of producing laughter in response to the child's laugh is not so different from that observed in very cooperative adult corpora (Chapter 3): DUEL French 42.18% (sd 15.07) and DUEL Chinese 42.13% (sd 17.47). By contrast, when looking exclusively at the percentage of dyadic laughter over the total, we observe much lower rates in mothers (18.67%), compared to adults generally (Duel Fr: 39%, Duel Ch: 37%, BNC: 26%). It is important to note that raw percentages are affected by the fact that children, especially in certain videos used,

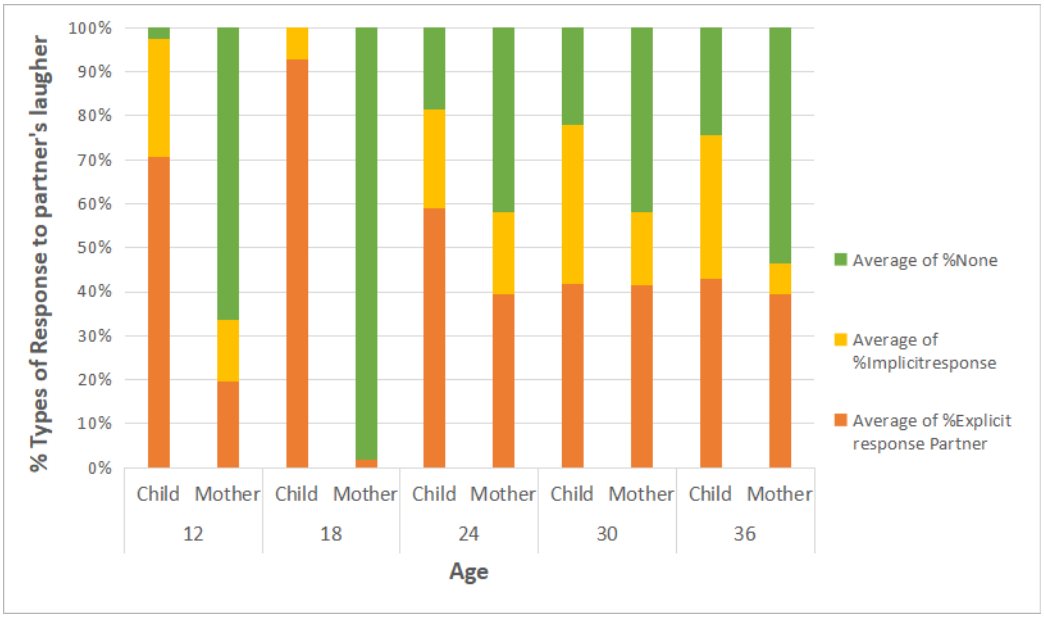


FIGURE 8.15: Types of responses to laughter from the partner over time: Transitional probabilities.

laugh far less than adults, offering therefore fewer opportunities for the mothers to laugh antiphonally.

Response to partner's laughter

We then observed the reactions to other's laughter productions, not only when they were constituted by laughter (Section 8.7.5), but also when they were constituted by other positive expressions (e.g. smile, exclamation) or by a clear orienting reaction (e.g. look). Interactants have indeed many ways to attune affectively (Stern, 1985), i.e. share the positive affect communicated by the laughter in a non-similar way (Nwokah et al. (1994) called these kind of situations *bimodal laughter situation*). On the basis of Reddy, Williams, and Vaughan (2002)'s study in particular, where they observed significantly lower reactions in terms of laughing back, smiling back and orienting to others' laughter in the ASD population in comparison to children with Down Syndrome (Section 8.4), we wanted to explore the development of these reactions in typically developing children from 12 to 36 months. In Figure 8.15 we report raw percentages of the three types of responses annotated.

Transitional probability was used to analyse explicit responses to the partner's laughter, on the grounds that it would be a more informative measure in this case than raw percentages, as it was in the analysis of dyadic laughter production. The calculations and the statistical analysis performed are very similar to the one conducted for dyadic laughter. The transitional probability of an explicit response to the partner's laughter (i.e. a smile, laugh, look, exclamation) is calculated by dividing the number of the responder's explicit responses by the number of possible response opportunities (i.e. the total number of laughs by the partner, minus the number of

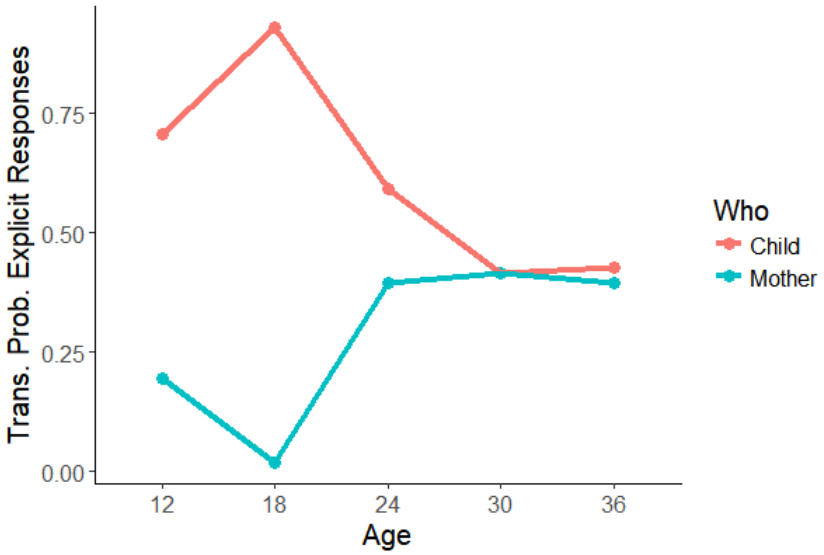


FIGURE 8.16: Explicit responses to laughter from the partner over time: Transitional probabilities.

cases in which the responder's reaction was not visible or was unclear)[13]. The other two categories were "implicit response" and "no response". The label "implicit" was used to classify all of the occasions in which the partner simply continued her activity/behaviour, e.g. child is singing and looking at the mother, the mother laughs, and the child continues singing and looking at the mother. In this case the gaze towards the mother cannot be considered as an orienting reaction to the mother's laughter, as it was already present. The idea of coding this particular class, as opposed to collapsing everything into the "no response" class, is based on observations from Nwokah et al. (1994), where laughter is considered as a reinforcer, encouraging the partner to repeat or keep engaging with the current behaviour.

In Figure 8.16 we observe clear changes over time both in children's and mothers' behaviour. Blue indicates the explicit responses produced by the mother in response to the child's laughter, while red indicates the children's explicit response to mothers' laughs. We see children's and mothers' responses to each other's laughter to be very different at the first time-point analysed (mothers much higher than children); values then get closer around the age of 24 months, and then come to almost identical values at the last 2 time points (Mother: 30 months 41.6% and 36 months 42.8%; Child: 30 months 41.5 and 36 months 39.5%). In order to conduct statistical tests, we divided the period of time analysed in 3 windows: 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 children's development. We

[13] e.g.

$$\text{trans. prob. of explicit response by child} = \frac{\#\text{explicit child responses}}{\#\text{laughs by mother} - \#\text{child response unclear or not visible}}$$

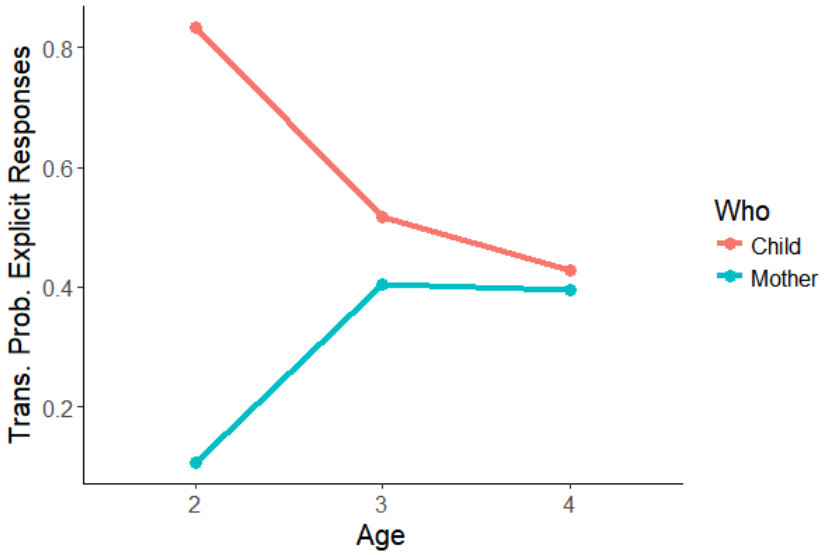


FIGURE 8.17: Percentages explicit responses from the partner

conducted Wilcoxon rank sum test to compare child and mother explicit responses to the partner's laughter within each window. We observe an important significant difference between mother and child during the second year (12 and 18 months) (W = 57.5, p-value = 0.007199), which then disappears during the third (W = 30.5, p-value = 0.9155) and the beginning of the fourth year (W = 8, p-value = 1). The trajectory is presented in Figure 8.17.

More specifically, in mothers we see a significant change from the second and the third year (W = 9, p-value = 0.01729), which is absent between the third and the beginning of the fourth (W = 15, p-value = 0.9333); overall then, when comparing the first window (12-18 months) with the last one (36 months) the change in transitional probability of explicit responses to the child's laughter is significant (W = 3, p-value = 0.03068). In children, on the other hand, the comparison between the second and the third year is not significant, and we see a significant change in the transitional probability of explicit response to the mothers' laughter only when comparing the second year to the beginning of the fourth (W = 28, p-value = 0.04599).

Discussion: Sequential laughter pattern and response to other's laughter

We observed higher transitional probabilities of dyadic laughter from the mothers, especially at the earliest time-points observed. A similar pattern is also observed more generally for the transitional probability of all explicit responses to children's laughter from mothers. This is in line with results from Cohn and Tronick (1987), who found that up until the age of 6 months it was generally the mother who first became positive, while from the 9th month of age the opposite was true, with children becoming positive before their mothers.

This could be explained by the fact that the child is the focus of the mother's attention, and she takes advantage of any occasion to engage positively with him/her and to react to their positive expressions. Mothers' response to children's laughter is particularly interesting when considered in the frame of maternal responsivity and contingency. Maternal responsiveness, both to vocalisations and to play, has been found to predict the timing of achievement of basic language milestones (Tamis-LeMonda, Bornstein, and Baumwell, 2001). Response to children's prelinguistic vocalisations is indeed a significant opportunity for mothers to establish the first experiences of mutual engagement with their children (Hoff, 2006). The production of dyadic laughter from the mother especially, may also be related to the fact that children in general prefer adults that imitate them (Meltzoff, 1990), and instinctively the mothers may align to child behaviour. Imitation, after all, could be considered one of the most sincere forms of flattery (for children and adults alike) (Lakin et al., 2003).

It is interesting to observe the differences in mother dyadic laughter behaviour and response to child laughter over time. While at the first time points of our observations mothers tend to laugh antiphonally (Figure 8.13) and respond explicitly to child laughter (Figure 8.16) very frequently, the more the child grows the less they do so.

This can be explained by the fact that by the age of two the child's language and social competences are much higher and more functional than before. Children have therefore new means to engage in mutual interaction, besides laughter, and the mother in turn has many more occasions to engage in mutual and balanced interaction with the child. Over time, mothers might therefore have a decrease in the urge to respond to every instance of laughter. The fact that the child does not orient towards the mother's laughter around 12 months of age can also be explained on the basis of attentional capacities at that stage: when the child is focused on an activity or object, she is not yet able to easily redirect her attention to an intervention or to other stimuli (Buckley, 2012). Moreover, over time it becomes more frequent for children to engage in provocative behaviour and to tease the parent, who responds with a (real or pretended) serious attitude (see Section 8.7.10 and Nwokah et al. (1994)), while during the second year of life (12-18 months) the contrary is more frequent, i.e. the mother laughing while the child is in an incongruent mood (e.g. the baby is crying, has mispronounced something or has made a clumsy movement, but doesn't join in the mother's response and remains self-absorbed etc.).The increase in explicit responses from the child is in line with the finding reported by Thompson (1991) of infants responding significantly more quickly to emotional elicitors with increasing age, showing more interest in others' reactions and more engagement in interaction. It is also consistent with comments reported in Nwokah et al. (1994) where laughter was observed to be particularly effective in the process of re-establishing attention from the child, particularly from the age of 24 months, and especially when visual attention was not possible, in this way therefore also functioning as an attention-getting device

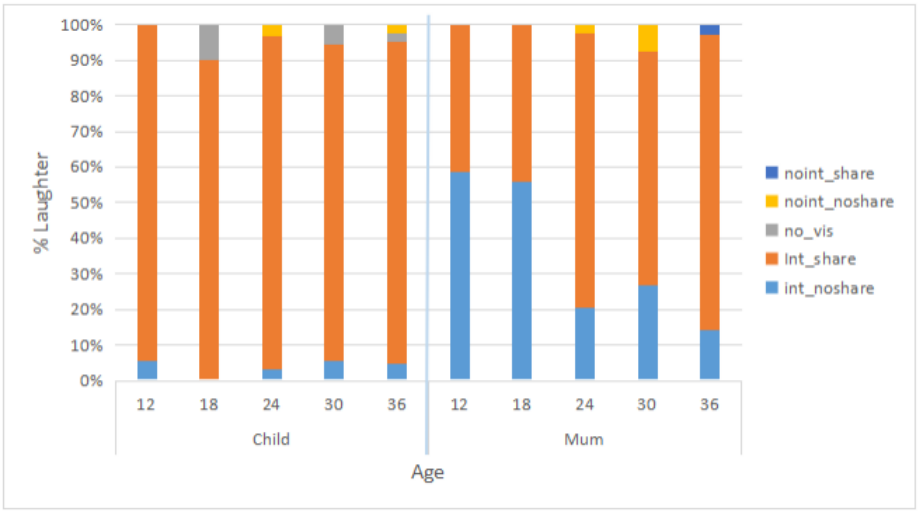


FIGURE 8.18: Interaction and shared attention on the laughable

(Stevenson et al., 1986). Similar increases in response to other's laughter have also been reported in primates (during development, chimpanzees replicate laughter more often (Davila-Ross et al., 2011) and orangutang juveniles show more rapid facial mimicry of their playmates than infants (Davila Ross, Menzler, and Zimmermann, 2007)).

At the last two time-points (30 and 36 months) we see much more balanced reactions to each others' laughter, both in terms of explicit responses generally and in terms of antiphonal laughter, signalling the child's increasing awareness and interest in others' non-verbal expressions and mental states, and the progressive establishment of more balanced dynamics in interaction.

8.7.6 Interaction and shared attention on the laughable

Tightly linked to the observations about response to the partner's laughter are the observations regarding laughter occurrence in the context of interaction and shared attention on the laughable with the partner (Figure 8.18). The occurrence of child laughter almost exclusively in the context of interaction and shared attention can be explained by assuming that the children are the main focus of the mothers' attention. Mothers tend to follow the child's focus of attention as much as possible and try to exploit it as a means to establish joint attention and interaction. Engaging in moments of joint attention is indeed extremely important for the communicative development of the child. The strategy used by mothers to follow the child's attention in order to engage in interaction, and thus provide linguistic input, is associated with more rapid language development (Akhtar, Dunham, and Dunham, 1991; Harris et al., 1986; Tomasello and Farrar, 1986; Carpenter et al., 1998).

On the other hand, the decrease in mother laughter occurring in interaction without shared attention (cases that in Del Ré, Dodane, and Morgenstern (2014)

would be named "humour non partagé", i.e. unshared humour) reflects the fact that over time the child becomes more interested in participation, and more and more able to redirect her attention in response to the mother's expressions and cues for attention. At the same time the child also becomes more and more able to identify and appreciate the laughables the mother's laughter is related to.

8.7.7 Laughable features

Origin of laughable

In Figure 8.19, we observe a higher percentage of laughter related to external stimuli (98) and to laughables produced by themselves in children compared to mothers, while mothers have a significantly higher proportion of laughterrelated to laughables produced by their children (*partner* in the graph legend). In example (98) it is interesting to observe the phase of accommodation before the laughter is produced: the child laughs only when he has grasped how the toy works.

(98) Example from Providence Corpus - William 010412 External laughable
Child: mamy
Mum: yeah ?
Mum: whoop .
Mum: what's this ? what's that ?
Child: yyy .
Mum: squeezing it ?
Mum: squeeze it again.
Mum: oh good job .
Mum: try again .
Mum: try again .
Mum: here push it right there , push it right in the middle .
Mum: you gotta squeeze it quick , xxx .
Child: < laughter/ >
Mum: oh , gentle .
Mum: gentle .
Mum: okay .

It is interesting to observe the changing patterns over time both in children and mothers (Figure 8.20). While we see a higher percentage of external laughables in children at all time points, we nevertheless see a decrease over time. In mothers on the other hand, we see a higher percentage of laughables produced by themselves at the last time point. At the age of 36 months we can observe much more similar percentages in the origin of laughables for child and mother.

When comparing the data collected from the child-mother interaction and data from adult-adult interaction (presented in Chapter 3), in mothers we observe a much higher percentage of laughables produced by the partner (77.71%) compared to that

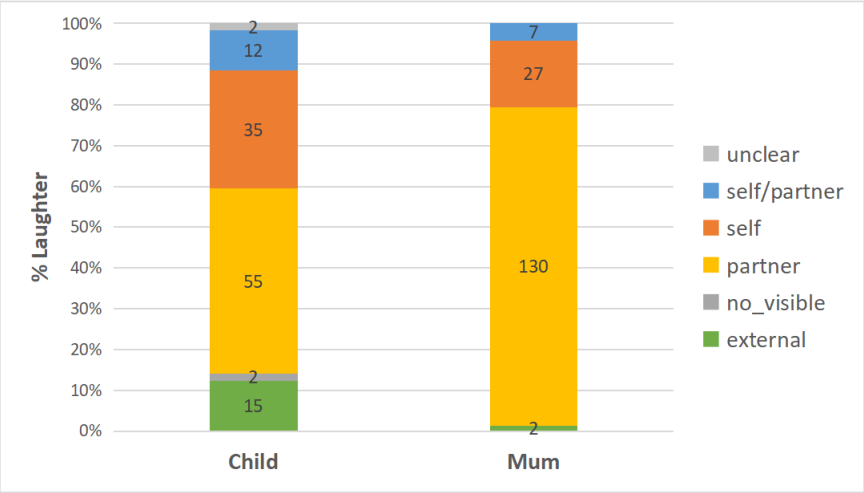


FIGURE 8.19: Origin of laughables over time in children and mothers

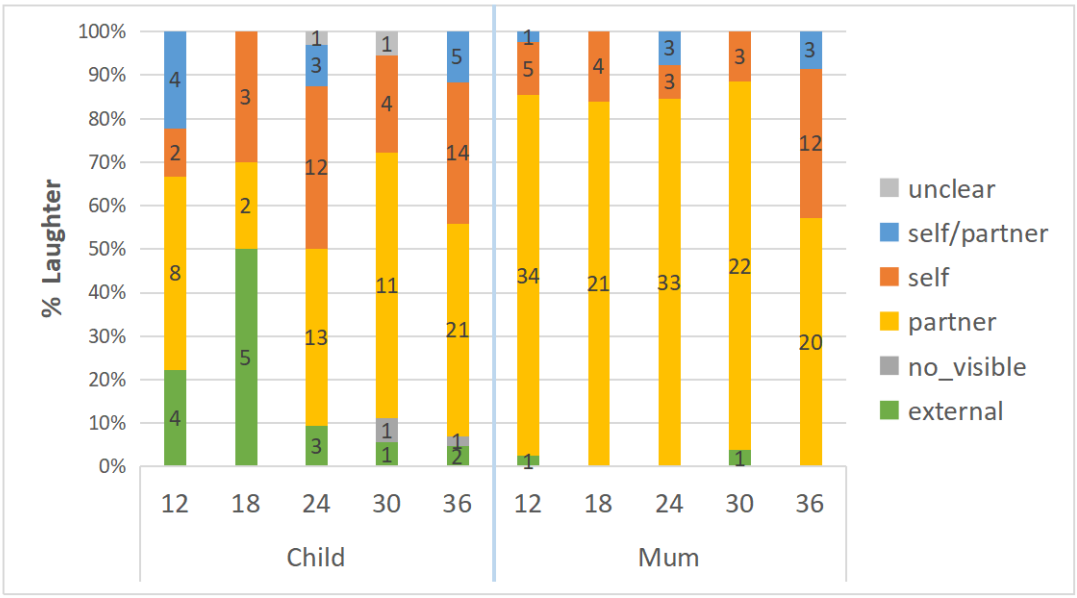


FIGURE 8.20: Origin of laughables over time for children and mothers

observed in adult-adult interaction (DUEL French: 34%, DUEL Chinese: 34%, BNC: 52%), while the percentages of exophoric laughables are similar (1.2% in mothers with the child, 1% in adult-adult conversation). On the other hand, we observe much lower percentages of laughables produced by the mother herself compared to the percentage for adults in adult-adult interaction: mothers 16.27%, DUEL French: 57%, DUEL Chinese 57%, BNC 46% (to allow for easier comparison, in Table 8.6 we report occurrences and percentages from the adult corpora presented in Chapter 2).

TABLE 8.6: Origin of laughables in adults, mothers in interaction with their children, and children

Laughable origin	DUEL Fr	DUEL Ch	BNC	Mothers	Children
Self	320 (57%)	125 (57%)	134 (46%)	27 (16%)	35 (29%)
Par	193 (34%)	76 (34%)	152 (52%)	130 (78%)	53 (44%)
Collab	13 (2%)	5 (2%)	0 (0%)	7(4%)	14(12%)
External	36 (7%)	15 (7%)	3 (1%)	2(1%)	15(12%)
Unclear/No_vis	-	-	-	0 (0%)	4(3%)

Type of Laughable

In Figure 8.21 we can observe how at the first time point (12 months) almost the totality of the laughter produced by children is related to exhophoric laughables (e.g. toys, books, noises) (98), with a small percentage of laughter related to non-verbal laughables (e.g. funny noises produced by the mother) (as in (99)). Over time though, we can observe a progressive increase in the appreciation of laughables which reside in the denotation of utterances produced in the interaction. In addition, at age 30 months we see the first laughter related to the incongruity of a dialogue act, and at age 36 months we see the first laughter related to a metalinguistic laughable.

(99) Example from Providence Corpus - Naima 010014 - Non-verbal laughable
Mum: and there's a hen .
Mum: a hen says ...
Mum: bocko
Child: < laughter/ >
Mum: bocko , bocko bocko bocko
Mum: a hen says bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko bocko
Child: < laughter/ >
Mum: that's what a hen says .
Mum: and here's a duck .

Discussion: Laughable Features

Our data shows that mother laughter is predominantly related to laughables produced by the child. This pattern fits quite well with the dynamics generally observed

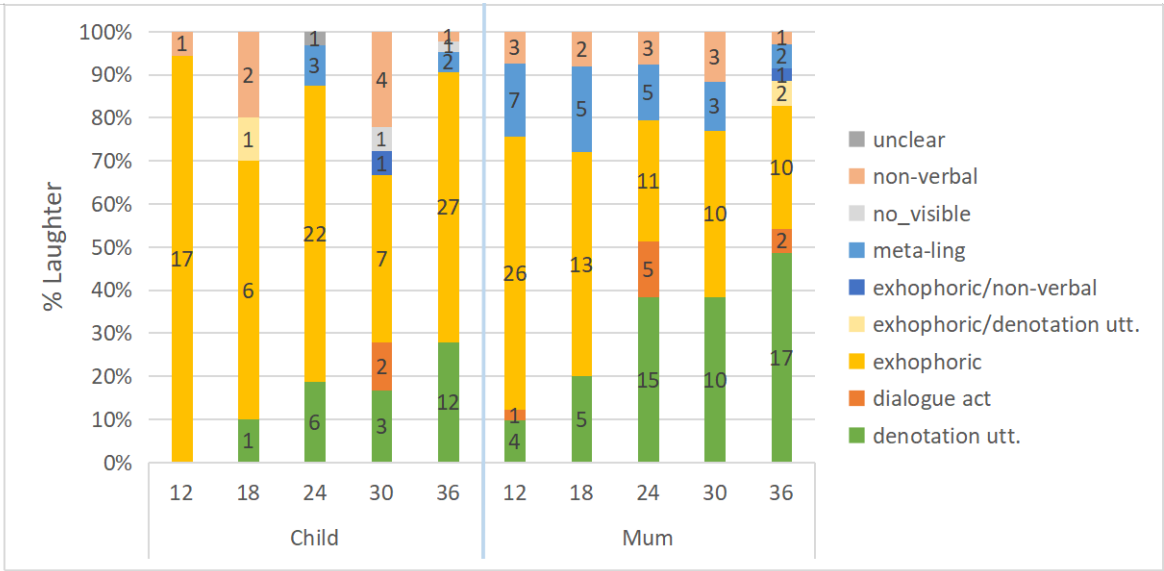


FIGURE 8.21: Types of laughables over time for children and mothers

in western middle-class mothers' interaction with their infants (Hoff, 2006), where mothers tend to continuously follow the child's attentional focus. For the mothers, the infant is clearly the primary focus of attention, and the infant's behaviours often constitute laughables for the mothers (Nwokah and Fogel, 1993). On the other end, this is not true for the child, for whom the focus of attention is anything interesting that happens around him, data that can also explain the higher percentage of exophoric laughables observed in children. Moreover, generally western middle-class mothers explicitly direct the child's attention toward objects, external targets and images in books (Hoff, 2006).This easily explains the differences in the percentages of laughs related to external and partner-produced laughables in mothers and children. This pattern is also reflected in the amount of laughter related to exophoric laughables as opposed to laughables channelled by an utterance denotation, the incongruity of a dialogue act, or a meta-linguistic incongruity (Figure 8.21).

The observation of lower percentages of laughables constituted by the denotation of utterances, by the incongruity of a dialogue act or by some metalinguistic event (Figure 8.21) is also explainable by the fact that at the first time-points analysed the child may lack the cognitive and linguistic competences to grasp these potential laughables. We indeed see a progressive increase in these types, indicating that over time there is an increasing interest and appreciation of linguistic material (and the incongruities they can give rise to) and an integration of pragmatic and linguistic rules. In parallel, in mothers there is a progressive reduction of laughter related to exophoric laughables over time and an increase in laughter related to the denotation of utterances. 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. This piece of data is particularly interesting when analysed 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). It might be that children opt for these kind of strategies especially because from the very first word those actions have been highly successful in eliciting laughter from the care-giver. Two examples are provided in extract (100) and (101).

(100) *Example from Providence Corpus (Demuth, Culbertson, and Alter, 2006) - Naima 010604-* Meta-linguistic laughable

Mum: Did you help Daddy make the coffee ?
Mum: Where did you make the coffee?
Child: Tea.
Mum: Tea? there was no tea !
Mum: did you make the coffee in the bathroom ?
Mum: no! Where did you make the coffee ?
Mum: where did you make the coffee this morning?
Child: < smiling >upstairs.
Mum: upstairs !?
Mum: that's a joke , right ?
Child: < laughter/ >
Mum: < laughter >yeah< /laughter >, you're making a joke !
Mum: you know that coffee +...
Mum: there's no kitchen upstairs !
Child: listen Mommy .
Mum: what ?
Child: nursie Daddy .
Mum: nursie Daddy , that's another joke !
Mum: you're being funny now , oh , no , we do not draw on clothes .

(101) *Example from Providence Corpus (Demuth, Culbertson, and Alter, 2006) - Naima 010604* - Meta-linguistic laughable

Mum: what is Daddy's name ?
Child: yyy Daddy .
Mum: and what is Dadaji's name ?
Child: xxx !
Child: and what is Babaji's name ?
Child: yyy .
Mum: xxx , right .
Mum: and what is Great Grandma's name ?
Child: Turtle .
Child: Myrtle .
Mum: Myrtle , right .

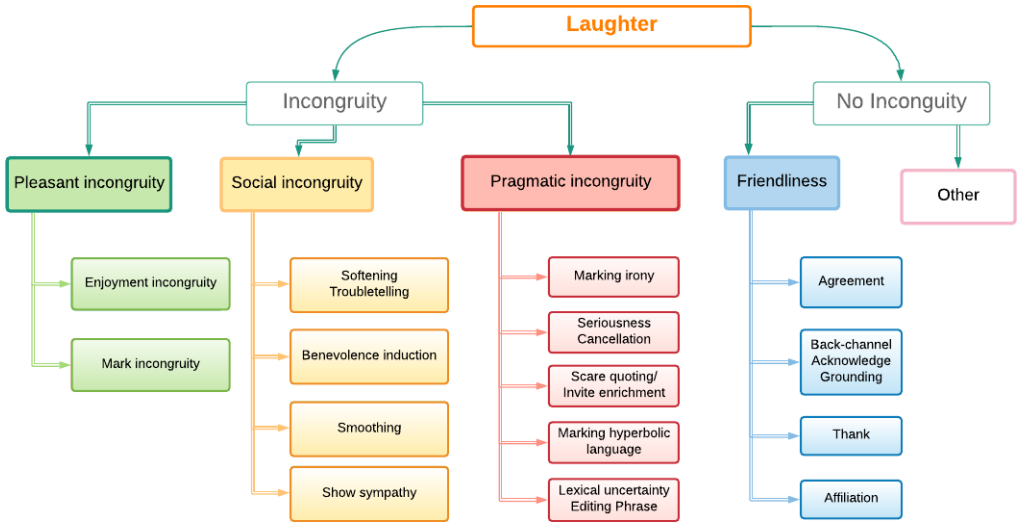
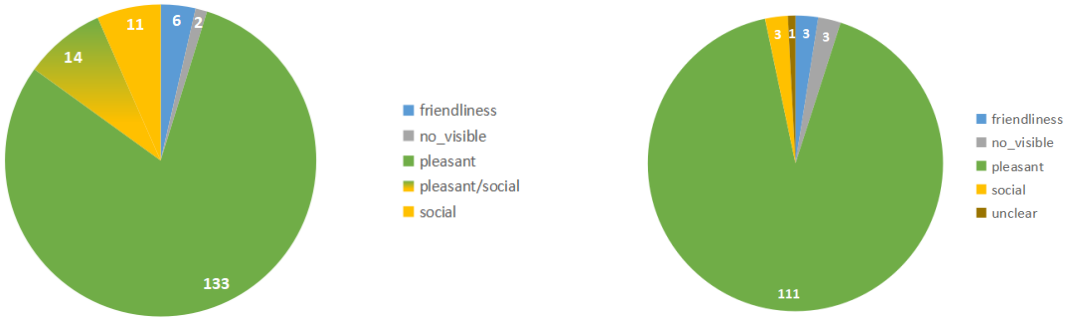


FIGURE 8.22: Laughter functions classification. (Binary Decision Tree to guide classification is presented in Figure 2.1 in Chapter 3)



(A) Mothers (B) Children

FIGURE 8.23: Type of incongruities in laughables

Child: Myrtle the turtle .

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

8.7.8 Incongruity in the laughable and laughter functions

Type of Incongruity

Figure 8.22 represents a simplified version of the binary decision tree presented in Chapter 2, as a helpful reminder of the structure of the taxonomy of laughables and laughter functions. The vast majority of laughter relates to *pleasant incongruity* both in children (92%) and mothers (79%), while *social incongruity* constitutes a laughable in 7% of the cases in mothers and 2% in children (Figure 8.23a and 8.23b).

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. These were the cases where the mother was laughing at her baby having disproportionate negative reactions (103) and desperately crying at small events, or the baby making a mistake, a clumsy movement or mispronouncing a word (whether the mother added a successive correction or not).At first we marked these cases as borderline pleasant/social, being unable to decide between the two. 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/attempts, 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 (8%) and was equally present in all mothers, and that as a result it should probably constitute a class in itself, seeming to be characteristic of mother-child interaction.

In (103) we have an example of a laughter produced by the mother which we classified as social incongruity. The mother is indeed reproaching the child for his disproportionate negative reaction, and the laugh softens her request to stop behaving loudly and being naughty. Her laughter proves to be very successful in helping the child regulate, and (maybe realising he was being funnily distressed) he even joins the mother's laughter.

(102) Example from Providence Corpus - Alex 020606 - Pleasant incongruity

Mum: what , shoes on his head ?
Mum: no: , that's silly!
Child: < laughter/ >.
Mum: then he can do a flip.
Mum: ooo boop ! (making sound of potato head flipping .)
Child: on ‹his (.)› head .
Mum: he stands on his head .
Child: on yyy his hat .
Mum: tuuuu . (sounds of potato head flipping .) Child: < laughter/ >
Mum: he's so silly .
Child: I want the head .

(103) *Example extracted from the Providence Corpus (Demuth, Culbertson, and Alter, 2006) - Alex 030103* - Social incongruity

Child: yyy try this .
Child: no this one !
Mum: alright could I use the pen ?
Child: nope [no] . Nooo! [screaming]
Mum: < laughter > stop it < /laughter > .
Child:< laughter/ >
Mum: stop that screaming .

Mum: stop that screaming !
Child: xxx try this .

(104) Example from Providence Corpus - William 010412 - Pleasant/Social Incongruity

Mum: what's that ?
Child: yyy .
Mum: nose.
Mum: where's your nose ?
Child: eye !
Mum: < laughter/ >< laughter > that's your nose , this is your eye. < /laughter >
< laughter/ >
Mum: you're funny .

(105) Example from Providence Corpus - Naima 020004 - Friendliness-Feedback

Mum: he's talking to his sister whose name is DW .
Mum: she has a helmet in her hands .
Mum: I'm a little nervous , said Arthur .
Mum: he said I'm a little nervous .
Chi: < laughter/ >
Mum: you'll do a fine job .
Chi: xxx who's that ?
Mum: that's his little , -uhhh , brother or sister .

These cases stress the importance of laughter in managing interaction from a very early age, and its important role in social referencing for the child, reassuring and encouraging the child as he/she learns to cope with 'life'. (Stenberg, 2017; Feinman, 2013; Fawcett and Liszkowski, 2015).

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 related to friendliness at 24 months (in Naima), and the use of laughter in relation to a social incongruity only when the child is 36 months old (Alex). Laughter related to pragmatic incongruity (the more complex from a pragmatic point of view) is absent both in mothers and in children.

The percentages observed in mothers are not so different from those observed in adult-adult conversation.To allow easier comparison, Table 8.7 presents data from the current study together with data presented in Chapter 3 collected from corpora of adults interactions.

Functions

In both mothers and children, over 70% of the laughs produced have the function of showing enjoyment of an incongruity, covering the majority of laughter-use, as is also

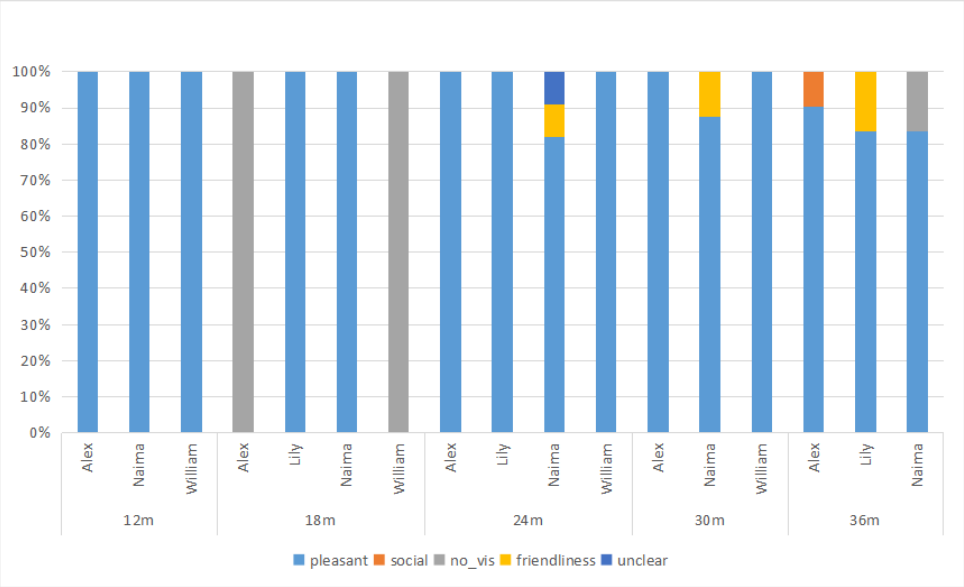
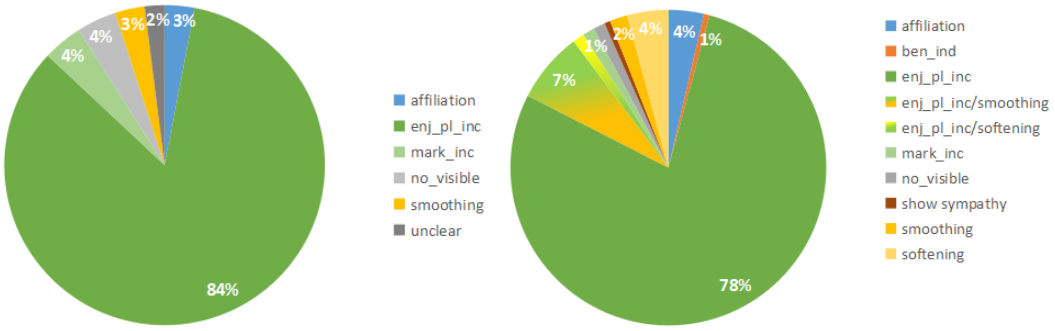


FIGURE 8.24: Incongruity types in children over time

TABLE 8.7: Occurences and percentages of laughter according to the type/absence of incongruity in the laughable

Corpus	Incong. Pleasant	Incong. Social	Incong. Ling.	Pleas./ Social	No incong. Friendl.	Other/ No vis.
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%)
Prov. Mum	133 (80%)	11 (7%)	0 (0%)	14 (8%)	6 (0.6%)	2 (2%)
Prov. Child	111 (92%)	6 (2%)	0 (0%)	-	3 (2%)	4 (0.6%)

reported for adult-adult interaction (DUEL French: 73.8%; DUEL Chinese: 54.29%; BNC: 62.02% - Chapter 3).While for mothers in comparison to adult interaction the percentages are quite similar (Chinese being the corpus with the lowest percentage of pleasant incongruities), in children the percentage of laughs used to show enjoyment of incongruity (84%) is significantly higher (McNemar's Chi-squared test with continuity correction = 80.277, df = 1, p-value < 2.2e-16). The range of functions used in children is therefore smaller than the one observed in mothers (Figure 8.25). In Figure 8.26 we can observe the progressive emergence of different functions over time: at 12 months of age for all of the children all 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 used to show affiliation; at 36 months laughter to smooth the interaction.



(A) Children. (B) Mothers.

FIGURE 8.25: Laughter functions in children and mothers

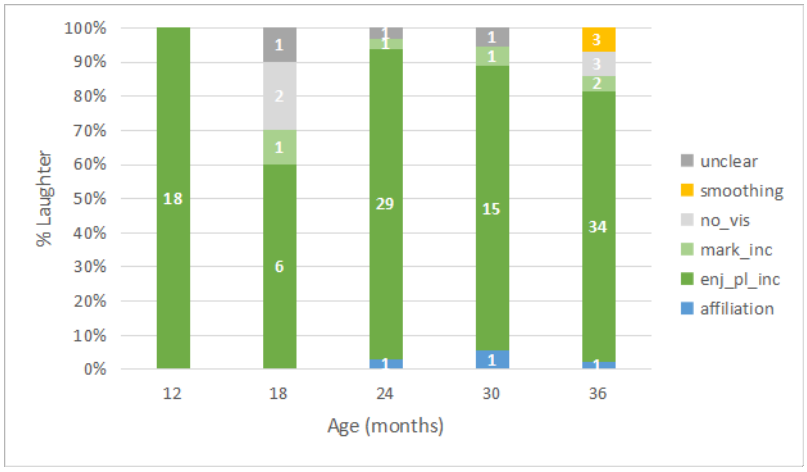


FIGURE 8.26: Laughter functions in children over time

Discussion: Incongruity in the laughable and functions - An ontogenetic and phylogenetic perspective

The results presented regarding the type (or absence) of incongruity in the laughable, and the functions laughter is used for, strikingly reflect a pattern of emergence which complies with what could be hypothesised on the basis of phylogenetic data: pleasant incongruity, friendliness (24 months) and social incongruity (36 months) (Figure 8.24). Up until the age of 18 months we indeed only observed laughter produced in social contexts where pleasant incongruities could be appraised, with the function of *showing enjoyment* or *marking pleasant incongruity*. These are the most ancient and basic functions of laughter, which can also be observed in non-human primates, where they are used with the aim of signalling playful and pleasant incongruity, something important for disambiguating events, and the maintenance and the prolongation of the interaction (both in play and tickling) (Ross, Owren, and Zimmermann, 2010; Matsusaka, 2004; Owren and Bachorowski, 2001; Provine, 2001; Vettin and Todt, 2005; Van Hooff and Preuschoft, 2003) (Section 8.3). It is then around 24 months that we observe the first laughter unrelated to the signalling or enjoying of any incongruity. This is the first use of laughter that we do not see in non-human primates (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 friendliness branch, i.e. *the pleasantness seems to reside exclusively in a sense of closeness either felt or aimed to be shown to the interlocutor*. This is the first co-option, but still quite close to the original function: even when occurring as a display of pleasant incongruity appreciation, laughter usually occurs in the context of play and it does not just mark that there is an incongruity, but that the laugher enjoys it and that she, crucially, enjoys it with the interactional partner. Laughter has therefore, since its most ancestral use in primates, an important adaptive function to promote social affiliation and coordination (Bard, 2007; Bourgeois and Hess, 2008; Byrne, 2003; Hatfield, Cacioppo, and Rapson, 1994). This component is then abstracted to be used independently when aiming to show closeness with a partner, independently from the detection or marking of an incongruity (Caruana, 2017; Dezecache and Dunbar, 2012).

It is only around 36 months then, that we observe in children the use of laughter most distant from its origin. Laughter, the sign used to show and mark appraisal of a pleasant incongruity, in humans seems to be co-opted for use in totally different situations (not observed in non-human primates) (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, Chapter 2), but it is rather an unpleasant one: a violation of social norms or social comfort that might disrupt the smoothness and agreeableness of the interaction. This seems to be quite a complex adaptation process, involving multiple factors. Firstly it involves awareness of social

norms and of the ideal conversational dynamics, as well as the awareness that violation of these might cause unpleasantness and disruption of the social interaction; secondly it requires the awareness (more or less conscious), and the experience, that our non-verbal positive emotional vocalisations can affect our interlocutor both with regards to the appraisal of the current situation, and with regards to her disposition towards the laugher; 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. We suggest that the aim of this transposition is to make unpleasant circumstances less bad both for the laugher and for the interlocutor, and in some instances to provide reassurance and support. 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) — see Chapter 2 for more details. It is maybe not a coincidence that we observed the first laughter used to smooth when the child is 36 months old, the age in which a sense of the public self (i.e. reputation) starts to emerge in children (Tomasello, 2009; Dweck, 2013).

It is also interesting to note that the first child to show different kinds of laughables (Naima) is the child with the fastest language development.

The absence of pragmatic incongruity in children can be interpreted taking into consideration that the use of laughter to modify linguistic meaning is an even more complex and sophisticated adaptation of laughter function, involving abilities which research shows to be acquired much later (e.g. Pexman and Glenwright (2007) and Recchia et al. (2010)).

Looking in more detail at the functions used by children over time, it is interesting to note that the first new function to emerge at 18 months (marking pleasant incongruity) is within the same type of "incongruity branch" (pleasant) (see Figure 2.1). In progression we then see the emergence of laughter used to show affiliation (friendliness branch) at 24 months and then at the last time point (36 months) laughter with smoothing function (social incongruity branch) (branches cited in parenthesis are relative to Figure 2.1).

We can speculate that in order to produce laughter in relation to social incongruity, from a socio-pragmatic perspective more complex processes are involved in comparison to laughter related to a pleasant incongruity. As anticipated before, there is need for attunement to social and cultural norms, the awareness that one's own actions can have negative effects on others, and the intention to avoid those negative effects.

8.7.9 Interaction across tiers: Arousal*Incongruity type

In Chapter 3 we found that in adults' dialogue the level of arousal displayed by the laughter (low, medium, high) was unevenly distributed across laughables constituted by different kinds of incongruities (see Section 3.4.6). I wanted to investigate whether

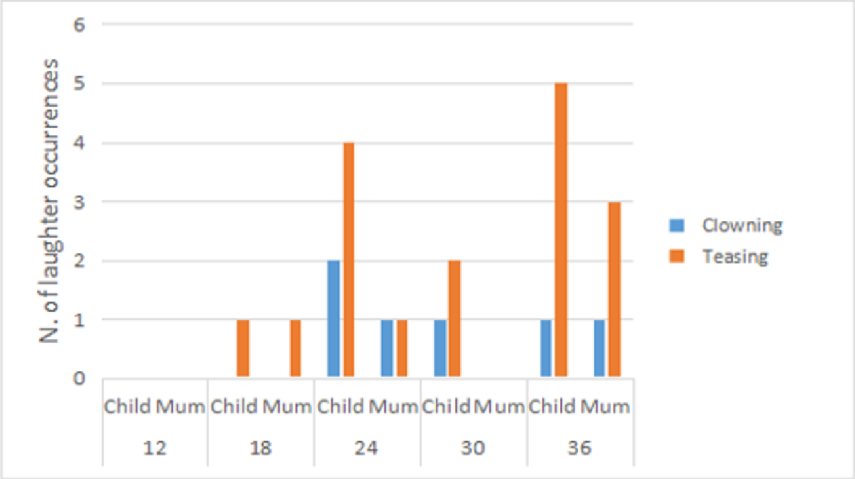


FIGURE 8.27: Clowning and teasing in mothers and children

the same pattern could be observed in mothers and in children (even though in children the presence of laughables related to incongruities other than pleasant is very rare). I was also interested in exploring whether the difference in the level of arousal displayed in mothers' laughter was the result of a different way to show arousal overall, or whether the same patterns observed in adult-adult interaction similarly applied. We excluded laughs related to *pleasant/social incongruity* from the mothers' analysis because of their ambiguity, and in order to make results comparable to adults (Chapter 3) and children.

The level of arousal displayed by the laughter turns out to be differently distributed across different types of laughables both in mothers (two-tailed Fisher's Exact Test: p-value = 0.03917) and in children (p-value = 5.662e-05). We therefore see that the laughter related to social incongruity and friendliness is already characterised by lower arousal even from its emergence (Figure 8.8).

TABLE 8.8: Contingency table arousal × type/absence of incongruity

	Mum			Child		
Arousal	Pleasant	Social	Friendl.	Pleasant	Social	Friendl.
high	19	0	0	31	0	0
medium	77	4	2	61	0	0
low	35	7	4	19	3	3

8.7.10 Clowning, Teasing and Incongruent mood

In this section I briefly report some annotation related to the contexts in which laughter occurred, namely clowning, teasing and incongruent mood from the partner. While they are not the focus of my study, they are of great importance for the interpretation of patterns observed in other variables (especially dyadic laughter occurrences and responses to the partner's laughter; Section 8.7.5).

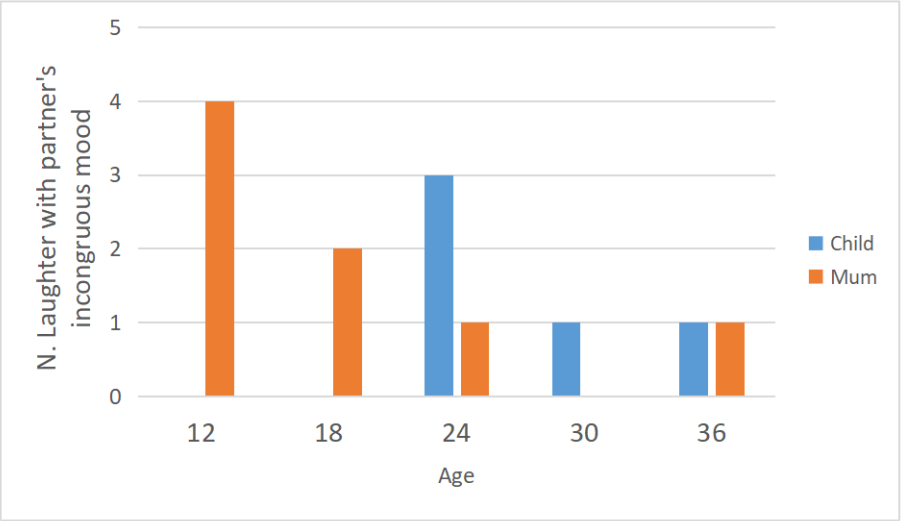


FIGURE 8.28: Laughter during partner's incongruent mood over time

In Figure 8.27 we report the number of laughter instances related to episodes of clowning and teasing, whether from the laugher or from the partner. We see laughter produced in the context of clowning and teasing from the age of 18-24 months. It is important to specify that this does not mean that clowning is not present before: our graph represents only the occasions in which laughter was related to an act of clowning either from the laugher or from the partner. We know from other research that clowning emerges as early as 8 months (Reddy, 2001) (Section 8.2.5).

With the term 'incongruent mood' we refer to the circumstances in which laughter is produced while the partner is in a negatively valenced emotional state, e.g. sad, angry, disappointed. Examples are given in (106) and (107). Looking at the graph 8.28 we can observe how laughter while the mother is in an incongruent mood is totally absent in children until the age of 24 months. Mothers on the other hand seem to display laughter while the child in a incongruent mood (e.g. crying or serious) much more often when s/he is 12 and 18 months old compared to later stages. We can observe a progressive decrease in laughter from the mother while the child is in an incongruent mood, until we reach the age of 36 months and the interactional dynamics seem to be more balanced.

(106) Example from Providence Corpus - Lily 010102 - Mother laughter, child incongruent mood
Mum: am I supposed to brush my teeth?
Mum: xxx (toothbrushing noise).
Child: < cry/ > (upset at the Mum hiding toothpaste)
Mum: < laughter/ >
Mum: you're a little baby toothpaste junkie!
Mum: you're a toothpaste junkie!

(107) *Example from Providence Coprus - Alex 020606* - Child laughter, Mother incongruent mood

Child: no more potato head .
Mum: well, you have to put the arms in so we don't lose all the pieces.
Child: no!
Mum: what do you mean, no?
Child: no!
Child: < laughter/ > Child: xxx Daddy.

The total absence of incongruent laughter by children at the first time points can be explained by the tendency of the mother, especially during the first year (Nwokah et al., 1994), to immediately share positive affect, either laughing back, smiling or vocalising (i.e. affect attunement (Stern, 1985)). But later, in our data especially from the third year, it is more frequent to see laughter from the child while the mother is in a negatively valenced state, whether real or faked. Such observations are of course not independent from the fact that around the age of 24 teasing appears to be more frequent in children (see Figure 8.27). Indeed, at this stage the child seems to master the social and cultural rules and to start to play with them, testing boundaries and reactions from the adult.

Supplementary material Additional variables that have been collected but which, despite being interesting, have not been the object of further analysis, are reported in Appendix D. No space was found for them in the current report due to their lesser relevance to the central aims of the corpus study presented. These are details about the laughables, laughable media, laughter speech-acts and the activities carried out when laughter occurred.

8.8 Summary and General Discussion

The aim of my study was to offer a detailed description of laughter development in children from 12 to 36 months, from a semantic and pragmatic perspective. The framework applied, presented in Chapter 2, has been shown to be a useful tool to grasp interesting aspects of the development of laughter use, and helped in addressing my motivating questions.

1. Can laughter be used as a marker of cognitive and communicative development during the second and third year of life?

Our analysis showed that child laughter behaviour, from 12 to 36 months of age, is nothing like adults'. Differences between children and mothers (and adults more generally) have been observed at each of the levels observed: form, positioning, laughable features, functions, response to other's laughter and interactional context.

Crucially we observed development and change in almost all of the features considered. Some of the changes observed seem to reflect purely cognitive achievements, while others seem to be more specifically informative about pragmatic abilities and the increasing social attunement to the cultural environment.

Already in terms of number of laughs produced overall in interaction, we saw a significant increase in children from 12 to 36 months, coming to values similar to those of their mothers at the last time point observed (36 months). In comparison to adults we saw also significant differences in the positioning of laughter in relation to speech (speech-laughter emerging only around 30 months) and to the laughable (no cataphoric use of laughter is observed).

Particularly interesting is the pattern observed in children's response to the mother's laughter. The observation of this variable allowed us to capture how the child over time becomes more and more attuned to the partner's emotional state, and more interested in and aware of others' communicative intentions. While at the first time points child responsiveness to mother laughter is very low, especially in comparison to the mother, over time we see children displaying behaviours and orienting attention reactions similar to the care-giver, indicating the progressive establishment of more balanced dynamics in interaction.These results mirror data from primate studies which show that both chimpanzees and orangutangs are more likely to respond to another's positive vocal or facial expression as they grow older (Davila-Ross et al., 2011; Davila Ross, Menzler, and Zimmermann, 2007).

We also observed changes in the type of laughable the children's laughter was related to. We observed children becoming more interested in laughables related to external targets rather than laughables produced by the partner, as well as appreciating more and more over time incongruities contained in the denotation of utterances and violations of conversational rules. In this respect therefore the analysis of the laughable is informative about the increasing interest and appreciation of linguistic material (and the incongruities they can give rise to) and the integration of pragmatic and linguistic rules.

The more striking and surprising observation we made was in relation to the type of incongruity the laughter was related to and the laughter functions over time. We observed a pattern of emergence which complies with what could be hypothesised on the base of phylogenetic data.

In primates laughter is used to mark the presence and enjoyment of an incongruity with the interactional partner (Ross, Owren, and Zimmermann, 2010; Vettin and Todt, 2005), which could be glossed as "This is not an attack, it's play! And it is fun with you!". In children from the age of 24 months we see a use of laughter that has not been attested in primates (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 social effect of laughter in the incongruous playful interaction was 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 primates. Laughter is now also used 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 – playfulness and pleasantness – starts to get used in relation to unpleasant circumstances. 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 it.

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 social norms and of the ideal conversational dynamics, as well as the awareness that violation of these might cause unpleasantness and disruption of the social interaction; secondly it requires the awareness (more or less conscious), and the experience, that our non-verbal emotional vocalisations can affect our interlocutor both with regards to the appraisal of the current situation, and with regards to her disposition towards the laugher; lastly it involves the transposition of a positive signal, the emblem and hallmark of playfulness and pleasure, into what is – in principle – a 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.

Laughter related to social incongruity is crucial in our interaction and crucial in managing the impression the interlocutor has about us. Interestingly, this use of laughter coincides with the emergence of a sense of the public self (i.e. reputation) (Tomasello, 2009; Dweck, 2013). We also observed that the use of laughter in relation to social incongruity, is marked from its emergence by the use of a typically low arousal laughter, suggesting that the further we move from the original core function of laughter, the lower the arousal. The observation of the interactional context and the shared attention on the laughable allowed us to show that over time the child is more and more attuned to the mother's attentional state, and more able to infer and appreciate the argument of mother laughter, both when joining the laughter and when not. I think therefore that a detailed analysis of laughter, taking into account the different aspects involved in its use in interaction, can be extremely informative about specific aspects of the neuro-psychological development of young children.

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

In our analysis we observed mothers displaying some laughter behaviour patterns very similar to those observed in adult interaction, while other laughter behaviours appeared to be more specifically adapted to interaction with the child, and calibrated to his/her cognitive and communicative development over time. Laughter is less frequent than in adult interaction, but in terms of speech-laughter production mothers interacting with their children do not differ from adults in adult-adult interaction.

So in terms of form, laughter is used in a rather similar way: what differs is its positioning, the type of laughable it relates to, and the functions it is used to perform. In our corpus, mothers never produced cataphoric laughter. Despite research being needed on the use of laughter cataphorically, we speculated that this may be due to the fact that resolving the argument of cataphoric laughter might be more complex, and the absence of cataphoric laughter might therefore be one of the adaptations mothers make in Child Directed Speech.

Especially interesting are the patterns observed in the transitional probabilities of laughter being produced antiphonally in response to child laughter, and the general responsive reactions to child laughter. During the second year (12, 18 months) mothers show particularly high percentages of antiphonal laughter and explicit responses to child laughter. They seem to exploit any laughter produced by the child to establish a balanced and mutual interaction, while over time this urge to respond to every laugh decreases. As the child becomes more and more competent from a linguistic and pragmatic perspective, the mother has many more means to engage in mutual interaction, therefore having less need to respond to every single instance of laughter.

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, suggesting that mothers use laughter mainly as a response to child behaviour and less so to modify and shape the meaning of their own productions. Also compared to adult interactions, a larger amount of laughter is related to exophoric laughables 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 linguistic interaction, which in adult-adult interaction are by far the most frequent.

Notably, in mothers we observe the presence of a very specific use of laughter that brought us to include a new hybrid class of laughables, i.e. *pleasant/social incongruity*. Although in the adult data there were of course cases which were less straightforward to classify, and where the agreement sometimes was lower, coders always managed to make a decision. In annotating mothers, 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 incongruity, which, even if rare, was present in almost all of the corpora of adult conversation analysed (Chapter 3). Overall, in terms of laughter functions, we therefore see mothers using a much narrower range of functions in comparison to the range used in adult interaction. We observe especially the absence of functions which are more complex and more distant from the original core function of laughter. We can therefore speculate that the use of different laughter functions is adapted to the interaction with the child in a similar fashion to that observed for language, potentially being

part of the calibration adopted by adults in Child Directed Speech.

Mother-child dynamics can, however, be very different across cultures (Lieven, 1994; Harkness, 1990). Many researchers have observed how these different dynamics in interaction can be correlated to language development in terms of the amount of nouns or verbs learned by children in the first years of life; indeed, such differences seem not to depend exclusively on language-specific structural features, but to also be shaped by exposure to different types of conversation and interaction with the physical world (Choi, 2000; Fernald and Morikawa, 1993; Tamis-LeMonda et al., 1992; Tardif, Shatz, and Naigles, 1997). We therefore think it would be extremely interesting to explore whether the different dynamics observed in the interaction between mother and child might also have an effect on the distribution of laughable types. Hence we stress that our data and discussion do not aim to be representative of universals. Firstly because of our small sample, and secondly because of important cultural variability.

To sum up, we observed specific and evolving patterns in the laughter use of mothers, 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 communicative and cognitive abilities.

8.9 Conclusion

Our observations show how laughter behaviour undergoes an important development from 12 to 36 months. Grounded in an interactional and multimodal approach, we observed children's laughter development in natural interaction with their mothers in a familiar environment. This approach allowed us to track both the child's and the mother's behaviour, taking into account the context and all the rich multimodal and non-verbal components of the communication. This method was essential in order to be able to infer the argument of the laughter and to understand the intentions and goals of participants. The framework applied, originally developed for adult interaction, proved to also be a valuable tool for the study of laughter behaviour in children, and helped us to capture many interesting aspects of its evolution. Child laughter-use proves to be very different from adult laughter behaviour and displays important development over the five time points analysed, in almost every layer analysed (form, positioning, laughable features, function and response to partner's laughter). All the changes observed over time have been discussed in the light of cognitive, linguistic and social developmental data. Laughter seems therefore to be informative about the development of various cognitive and social abilities in its use as a response to another's laughter, in the type of arguments it relates to over time, in its positioning in relation to its arguments, and in the functions it is used for. We also showed how the response to others' laughter changes over time, and discussed how this is informative about cognitive, emotional and attentional developing processes.

We offered what is to our knowledge the first detailed analysis of laughter development from a semantic and pragmatic point of view, from 12 to 36 months. We provided evidence that laughter can be used as a sign of cognitive and pragmatic development, complying with hypotheses from the literature. Our main contribution is to have demonstrated that laughter in interaction, rather than just laughter in response to isolated humorous stimuli, can be a valuable source of information with regards to the development of pragmatic abilities.

We acknowledge the limitations of our study especially in terms of sample size and cultural bias, but nevertheless we believe that it offers interesting results and opens a broad range of further research questions. We stress that our data and discussion do not aim to be representative of universals. Firstly because of our small sample, and secondly because of important cultural variability in laughter behaviour (Apte, 1985), observed even in primates across colonies (Davila-Ross et al., 2011; Van IJzendoorn et al., 2009).

Chapter 9

Conclusion and Further studies

The main goal of my work was to provide a deeper understanding of the semantic and pragmatic use of laughter in conversation, and investigate whether its use in children over time could be informative about their communicative development.

Applying a crucially multi- and inter-disciplinary approach, this thesis tried to tackle the motivating questions stated in the introduction. A brief synthesis of the main findings is presented below.

1. **How can laughter be classified in a systematic and reliable way accounting for its multifaceted nature?**

Based on an in-depth analysis of conversational data, we found that an effective way to analyse and classify laughter is to distinguish different layers of analysis. Making an analogy with speech, we argue that for the study of laughter it is likewise fruitful to differentiate aspects relative to the form (in term of acoustics, phonetics and eventually phonologic features), the positioning (syntax), the meaning (semantics) and the effects on dialogue and the social dynamics (pragmatics). We showed that embracing a multi-layered analysis of laughter can allow us to comprehensively account for and unify insights from previous studies in different disciplines (Chapter 2 and Chapter 3). The framework adopted, where laughter is crucially considered as a visible and audible act of meaning (Bavelas and Chovil, 2000; Wierzbicka, 1995; Wierzbicka, 2000), and which needs to be integrated with linguistic import in a multimodal framework of dialogical interaction, has been shown to be reliably applicable by naive coders and able to give insights about the semantic and pragmatic dynamics of laughter use. The annotation scheme for laughter functions is set out in concrete terms in the form of a binary decision tree, which provides a valuable guide for annotation. We applied it fruitfully in three different languages (French, Mandarin Chinese and English), observing interesting similarities and differences. More specifically, we focused on the argument the laughter is related to (the *laughable*), as a basis to infer the function of the laughter. We distinguish laughables which contain incongruity and those that do not. In detail we than observe three different kinds of incongruity that can be applicable to laughter: pleasant (ca. humour), social (clash between social norms / comfort and the current situations) and pragmatic (clash between what is said and what is meant, signalling to the listener that she has to

consider the less probable interpretation). In the case where no incongruity can be identified, the laughable seems to be associated with a sense of friendliness and closeness either felt or displayed towards the interlocutor. From these, different functions derive and laughter can be used to show enjoyment of an incongruity, to signal it to the interlocutor, to soften a statement, to induce benevolence from the interlocutor, to smooth a moment of embarrassment, to signal the need of opting for a not-literal interpretation of an utterance, or simply to show affiliation. We pose therefore on another level of analysis reflection whether the laughter is produced with a cooperative or non-cooperative intention.

2. **How is laughter used in dialogue? How to develop a formal theory of the meaning of laughter?**

The analysis of corpus data provided extensive evidence for the argument that laughter has propositional content. We saw this evidence in the analysis of stand-alone uses of laughter, in the responses and rebuttals laughter can elicit from interlocutors, and in the clarification requests speakers make to aid in laughter interpretation. We propose that laughter functions similarly to an event predicate, having a core meaning which, when aligned with rich contextual reasoning, can yield to a wide range of functions. (Chapter 2, 3 and 4).

The argument of its predication can either be an exophoric event, or something occurring in the interaction (i.e. the denotation of an utterance, a non-verbal contribution, a dialogue act, etc.). Our corpus study showed that contrary to what is commonly assumed, laughter does not always occur after its argument. We actually observe a rather free alignment between the laughter and its laughable, i.e. laughter can occur after, most frequently, but also during or before the laughable it is related to. This observation invalidates the common sequential adjacency assumption, showing instead patterns resembling those observed for manual gesture in relation to speech (Rieser, 2015; Alahverdzhieva, Lascarides, and Flickinger, 2018). Our results challenge the assumption that what laughter follows is what it is about, and thus question previous claims based on this assumption. Moreover, we also observed a rather high flexibility in the overlap between speech and laughter. Interestingly, when speech-laughter occurs, the laughter is not always related to the co-occurring speech. Importantly, we showed how laughter can affect utterance meaning and in some of its uses how crucial and careful must its positioning be in order to convey the intended meaning. (Chapter 3). Our observation, concerning the placement of laughter in relation to the laughable and to speech, favours the view that laughter belongs to a parallel independent channel from speech, though the two channels interact multimodally to convey meaning.

In our data, 90% of laughter instances involve an incongruity, 70% of these constitute what we call a *pleasant incongruity* while approximately 20% a *social* one. Given the differences between corpora and even within distinct parts of those, it seems clear that such distributions are highly setting dependent and, hence, cannot be used to

make domain-independent claims about the nature of laughter. Nonetheless, without disregarding the crucial role that laughter has in managing social interactions, they do call into question previous such general claims that laughter is very rarely about something humorous and that it is most of the time related to "banal comments", functioning almost exclusively as a "social lubricant" (Provine, 1993; Provine, 1996). In Chapter 5 we sketched a formal representation of how laughter predication could be integrated into a dynamic framework for dialogue modelling. We offer a formalization of the arguments it can be related to, of how incongruities arise in context and how interlocutors can derive inferences from laughter productions.

4. **Laughter can serve a variety of functions in interaction, can we identify a form-function mapping in laughter productions?**

Based on our acoustic analysis and our semantically and pragmatically grounded classification, we found support for the lack of a form-function mapping. The statistical analysis of the corpus annotation data suggests that none of the functions can be reliably predicted from a single factor of our analysis, but is rather a specific cluster of features that characterises different functions in the different languages analysed. In addition, some similarities were observed across languages, especially when context was held constant (i.e. DUEL corpus), allowing us to tentatively suggest that some laughter features are not heavily influenced by the language spoken and the culture of origin. Our data therefore support the hypothesis that the process of derivation of the different laughter functions, especially when arousal is taken constant, is grounded in contextual reasoning, and acoustics alone, despite being an important factor, does not suffice to derive inferences about the laughter aimed effect on the discourse.

5. **Do different types of laughter require different levels of pragmatic reasoning about others' mental states? Is that mirrored in neuro-cortical activation?**

Regarding this point, we cannot give any conclusive answer, given the need for a larger sample size and important improvements in the design and procedure of the neuro-imaging study conducted. We nevertheless got some encouraging data that may support this hypothesis, but further studies are needed. From our behavioural study we can nonetheless conclude that arguments of laughter are fairly straightforward to resolve for typical adults, and that when participants, totally naive to our multi-layered framework, are asked explicitly to classify the argument of the laughter, they are strongly influenced by the perceptual features of the laughs, giving higher priority to the authenticity of the non-verbal social signal rather than its argument. (Chapter 7)

6. **Does laughter behaviour in interaction develop during childhood? Can laughter be informative of pragmatic development? How can we relate laughter use in humans and in primates?**

Our corpus study shows that there are highly significant differences in the use of laughter between children and adults, and that it undergoes considerable development from 12 to 36 months of age. The differences with adults and the changes observable concern all the layers of analysis considered: form, positioning in relation to speech, other laughter and laughable. We commented on how the changes observed can be interpreted as a reflection of cognitive, linguistic, attentional and pragmatic development. Strikingly, the types of laughables child laughter is related to vary over time following what could be hypothesised on the base of phylogenetic data. In primates laughter is used to mark the presence and enjoyment of an incongruity with the interactional partner (Ross, Owren, and Zimmermann, 2010; Vettin and Todt, 2005), which could be dubbed as "This is not an attack, it's play! And it is fun with you!". In children from the age of 24 months, we then see a use of laughter that has not been attested in primates (Gervais and Wilson, 2005; Owren and Bachorowski, 2001; Davila-Ross et al., 2011), i.e. laughter used when no incongruity can be detected to show exclusively affiliation and closeness to the interactional partner. It seems like if the social effect of laughter in the incongruous playful interaction got abstracted to be used in contexts where no incongruity is present. Finally, around 36 months of age, we observe the furthest co-option of laughter use from the one observed in primates. Laughter is now also used in relation to incongruities which are not pleasant, but rather unpleasant, i.e. violation of social norms and comfort, which might cause disruption of the social interaction. Laughter, the hallmark of playfulness and pleasantness, starts to get used in relation to unpleasant circumstances. We speculate that this transposition, arguably, is to make unpleasant circumstances less bad both for the laugher and the interlocutor, reassuring about closeness and in some cases aiming for it. We believe that each co-option observed in laughter use mirrors complex process from a socio-pragmatic point of view: i.e. awareness that our behaviours have an effect on the partner, attunement to social conventions, awareness that others might be negatively affected by our actions and the intention to avoid it.

From a conversational point of view, we claim that laughter can be a highly useful means for infants to engage in interaction, attract attention to themselves and to external targets, as well as offering the possibility to contribute vocally to the conversation at the same level as adult interlocutors. Laughter seems therefore to be of great importance for young children, allowing them to learn incidentally about important social dynamics and to test elementary abilities for dialogue, i.e. establishing shared attention, attune to others' attentional, intentional and emotional states, learn about social and cultural norms, and learn how to contribute to conversation in terms of content and hold turns. We argue therefore that the observation of laughter development in infants and young children might be a valuable means, together with other non-verbal behaviours, to shed light on their cognitive and pragmatic development and be informative about potential delays or difficulties.

9.1 Further Studies

While the general framework proposed in this dissertation provides a high-level guideline to future laughter analysis in dialogue, the studies and experiments proposed suggest many more specific open questions and directions. First and foremost, all the studies presented in the current thesis would see their conclusions strengthened by replication and extension to a larger sample size and a wider range of genres and cultures. Some of the proposals presented are in many respects still quite preliminary and require significant follow-up. The remainder of this section will lay out implications for different disciplines and some of the more immediately accessible avenues for future research.

Linguistic Perspective One of the main findings from the corpus studies presented is the observation of a rather free alignment between laughter and laughable. Additional work will be required in order to explore the syntactic, semantic and prosodic constraints concerning the alignment between laughter and laughable. As observed by Glenn (2003), the placement of laughter relative to its argument in the flow of conversation is important to reduce its ambiguity: therefore we hypothesise misalignment to have specific boundaries. Moreover given the interesting similarities and differences observed between languages, it will be interesting to explore further whether laughter positioning might be limited by language-dependent syntactic constraints. Further interesting insight about laughter use and interaction with linguistics semantics, will be gained by the study of laughter in sign languages. Provine and Emmorey (2006) observed that laughter occurs at phrase boundaries in deaf signers. They suggested that this might be due to a higher priority of language over laughter. This priority at least for verbal language has been invalidated for some time, as laughter frequently overlaps speech, and can also interrupt utterances. A corpus study will be needed in order to replicate their observation. Whether their results hold, i.e., laughter punctuates speech in signers, that would have interesting implications. It would indeed mean that in deaf signers, since the laughter is perceived only visually involving marked facial movements, it would interfere with the perception of the message conveyed by language. In sign languages, body and face movements constitute important communicative elements at all linguistic levels from phonology to morphology, semantics, syntax and prosody (Liddell, 1978; Campbell, 1999; Freitas et al., 2017). Despite the fact that emotional facial expressions can overlap with linguistic facial movements (Dachkovsky and Sandler, 2009), a laugh, implying a significant alteration of facial configuration could be excessively disruptive for the message aimed to be conveyed. In contrast, in verbal language, the laughter signal can be completely fused in the speech (Crystal, 1976) and used in a sophisticated manner to enrich and facilitate communication.

Dialogue Systems Especially important are the implications that my work brings for researchers working on the implementation of dialogue systems. No dearth of

work is being devoted in the last years to have laughter integrated into human-agent interactions thanks especially to the ILHAIRE project (Dupont et al., 2016). The results of our analysis suggest that laughter is an important social vocalization to be integrated in human-agent interaction not only because of the effect it can have on the speaker, the role it has in turn-taking, the effect it has on the agreeableness, naturalness perception of the conversation and sense of bonding (El Haddad et al., 2016; Trouvain and Schröder, 2004), but also because crucially it conveys meaning. Implications for dialogue systems therefore do not only include emotional and affective computing aspects, their importance notwithstanding, but also aspects related to natural language understanding.

To integrate laughter with the implementation of dialogue systems is no small task. Some of the main challenges to face are indeed the identification of laughables (which can occur before, during or after the laughter), and the issue of formally characterizing incongruity in the different classes distinguished, trying to account also for their contextual and cultural bounds.

Neuro-psychological processing of laughter In this respect, the results presented in the current thesis are particularly preliminary, but were particularly successful in opening up a broad range of further investigations.

In order to further explore whether the acoustics of laughter and its perceptual features have a central role in its processing or whether the context might actually have a predominant influence on its meaning, pragmatic enrichment and interpretation, it would be interesting to carry out an experiment where laughter form and functions cross. The method will involve the extraction of laughter from corpora of natural dialogues and manipulation of the contexts in which they are presented (similar to the one adopted in Curran et al. (2017)). The main aim would be to investigate whether, despite the very same acoustic characteristics of the laughter, the context can affect both its conscious perception and its neural processing.

On the other hand, in order to explore whether the two classes of laughables we postulated are mirrored in perception, it could be interesting to conduct an fMRI experiment, enabling us to look at deeper structures, in comparison to fNIRS. A detailed discussion of the further directions to be taken is presented in Section 7.5.

All the work presented stressed especially the importance of laughter investigation in interaction, rather than only in response to isolated humourous stimuli. A fascinating path to follow would therefore be the investigation of the neuro-correlates of laughter use in interaction, exploiting the advantages of fNIRS, and its relative robustness to motion artefact (Pinti et al., 2015; Noah et al., 2015), for recording brain activity in real interaction (Cannizzaro et al., 2016). These kinds of studies could indeed provide important insights for the pragmatic functions laughter can serve in dialogue and what it takes to process them. Such strands of investigation in neuro-typical subjects will constitute an important basis for studies in clinical

populations where pragmatic reasoning might be affected, of particular interest for autism research.

Developmental Psychology Our corpus study showed that laughter behaviour in interaction undergoes important development from the age of 12 to 36 months. Especially interesting would be to extend the age range of observation to the first months of life, in order to confirm and extend our results. It is at this stage that laughter observation might be most valuable. Emerging much earlier than language 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 development, and potential difficulties or delays very early on.

In order to further sustain the hypothesis that laughter can be used as a sign of development of mentalising abilities (Reddy, 2008), a parallel and comparative analysis between laughter behaviour and non-verbal communication development (pointing, eye gaze, etc.) together with a periodic assessment of language and Theory of Mind (administrating tasks suitable for the children's age) is needed in order to attest laughter as a reliable marker and tool to detect early cognitive, emotional and communicative delay or impairment. Finally, the analysis conducted on mothers' behaviour should be extended in order to explore whether the hypothesized privileged use of laughter as a response to children behaviour, when they are not enough confident with language, is exclusive about laughter or general about all children's non-verbal behaviours.

Clinical Neuropsychology One of the main points put forward in my work is that semantic and pragmatic reasoning are crucial elements in the understanding and interpretation of laughter in conversational context, and that in turn laughter can be informative about these. Being pragmatic skills, social cognition and the use of contextual cues (Klin, 2000; Klin et al., 2002) the central core of difficulties in the Autism Spectrum Disorder (ASD), it would be extremely interesting to conduct some of the studies proposed for neuro-typical populations, with ASD participants. This would indeed shed light both on the nature of laughter and on the ASD condition itself. For example on the base of Giganti and Esposito Ziello (2009)

Particularly interesting would then be the theoretical and clinical implications of a comparison of laughter behaviour between High (HFA) and Low Functioning Autistic (LFA) populations. Giganti and Esposito Ziello (2009), conducted a study on yawning and laughter contagiousness in autistic children and reported an absence of yawning contagiousness both in HFA and LFA, while smiling and laughter contagion has been reported exclusively in the HFA group, but not in the LFA one (Helt, Fein, and Vargas, 2019). These data support the hypothesis advanced by Blair (2005) that empathy could actually be distinguished in 3 subsystems: cognitive (i.e. mind-reading ability), motor (i.e. ability to mirror others movements, expressions and behaviours) and emotional empathy (i.e. ability in understanding and eventually share and respond

to others emotional expressions). Absence of yawning contagiousness could signal a deficit in cognitive and motor empathy, while response to laughter and smiling could reflect emotional empathy capacities. Consequently, we would expect discrepancy in laughter behaviour between the two groups, both in production and in reaction to others' laughter.

Furthermore, a better understanding of laughter behaviour and humour in clinical populations can be extremely important both for the pedagogic and learning facilitation effect that laughter can have (Yuill, 2007; Yuill, 2009), as well as giving special support and benefits for the development of cognitive and social skills (Wu et al., 2016; Degabriele and Walsh, 2010). Especially given results from Reddy, Williams, and Vaughan (2002), Cai, White, and Scott (2019), Helt, Fein, and Vargas (2019) and Giganti and Esposito Ziello (2009), we have good reason to think that some aspects of laughter production and perception are definitely preserved, while others might be more affected. Studies report that ASD subjects have major difficulties in appreciating humour that requires some degree of mentalising reasoning, while other kinds of humour are preserved. A similar pattern is observed in laughter: while some functions are preserved, others are absent and often misinterpreted in perception. It is possible that explicit work on laughter and humour understanding and production could have positive effects on multiple levels, primarily social, but also cognitive. It is especially important also to raise awareness in caregivers and therapists about the importance that laughter and humour have in our interactions and in the establishment of reassuring relationships. It is often observed that the caregivers and professionals tend to laugh less and less, almost discouraged by the frequent lack of response or misunderstanding. The primary difficulty, therefore, seems to bring to a secondary handicap, i.e. the deprivation of an emotional and intentional cue, as well as one of the best means to boost and stimulate bonding despite the difficulties.

Appendix A

List of audio/video extracts

A.1 Chapter 2 - Our Framework

- Example 4, p. 21
  Laughable: Linguistic denotation (Example from DUEL French 3_1: Dream apartment)
- Example 7, p. 22
  Laughable: Metalinguistic (Example from DUEL French 1_3: Border Control) - Mispronunciation
- Example 9, p. 22
  Eagles of Death Metal Discuss Paris Terror Attacks - Pleasant incongruity in negative circumstance.
- Example 10, p. 23
  Eagles of Death Metal Discuss Paris Terror Attacks - Friendliness in negative circumstance
- Example 11, p. 25
  Example from informal conversation mums at the park (BNC, KDE)
- Example 12, p. 26
  Example from politics lecture (BNC, JSM)
- Example 13, p. 26
  Example from politics lecture (BNC, JSM)
- Example 14, p. 28
  Example from job interview (BNC, JNW)
- Example 16, p. 29
  Example from a job interview (BNC, JNV)
- Example 17, p. 29
  Example from a job interview (BNC, JNV)
- Example 18, p. 29
  Example from Interview to Michael Heseltine after heart attack (BNC, K6A)

- Example 20, p. 30
  Example from Politics Lecture (BNC, JSM)
- Example 21, p. 31
  Example from Trial Court (BNC, F7X)
- Example 22, p. 31
  Example from Politics Lecture (BNC, JSM)
- Example 24, p. 32
  Extract from DUEL French 3_1 - Dream Apartment Task
- Example 27, p. 33
  The Simpsons: Nelson Laughs at the Very Tall, Season 7, episode 21: "22 Short Films About Springfield"

A.2 Chapter 3 - Laughing Adults

- Example 29, p. 52
  Example from DUEL Chinese 2_3
- Example in footnote 9, p. 57
  Extract from Providence Corpus, mother-child interaction.

A.3 Chapter 4 - Why did you laugh?

-]Example 34, p. 64
  Example from politics lecture (BNC, JSM)
- Example 36, p. 64
  Example from Providence Corpus, Lily 030010
- Example 37, p. 65
  Example from Providence corpus, Lily 030010
- Example 54, p. 74
  Example from the Providence Corpus - William 020012

A.4 Chapter 8 - Laughter in development

- Example 91, p. 161
  Example from Providence Corpus - William 010412
- Example 92, p. 162
  Example from Providence Corpus - Alex 020606

- Example 93, p. 163
  Example from Providence Corpus - William 020012
- Example 94, p. 164
  Example from Providence Corpus - Naima 010014 - Mother Antiphonal laughter
- Example 95, p. 164
  Example from Providence Corpus - Naima 010014
- Example 96, p. 164
  Example from Providence Corpus - William 020012
- Example 97, p. 165
  Example from Providence Corpus - William 010605
- Example 98, p. 172
  Example from Providence Corpus - William 010412
- Example 99, p. 174
  Example from Providence Corpus - Naima 010014
- Example 100, p. 176
  Example from Providence Corpus - Naima 010604
- Example 101, p. 176
  Example from Providence Corpus -Naima 010604
- Example 102, p. 178
  Example from Providence Corpus - Alex 020606
- Example 103, p. 178
  Example from Providence Corpus - Alex 030103
- Example 104, p. 179
  Example from Providence Corpus - William 010412
- Example 105, p. 179
  Example from Providence Corpus - Naima 020004
- Example 106, p. 185
  Example from Providence Corpus - Lily 010102
- Example 107, p. 185
  Example from Providence Corpus - Alex 020606

Appendix B

Appendix to Chapter 3

B.1 Conversations Analysed

B.1.1 BNC

Table B.1: BNC conversations analysed: link to audio, description of context, duration and number of laughter identified.

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

B.1.2 Duel Corpus

- French Audio: 3 dyads - 9 videos
  Link to folder
- Chinese Audio: 2 dyads - 6 videos
  Link to folder

Note: All the annotation on the DUEL corpus has been performed on the basis of the audio-visual data. However, the video cannot be made public due to privacy concerns: therefore the links lead exclusively to audio-clips.

Appendix C

Appendix to Chapter 7

C.1 Stimuli used for the fNIRS and behavioural experiment

- Pleasant Incongruity: 20 video-clips
  Link to folder
- Social Incongruity: 20 video-clips
  Link to folder
- Controls: 20 video-clips
  Link to folder

Note: For both the behavioural and fNIRS experiments participants have been presented audio-video clips. However, the video cannot be made public due to privacy concerns: therefore the links lead exclusively to audio-clips.

C.2 Questionnaire on laughter perception

TABLE C.1: Questionnaire on People's Experiences of Their Own Laughter Production and Perception - Chinese Translation

Questions
1)我独处的时候很少笑
2)我的笑很内敛
3)听到笑声会让我感到紧张
4)我不喜欢那些笑得特别多的人
5)我觉得一些事情很搞笑，但我很少放声大笑
6)我比我身边认识的大多数人都笑得更少
7)我比我身边认识的大多数人都笑得更多
8)当我难过时，听到别人的笑声会让我感觉好一点
9)我很少会突然笑得不能自已
10)当我遇到搞笑的事情时，我通常就会大声笑出来
11)当我开心时，听到别人笑会让我更开心
12)我常常会故意地笑来展现我对某个人的喜欢
13)听到别人假笑会惹恼我
14)我可以看得出来，有些人笑是有求于我
15)我可以觉察到有些人笑是为了让我对他们消气
16)我享受人们的笑声
17)当有人在假装开心而刻意大笑时，我能察觉出来
18)朋友的笑/笑声于我而言总是悦耳的
19)我认为笑/笑声对于人们之间的互动有积极的影响
20)我觉得笑/笑声是亲密关系中重要 的一部分
21)当我希望别人喜欢我的时候就会笑 得更多
22)我无法察觉出有些人是在刻意地笑 来伪装自己感到愉悦
23)我无法察觉出来，有些人之所以笑 是因为他们有求于我
24)我无法觉察出有些人笑是为了让我 对他们消气
25)我有时候会通过笑来让其他人不再 对我生气
26)有时候，我会觉得难以辨别出别人 带有恶意的笑
27)我有时候会用笑/笑声来掩盖悲伤
28)我发现有时候会难以辨别出别人只 是在迎合地笑
29)我常常用笑/笑声来避免表现出失 望
30)我总能察觉出别人是在取笑我，还 是在同我一起笑

Appendix D

Appendix to Chapter 8

D.1 Media laughable

With this variable we tried to capture the channels the laughable was conveyed by, percentages are reported in Figure D.1.

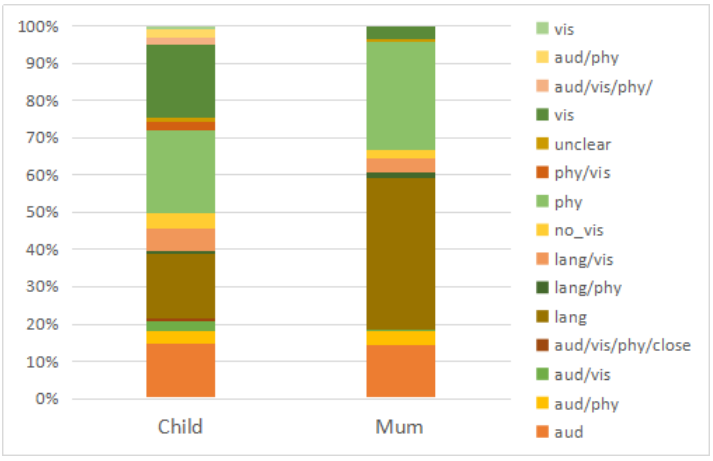


FIGURE D.1: Laughable media in children and mothers

D.2 Details laughable

With this annotation we tried to explore in more detail the specificities of the laughables (Figure D.2). The classes are arbitrary but at a graph inspection they manage to be informative about some characteristics of mother and child laughter behaviour.

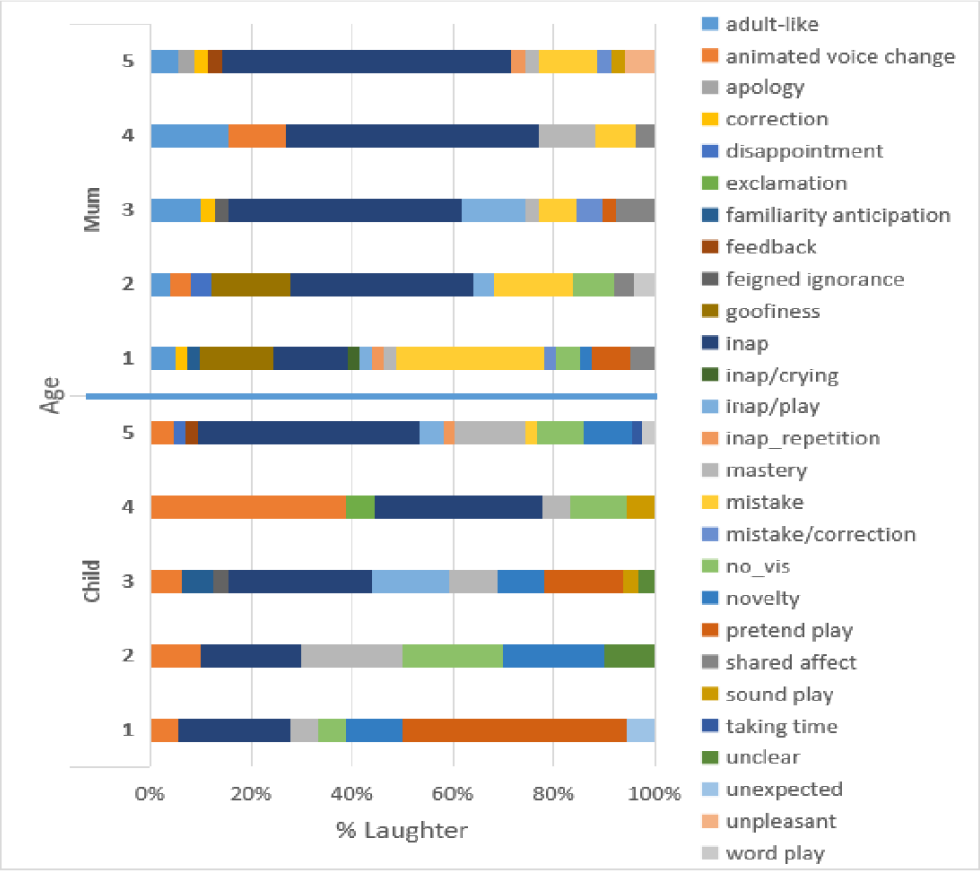
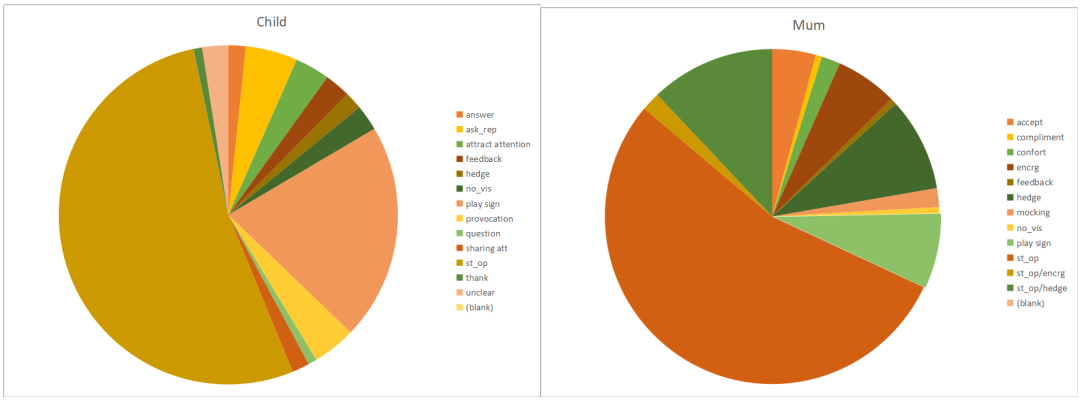


FIGURE D.2: Laughable details over time

D.3 Laughter Dialogue-Acts

Dialogue acts performed by laughter over time in mother and children are reported in Figure D.3a and D.3b.



(A) Children. (B) Mothers.

FIGURE D.3: Laughter dialogue-acts in children and mothers

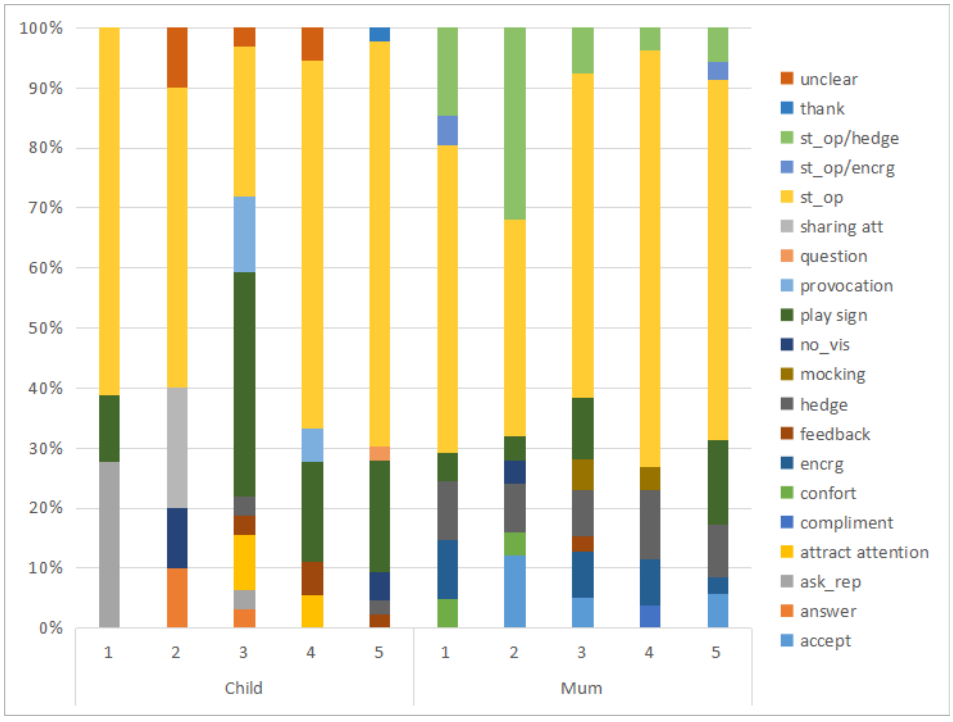


FIGURE D.4: Laughter Dialogue-Acts over time

D.4 Activities

Activities in which the dyad mother-child was engaged with when each laughter occurred are shown in Table D.5.

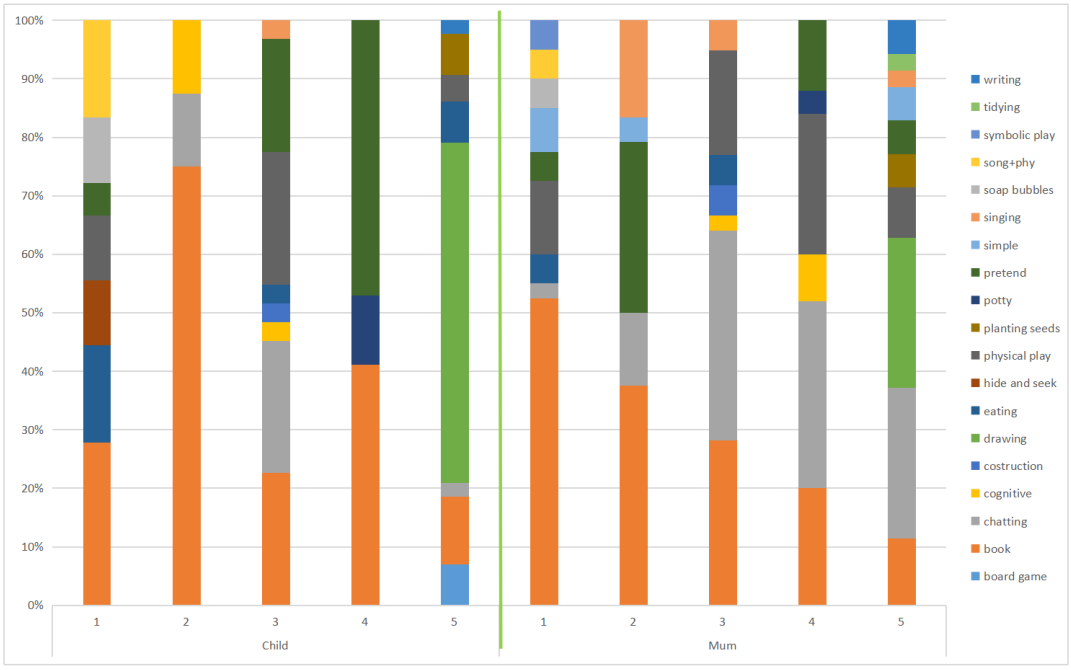


FIGURE D.5: Laughter contextual activities in Mothers and children

Appendix E

Résumé substantiel

Le rire est une vocalisation universelle à travers les cultures et les langues. Il est omniprésent dans nos dialogues et utilisé pour un large éventail de fonctions. Le rire a été étudié sous plusieurs angles, mais les classifications proposées sont difficiles à intégrer dans un même système. Malgré le fait qu'il soit crucial dans nos interactions quotidiennes, le rire en conversation a reçu peu d'attention et les études sur la pragmatique du rire en interaction, ses corrélats neuronaux perceptuels et son développement chez l'enfant sont rares. Dans cette thèse, est proposé un nouveau cadre pour l'analyse du rire, fondé sur l'hypothèse cruciale que le rire a un contenu propositionnel et plaidant pour la nécessité de distinguer différentes couches d'analyse, tout comme dans l'étude de la parole: forme, positionnement, sémantique et pragmatique. Une représentation formelle de la signification du rire est proposée et une étude de corpus multilingue (français, chinois et anglais) est menée afin d'approfondir notre compréhension de l'utilisation du rire dans les conversations entre adultes. Des études préliminaires sont menées sur la viabilité d'un mappage forme-fonction du rire basée sur ses caractéristiques acoustiques, ainsi que sur les corrélats neuronaux impliqués dans la perception du rire qui servent différentes fonctions dans un dialogue naturel. Nos résultats donnent lieu à de nouvelles généralisations sur le placement, l'alignement, la sémantique et les fonctions du rire, soulignant le haute niveau des compétences pragmatiques impliquées dans sa production et sa perception. Le développement de l'utilisation sémantique et pragmatique du rire est observé dans une étude de corpus longitudinale de 4 dyades mère-enfant de l'age de 12 à 36 mois, locuteurs d'anglais américain. Les résultats montrent que l'utilisation du rire subit un développement important à chaque niveau analysé et que le rire peut être un indicateur précoce du développement cognitif, communicatif et social.

Le **Chapitre 1** est composé de deux parties principales: dans la première est présentée une revue de la littérature sur l'état de l'art concernant l'étude du rire chez les adultes, les enfants et la population clinique; dans la deuxième sont présentés les objectifs et les motivations de mon travail.

La recherche montre que le rire est un comportement beaucoup plus complexe qu'on ne le pensait auparavant, à la fois en réponse à des stimuli humoristiques isolés et dans son utilisation conversationnelle. Il est particulièrement souligné que peu

d'attention a été accordée à l'étude du rire dans la conversation naturelle et que l'on en sait peu sur le développement de son utilisation chez les enfants. L'objectif principal de cette thèse est d'approfondir notre compréhension de la sémantique et de la pragmatique du rire dans la conversation adulte, puis d'explorer son développement chez les enfants.

Cette thèse tente de combler certaines des lacunes de la littérature en répondant aux questions de recherche suivantes :

1. Comment classer le rire de manière systématique et fiable en tenant compte de ses multiples facettes ?

2. Comment le rire est-il utilisé dans le dialogue ? Comment développer une théorie formelle de la signification du rire ?

3. Le rire peut remplir de nombreuses fonctions différentes dans l'interaction: pouvons-nous identifier un mappage forme-fonction dans les productions de rire ?

4. Les différents types de rires nécessitent-ils différents niveaux de raisonnement pragmatique au sujet des états mentaux des interlocuteurs ? Est-il reflété dans l'activation neuro-corticale ? Le rire est-il traité différemment selon l'argument auquel il fait référence ?

5. L'utilisation du rire dans l'interaction se développe-t-il pendant l'enfance? Le rire peut-il être révélateur d'un développement pragmatique ? Comment établir un lien entre l'utilisation du rire chez les humains et chez les primates ?

Pour tenter de répondre à ces questions, j'adopte une approche dialogique, en me concentrant spécifiquement sur le rire et essayant de rendre compte de tous ses usages en interaction, que l'humour soit présent ou non.

Mon travail prend comme points de départ la proposition, présentée à l'origine par Plessner (1970) puis par Glenn (2003) and Ginzburg et al. (2015), que le rire apporte une signification, ainsi que l'hypothèse que la compréhension et la production du rire dépendent dans une large mesure de raisonnements pragmatiques et contextuels (Reddy, Williams, and Vaughan, 2002). L'ensemble de la thèse repose sur la conception, aujourd'hui généralement bien acceptée, que la communication en interaction implique de multiples modes et canaux en dehors de la parole, capables de véhiculer des signification (Iedema, 2007; Jones and LeBaron, 2002; Kress and Van Leeuwen, 2001; Streeck, Goodwin, and LeBaron, 2011; Wierzbicka, 2000).

Afin d'approfondir nos connaissances sur le comportement lié au rire chez les adultes et les enfants, j'adopte une approche radicalement pluridisciplinaire et interdisciplinaire (Choi and Pak, 2006). Je crois en effet, surtout pour un comportement

aussi complexe que le rire, qu'il est impossible d'éviter une approche pluridisciplinaire lorsqu'il s'agit d'intégrer des connaissances provenant de diverses disciplines comme la psychologie, la biologie, la neurologie, la physiologie et la linguistique au sein d'un même système. Dans mon travail, j'ai donc utilisé une variété de méthodes, en étudiant la sémantique et de la pragmatique du rire sous différents angles, dans le but de comprendre les données recueillies et de les interpréter à la lumière des différentes disciplines et domaines de recherche.

J'utilise des méthodes d'étude de corpus, des analyses acoustiques, une expérience comportementale, une étude de questionnaire et des techniques de neuro-imagerie, tout cela dans le but de mieux comprendre l'utilisation sémantique et pragmatique du rire dans l'interaction. Dans l'analyse des données du corpus, j'adopte une approche à la fois quantitative et qualitative, pour voir d'une part le tableau d'ensemble et d'autre part les nuances plus fines ainsi que les cas inévitables de frontières floues.

Dans le **Chapitre 2**, je relève le défi de formuler un cadre pour l'analyse du rire qui unifie les connaissances acquises lors de recherches antérieures dans différentes disciplines. Les taxonomies du rire disponibles sont très diverses et, par conséquent, difficiles à intégrer, soit parce qu'elles ont été proposées par des chercheurs dans différents domaines (psychologie, linguistique, biologie, neuro-science, anthropologie), soit parce qu'elles sont motivées par différents objectifs de recherche. L'une des hypothèses centrales qui oriente mon travail est que l'analyse du rire peut être décomposée en différents niveaux, comme cela a été fait en linguistique traditionnelle : séparation des formes acoustique et phonétique, positionnement dans la structure plus large du discours (syntaxe), sémantique, pragmatique et effets, finalités et fonctions pour les interactions sociales (Table E.1). Cette thèse propose donc, dans la lignée de Plessner (1970), Glenn (2003), and Ginzburg et al. (2015) que le rire *mérite* une composante sémantique, c'est à dire qu'il a du contenu propositionnel.

TABLE E.1: Niveaux pertinents à l'analyse du rire

Forme
Caractéristiques acoustiques, phonologie, posture etc.
Positionnement
Ordre par rapport à la parole, le rire des autres et le *laughable*.
Sémantique
Prédication de incongruité/plaisir causant un changement positif d'*arousal*.
Fonctions
effet du rire souhaité par le rieur.
Aspects sociaux
Acte de dialogue réalisé, intentions, réponse du contexte

Je propose que le rire fonctionne de la même manière qu'un prédicat d'événement, avec une signification centrale qui, lorsqu'elle est alignée sur un riche raisonnement

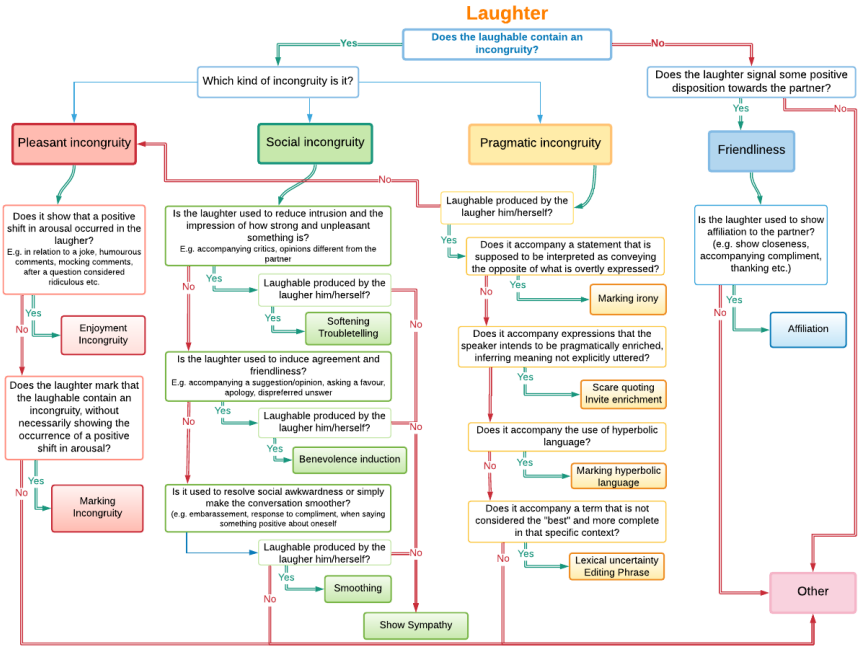


FIGURE E.1: Arbre de décision pour classer les fonctions pragmatiques du rire

contextuel, peut donner lieu à une large gamme de fonctions. Le schéma d'annotation des fonctions du rire est présenté concrètement sous la forme d'un arbre de décision binaire (Figure E.1), qui constitue un guide précieux pour l'annotation.

Afin de tester ces hypothèses et de comprendre la dynamique de génération et de composition incrémentale du contenu sémantique du rire, deux différentes études de corpus ont été réalisées, sujets des Chapitres 3 et 4.

Au **Chapitre 3**, une analyse détaillée de l'utilisation du rire dans la conversation adulte dans trois langues différentes est présentée afin d'examiner l'applicabilité du cadre proposé dans le Chapitre 2.

Nous avons appliqué le cadre avec succès dans les trois langues (français, chinois mandarin et anglais), en observant des similitudes et des différences intéressantes. Plus spécifiquement, nous nous sommes concentrés sur l'argument auquel le rire est associé (le *laughable*) comme base selon laquelle déduire la fonction du rire. Nous distinguons les *laughables* qui contiennent des incongruités et ceux qui n'en contiennent pas. En détail, nous observons ensuite trois différents types d'incongruités qui peuvent s'appliquer au rire : plaisante (humour), sociale (conflit entre les normes sociales/le confort de l'interlocuteur et les situations actuelles) et pragmatique (conflit entre ce qui est dit et ce qui est voulu, indiquant à l'interlocuteur qu'il doit envisager l'interprétation la moins probable). Dans le cas où aucune incongruité ne peut être identifiée, le *laughable* semble être associé à un sentiment d'amitié et de proximité ressenti ou montré vers l'interlocuteur. Les différentes fonctions du rire découlent de ces grandes catégories: il peut être utilisé pour indiquer que le locuteur prend

plaisir à relever une incongruité, pour la signaler à l'interlocuteur, pour adoucir une assertion, pour induire de l'indulgence, pour atténuer un désaccord, pour indiquer la nécessité de choisir une interprétation non littérale d'une énoncé ou simplement pour démontrer son affiliation.

L'argument de la prédication du rire peut être soit un événement exophorique, soit quelque chose qui se produit dans l'interaction (par exemple la dénotation d'un énoncé, une contribution non verbale, un acte de dialogue, *etc*.) Notre étude de corpus montre que contrairement à ce qui est communément supposé, le rire peut non seulement se produire après son argument. Nous observons en fait un alignement assez libre entre le rire et son *laughable*, c'est-à-dire que le rire peut se produire après, cas le plus fréquent, mais aussi pendant ou avant le *laughable* auquel il est associé. Cette observation invalide l'hypothèse de contiguïté séquentielle, rappelant plutôt des modèles comme ceux observés pour le geste manuel par rapport à la parole (Rieser, 2015; Alahverdzhieva, Lascarides, and Flickinger, 2018). Nos résultats remettent en question l'hypothèse selon laquelle le rire porte toujours sur ce qu'il suit, et donc les affirmations antérieures fondées sur cette hypothèse. De plus, nous avons également observé une assez grande flexibilité dans le chevauchement entre la parole et le rire. Il est intéressant de noter que lorsque le rire se superpose à la parole, il n'est pas toujours en relation avec le discours qui est co-produit. Nous avons montré que le rire peut affecter le sens de l'énoncé et dans certaines de ses utilisations, à quel point son positionnement est crucial pour la bonne transmission du sens voulu. (Chapitre 3). Notre observation concernant le positionnement du rire par rapport au *laughable* et au discours favorise l'idée que le rire appartient à un canal parallèle indépendant de la parole, et que les deux canaux interagissent de façon multimodale pour transmettre un sens.

Dans nos données, 90% des cas de rires se rapportent à une incongruité, 70% d'entre eux constituent ce que nous appelons *une incongruité plaisante* alors que 20% environ sont de nature sociale. Étant donné les différences entre les corpus et même entre les différentes parties de ceux-ci, il semble clair que ces distributions dépendent fortement du contexte et ne peuvent donc pas être utilisées pour faire des affirmations sur la nature du rire indépendamment du domaine. Néanmoins, sans négliger le rôle crucial du rire dans la gestion des interactions sociales, nos données remettent en question des affirmations générales précédentes selon lesquelles le rire est très rarement d'ordre humoristique et qu'il est la plupart du temps lié à des "commentaires banals", fonctionnant presque exclusivement comme un "lubrifiant social" (Provine, 1993; Provine, 1996).

Dans le **Chapitre 4**, je présent une étude de corpus portant spécifiquement sur les questions que les interlocuteurs posent afin de clarifier le sens et les arguments du rire. Je les utilise comme outil diagnostic pour déterminer les composantes dont les interlocuteurs ont besoin pour interpréter le sens du rire.

Dans ce chapitre, je présente des preuves à l'appui de l'idée selon laquelle le rire

a un contenu propositionnel, en analysant à la fois les demandes d'éclaircissements qui surviennent après des éclats de rire et les corrections après le rire d'un interlocuteur, qui signalent une mauvaise interprétation de la contribution précédente. En utilisant les demandes de clarification comme outil diagnostique, j'ai distingué différents éléments constitutifs du rire et nécessaires à son interprétation, notamment le *laughable* (avec ses composantes) et l'*arousal* (niveau d'excitation). Le type de demandes d'éclaircissements que l'on trouve dans les corpus confirme donc la structure de base de notre modélisation de la signification du rire proposé dans les chapitres précédents. Nous proposons l'hypothèse qu'il existe des restrictions quant à la forme que peuvent prendre les demandes d'éclaircissements peuvent prendre selon le type de rire. Cette hypothèse doit être étudiée expérimentalement. Je propose également des hypothèses provisoires sur la façon dont le contexte social pourrait avoir une incidence sur les occurrences de demandes d'éclaircissements relatives au rire. Des données sur la relation entre le sourire et le rire sont également fournies, ce qui suggère la possibilité que, dans certains cas, le sourire et le rire peuvent être considérés comme des signaux sociaux non-verbaux qui peuvent véhiculer la même signification sur une échelle graduée en fonction de l'intensité. Cela donne à penser qu'il est nécessaire d'enquêter sur les cas où une telle graduation de sensn'est pas mise en évidence. De plus, le fait que dans les deux corpus analysés, on trouve des demandes d'éclaircissements liés au sourire tels que "Qu'est-ce qui te fait sourire ?" "Pourquoi souriez-vous ?", suggère que nos affirmations sur le rire comme ayant un contenu propositionnel et fonctionnant comme un prédicat d'événement qui nécessite un argument contextuel, peut également être généralisé à d'autres types de signaux sociaux non-verbaux (par exemple: sourire et froncer les sourcils).

Dans le **Chapitre 5** nous proposons une représentation formelle de la manière dont la prédication du rire pourrait être intégrée dans un cadre dynamique pour la modélisation du dialogue: KoS (Ginzburg, 2012). Nous proposons une formalisation des arguments auxquels il peut être associé, des manières dont les incongruités émergent dans le contexte et comment les interlocuteurs peuvent faire des inférences sur des productions de rire.

Le rire peut servir de nombreuses fonctions différentes dans l'interaction et certains chercheurs soutiennent qu'existe une correspondance entre forme et fonction. Le **Chapitre 6** cherche à établir si cette hypothèse se vérifie lorsque les paramètres relatifs aux autres niveaux d'analyse sont maintenus constants, en effectuant une comparaison d'analyse acoustique entre des rires similaires en tout sauf en leur fonction pragmatique. Une telle analyse pourrait avoir des implications importantes tant pour la mise en place de systèmes de dialogue efficaces dans l'interprétation et la production des rires que pour les traitements thérapeutiques. Qui plus est, elle permet de savoir si, d'un point de vue neuro-psychologique, le contexte est un facteur

important dans l'interprétation des fonctions du rire ou si les locuteurs peuvent simplement se fier à des caractéristiques de niveau "inférieur" comme l'acoustique. Sur la base de notre analyse acoustique et de notre classification sémantique et pragmatique (Chapitre 2), nous avons trouvé des preuves de l'absence d'une correspondance fiable forme-fonction. L'analyse statistique des données d'annotation du corpus suggère qu'aucune des fonctions ne peut être prédite de manière fiable à partir d'un seul facteur de notre analyse, mais qu'il s'agit plutôt d'un ensemble spécifique de caractéristiques qui distinguent les différentes fonctions dans les langues analysées. De plus, certaines similitudes ont été observées d'une langue à l'autre, surtout lorsque le contexte était maintenu constant (i.e. le corpus DUEL (Hough et al., 2016)), ce qui nous permet de supposer que certaines caractéristiques du rire ne sont pas fortement influencées par la langue parlée et la culture d'origine. Nos données soutiennent donc l'hypothèse que le processus de dérivation des différentes fonctions du rire, surtout lorsque l'*arousal* est gardé constant, est fondé sur un raisonnement contextuel, et que l'acoustique seule, bien qu'étant un facteur important, ne suffit pas à en déduire l'effet visé sur le discours.

Toujours dans le but d'explorer les processus neuro-psychologiques impliqués dans l'interprétation du rire dans différentes fonctions, j'ai mené une étude pilote en neuro-imagerie (**Chapitre 7**). La principale question était de savoir si les différents usages du rire pouvaient différer dans leur complexité pragmatique en perception, certains nécessitant plus de mentalisation que d'autres. Cette hypothèse est basée sur les résultats récents d'études de perception du rire en neuro-imagerie (McGettigan et al., 2013) et sur des données relatives à l'utilisation et à la compréhension atypiques du rire dans des populations où les capacités pragmatiques sont généralement particulièrement minées (par ex. autisme et schizophrénie) (Reddy, Williams, and Vaughan, 2002; Samson, 2013; Polimeni and Reiss, 2006; Hudenko, Stone, and Bachorowski, 2009).

Sur ce point, nous ne pouvons pas donner de réponse définitive, cela nécessiterait un échantillon plus important et des améliorations considérables dans la conception et la procédure de l'étude de neuro-imagerie. Nous avons toutefois obtenu des données encourageantes qui pourraient soutenir cette hypothèse, mais d'autres études sont nécessaires. Dans le cadre de notre étude comportementale, nous pouvons néanmoins conclure que les arguments du rire sont assez simples à résoudre pour les adultes typiques et que, lorsqu'on demande explicitement aux participants, totalement naïfs par rapport à notre cadre multi-couches, de classifier l'argument du rire, ils sont fortement influencés par ses caractéristiques perceptives et accordent davantage de valeur à la spontanéité du signal non- verbal qu'à son argument.

Enfin, ayant établi un point de référence pour l'utilisation sophistiquée du rire chez les adultes, j'explore comment les complexités observées dans l'interprétation et la production du rire pourraient se développer chez les enfants et s'il est possible

en tirer des hypothèses sur l'évolution du rire. Au **Chapitre 8**, je présente une étude longitudinale détaillée de l'utilisation du rire dans l'interaction mère-enfant de 12 à 36 mois, d'un point de vue sémantique et pragmatique.

Notre étude de corpus montre qu'il existe des différences très importantes dans l'utilisation du rire chez les enfants et les adultes, et qu'il a un développement considérable entre 12 et 36 mois d'âge. Les différences avec les adultes et les changements observables concernent toutes les couches d'analyse considérées : forme, positionnement par rapport à la parole, les rires des autres et les *laughables*. Les changements observés peuvent être interprétés comme un miroir du développement cognitif, linguistique, attentionnel et pragmatique. Il est étonnant de constater que les types de *laughables* des enfants varient au fil du temps convenant avec des données phylogénétiques. Chez les primates, le rire est utilisé pour marquer la présence et l' appréciation d'une incongruité avec le partenaire interactionnel (Ross, Owren, and Zimmermann, 2010; Vettin and Todt, 2005), qui pourrait être glosée "Ce n'est pas un attaque, c'est du jeux ! Et c'est amusant avec toi !" Chez les enfants à partir de 24 mois, on observe ensuite une utilisation du rire non attestée chez les primates (Gervais and Wilson, 2005; Owren and Bachorowski, 2001; Davila-Ross et al., 2011), c'est-à-dire un rire utilisé lorsqu'aucune incongruité ne peut être détectée, exclusivement pour montrer une affiliation et une proximité avec le partenaire interactionnel. Il semble que l'effet social positif du rire dans l'interaction ludique incongrue se soit abstrait pour être utilisé dans des contextes où il n'y a aucune incongruité. Enfin, vers l'âge de 36 mois, on observe la cooptation de l'utilisation du rire la plus éloignée de celle observée chez les primates. Le rire est maintenant aussi utilisé en relation avec des incongruités qui ne sont pas agréables, mais plutôt désagréables, c'est-à-dire la violation des normes sociales et du confort, ce qui pourrait perturber l'interaction sociale. Le rire, signe distinctif de la gaieté et du plaisir, commence à se manifester par rapport aux circonstances désagréables. Je spécule que la raison de cette transposition est de rendre les circonstances désagréables moins mauvaises à la fois pour le rieur et l'interlocuteur, rassurant sur la proximité ou dans certains cas visant à l'atteindre. Je crois que chaque cooptation observée dans l'utilisation du rire reflète un processus complexe d'un point de vue socio-pragmatique : c'est-à-dire la conscience que nos comportements ont un effet sur le partenaire, l'harmonisation avec les conventions sociales, la conscience que les autres peuvent être affectés négativement par nos actions et l'intention de les éviter.

Pour résumer, les travaux présentés proposent les hypothèses suivantes, en les soutenant par des données empiriques :

1. Une analyse précise et informative du rire, capable d'unifier de manière compréhensive les connaissances de différents domaines, doit distinguer différents niveaux, comme dans l'étude de la linguistique traditionnelle : la forme, le positionnement, la sémantique, les fonctions et les effets pragmatiques sur le dialogue, sur les interactions et sur les relations entre interlocuteurs ;

2. Le rire a un contenu propositionnel qui interagit avec le contenu linguistique ;

3. L'interprétation des fonctions du rire ne peut s'appuyer exclusivement sur les caractéristiques acoustiques du rire, mais implique un raisonnement pragmatique plus complexe nécessitant la prise en compte du contexte ainsi que des inférences sur les états attentionnels, émotionnels et intentionnels des autres ;

4. L'interprétation de différentes types de rire implique l'engagement de différent circuits neuronaux ;

5. L'utilisation sophistiquée du rire, au niveau pragmatique, observée chez les adultes n'est pas innée, mais évolue dans l'interaction et subit un développement important, offrant un aperçu sur le développement cognitif de l'enfant et sur l'évolution-même du rire. L'observation de l'utilisation du rire dans la petite enfance peut donc être informatif quant au développement de processus neuro-psychologiques spécifiques et, une fois analysée en détail, pourrait être utilisée comme marqueur précoce du développement communicatif, social et pragmatique.

Bibliography

Adams, Dawn et al. (2015). "Brief report: a longitudinal study of excessive smiling and laughing in children with Angelman syndrome". In: *Journal of autism and developmental disorders* 45.8, pp. 2624–2627.

Addyman, Caspar et al. (2018). "Social facilitation of laughter and smiles in preschool children". In: *Frontiers in psychology* 9, p. 1048.

Akhtar, Nameera, Frances Dunham, and Philip J Dunham (1991). "Directive interactions and early vocabulary development: The role of joint attentional focus". In: *Journal of child language* 18.1, pp. 41–49.

Alahverdzhieva, Katya, Alex Lascarides, and Dan Flickinger (2018). "Aligning speech and co-speech gesture in a constraint-based grammar". In: *Journal of Language Modelling* 5.3, pp. 421–464.

Andrews, Janet et al. (1986). "Children's abilities to distinguish metaphoric and ironic utterances from mistakes and lies." In: *Communication & Cognition*.

Apte, Mahadev L (1985). *Humor and laughter: An anthropological approach*. Cornell University Press.

Argyle, M (1988). "Social cognition and social interaction". In: *The Psychologist* 1.5, pp. 177–83.

Arthurs, OJ and SJ Boniface (2003). "What aspect of the fMRI BOLD signal best reflects the underlying electrophysiology in human somatosensory cortex?" In: *Clinical Neurophysiology* 114.7, pp. 1203–1209.

Artstein, Ron and Massimo Poesio (2008). "Inter-coder agreement for computational linguistics". In: *Computational Linguistics* 34.4, pp. 555–596.

Astington, Janet Wilde and Jennifer M Jenkins (1999). "A longitudinal study of the relation between language and theory-of-mind development." In: *Developmental psychology* 35.5, p. 1311.

Attardo, S. (1994). *Linguistic theories of humor*. Vol. 1. Walter de Gruyter.

Attardo, Salvatore, Christian F Hempelmann, and Sara Di Maio (2002). "Script oppositions and logical mechanisms: Modeling incongruities and their resolutions". In: *Humor* 15.1, pp. 3–46.

Attardo, Salvatore and Victor Raskin (1991). "Script theory revis (it) ed: Joke similarity and joke representation model". In: *Humor-International Journal of Humor Research* 4.3-4, pp. 293–348.

Bachorowski, Jo-Anne and Michael J Owren (2001). "Not all laughs are alike: Voiced but not unvoiced laughter readily elicits positive affect". In: *Psychological Science* 12.3, pp. 252–257.

Bachorowski, Jo-Anne and Michael J Owren (2002). "Vocal acoustics in emotional intelligence." In: *Emotions and social behavior. The wisdom in feeling: Psychological processes in emotional intelligence*, pp. 11–36.

Bachorowski, Jo-Anne, Moria J Smoski, and Michael J Owren (2001). "The acoustic features of human laughter". In: *The Journal of the Acoustical Society of America* 110.3, pp. 1581–1597.

Baillargeon, Renee, Elizabeth S Spelke, and Stanley Wasserman (1985). "Object permanence in five-month-old infants". In: *Cognition* 20.3, pp. 191–208.

Bainum, Charlene K, Karen R Lounsbury, and Howard R Pollio (1984). "The development of laughing and smiling in nursery school children". In: *Child Development*, pp. 1946–1957.

Banning, Mary Rus and David L Nelson (1987). "The effects of activity-elicited humor and group structure on group cohesion and affective responses". In: *American Journal of Occupational Therapy* 41.8, pp. 510–514.

Bard, Kim A (2007). "Neonatal imitation in chimpanzees (Pan troglodytes) tested with two paradigms". In: *Animal Cognition* 10.2, pp. 233–242.

Baron-Cohen, Simon (1989). "Perceptual role taking and protodeclarative pointing in autism". In: *British Journal of Developmental Psychology* 7.2, pp. 113–127.

— (1991). "Precursors to a theory of mind: Understanding attention in others". In: *Natural theories of mind: Evolution, development and simulation of everyday mindreading* 1, pp. 233–251.

— (1997). *Mindblindness: An essay on autism and theory of mind*. MIT press.

Baron-Cohen, Simon, Alan M Leslie, and Uta Frith (1985). "Does the autistic child have a "theory of mind"?" In: *Cognition* 21.1, pp. 37–46.

Barr, Dale J. et al. (2013). "Random effects structure for confirmatory hypothesis testing : Keep it maximal". In: *Journal of Memory and Language* 44, pp. 255–278.

Barrett, Lisa Feldman and James A Russell (1999). "The structure of current affect: Controversies and emerging consensus". In: *Current directions in psychological science* 8.1, pp. 10–14.

Barwise, Jon and John Etchemendy (1987). *The Liar*. New York: Oxford University Press.

Barwise, Jon and John Perry (1983). *Situations and Attitudes*. Bradford Books. Cambridge: MIT Press.

Bastin, Coralie et al. (2016). "Feelings of shame, embarrassment and guilt and their neural correlates: A systematic review". In: *Neuroscience & Biobehavioral Reviews* 71, pp. 455–471.

Bates, Douglas et al. (2015a). *lme4: Linear mixed-effects models using 'Eigen' and S4: Version 1.1-9*.

Bates, Douglas et al. (2015b). "Parsimonious mixed models". In: *arXiv preprint arXiv: 1506.04967*.

Bates, Elizabeth, Luigia Camaioni, and Virginia Volterra (1975). "The acquisition of performatives prior to speech." In: *Merrill-Palmer Quarterly*.

Batliner, Anton et al. (2010). "On laughter and speech laugh, based on observations of child-robot interaction". In: *The phonetics of laughing, trends in linguistics. de Gruyter, Berlin*.

Bavelas, Janet Beavin and Nicole Chovil (2000). "Visible acts of meaning: An integrated message model of language in face-to-face dialogue". In: *Journal of Language and social Psychology* 19.2, pp. 163–194.

Bays, Paul M, J Randall Flanagan, and Daniel M Wolpert (2006). "Attenuation of self-generated tactile sensations is predictive, not postdictive". In: *PLoS biology* 4.2, e28.

Bekinschtein, Tristan A et al. (2011). "Why clowns taste funny: the relationship between humor and semantic ambiguity". In: *Journal of Neuroscience* 31.26, pp. 9665–9671.

Bell, Emma and Jane Davison (2013). "Visual management studies: Empirical and theoretical approaches". In: *International Journal of Management Reviews* 15.2, pp. 167–184.

Bergen, Doris (2003). "Humor, play, and child development". In: *Humor in children's lives: A guidebook for practitioners*, pp. 17–32.

Bergson, Henri (1901). *Le rire: essai sur la signification du comique*. F. Alcan.

Berk, Ronald A (2001). "The active ingredients in humor: Psychophysiological benefits and risks for older adults". In: *Educational Gerontology* 27.3-4, pp. 323–339.

Berndt, Rita Sloan et al. (1997). "Verb retrieval in aphasia. 2. Relationship to sentence processing". In: *Brain and language* 56.1, pp. 107–137.

Bernstein, Deena Kahan, Ellenmorris Tiegerman-Farber, and Ellenmorris Tiegerman-Farber (1993). *Language and communication disorders in children*. Merrill.

Berridge, Kent C and Terry E Robinson (2003). "Parsing reward". In: *Trends in neurosciences* 26.9, pp. 507–513.

Berthoz, S et al. (2002). "An fMRI study of intentional and unintentional (embarrassing) violations of social norms". In: *Brain* 125.8, pp. 1696–1708.

Blair, Robert James R (2005). "Responding to the emotions of others: dissociating forms of empathy through the study of typical and psychiatric populations". In: *Consciousness and cognition* 14.4, pp. 698–718.

Blakemore, Sarah-J, Daniel M Wolpert, and Chris D Frith (1998). "Central cancellation of self-produced tickle sensation". In: *Nature neuroscience* 1.7, p. 635.

Blakemore, Sarah-Jayne, Daniel Wolpert, and Chris Frith (2000). "Why can't you tickle yourself?" In: *Neuroreport* 11.11, R11–R16.

Boersma, Paul et al. (2002). "Praat, a system for doing phonetics by computer". In: *Glot international* 5.9/10, pp. 341–345.

Bourgeois, Patrick and Ursula Hess (2008). "The impact of social context on mimicry". In: *Biological psychology* 77.3, pp. 343–352.

Bowlby, J (1969). "Attachment and loss v. 3 (Vol. 1)". In: *Random House. Furman, W., & Buhrmester, D.(2009). Methods and measures: The network of relationships inventory:*

Behavioral systems version. International Journal of Behavioral Development 33, pp. 470–478.

Boxer, Diana and Florencia Cortés-Conde (1997). "From bonding to biting: Conversational joking and identity display". In: *Journal of Pragmatics* 27.3, pp. 275–294.

Brainard, David H and Spatial Vision (1997). "The psychophysics toolbox". In: *Spatial vision* 10, pp. 433–436.

Breitholtz, Ellen (2014). "Enthymemes in Dialogue: A micro-rhetorical approach". PhD thesis. University of Gothenburg.

Breitholtz, Ellen and Robin Cooper (2011). "Enthymemes as rhetorical resources". In: *Proceedings of the 15th Workshop on the Semantics and Pragmatics of Dialogue (SemDial 2011), Los Angeles (USA)*. Citeseer, pp. 149–157.

Brown, Penelope and Stephen C Levinson (1987). *Politeness: Some universals in language usage*. Vol. 4. Cambridge university press.

Brown, Roger (1973). *A first language: The early stages.* Harvard U. Press.

Brugman, Hennie and Albert Russel (2004). "Annotating Multi-media/ Multi-modal Resources with ELAN." In: *LREC*.

Bryant, Gregory A (2010). "Prosodic contrasts in ironic speech". In: *Discourse Processes* 47.7, pp. 545–566.

— (2011). "Verbal irony in the wild". In: *Pragmatics & Cognition* 19.2, pp. 291–309.

Bryant, Gregory A and C Athena Aktipis (2014). "The animal nature of spontaneous human laughter". In: *Evolution and Human Behavior* 35.4, pp. 327–335.

Bryant, Gregory A and Jean E Fox Tree (2002). "Recognizing verbal irony in spontaneous speech". In: *Metaphor and symbol* 17.2, pp. 99–119.

Buckley, Belinda (2012). *Children's communication skills: from birth to five years*. Routledge.

Buitelaar, Jan K et al. (1999). "Verbal memory and performance IQ predict theory of mind and emotion recognition ability in children with autistic spectrum disorders and in psychiatric control children". In: *The Journal of Child Psychology and Psychiatry and Allied Disciplines* 40.6, pp. 869–881.

Burnard, Lou (2000). *Reference guide for the british national corpus (world edition)*.

Bush, Lauren K et al. (1989). "The effects of facial control and facial mimicry on subjective reactions to comedy routines". In: *Motivation and emotion* 13.1, pp. 31–52.

Byrne, Richard W (2003). "Imitation as behaviour parsing". In: *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences* 358.1431, pp. 529–536.

Cai Qing ans Chen, Sinead, Sarah J. White, and Sophie K. Scott (2019). "Modulation of humor ratings of bad jokes by other people's laughter". In: *Current biology* 29.14, R677–R678.

Camaioni, Luigia (1992). "Mind knowledge in infancy: The emergence of intentional communication". In: *Early Development and Parenting* 1.1, pp. 15–22.

Campbell, Darren W et al. (2015). "The neural basis of humour comprehension and humour appreciation: The roles of the temporoparietal junction and superior frontal gyrus". In: *Neuropsychologia* 79, pp. 10–20.

Campbell, Nick, Hideki Kashioka, and Ryo Ohara (2005). "No laughing matter". In: *Ninth European Conference on Speech Communication and Technology*.

Campbell, Ruth (1999). "Categorical perception of face actions: Their role in sign language and in communicative facial displays". In: *The Quarterly Journal of Experimental Psychology: Section A* 52.1, pp. 67–95.

Cannizzaro, Michael S et al. (2016). "Prefrontal Cortical Activity During Discourse Processing". In: *Topics in Language Disorders* 36.1, pp. 65–79.

Caron, James E (2002). "From ethology to aesthetics: Evolution as a theoretical paradigm for research on laughter, humor, and other comic phenomena". In: *Humor* 15.3, pp. 245–282.

Carpenter, Malinda, Nameera Akhtar, and Michael Tomasello (1998). "Fourteen-through 18-month-old infants differentially imitate intentional and accidental actions". In: *Infant behavior and development* 21.2, pp. 315–330.

Carpenter, Malinda et al. (1998). "Social cognition, joint attention, and communicative competence from 9 to 15 months of age". In: *Monographs of the society for research in child development*, pp. i–174.

Carré, Arnaud et al. (2015). "Tracking social motivation systems deficits: the affective neuroscience view of autism". In: *Journal of autism and developmental disorders* 45.10, pp. 3351–3363.

Caruana, Fausto (2017). "Laughter as a neurochemical mechanism aimed at reinforcing social bonds: Integrating evidence from opioidergic activity and brain stimulation". In: *Journal of Neuroscience* 37.36, pp. 8581–8582.

Cashon, Cara H and Leslie B Cohen (2000). "Eight-month-old infants' perception of possible and impossible events". In: *Infancy* 1.4, pp. 429–446.

Chafe, Wallace L (2007). *The importance of not being earnest: The feeling behind laughter and humor*. Vol. 3. John Benjamins Publishing.

Chan, Yu-Chen et al. (2016). "Neural correlates of hostile jokes: cognitive and motivational processes in humor appreciation". In: *Frontiers in human neuroscience* 10, p. 527.

Chapman, Antony J (1975). "Humorous laughter in children." In: *Journal of Personality and Social Psychology* 31.1, p. 42.

Chapman, Antony J and Derek S Wright (1976). "Social enhancement of laughter: An experimental analysis of some companion variables". In: *Journal of Experimental Child Psychology* 21.2, pp. 201–218.

Charman, Tony et al. (2000). "Testing joint attention, imitation, and play as infancy precursors to language and theory of mind". In: *Cognitive development* 15.4, pp. 481–498.

Chaspari, Theodora et al. (2012). "An acoustic analysis of shared enjoyment in ECA interactions of children with autism". In: *2012 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE, pp. 4485–4488.

Cheang, Henry S and Marc D Pell (2009). "Acoustic markers of sarcasm in Cantonese and English". In: *The Journal of the Acoustical Society of America* 126.3, pp. 1394–1405.

Choi, Bernard CK and Anita WP Pak (2006). "Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness". In: *Clinical and investigative medicine* 29.6, p. 351.

Choi, Soonja (2000). "Caregiver input in English and Korean: Use of nouns and verbs in book-reading and toy-play contexts". In: *Journal of Child Language* 27.1, pp. 69–96.

Chomsky, Noam (1980). "Rules and representations". In: *Behavioral and brain sciences* 3.1, pp. 1–15.

Clark, Herbert (1996). *Using Language*. Cambridge: Cambridge University Press.

Claxton, Guy (1975). "Why can't we tickle ourselves?" In: *Perceptual and Motor Skills* 41.1, pp. 335–338.

Coates, Jennifer (2007). "Talk in a play frame: More on laughter and intimacy". In: *Journal of Pragmatics* 39.1, pp. 29–49.

Cohn, Jeffrey F and Edward Z Tronick (1987). "Mother–infant face-to-face interaction: The sequence of dyadic states at 3, 6, and 9 months." In: *Developmental psychology* 23.1, p. 68.

Coles, Nicholas A et al. (2019). "The Many Smiles Collaboration: A Multi-Lab Foundational Test of the Facial Feedback Hypothesis". In: *PsyArXiv PrePrints*.

Collis, Glyn M (1985). "On the origins of turn-taking: Alternation and meaning". In: *Children's single-word speech*, pp. 217–230.

Conroy, Paul, Karen Sage, and Matthew A Lambon Ralph (2006). "Towards theory-driven therapies for aphasic verb impairments: A review of current theory and practice". In: *Aphasiology* 20.12, pp. 1159–1185.

Cooper, Robin (2005). "Austinian truth, attitudes and type theory". In: *Research on Language and Computation* 3.4, pp. 333–362.

— (2012). "Type Theory and Semantics in Flux". In: *Handbook of the Philosophy of Science*. Ed. by Ruth Kempson, Nicholas Asher, and Tim Fernando. Vol. 14: Philosophy of Linguistics. Amsterdam: Elsevier.

— (2016). *Type Theory and Language: From perception to linguistic communication*. Book Draft.

Cooper, Robin and Jonathan Ginzburg (2015). "Type Theory with Records for NL Semantics". In: *Handbook of Contemporary Semantic Theory, Second Edition*. Ed. by Chris Fox and Shalom Lappin. Oxford: Blackwell, pp. 375–407.

Cooper, Robin and Massimo Poesio (1994). "Situation Theory". In: *Fracas Deliverable D8*. Centre for Cognitive Science, Edinburgh: The Fracas Consortium.

Cosentino, Sarah, Salvatore Sessa, and Atsuo Takanishi (2016). "Quantitative laughter detection, measurement, and classification—A critical survey". In: *IEEE Reviews in Biomedical engineering* 9, pp. 148–162.

Crivelli, Carlos and Alan J Fridlund (2019). "Inside-out: From basic emotions theory to the behavioral ecology view". In: *Journal of Nonverbal Behavior* 43.2, pp. 161–194.

Crystal, David (1976). *Prosodic systems and intonation in English*. Vol. 1. CUP Archive.

Cundall Jr, Michael K (2007). "Humor and the limits of incongruity". In: *Creativity Research Journal* 19.2-3, pp. 203–211.

Cunningham, J (2005). "Children's humor". In: *Children's play. SAGE publications*.

Curran, William et al. (2017). "Social Context Disambiguates the Interpretation of Laughter". In: *Frontiers in Psychology* 8, p. 2342.

Dachkovsky, Svetlana and Wendy Sandler (2009). "Visual intonation in the prosody of a sign language". In: *Language and Speech* 52.2-3, pp. 287–314.

Darwin, Charles (1872). "The expression of the emotions in man and animals Chicago: University of Chicago". In: *Original work published*.

— (1877). "A biographical sketch of an infant". In: *Mind* 2.7, pp. 285–294.

Darwin, Charles and Phillip Prodger (1998). *The expression of the emotions in man and animals*. Oxford University Press, USA.

David, Florence Nightingale (1938). *Tables of the Correlation Coefficient*.

Davila Ross, Marina, Susanne Menzler, and Elke Zimmermann (2007). "Rapid facial mimicry in orangutan play". In: *Biology letters* 4.1, pp. 27–30.

Davila-Ross, Marina et al. (2011). "Aping expressions? Chimpanzees produce distinct laugh types when responding to laughter of others." In: *Emotion* 11.5, p. 1013.

De Villiers, Jill G and Peter A De Villiers (1973). "A cross-sectional study of the acquisition of grammatical morphemes in child speech". In: *Journal of psycholinguistic research* 2.3, pp. 267–278.

De Waal, Frans BM (1986). "The integration of dominance and social bonding in primates". In: *The Quarterly review of biology* 61.4, pp. 459–479.

Degabriele, James and Irene P Walsh (2010). "Humour appreciation and comprehension in children with intellectual disability". In: *Journal of Intellectual Disability Research* 54.6, pp. 525–537.

Del Ré, Alessandra, Christelle Dodane, and Aliyah Morgenstern (2014). *De l'amusement partagé à la production de l'humour chez l'enfant*.

Demuth, Katherine, Jennifer Culbertson, and Jennifer Alter (2006). "Word-minimality, epenthesis and coda licensing in the early acquisition of English". In: *Language and Speech* 49.2, pp. 137–173.

Devereux, Paul G and Gerald P Ginsburg (2001). "Sociality effects on the production of laughter". In: *The Journal of General Psychology* 128.2, pp. 227–240.

Devillers, Laurence and Laurence Vidrascu (2007). "Positive and negative emotional states behind the laughs in spontaneous spoken dialogs". In: *Interdisciplinary workshop on the phonetics of laughter*, p. 37.

Dezecache, Guillaume and Robin IM Dunbar (2012). "Sharing the joke: the size of natural laughter groups". In: *Evolution and Human Behavior* 33.6, pp. 775–779.

Dupont, Stéphane et al. (2016). "Laughter research: a review of the ILHAIRE project". In: *Toward Robotic Socially Believable Behaving Systems-Volume I*. Springer, pp. 147–181.

Dweck, Carol S (2013). *Self-theories: Their role in motivation, personality, and development*. Psychology press.

Ekman, Paul and Wallace V Friesen (1975). *Unmasking the face: A guide to recognizing emotions from facial cues*.

Ekman, Rosenberg (1997). *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System (FACS)*. Oxford University Press, USA.

El Haddad, Kevin et al. (2016). "Laughter and Smile Processing for Human-Computer Interactions". In: *Just talking-casual talk among humans and machines, Portoroz, Slovenia*, pp. 23–28.

Elliott, Rebecca, Karl J Friston, and Raymond J Dolan (2000). "Dissociable neural responses in human reward systems". In: *Journal of neuroscience* 20.16, pp. 6159–6165.

Ellis, Yvette (1997). "Laughing together: Laughter as a feature of affiliation in French conversation". In: *Journal of French Language Studies* 7.2, pp. 147–161.

Elman, Jeffrey L, Elizabeth A Bates, and Mark H Johnson (1998). *Rethinking innateness: A connectionist perspective on development*. Vol. 10. MIT press.

Emerich, David M et al. (2003). "The comprehension of humorous materials by adolescents with high-functioning autism and Asperger's syndrome". In: *Journal of autism and developmental disorders* 33.3, pp. 253–257.

Everitt, Barry J and Trevor W Robbins (2013). "From the ventral to the dorsal striatum: devolving views of their roles in drug addiction". In: *Neuroscience & Biobehavioral Reviews* 37.9, pp. 1946–1954.

Fawcett, Christine and Ulf Liszkowski (2015). "Social referencing during infancy and early childhood across cultures". In: *International encyclopedia of the social & behavioral sciences*, pp. 556–562.

Feinman, Saul (2013). *Social referencing and the social construction of reality in infancy*. Springer Science & Business Media.

Fernald, Anne and Hiromi Morikawa (1993). "Common themes and cultural variations in Japanese and American mothers' speech to infants". In: *Child development* 64.3, pp. 637–656.

Fernández, Raquel (2006). "Non-Sentential Utterances in Dialogue: Classification, Resolution and Use". PhD thesis. King's College, London.

Filippova, Eva (2014). "Irony production and comprehension". In: *Pragmatic development in first language acquisition*, pp. 261–278.

Fodor, Jerry A (1992). "A theory of the child's theory of mind." In: *Cognition*.

Fogel, Alan (1982). "Social play, positive affect, and coping skills in the first 6 months of life". In: *Topics in Early Childhood Special Education* 2.3, pp. 53–65.

— (1990). "The process of developmental change in infant communicative action: Using dynamic systems theory to study individual ontogenies". In: *Individual differences in infancy: Reliability, stability, prediction*, pp. 341–358.

Foley, Erin, Robert Matheis, and Charles Schaefer (2002). "Effect of forced laughter on mood". In: *Psychological reports* 90.1, pp. 184–184.

Foot, Hugh C and Antony J Chapman (1976). "The social responsiveness of young children in humorous situations". In: *Humor and laughter: Theory, research, and applications*, pp. 187–214.

Freitas, Fernando A et al. (2017). "Grammatical facial expression recognition in sign language discourse: a study at the syntax level". In: *Information Systems Frontiers* 19.6, pp. 1243–1259.

Freud, Sigmund (1960). *Jokes and their relation to the unconscious*. WW Norton & Company.

Freud, Sigmund and Philip Rief (1963). "Freud: Character and culture". In: *New York: Collier*.

Fridlund, Alan J (1994). *Human facial expression: An evolutionary perspective*.

— (1997). "The new ethology of human facial expressions". In: *The psychology of facial expression* 103.

— (2014). *Human facial expression: An evolutionary view*. Academic Press.

Fridlund, Alan J and Jennifer M Loftis (1990). "Relations between tickling and humorous laughter: Preliminary support for the Darwin-Hecker hypothesis". In: *Biological Psychology* 30.2, pp. 141–150.

Frijda, Nico H and Anna Tcherkassof (1997). "Facial expressions as modes of action readiness". In: *The psychology of facial expression*, pp. 78–102.

Fry Jr, William F (2013). "The appeasement function of mirthful laughter". In: *It's a Funny Thing, Humour: Proceedings of The International Conference on Humour and Laughter 1976*. Elsevier, p. 23.

Fuchs, Susanne and Tamara Rathcke (2018). "Laugh is in the air? Physiological analysis of laughter as a correlate of attraction during speed dating". In: *Proceedings of Laughter Workshop*.

Führ, Martin (2002). "Coping humor in early adolescence". In: *Humor* 15.3, pp. 283–304.

Gamble, Jennifer (2001). *Humor in apes*.

Gelder, Beatrice de and Elisabeth MJ Huis In'T Veld (2016). "Cultural Differences in Emotional Expressions and Body Language". In: *The Oxford Handbook of Cultural Neuroscience*.

Gervain, Judit et al. (2011). "Near-infrared spectroscopy: a report from the McDonnell infant methodology consortium". In: *Developmental cognitive neuroscience* 1.1, pp. 22–46.

Gervais, Matthew and David Sloan Wilson (2005). "The evolution and functions of laughter and humor: A synthetic approach". In: *The Quarterly Review of Biology* 80.4, pp. 395–430.

Giganti, Fiorenza and Maria Esposito Ziello (2009). "Contagious and spontaneous yawning in autistic and typically developing children". In: *Current psychology letters. Behaviour, brain & cognition* 25.1, 2009.

Gilmartin, Emer et al. (2013). "Exploring the role of laughter in multiparty conversation". In: *Proceedings of the SemDial*, pp. 191–193.

Ginzburg, Jonathan (1994). "An Update Semantics for Dialogue". In: *Proceedings of the 1st International Workshop on Computational Semantics*. Ed. by H. Bunt. Tilburg: ITK, Tilburg University.

— (2012). *The Interactive Stance: Meaning for Conversation*. Oxford: Oxford University Press.

Ginzburg, Jonathan and Robin Cooper (2004a). "Clarification, Ellipsis, and the Nature of Contextual Updates". In: *Linguistics and Philosophy* 27.3, pp. 297–366.

— (2004b). "Clarification, ellipsis, and the nature of contextual updates in dialogue". In: *Linguistics and philosophy* 27.3, pp. 297–365.

Ginzburg, Jonathan and Raquel Fernández (2010). "Computational Models of Dialogue". In: *Handbook of Computational Linguistics and Natural Language*. Ed. by Alex Clark, Chris Fox, and Shalom Lappin. Oxford: Blackwell.

Ginzburg, Jonathan, Raquel Fernández, and David Schlangen (2014). "Disfluencies as Intra-Utterance Dialogue Moves". In: *Semantics and Pragmatics* 7.9, pp. 1–64.

Ginzburg, Jonathan, Chiara Mazzocconi, and Ye Tian (subm). "Laughter as Language". In:

Ginzburg, Jonathan and Massimo Poesio (2016). "Grammar Is a System That Characterizes Talk in Interaction". In: *Frontiers in Psychology* 7, p. 1938. ISSN: 1664-1078. URL: http://journal.frontiersin.org/article/10.3389/fpsyg.2016.01938.

Ginzburg, Jonathan and Ivan A. Sag (2000). *Interrogative Investigations: the form, meaning and use of English Interrogatives*. CSLI Lecture Notes 123. Stanford: California: CSLI Publications.

Ginzburg, Jonathan et al. (2015). "Understanding Laughter". In: *Proceedings of the 20th Amsterdam Colloquium*. University of Amsterdam.

Glenn, Phillip (2003). *Laughter in interaction*. Vol. 18. Cambridge University Press.

Glenn, Phillip and Elizabeth Holt (2013). *Studies of laughter in interaction*. A&C Black.

Godfrey, John J, Edward C Holliman, and Jane McDaniel (1992). "SWITCHBOARD: Telephone speech corpus for research and development". In: *Acoustics, Speech, and Signal Processing, 1992. ICASSP-92., 1992 IEEE International Conference on*. Vol. 1. IEEE, pp. 517–520.

Goel, Vinod and Raymond J Dolan (2001). "The functional anatomy of humor: segregating cognitive and affective components". In: *Nature neuroscience* 4.3, p. 237.

Goldin-Meadow, Susan and David McNeill (1999). *The role of gesture and mimetic representation in making language the province of speech*. na.

Goodhart, Frances and Simon Baron-Cohen (1993). "How many ways can the point be made? Evidence from children with and without autism". In: *First Language* 13.38, pp. 225–233.

Gopnik, Alison, Andrew N Meltzoff, and Patricia K Kuhl (1999). *The scientist in the crib: Minds, brains, and how children learn*. William Morrow & Co.

Gottfried, Gail M (1997). "Using metaphors as modifiers: children's production of metaphoric compounds". In: *Journal of Child Language* 24.3, pp. 567–601.

Gratch, Jonathan and Stacy Marsella (2004). "Technical details of a domain-independent framework for modeling emotion". In: *ICT tech report*.

Gregory, Joshua C (1924). *The nature of laughter*. Routledge.

Griffin, Harry J et al. (2013). "Laughter type recognition from whole body motion". In: *2013 Humaine Association Conference on Affective Computing and Intelligent Interaction*. IEEE, pp. 349–355.

Gruner, Charles R (1997). "The Game of Humour". In: *A Comprehensive Theory of Why We Laugh. New Jersey: Transaction*.

Gumperz, John J (1982). *Discourse strategies*. Vol. 1. Cambridge University Press.

Haakana, Markku (1999). "Laughing matters: A conversation analytical study of laughter in doctor-patient interaction". In: *Doctoral Thesis, University of Helsinki*.

— (2001). "Laughter as a patient's resource: Dealing with delicate aspects of medical interaction". In: *Text–Interdisciplinary Journal for the Study of Discourse* 21.1-2, pp. 187–219.

— (2002). "Laughter in medical interaction: From quantification to analysis, and back". In: *Journal of sociolinguistics* 6.2, pp. 207–235.

Hall, Suzanne et al. (2013). "Associations among play, gesture and early spoken language acquisition". In: *First Language* 33.3, pp. 294–312.

Happé, Francesca GE (1995). "The role of age and verbal ability in the theory of mind task performance of subjects with autism". In: *Child development* 66.3, pp. 843–855.

Hareli, Shlomo, Konstantinos Kafetsios, and Ursula Hess (2015). "A cross-cultural study on emotion expression and the learning of social norms". In: *Frontiers in psychology* 6, p. 1501.

Harkness, Sara (1990). "A cultural model for the acquisition of language: Implications for the innateness debate". In: *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology* 23.7, pp. 727–739.

Harris, Christine and Nancy Alvarado (2005). "Facial expressions, smile types, and self-report during humour, tickle, and pain". In: *Cognition & Emotion* 19.5, pp. 655–669.

Harris, Christine R (1999). "The mystery of ticklish laughter". In: *American Scientist* 87.4, p. 344.

Harris, Christine R and Nicholas Christenfeld (1997). "Humour, tickle, and the Darwin-Hecker hypothesis". In: *Cognition & Emotion* 11.1, pp. 103–110.

— (1999). "Can a machine tickle?" In: *Psychonomic bulletin & review* 6.3, pp. 504–510.

Harris, Margaret et al. (1986). "Relations between the non-verbal context of maternal speech and rate of language development". In: *British journal of developmental psychology* 4.3, pp. 261–268.

Hatfield, Elaine, John T Cacioppo, and Richard L Rapson (1994). "Emotional contagion". In: *Studies in Emotion and Social Interaction.*

Hay, Jennifer (2000). "Functions of humor in the conversations of men and women". In: *Journal of pragmatics* 32.6, pp. 709–742.

Hayakawa, Haruko (2003). "The meaningless laugh: Laughter in Japanese communication". PhD thesis. University of Sydney.

Hecker, Ewald (1873). *Die Physiologie und Psychologie des Lachens und des Komischen*.

Helt, Molly S, Deborah A Fein, and Jacob E Vargas (2019). "Emotional contagion in children with autism spectrum disorder varies with stimulus familiarity and task instructions". In: *Development and psychopathology*, pp. 1–11.

Hempelmann, Christian F and Salvatore Attardo (2011). "Resolutions and their incongruities: Further thoughts on logical mechanisms". In: *Humor-International Journal of Humor Research* 24.2, pp. 125–149.

Hepburn, Alexa and Scott Varney (2013). "Beyond ((laughter)): some notes on transcription". In: *Studies of Laughter in Interaction*. Ed. by Philip Glenn and Elizabeth Holt. Bloomsbury.

Hess, Ursula, Martin G Beaupré, Nicole Cheung, et al. (2002). "Who to whom and why–cultural differences and similarities in the function of smiles". In: *An empirical reflection on the smile* 4, p. 187.

Hobbes, Thomas (1994). "Leviathan, ed". In: *Edwin Curley (Indianapolis: Hackett, 1994)* 78.

Hoff, Erika (2006). "How social contexts support and shape language development". In: *Developmental review* 26.1, pp. 55–88.

Hofmann, Jennifer et al. (2015). "Individual differences in gelotophobia predict responses to joy and contempt". In: *Sage Open* 5.2, 1–12.

Hoicka, Elena (2014). "The pragmatic development of humor". In: *Pragmatic development in first language acquisition* 10, p. 219.

— (2016). "Parents and toddlers distinguish joke, pretend and literal intentional contexts through communicative and referential cues". In: *Journal of Pragmatics* 95, pp. 137–155.

Hoicka, Elena and Nameera Akhtar (2011). "Preschoolers joke with jokers, but correct foreigners". In: *Developmental Science* 14.4, pp. 848–858.

— (2012). "Early humour production". In: *British Journal of Developmental Psychology* 30.4, pp. 586–603.

Hoicka, Elena and Merideth Gattis (2008). "Do the wrong thing: How toddlers tell a joke from a mistake". In: *Cognitive Development* 23.1, pp. 180–190.

— (2012). "Acoustic differences between humorous and sincere communicative intentions." In: *The British journal of developmental psychology* 30 Pt 4, pp. 531–49.

Hoicka, Elena, Sarah Jutsum, and Merideth Gattis (2008). "Humor, abstraction, and disbelief". In: *Cognitive Science* 32.6, pp. 985–1002.

Hoicka, Elena and Su-hua Wang (2011). "Fifteen-month-old infants match vocal cues to intentional actions". In: *Journal of Cognition and Development* 12.3, pp. 299–314.

Hough, Julian et al. (2016). "DUEL: A Multi-lingual Multimodal Dialogue Corpus for Disfluency, Exclamations and Laughter". In: *10th edition of the Language Resources and Evaluation Conference*.

Hudenko, William J, Wendy Stone, and Jo-Anne Bachorowski (2009). "Laughter differs in children with autism: An acoustic analysis of laughs produced by children with and without the disorder". In: *Journal of autism and developmental disorders* 39.10, pp. 1392–1400.

Hudenko, William John (2004). "A Comparative Study of Laugh Acoustics in Children With and Without Autism". PhD thesis. Vanderbilt University.

Huppert, Theodore J et al. (2006). "A temporal comparison of BOLD, ASL, and NIRS hemodynamic responses to motor stimuli in adult humans". In: *Neuroimage* 29.2, pp. 368–382.

Iedema, Rick (2007). "On the multi-modality, materially and contingency of organization discourse". In: *Organization Studies* 28.6, pp. 931–946.

Iidaka, Tetsuya (2016). "Humor Appreciation Involves Parametric and Synchronized Activity in the Medial Prefrontal Cortex and Hippocampus". In: *Cerebral Cortex*.

Iwase, Masao et al. (2002). "Neural substrates of human facial expression of pleasant emotion induced by comic films: a PET study". In: *Neuroimage* 17.2, pp. 758–768.

James, William (1884). "What is an emotion?" In: *Mind* 9.34, pp. 188–205.

Jancsary, Dennis et al. (2017). "Institutions as multimodal accomplishments: Towards the analysis of visual registers". In: *Multimodality, Meaning, and Institutions*. Emerald Publishing Limited, pp. 87–117.

Jefferson, Gail (1984). "On the organization of laughter in talk about troubles". In: *Structures of social action: Studies in conversation analysis* 346, p. 369.

— (2004). "A note on laughter in 'male–female' interaction". In: *Discourse Studies* 6.1, pp. 117–133.

Jefferson, Gail, Harvey Sacks, and Emanuel Schegloff (1977). "Preliminary notes on the sequential organization of laughter". In: *Pragmatics Microfiche* 1, A2–D9.

Jin, Gulun (2018). "A Psychometric and Behavioural Study of the Experience of Laughter in Chinese". MA thesis. UK: UCL.

Jokinen, Kristiina and Katri Hiovan (2016). "Laughing and co-construction of common ground in human conversations". In: *The 4th European and 7th Nordic Symposium on Multimodal Communication (MMSYM 2016)*.

Jones, Stanley E and Curtis D LeBaron (2002). "Research on the relationship between verbal and nonverbal communication: Emerging integrations". In: *Journal of Communication* 52.3, pp. 499–521.

Jordan, Timothy R and Lily Abedipour (2010). "The importance of laughing in your face: Influences of visual laughter on auditory laughter perception". In: *Perception* 39.9, pp. 1283–1285.

Jung, Wonil Edward (2003). "The inner eye theory of laughter: Mindreader signals cooperator value". In: *Evolutionary Psychology* 1.1, pp. 214–253.

Kahneman, Daniel and Jason Riis (2005). "Living, and thinking about it : two perspectives on life". In: *The science of well-being*. Ed. by F.A. Huppert, N. Baylis, and B. Keverne. Oxford University Press, pp. 285–304.

Kant, Immanuel (1790a). "Critique of Judgment." In: *Trans. Werner S. Pluhar. Indianapolis: Hackett (1987)* 212.

— (1790b). "The critique of judgment, Bernard JH, trans". In: *Amherst, NY: Prometheus Books*.

Keltner, Dacher and George A Bonanno (1997). "A study of laughter and dissociation: distinct correlates of laughter and smiling during bereavement." In: *Journal of personality and social psychology* 73.4, p. 687.

Kempson, Ruth et al. (2016). "Language as Mechanisms for Interaction". In: *Theoretical Linguistics* 42.3-4, pp. 203–276.

Khudyakova, Mariya V and Mira B Bergelson (2015). "Interpretation of "embarrassement" laughter in narratives by people with aphasia and non-language-impaired speakers." In: *Proceedings of the 4th Interdisciplinary Workshop on Laughter and Other Non-verbal Vocalisations in Speech*. Vol. 14, p. 15.

Kierkegaard, Søren (1941). "Concluding Unscientific Postscript, trans. David F. Swenson". In: *Princeton, NJ: Princeton University Press* 317, pp. 25–26.

Kipper, Silke and Dietmar Todt (2003). "The role of rhythm and pitch in the evaluation of human laughter". In: *Journal of Nonverbal Behavior* 27.4, pp. 255–272.

Klin, Ami (2000). "Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger syndrome: the Social Attribution Task". In: *Journal of Child psychology and Psychiatry* 41.7, pp. 831–846.

Klin, Ami et al. (2002). "Visual fixation patterns during viewing of naturalistic social situations as predictors of social competence in individuals with autism". In: *Archives of general psychiatry* 59.9, pp. 809–816.

Klinnert, Mary D et al. (1983). "Emotions as behavior regulators: Social referencing in infancy". In: *Emotions in early development*. Elsevier, pp. 57–86.

Koestler, Arthur (1964). *The act of creation*. London Hutchinson.

Kohler, Klaus J (2008). "'Speech-smile','speech-laugh','laughter'and their sequencing in dialogic interaction". In: *Phonetica* 65.1-2, pp. 1–18.

Kousidis, Spyridon, Thies Pfeiffer, and David Schlangen (2013). "Mint. tools: Tools and adaptors supporting acquisition, annotation and analysis of multimodal corpora". In: *Proceedings of Interspeech 2013*.

Kozintsev, Alexander (2011). *The Mirror of laughter*. Vol. 1. Transaction Publishers.

Kress, Gunther and Theo Van Leeuwen (2001). *Multimodal discourse: The modes and media of contemporary communication*. Edward Arnold.

Krippendorff, Klaus (2012). *Content analysis: An introduction to its methodology*. Sage.

Krishan, Smriti, Jennifer Batchelor, and Melanie Porter (2017). "Humour comprehension and use of mental state language in William Syndrome and Down Syndrome". In: *Global J. Intellect. Dev. Disabil* 2.555594, pp. 10–19080.

Kuehne, Maria et al. (2019). "Out of Focus: Facial Feedback Manipulation Modulates Automatic Processing of Unattended Emotional Faces". In: *Journal of cognitive neuroscience*, pp. 1–10.

Kuhbandner, Christof and Michael Zehetleitner (Dec. 2011). "Dissociable Effects of Valence and Arousal in Adaptive Executive Control". In: *PLOS ONE* 6.12, pp. 1–8.

Kuiper, Nicholas A and Rod A Martin (1998). "Laughter and stress in daily life: Relation to positive and negative affect". In: *Motivation and emotion* 22.2, pp. 133–153.

Kuznetsova, Alexandra, Peter Bruun Brockhoff, and Rune Haubo Bojesen Christensen (2015). *lmerTest: Tests in Linear Mixed Effects Models: Version 2.0-33*.

LaGreca, Steve et al. (1996). "Laughter as interaction strategy: discursive and phonetic aspects". In: *Sociolinguistic Variation: Data, Theory, and Analysis: Selected Papers from NWAV 23 at Stanford*, pp. 313–332.

Lakin, Jessica L et al. (2003). "The chameleon effect as social glue: Evidence for the evolutionary significance of nonconscious mimicry". In: *Journal of nonverbal behavior* 27.3, pp. 145–162.

Larsson, Staffan (2002). "Issue based Dialogue Management". PhD thesis. Gothenburg University.

Laskowski, Kornel and Susanne Burger (2007). "Analysis of the occurrence of laughter in meetings." In: *INTERSPEECH*, pp. 1258–1261.

Laukka, Petri, Patrik Juslin, and Roberto Bresin (2005). "A dimensional approach to vocal expression of emotion". In: *Cognition & Emotion* 19.5, pp. 633–653.

Lavan, Nadine and Carolyn McGettigan (2016). "Increased discriminability of authenticity from multimodal laughter is driven by auditory information". In: *The Quarterly Journal of Experimental Psychology*, pp. 1–10.

Lavan, Nadine, Sophie K Scott, and Carolyn McGettigan (2016). "Laugh like you mean it: Authenticity modulates acoustic, physiological and perceptual properties of laughter". In: *Journal of Nonverbal Behavior* 40.2, pp. 133–149.

Lavan, Nadine et al. (2017). "Neural correlates of the affective properties of spontaneous and volitional laughter types". In: *Neuropsychologia* 95, pp. 30–39.

Lavan, Nadine et al. (2018). "Impoverished encoding of speaker identity in spontaneous laughter". In: *Evolution and Human Behavior* 39.1, pp. 139–145.

Leavens, David A (2009). "Animal communication: laughter is the shortest distance between two apes". In: *Current Biology* 19.13, R511–R513.

Lemaitre, Anne-Laure, Marion Luyat, and Gilles Lafargue (2016). "Individuals with pronounced schizotypal traits are particularly successful in tickling themselves". In: *Consciousness and cognition* 41, pp. 64–71.

Lennox, James G et al. (2002). *Aristotle: On the parts of animals*. Clarendon Press.

Lenth, Russell (2016). *lsmeans: Least-Squares Means: Version 2.25*.

Leuba, Clarence (1941). "Tickling and laughter: Two genetic studies". In: *The Pedagogical Seminary and Journal of Genetic Psychology* 58.1, pp. 201–209.

Lewis, David (1970). "General semantics". In: *Synthese* 22.1, pp. 18–67.

Liddell, Scott K (1978). "Nonmanual signals and relative clauses in American Sign Language". In: *Understanding language through sign language research*, pp. 59–90.

Lieven, Elena VM (1994). "Crosslinguistic and crosscultural aspects of language addressed to children." In: *Input and interaction in language acquisition*, pp. 56–73.

Lim, Nangyeon (2016). "Cultural differences in emotion: differences in emotional arousal level between the East and the West". In: *Integrative medicine research* 5.2, pp. 105–109.

Linck, Jared A. and Ian Cunnings (2015). "The Utility and Application of Mixed-Effects Models in Second Language Research". In: *Language Learning* 65.S1, pp. 185–207. ISSN: 00238333.

Lindholm, Camilla (2008). "Laughter, communication problems and dementia." In: *Communication & medicine* 5.1, pp. 3–14.

Lipovsky, Caroline (2012). "Fostering affiliation through humour in a job interview". In: *Sociolinguistic Studies* 6.1, p. 149.

Lockard, JS et al. (1977). "Smiling and laughter: Different phyletic origins?" In: *Bulletin of the Psychonomic Society* 10.3, pp. 183–186.

Logothetis, Nikos K et al. (2001). "Neurophysiological investigation of the basis of the fMRI signal". In: *Nature* 412.6843, p. 150.

Loizou, Eleni (2005). "Infant humor: The theory of the absurd and the empowerment theory". In: *International Journal of Early Years Education* 13.1, pp. 43–53.

Lösche, Gisela (1990). "Sensorimotor and action development in autistic children from infancy to early childhood". In: *Journal of Child psychology and Psychiatry* 31.5, pp. 749–761.

Lowder, Matthew W and Fernanda Ferreira (2018). "I see what you meant to say: Anticipating speech errors during online sentence processing." In: *Journal of Experimental Psychology: General*.

Lowe, Geoff and Sharon B Taylor (1997). "Effects of alcohol on responsive laughter and amusement". In: *Psychological reports* 80.3_suppl, pp. 1149–1150.

Luyster, Rhiannon J et al. (2008). "Language assessment and development in toddlers with autism spectrum disorders". In: *Journal of autism and developmental disorders* 38.8, pp. 1426–1438.

Lyons, Viktoria and Michael Fitzgerald (2004). "Humor in autism and Asperger syndrome". In: *Journal of autism and developmental disorders* 34.5, pp. 521–531.

MacDonald, Nancy E and Irwin W Silverman (1978). "Smiling and laughter in infants as a function of level of arousal and cognitive evaluation." In: *Developmental Psychology* 14.3, p. 235.

MacWhinney, Brian (2000). *The CHILDES project: Tools for analyzing talk: Volume I: Transcription format and programs, volume II: The database*.

Madden, ML, Mary L Oelschlaeger, and Jack S Damico (2002). "The conversational value of laughter for a person with aphasia". In: *Aphasiology* 16.12, pp. 1199–1212.

Marsella, Stacy, Jonathan Gratch, and Paolo Petta (2010). "A blueprint for an affectively competent agent: Cross-fertilization between Emotion Psychology, Affective Neuroscience, and Affective Computing". In: ed. by K.R Scherer, T. Bänziger, and E. Roesch. Oxford: Oxford University Press. Chap. Computational Models of Emotion.

Marshall, Jane (2009). "Framing ideas in aphasia: The need for thinking therapy". In: *International journal of language & communication disorders* 44.1, pp. 1–14.

Marshall, Jane, Tim Pring, and Shula Chiat (1998). "Verb retrieval and sentence production in aphasia". In: *Brain and language* 63.2, pp. 159–183.

Martin, Rod A (2010). *The psychology of humor: An integrative approach*. Elsevier.

Martin, Rod A and Nicholas A Kuiper (1999). "Daily occurrence of laughter: Relationships with age, gender, and Type A personality". In: *Humor* 12.4, pp. 355–384.

Matsusaka, Takahisa (2004). "When does play panting occur during social play in wild chimpanzees?" In: *Primates* 45.4, pp. 221–229.

Mazzocconi, Chiara, Vladislav Maraev, and Jonathan Ginzburg (2018). "Laughter Repair". In: *Proceedings of SemDial 2018 (AixDial), The 22nd workshop on the Semantics and Pragmatics of Dialogue, Aix-en-Provence (France)*.

Mazzocconi, Chiara, Ye Tian, and Jonathan Ginzburg (2016). "Towards a Multilayered Analysis of Laughter". In: *Proceedings of JerSem, the 20th Workshop on the Semantics and Pragmatics of Dialogue (SemDial), Rutgers, the State University of New Jersey, New Brunswick, USA*.

— (2019). "What's your laughter doing there? A taxonomy of the pragmatic functions of laughter." In: *(Under Revision)*.

Mazzocconi, Chiara et al. (2018). "Perception of laughter related to different laughables in spontaneous conversation: a fNIRS pilot study." In: *Neuroscience 2018, San Diego, California, November 3-7, 2018*. Society for Neuroscience.

McCall, Robert B (1972). "Smiling and vocalization in infants as indices of perceptual-cognitive processes". In: *Merrill-Palmer Quarterly of Behavior and Development* 18.4, pp. 341–347.

McComas, HC (1923). "The Origin of Laughter." In: *Psychological Review* 30.1, p. 45.

McCune-Nicolich, Lorraine (1981). "Toward symbolic functioning: Structure of early pretend games and potential parallels with language". In: *Child development*, pp. 785–797.

McGettigan, C et al. (2013). "Individual differences in laughter perception reveal roles for mentalizing and sensorimotor systems in the evaluation of emotional authenticity". In: *Cerebral Cortex*, pp. 220–227.

McGhee, Paul E (1977). "A model of the origins and early development of incongruity-based humour". In: *It's a funny thing, humour*. Elsevier, pp. 27–36.

McGhee, Paul E and Edie Pistolesi (1979). *Humor: Its origin and development*. WH Freeman San Francisco.

McKeon, Richard et al. (2009). *The basic works of Aristotle*. Modern Library.

McKeown, Gary (2016). "Laughter and Humour as Conversational Mind-Reading Displays". In: *International Conference on Distributed, Ambient, and Pervasive Interactions*. Springer, pp. 317–328.

McKeown, Gary and Will Curran (2015). "The Relationship between laughter intensity and perceived humour". In: *The 4th Interdisciplinary Workshop on Laughter and other Non-Verbal Vocalisations in Speech, Enschede, Netherlands*, pp. 27–29.

Meltzoff, Andrew N (1990). "Towards a Developmental Cognitive Science: The Implications of Cross-Modal Matching and Imitation for the Development of Representation and Memory in Infancy a". In: *Annals of the New York academy of sciences* 608.1, pp. 1–37.

— (1995). "Understanding the intentions of others: re-enactment of intended acts by 18-month-old children." In: *Developmental psychology* 31.5, p. 838.

Milford, Patricia (1977). "The functions of laughter as human communication". PhD thesis. Eastern Michigan University.

Minsky, Marvin (2007). *The emotion machine: Commonsense thinking, artificial intelligence, and the future of the human mind*. Simon and Schuster.

Mireault, Gina et al. (2012). "Humour perception and creation between parents and 3-to 6-month-old infants". In: *Infant and Child Development* 21.4, pp. 338–347.

Mireault, Gina C and Vasudevi Reddy (2016). *Humor in infants: developmental and psychological perspectives*. Springer.

Mora-Ripoll, Ramon et al. (2010). "The therapeutic value of laughter in medicine". In: *Altern Ther Health Med* 16.6, pp. 56–64.

Moran, Joseph M et al. (2004). "Neural correlates of humor detection and appreciation". In: *Neuroimage* 21.3, pp. 1055–1060.

Morreall, John (1982). "A New Theory of Laughter". In: *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 42.2, pp. 243–254.

— (1983). *Taking laughter seriously*. SUNY Press.

Mowrer, Donald E, Leonard L LaPointe, and James Case (1987). "Analysis of five acoustic correlates of laughter". In: *Journal of Nonverbal Behavior* 11.3, pp. 191–199.

Müller, Marie (2017). "Development and Validation of a Questionnaire on People's Experiences of Their Own Laughter Production and Perception". MA thesis. UK: UCL.

Mundy, Peter and Antoinette Gomes (1998). "Individual differences in joint attention skill development in the second year". In: *Infant behavior and development* 21.3, pp. 469–482.

Mundy, Peter et al. (1986). "Defining the social deficits of autism: The contribution of non-verbal communication measures". In: *Journal of child psychology and psychiatry* 27.5, pp. 657–669.

Nadel, Jacqueline and Luigia Camaioni (2017). *New perspectives in early communicative development*. Routledge.

Nelson, Cynthia D (2005). "Crafting researcher subjectivity in ways that enact theory". In: *Journal of Language, Identity, and Education* 4.4, pp. 315–320.

Neuhoff, Charles C and Charles Schaefer (2002). "Effects of laughing, smiling, and howling on mood". In: *Psychological Reports* 91.3_suppl, pp. 1079–1080.

Nichols, Shaun and Stephen P Stich (2003). *Mindreading: an integrated account of pretence, self-awareness, and understanding other minds.* Clarendon Press/Oxford University Press.

Nikopoulos, James (2017). "The stability of laughter". In: *Humor* 30.1, pp. 1–21.

Noah, J Adam et al. (2015). "fMRI validation of fNIRS measurements during a naturalistic task". In: *JoVE (Journal of Visualized Experiments)* 100, e52116.

Noah, Tom, Yaacov Schul, and Ruth Mayo (2018). "When both the original study and its failed replication are correct: Feeling observed eliminates the facial-feedback effect." In: *Journal of personality and social psychology* 114.5, p. 657.

Norrick, Neal R (1993). *Conversational joking: Humor in everyday talk.* Indiana University Press.

— (2010). "Humor in interaction". In: *Language and Linguistics Compass* 4.4, pp. 232–244.

Norris, Melissa R and Sakina S Drummond (1998). "Communicative functions of laughter in aphasia". In: *Journal of Neurolinguistics* 11.4, pp. 391–402.

Nwokah, Eva E et al. (1999). "The integration of laughter and speech in vocal communicationa dynamic systems perspective". In: *Journal of Speech, Language, and Hearing Research* 42.4, pp. 880–894.

Nwokah, Evangeline and Alan Fogel (1993). "Laughter in mother-infant emotional communication." In: *Humor: International Journal of Humor Research*.

Nwokah, Evangeline E et al. (1993). "Vocal affect in three-year-olds: A quantitative acoustic analysis of child laughter". In: *The Journal of the Acoustical Society of America* 94.6, pp. 3076–3090.

Nwokah, Evangeline E et al. (1994). "The development of laughter in mother-infant communication: Timing parameters and temporal sequences". In: *Infant Behavior and Development* 17.1, pp. 23–35.

Nygaard, Lynne C and Jennifer S Queen (2008). "Communicating emotion: linking affective prosody and word meaning." In: *Journal of Experimental Psychology: Human Perception and Performance* 34.4, p. 1017.

Oatley, Keith and Elaine Duncan (1994). "The experience of emotions in everyday life". In: *Cognition & emotion* 8.4, pp. 369–381.

Oatley, Keith and PN Johnson-Laird (2014). "Cognitive approaches to emotions". In: *Trends in cognitive sciences* 18.3, pp. 134–140.

O'Connell, Daniel C and Sabine Kowal (2005). "Laughter in Bill Clinton's My life (2004) interviews". In: *Pragmatics. Quarterly Publication of the International Pragmatics Association (IPrA)* 15.2, pp. 275–299.

O'Donnell-Trujillo, Nick and Katherine Adams (1983). "Heheh in conversation: Some coordinating accomplishments of laughter". In: *Western Journal of Communication (includes Communication Reports)* 47.2, pp. 175–191.

O'Reilly, Anne Watson, Kathleen M Painter, and Marc H Bornstein (1997). "Relations between language and symbolic gesture development in early childhood". In: *Cognitive Development* 12.2, pp. 185–197.

Oring, Elliott (2016). *Joking Asides: The Theory, Analysis, and Aesthetics of Humor*. University Press of Colorado.

Owren, Michael J and Jo-Anne Bachorowski (2001). "The evolution of emotional experience: A "selfish-gene" account of smiling and laughter in early hominids and humans." In: *Emotions and social behavior. Emotions: Currrent issues and future directions*, pp. 152–191.

— (2003). "Reconsidering the evolution of nonlinguistic communication: The case of laughter". In: *Journal of Nonverbal Behavior* 27.3, pp. 183–200.

Panksepp, Jaak (1998). "The Foundations of Human and Animal E motions". In:

— (2000). "The riddle of laughter: Neural and psychoevolutionary underpinnings of joy". In: *Current Directions in Psychological Science* 9.6, pp. 183–186.

— (2004). *Affective neuroscience: The foundations of human and animal emotions*. Oxford university press.

Panksepp, Jaak and Jeff Burgdorf (2003). ""Laughing" rats and the evolutionary antecedents of human joy?" In: *Physiology & behavior* 79.3, pp. 533–547.

Panksepp, Jaak and Jeffrey Burgdorf (2000). "50-kHz chirping (laughter?) in response to conditioned and unconditioned tickle-induced reward in rats: effects of social housing and genetic variables". In: *Behavioural brain research* 115.1, pp. 25–38.

Papafragou, Anna, Kimberly Cassidy, and Lila Gleitman (2007). "When we think about thinking: The acquisition of belief verbs". In: *Cognition* 105.1, pp. 125–165.

Paparella, Tanya et al. (2011). "The emergence of nonverbal joint attention and requesting skills in young children with autism". In: *Journal of communication disorders* 44.6, pp. 569–583.

Papousek, Ilona et al. (2009). "Gelotophobia, emotion-related skills and responses to the affective states of others". In: *Personality and Individual Differences* 47.1, pp. 58–63.

Papousek, Ilona et al. (2014). "Laughter as a social rejection cue: gelotophobia and transient cardiac responses to other persons' laughter and insult". In: *Psychophysiology* 51.11, pp. 1112–1121.

Parker, Matthew D and Kent Brorson (2005). "A comparative study between mean length of utterance in morphemes (MLUm) and mean length of utterance in words (MLUw)". In: *First language* 25.3, pp. 365–376.

Parrott, W Gerrod and Henry Gleitman (1989). "Infants' expectations in play: The joy of peek-a-boo". In: *Cognition & Emotion* 3.4, pp. 291–311.

Pearson, Barbara Zurer (1990). "The comprehension of metaphor by preschool children". In: *Journal of child language* 17.1, pp. 185–203.

Peirce, Jonathan et al. (2019). "PsychoPy2: Experiments in behavior made easy". In: *Behavior research methods* 51.1, pp. 195–203.

Pereira, Cécile (2000). "Dimensions of emotional meaning in speech". In: *ISCA Tutorial and Research Workshop (ITRW) on Speech and Emotion*.

Perner, Josef et al. (1989). "Exploration of the autistic child's theory of mind: Knowledge, belief, and communication". In: *Child development*, pp. 689–700.

Petitjean, Cécile and Esther González-Martínez (2015). "Laughing and smiling to manage trouble in French-language classroom interaction". In: *Classroom Discourse* 6.2, pp. 89–106.

Petridis, Stavros and Maja Pantic (2008). "Audiovisual discrimination between laughter and speech". In: *Acoustics, Speech and Signal Processing, 2008. ICASSP 2008. IEEE International Conference on*. IEEE, pp. 5117–5120.

— (2009). "Is this joke really funny? judging the mirth by audiovisual laughter analysis". In: *Multimedia and Expo, 2009. ICME 2009. IEEE International Conference on*. IEEE, pp. 1444–1447.

— (2011). "Audiovisual discrimination between speech and laughter: Why and when visual information might help". In: *IEEE Transactions on Multimedia* 13.2, pp. 216–234.

Pexman, Penny M and Melanie Glenwright (2007). "How do typically developing children grasp the meaning of verbal irony?" In: *Journal of Neurolinguistics* 20.2, pp. 178–196.

Piaget, Jean (1945). *1962. Play, dreams, and imitation in childhood*.

Pien, Diana and Mary K Rothbart (1980). "Incongruity humour, play, and self-regulation of arousal in young children". In: *Children's humour*, pp. 1–26.

Pinti, Paola et al. (2015). "Using fiberless, wearable fNIRS to monitor brain activity in real-world cognitive tasks". In: *JoVE (Journal of Visualized Experiments)* 106, e53336.

Plessner, Helmuth (1970). *Laughing and crying: a study of the limits of human behavior*. Northwestern University Press.

Poesio, Massimo and David R Traum (1997). "Conversational actions and discourse situations". In: *Computational intelligence* 13.3, pp. 309–347.

Poggi, Isabella and Catherine Pelachaud (2000). "Performative facial expressions in animated faces". In: *Embodied conversational agents*, pp. 155–189.

Polimeni, Joseph and Jeffrey P Reiss (2006). "Humor perception deficits in schizophrenia". In: *Psychiatry Research* 141.2, pp. 229–232.

Pollio, Howard R, Rodney Mers, and William Lucchesi (1972). "Humor, laughter, and smiling: Some preliminary observations of funny behaviors". In: *The psychology of humor*. Elsevier, pp. 211–239.

Portes, Cristel and Claire Beyssade (2015). "Is intonational meaning compositional". In: *Verbum, forthcoming*.

Potter, Jonathan and Alexa Hepburn (2010). "Putting aspiration into words:'Laugh particles', managing descriptive trouble and modulating action". In: *Journal of Pragmatics* 42.6, pp. 1543–1555.

Pouscoulous, Nausicaa (2014). "The elevator's buttocks: Metaphorical abilities in children." In: *In D. Matthews (Ed.), Pragmatic development in first language acquisition*, pp. 239–259.

Poyatos, Fernando (1993). "The many voices of laughter: A new audible-visual paralinguistic approach". In: *Semiotica* 93.1-2, pp. 61–82.

Predelli, Stefano (2003). "Scare Quotes and Their Relation to Other Semantic Issues". In: *Linguistics and Philosophy* 26, pp. 1–28.

Preuschoft, Signe and Jan ARAM van Hooff (1997). "The social function of" smile" and" laughter": Variations across primate species and societies." In: *Nonverbal communication: Where nature meets culture*, pp. 171–190.

Priego-Valverde, Béatrice et al. (2018). "Is smiling during humor so obvious? A cross-cultural comparison of smiling behavior in humorous sequences in American English and French interactions". In: *Intercultural Pragmatics* 15.4, pp. 563–591.

Provine, Robert R (1992). "Contagious laughter: Laughter is a sufficient stimulus for laughs and smiles". In: *Bulletin of the Psychonomic Society* 30.1, pp. 1–4.

— (1993). "Laughter punctuates speech: Linguistic, social and gender contexts of laughter". In: *Ethology* 95.4, pp. 291–298.

— (1996). "Laughter". In: *American scientist* 84.1, pp. 38–45.

— (2001). *Laughter: A scientific investigation*. Penguin.

— (2004). "Laughing, tickling, and the evolution of speech and self". In: *Current Directions in Psychological Science* 13.6, pp. 215–218.

Provine, Robert R and Karen Emmorey (2006). "Laughter among deaf signers". In: *Journal of Deaf Studies and Deaf Education* 11.4, pp. 403–409.

Provine, Robert R and Kenneth R Fischer (1989). "Laughing, smiling, and talking: Relation to sleeping and social context in humans". In: *Ethology* 83.4, pp. 295–305.

Provine, Robert R and Yvonne L Yong (1991). "Laughter: A stereotyped human vocalization". In: *Ethology* 89.2, pp. 115–124.

Purver, Matthew (2001). "SCoRE: A tool for searching the BNC". In: *Technical Report TR-01-07*.

— (2004). "The theory and use of clarification requests in dialogue: King's college, University of London Ph. D". PhD thesis. dissertation.

— (2006). "CLARIE: Handling Clarification Requests in a Dialogue System". In: *Research on Language and Computation* 4.2, pp. 259–288.

— (2014). "Ask Not What Semantics Can Do For Dialogue - Ask What Dialogue Can Do For Semantics". In: *Proceedings of DialWatt — Semdial 2014, The 18th Workshop on the Semantics and Pragmatics of Dialogue Edinburgh, UK*.

Purver, Matthew and Jonathan Ginzburg (2004). "Clarifying noun phrase semantics". In: *Journal of Semantics* 21.3, pp. 283–339.

Rakoczy, Hannes, Michael Tomasello, and Tricia Striano (2004). "Young children know that trying is not pretending: a test of the" behaving-as-if" construal of children's early concept of pretense." In: *Developmental Psychology* 40.3, p. 388.

Ranta, Aarne (1994). *Type Theoretical Grammar*. Oxford: Oxford University Press.

Raskin, V. (1985). *Semantic mechanisms of humor*. Vol. 24. Springer.

Ratner, Nan Bernstein (2013). "Why talk with children matters: clinical implications of infant-and child-directed speech research". In: *Seminars in Speech and Language*. Vol. 34. 04. Thieme Medical Publishers, pp. 203–214.

Recchia, Holly E et al. (2010). "Children's understanding and production of verbal irony in family conversations". In: *British Journal of Developmental Psychology* 28.2, pp. 255–274.

Reddy, Vasudevi (1991). "Playing with others' expectations: Teasing and mucking about in the first year." In:

— (2001). "Infant clowns: The interpersonal creation of humour in infancy". In: *Enfance* 53.3, pp. 247–256.

— (2008). *How infants know minds*. Harvard University Press.

Reddy, Vasudevi, Emma Williams, and Amy Vaughan (2002). "Sharing humour and laughter in autism and Down's syndrome". In: *British journal of psychology* 93.2, pp. 219–242.

Reuderink, Boris et al. (2008). "Decision-level fusion for audio-visual laughter detection". In: *International Workshop on Machine Learning for Multimodal Interaction*. Springer, pp. 137–148.

Rieser, Hannes (2015). "When Hands Talk to Mouth. Gesture and Speech as Autonomous Communicating Processes". In: *SEMDIAL 2015 goDIAL*, p. 122.

Rieser, Hannes and Massimo Poesio (2009). "Interactive gesture in dialogue: a ptt model". In: *Proceedings of the SIGDIAL 2009 Conference: The 10th Annual Meeting of the Special Interest Group on Discourse and Dialogue*. Association for Computational Linguistics, pp. 87–96.

Ripley, Brian, William Venables, and Maintainer Brian Ripley (2016). "Package 'nnet'". In: *R package version* 7, pp. 3–12.

Ritchie, Graeme (2018). *The Comprehension of Jokes: A Cognitive Science Framework*. Routledge.

Roberts, Craige (1996). "Information structure in discourse: Towards an integrated formal theory of pragmatics". In: *Working Papers in Linguistics-Ohio State University Department of Linguistics*. Reprinted in Semantics and Pragmatics, 2012, pp. 91–136.

Romaniuk, T. (2013). "Interviewee laughter and disaffiliation in broadcast news interviews". In: *Studies of Laughter in Interaction*. Ed. by Philip Glenn and Elizabeth Holt. Bloomsbury.

Ross, Marina Davila, Michael J Owren, and Elke Zimmermann (2009). "Reconstructing the evolution of laughter in great apes and humans". In: *Current Biology* 19.13, pp. 1106–1111.

Ross, Marina Davila, Michael J Owren, and Elke Zimmermann (2010). "The evolution of laughter in great apes and humans". In: *Communicative & integrative biology* 3.2, pp. 191–194.

Rothbart, Mary K (1973). "Laughter in young children." In: *Psychological bulletin* 80.3, p. 247.

Rothgänger, Hartmut et al. (1998). "Analysis of laughter and speech sounds in Italian and German students". In: *Naturwissenschaften* 85.8, pp. 394–402.

Ruch, Willibald (1993). "Exhilaration and humor". In: *Handbook of emotions* 1, pp. 605–616.

— (1997). "Laughter and temperament". In: *Paul Ekman Erika L. Rosenberg*, p. 131.

— (2009). "Fearing humor? Gelotophobia: The fear of being laughed at Introduction and overview". In: *Humor-International Journal of Humor Research* 22.1-2, pp. 1–25.

Ruch, Willibald and Paul Ekman (2001). "The expressive pattern of laughter". In: *Emotion, qualia, and consciousness*, pp. 426–443.

Russell, James A (1980). "A circumplex model of affect." In: *Journal of personality and social psychology* 39.6, p. 1161.

— (2003). "Core affect and the psychological construction of emotion." In: *Psychological review* 110.1, p. 145.

Rychlowska, Magdalena et al. (2018). "Not only decibels: Exploring human judgements of laughter intensity". In: *Proceedings of Laughter Workshop*.

Samson, Andrea C and Michael Hegenloh (2010). "Stimulus characteristics affect humor processing in individuals with Asperger syndrome". In: *Journal of Autism and Developmental Disorders* 40.4, pp. 438–447.

Samson, Andrea C, Oswald Huber, and Willibald Ruch (2011). "Teasing, ridiculing and the relation to the fear of being laughed at in individuals with Asperger's syndrome". In: *Journal of Autism and Developmental Disorders* 41.4, pp. 475–483.

Samson, Andrea Christiane (2013). "Humor (lessness) elucidated–Sense of humor in individuals with autism spectrum disorders: Review and Introduction". In: *Humor* 26.3, pp. 393–409.

Sander, Kerstin and Henning Scheich (2001). "Auditory perception of laughing and crying activates human amygdala regardless of attentional state". In: *Cognitive Brain Research* 12.2, pp. 181–198.

Sauter, Disa et al. (2009). "Universal vocal signals of emotion". In: *31st Annual Meeting of the Cognitive Science Society (CogSci 2009)*. Cognitive Science Society, pp. 2251–2255.

Sauter, Disa A et al. (2010). "Cross-cultural recognition of basic emotions through nonverbal emotional vocalizations". In: *Proceedings of the National Academy of Sciences* 107.6, pp. 2408–2412.

Schaafsma, Sara M et al. (2015). "Deconstructing and reconstructing theory of mind". In: *Trends in cognitive sciences* 19.2, pp. 65–72.

Scherer, Klaus R (2009). "The dynamic architecture of emotion: Evidence for the component process model". In: *Cognition and emotion* 23.7, pp. 1307–1351.

Schopenhauer, Arthur (1891). *The world as will and idea*. Vol. 1. Library of Alexandria.

Schröder, Marc et al. (2001). "Acoustic correlates of emotion dimensions in view of speech synthesis". In: *Seventh European Conference on Speech Communication and Technology*.

Scott, Sophie K, Disa Sauter, and Carolyn McGettigan (2010). "Brain mechanisms for processing perceived emotional vocalizations in humans". In: *Handbook of behavioral neuroscience*. Vol. 19. Elsevier, pp. 187–197.

Scott, Sophie K et al. (1997). "Impaired auditory recognition of fear and anger following bilateral amygdala lesions". In: *Nature* 385.6613, p. 254.

Seligman, Jerry and Larry Moss (1997). "Situation Theory". In: *Handbook of Logic and Linguistics*. Ed. by Johan van Benthem and Alice ter Meulen. Amsterdam: North Holland.

Semrud-Clikeman, Margaret and Kimberly Glass (2010). "The relation of humor and child development: Social, adaptive, and emotional aspects". In: *Journal of Child Neurology*.

Shaw, Chloe, Alexa Hepburn, and Jonathan Potter (2013). "Having the last laugh: On post-completion laughter particles". In: *Studies of laughter in interaction*, pp. 91–106.

Shergill, Sukhwinder S et al. (2005). "Evidence for sensory prediction deficits in schizophrenia". In: *American Journal of Psychiatry* 162.12, pp. 2384–2386.

Shibata, Dean and Jianhui Zhong (2001). "Humour and Laughter: localization with fMRI". In: *NeuroImage* 13.6, p. 476.

Shimizu, A, N Sumitsuji, and M Nakamura (1994). *Why do people laugh*.

Shochi, Takaaki et al. (2017). "Perceptual and acoustic correlates of spontaneous vs. social laughter". In: *1st International Workshop on Vocal Interactivity in-and-between Humans, Animals and Robots*.

Shultz, Thomas R (1976). "Humour and laughter: Theory, research and applications." In: ed. by Anthony J. Chapman and Hugh C. Foot. Oxford, England: John Wiley and Sons. Chap. A cognitive-developmental analysis of humour.

Shultz, Thomas R and Edward Zigler (1970). "Emotional concomitants of visual mastery in infants: The effects of stimulus movement on smiling and vocalizing". In: *Journal of Experimental Child Psychology* 10.3, pp. 390–402.

Silva, Catarina et al. (2017). "Seeing the funny side of things: Humour processing in Autism Spectrum Disorders". In: *Research in Autism Spectrum Disorders* 43, pp. 8–17.

Smoski, Moria (2004). "The development of antiphonal laughter between friends and strangers". PhD thesis. Vanderbilt University.

Smoski, Moria and Jo-Anne Bachorowski (2003). "Antiphonal laughter between friends and strangers". In: *Cognition & Emotion* 17.2, pp. 327–340.

Snow, Catherine E (1989). "Understanding social interaction and language acquisition; sentences are not enough." In: *Crosscurrents in contemporary psychology. Interaction in human development*, pp. 83–103.

Snow, Catherine E (2017). "Issues in the study of input: Finetuning, universality, individual and developmental differences, and necessary causes". In: *The handbook of child language*, pp. 179–193.

Söderkvist, Sven, Kajsa Ohlén, and Ulf Dimberg (2018). "How the experience of emotion is modulated by facial feedback". In: *Journal of nonverbal behavior* 42.1, pp. 129–151.

Soderstrom, Melanie (2007). "Beyond babytalk: Re-evaluating the nature and content of speech input to preverbal infants". In: *Developmental Review* 27.4, pp. 501–532.

Sokolov, Jeffrey L (1993). "A local contingency analysis of the fine-tuning hypothesis." In: *Developmental psychology* 29.6, p. 1008.

Soury, Mariette and Laurence Devillers (2014). "Smile and Laughter in Human-Machine Interaction: a study of engagement." In: *LREC*, pp. 3633–3637.

Sperber, Dan (1995). "How do we communicate". In: *How things are: A science toolkit for the mind*, pp. 191–199.

Sroufe, L Alan (1997). *Emotional development: The organization of emotional life in the early years*. Cambridge University Press.

Sroufe, L Alan and Jane Piccard Wunsch (1972). "The development of laughter in the first year of life". In: *Child Development*, pp. 1326–1344.

Stearns, Frederic R (1972). *Laughing: Physiology, pathophysiology, psychology, pathopsychology, and development*. Oxford, England: Charles C Thomas.

Steensig, Jakob and Trine Heinemann (2015). "Opening up codings?" In: *Research on Language and Social Interaction* 48.1, pp. 20–25.

Steglich-Petersen, Asbjørn and John Michael (2015). "Why desire reasoning is developmentally prior to belief reasoning". In: *Mind & Language* 30.5, pp. 526–549.

Stenberg, Gunilla (2017). "Does contingency in adults' responding influence 12-month-old infants' social referencing?" In: *Infant Behavior and Development* 46, pp. 67–79.

Stern, Daniel N (1985). *The interpersonal world of the infant: A view from psychoanalysis and developmental psychology*. Karnac Books.

Stevenson, Marguerite B et al. (1986). "The beginning of conversation: Early patterns of mother-infant vocal responsiveness". In: *Infant behavior and Development* 9.4, pp. 423–440.

Stolcke, Andreas et al. (2000). "Dialogue act modeling for automatic tagging and recognition of conversational speech". In: *Computational linguistics* 26.3, pp. 339–373.

Strack, Fritz, Leonard L Martin, and Sabine Stepper (1988). "Inhibiting and facilitating conditions of the human smile: a nonobtrusive test of the facial feedback hypothesis." In: *Journal of personality and social psychology* 54.5, p. 768.

Streeck, Jürgen, Charles Goodwin, and Curtis LeBaron (2011). *Embodied interaction: Language and body in the material world*. Cambridge University Press.

Sullivan, Kate, Ellen Winner, and Natalie Hopfield (1995). "How children tell a lie from a joke: The role of second-order mental state attributions". In: *British Journal of Developmental Psychology* 13.2, pp. 191–204.

Szameitat, Diana P et al. (2009a). "Acoustic profiles of distinct emotional expressions in laughter". In: *The Journal of the Acoustical Society of America* 126.1, pp. 354–366.

— (2009b). "Acoustic profiles of distinct emotional expressions in laughter". In: *The Journal of the Acoustical Society of America* 126.1, pp. 354–366.

Szameitat, Diana P et al. (2010). "It is not always tickling: distinct cerebral responses during perception of different laughter types". In: *Neuroimage* 53.4, pp. 1264–1271.

Szameitat, Diana P et al. (2011a). "Acoustic correlates of emotional dimensions in laughter: arousal, dominance, and valence". In: *Cognition and Emotion* 25.4, pp. 599–611.

Szameitat, Diana P et al. (2011b). "Formant characteristics of human laughter". In: *Journal of voice* 25.1, pp. 32–37.

Tamis-LeMonda, Catherine S, Marc H Bornstein, and Lisa Baumwell (2001). "Maternal responsiveness and children's achievement of language milestones". In: *Child development* 72.3, pp. 748–767.

Tamis-LeMonda, Catherine S et al. (1992). "Language and play at one year: A comparison of toddlers and mothers in the United States and Japan". In: *International Journal of Behavioral Development* 15.1, pp. 19–42.

Tanaka, Hiroki and Nick Campbell (2011). "Acoustic features of four types of laughter in natural conversational speech". In: *Proc. 17th International Congress of Phonetic Sciences (ICPhS)*, pp. 1958–1961.

— (2014). "Classification of social laughter in natural conversational speech". In: *Computer Speech & Language* 28.1, pp. 314–325.

Tardif, Twila, Marilyn Shatz, and Letitia Naigles (1997). "Caregiver speech and children's use of nouns versus verbs: A comparison of English, Italian, and Mandarin". In: *Journal of Child Language* 24.3, pp. 535–565.

Team, R Core (2016). "R: A language and environment for statistical computing". In: *Computer software manual*.

Thompson, Ross A (1991). "Emotional regulation and emotional development". In: *Educational Psychology Review* 3.4, pp. 269–307.

Tian, Ye, Takehiko Maruyama, and Jonathan Ginzburg (2017). "Self addressed questions and filled pauses: A cross-linguistic investigation". In: *Journal of psycholinguistic research* 46.4, pp. 905–922.

Tian, Ye et al. (2015). "Editing Phrases". In: *Proceedings of GoDial, the 18th Workshop on the Semantics and Pragmatics of Dialogue*. Ed. by Chris Howes and Staffan Larsson. Gothenburg University. Gothenburg.

Tomasello, Michael (2009). *Why we cooperate*. MIT press.

Tomasello, Michael and Michael Jeffrey Farrar (1986). "Joint attention and early language". In: *Child development*, pp. 1454–1463.

Tomasello, Michael, Deborah Gust, and G Thomas Frost (1989). "A longitudinal investigation of gestural communication in young chimpanzees". In: *Primates* 30.1, pp. 35–50.

Tomasello, Michael et al. (1994). "The learning and use of gestural signals by young chimpanzees: A trans-generational study". In: *Primates* 35.2, pp. 137–154.

Tomasello, Michael et al. (1995). "Joint attention as social cognition". In: *Joint attention: Its origins and role in development* 103130.

Traum, D. et al. (2008). "Multi-party, multi-issue, multi-strategy negotiation for multi-modal virtual agents". In: *Intelligent Virtual Agents*. Springer, pp. 117–130.

Trouvain, Jürgen (2001). "Phonetic aspects of "speech-laughs"". In: *Proceedings of the 2nd Conference on Orality and Gestuality*, pp. 634–639.

— (2003a). "Segmenting phonetic units in laughter". In: *Proc. 15th International Conference of the Phonetic Sciences, Barcelona, Spain*, pp. 2793–2796.

— (2003b). "Segmenting phonetic units in laughter". In: *Proc. 15th International Conference of the Phonetic Sciences, Barcelona, Spain*, pp. 2793–2796.

Trouvain, Jürgen and Marc Schröder (2004). "How (not) to add laughter to synthetic speech". In: *Tutorial and Research Workshop on Affective Dialogue Systems*. Springer, pp. 229–232.

Trouvain, Jürgen and Khiet P Truong (2012). "Convergence of laughter in conversational speech: effects of quantity, temporal alignment and imitation". In: *International Symposium on Imitation and Convergence in Speech, Aix-en-Provence, France*.

Truong, Khiet P and Jürgen Trouvain (2012). "On the acoustics of overlapping laughter in conversational speech". In: *Thirteenth Annual Conference of the International Speech Communication Association*.

— (2014). "Investigating prosodic relations between initiating and responding laughs". In: *Fifteenth Annual Conference of the International Speech Communication Association*.

Truong, Khiet P and David A Van Leeuwen (2007). "Automatic discrimination between laughter and speech". In: *Speech Communication* 49.2, pp. 144–158.

Urbain, Jérôme and Thierry Dutoit (2011a). "A phonetic analysis of natural laughter, for use in automatic laughter processing systems". In: *Affective Computing and Intelligent Interaction*. Springer, pp. 397–406.

— (2011b). "A phonetic analysis of natural laughter, for use in automatic laughter processing systems". In: *Affective Computing and Intelligent Interaction*. Springer, pp. 397–406.

Urbain, Jérôme et al. (2013). "Multimodal analysis of laughter for an interactive system". In: *International Conference on Intelligent Technologies for Interactive Entertainment*. Springer, pp. 183–192.

Van Hooff, JARAM (1972). "A comparative approach to the phylogeny of laughter and smiling". In: *Non-verbal communication*, pp. 209–241.

Van Hooff, JARAM and Signe Preuschoft (2003). "Laughter and smiling: The intertwining of nature and culture". In: *Animal social complexity: Intelligence, culture, and individualized societies*, pp. 260–287.

Van IJzendoorn, Marinus H et al. (2009). "Enhancement of attachment and cognitive development of young nursery-reared chimpanzees in responsive versus standard care". In: *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology* 51.2, pp. 173–185.

Van Leeuwen, Edwin JC, Elke Zimmermann, and Marina Davila Ross (2010). "Responding to inequities: Gorillas try to maintain their competitive advantage during play fights". In: *Biology letters* 7.1, pp. 39–42.

Vettin, Julia and Dietmar Todt (2004). "Laughter in conversation: Features of occurrence and acoustic structure". In: *Journal of Nonverbal Behavior* 28.2, pp. 93–115.

— (2005). "Human laughter, social play, and play vocalizations of non-human primates: An evolutionary approach". In: *Behaviour* 142.2, pp. 217–240.

Vinton, Karen L (1989). "Humor in the workplace: It is more than telling jokes". In: *Small group behavior* 20.2, pp. 151–166.

Vygotsky, Lev Semenovich (1980). *Mind in society: The development of higher psychological processes*. Harvard university press.

Warren, Jane E et al. (2006). "Positive emotions preferentially engage an auditory–motor "mirror" system". In: *Journal of Neuroscience* 26.50, pp. 13067–13075.

Wattendorf, Elise et al. (2012). "Exploration of the neural correlates of ticklish laughter by functional magnetic resonance imaging". In: *Cerebral Cortex* 23.6, pp. 1280–1289.

Weaver, James B et al. (1985). "Effect of alcoholic intoxication on the appreciation of different types of humor." In: *Journal of Personality and Social Psychology* 49.3, p. 781.

Weisfeld, Glenn E (1993). "The adaptive value of humor and laughter". In: *Evolution and Human Behavior* 14.2, pp. 141–169.

Weiskrantz, L, J Elliott, and C Darlington (1971). "Preliminary observations on tickling oneself". In: *Nature* 230.5296, p. 598.

Wessel-Tolvig, Bjørn Nicola and Patrizia Paggio (2017). "Can co-speech gesture change the perception of ambiguous motion events? Experimental evidence from Italian". In: *4th European and 7th Nordic Symposium on Multimodal Communication*. Vol. 141, pp. 56–65.

West, Candace (1984). "Routine Complications: Troubleswith Talk Between Doctors and Patients". In: *Blooming-ton: Indiana University Press. WestRoutine Complications: Troubles with Talk Between Doctors and Patients1984*.

Westra, Evan (2017). "Pragmatic development and the false belief task". In: *Review of Philosophy and Psychology* 8.2, pp. 235–257.

Westra, Evan and Peter Carruthers (2017). "Pragmatic development explains the Theory-of-Mind Scale". In: *Cognition* 158, pp. 165–176.

Wierzbicka, Anna (1995). "Kisses, handshakes, bows: The semantics of nonverbal communication". In: *Semiotica* 103.3-4, pp. 207–252.

— (2000). "The semantics of human facial expressions". In: *Pragmatics & cognition* 8.1, pp. 147–183.

Wild, Barbara et al. (2003). "Neural correlates of laughter and humour". In: *Brain* 126.10, pp. 2121–2138.

Wild, Barbara et al. (2006). "Humor and smiling Cortical regions selective for cognitive, affective, and volitional components". In: *Neurology* 66.6, pp. 887–893.

Wilkie, Ian and Matthew Saxton (2010). "The origins of comic performance in adult-child interaction." In: *Comedy Studies* 1.1.

Wolff, Peter H (1987). *The development of behavioral states and the expression of emotions in early infancy: New proposals for investigation*. University of Chicago Press.

Wolpert, Daniel M and J Randall Flanagan (2001). "Motor prediction". In: *Current biology* 11.18, R729–R732.

Wu, Ching-Lin et al. (2016). "Effectiveness of humor training among adolescents with autism". In: *Psychiatry research* 246, pp. 25–31.

Yuill, Nicola (2007). "Visiting joke city: How can talking about jokes foster metalinguistic awareness in poor comprehenders". In: *Reading comprehension strategies: Theories, interventions and technologies*, pp. 325–346.

— (2009). "The relation between ambiguity understanding and metalinguistic discussion of joking riddles in good and poor comprehenders: Potential for intervention and possible processes of change". In: *First language* 29.1, pp. 65–79.

Zalla, Tiziana et al. (2009). "Faux pas detection and intentional action in Asperger Syndrome. A replication on a French sample". In: *Journal of Autism and Developmental Disorders* 39.2, pp. 373–382.

Zelazo, Philip R (1971). "Smiling to social stimuli: Eliciting and conditioning effects." In: *Developmental Psychology* 4.1p1, p. 32.

— (1972). "Smiling and vocalizing: A cognitive emphasis". In: *Merrill-Palmer Quarterly of Behavior and Development* 18.4, pp. 349–365.

Zigler, Edward, Jacob Levine, and Laurence Gould (1966). "Cognitive processes in the development of children's appreciation of humor". In: *Child development*, pp. 507–518.