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Multi-layered analysis of laughter

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This paper presents a multi-layered classification of laughter in French and Chinese dialogues (from the DUEL corpus). Analysis related to the form, the semantic meaning and the function of laughter and its context provides a detailed study of the range of uses of laughter and their distributions. A similar distribution was observed in most of the data collected for French and Chinese. We ground our classification in a formal semantic and pragmatic analysis. We propose that most functions of laughter can be analyzed by positing a unified meaning with two dimensions, which when aligned with rich contextual reasoning, yields a wide range of functions. However, we also argue that a proper treatment of laughter involves a significant conceptual modification of information state account of dialogue to incorporate emotive aspects of interaction.

1 Introduction

Laughter is very frequent in everyday conversational interaction—(Vettin and Todt, 2005) suggest a frequency of 5,8/10 min of conversation. Although we can easily recognize laughter, it is not a homogeneous phenomenon. Laughter can take various forms and occur in a variety of contexts. Attempts to understand the nature of laughter go back as early as Aristotle, frequently intertwined with theories concerning humour. There have been many proposals on the laughter types yet little agreement on how laughter should be classified. We believe that one reason for the lack of agreement is that there are several layers relevant to the analysis of laughter. Different classification systems and even types within systems in fact often relate to different layers of analysis. In what follows, we will initially present a brief critical review of studies on laughter types. Building on this, we propose a multi-layered analysis of laughter, including a novel analysis of the meaning of laughter and attempt to describe its various uses. We then present our corpus study in sections 4 and 5. In section 7, on the base of our data observation, we will try to ground our classification in a formal semantic and pragmatic analysis within the

KoS framework (Ginzburg, 2012).

2 Background

2.1 Existing taxonomies/classifications

Studies on laughter classification concern at least three areas: the sound, the context and the function¹. Studies on the sound of laughter analyze phonetic, acoustic, para-linguistic, kinesic and anatomical features e.g.(Poyatos, 1993; Urbain and Dutoit, 2011; Trouvain, 2003; Provine and Yong, 1991, for example)), or propose constitutive elements of laughter (Kipper and Todt, 2003; Trouvain, 2003; Bachorowski and Owren, 2001; Campbell et al., 2005; Tanaka and Campbell, 2014; Nwokah and Fogel, 1993; Ruch and Ekman, 2001, for example). Due to space constraints and pertinence we will focus on reviewing analyses on contextual and functional classifications.

2.1.1 Contextual classifications

Studies on context of laughter investigate the stimuli (triggers) and the position of a given laughter event in relation to other components in conversation (e.g. speech and partner's laughter). Studies on laughter stimuli distinguish those that are “funny” (though that in itself is a tricky matter to characterize) and those that are not. It has been reported that contrary to ‘folk wisdom’, most laughers in fact follow a stimuli that is not “funny” (Coates, 2007; Provine, 2004).

A second level of contextual analysis concerns the position of laughter in relation to 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 nor followed by

¹There are also proposals on the causes of laughter e.g. (Morreall, 1983; Owren et al., 2003; Bachorowski and Owren, 2001)

others' laughter, (Nwokah et al., 1994), *reciprocal/antiphonal/chiming in laughter* i.e., laughter that occurs immediately after partners laughter (Nwokah et al., 1994; Smoski and Bachorowski, 2003; Hayakawa, 2003), and *co-active/plural laughter* (Nwokah et al., 1994; Hayakawa, 2003). (Vettin and Todt, 2004) make an initial distinction between speaker and audience laughter. Then, they characterize the event preceding the laughter as being a complete sentence, a short confirmation, or a laughter bout. Combining these parameters, they obtain 6 mutually exclusive contexts for laughter to occur (see 1):

Conversational Partner	A participant's laughter occurring immediately (up to 3 s) after a complete utterance of their conversational partner
Participant	The participant laughed immediately (up to 3 s) after his/her own complete utterance
Short confirmation	Participant's laughter immediately (up to 3 s) after a confirming 'mm,' 'I see' or something comparable by himself or his conversational partner
Laughter	Participant's laughter after a conversational partner's laughter. With an interval of less than 3 s.
Before utterance	Participant's laughter after a short pause (at least 3 s) in conversation, but immediately (up to 500 ms) before an utterance by him/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

Figure 1: Vetting and Todt, 2004 - Context classification

2.1.2 Functional classifications

This is the area where debate is quite unresolved. Many taxonomies have been proposed; some contain binary types and others contain dozens. The most problematic issue is that very often, taxonomies have within them a mixture of types of function and types regarding triggers.

(Szameitat et al., 2009) distinguishes between physical (tickling) and emotional laughter (including joy, taunts, and *schadenfreude*). While (Poyatos, 1993) bases its 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, amusement and social interaction, self-directedness. (Shimizu et al., 1994) identifies 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 et al., 2005; Reuderink et al., 2008), where four laughter types are distinguished on the basis of perceptual analyses of their characteristics: hearty, amused, satirical, social.

2.1.3 Weaknesses of existing classifications

A common issue with most taxonomies, as has been mentioned before, is that they contain types that relate to different layers of analysis. For example, in (Poyatos, 1993)'s taxonomy, affiliation (e.g., agree) is roughly the illocutionary act performed by a laughter, while joy is a feature of the laughter trigger. Apart from that, at least three issues can be raised.

Contextual classification: (Vettin and Todt, 2004) 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. In Figure 2 we schematize some possible patterns observed in our corpus when conducting a detailed analysis of each laughter in relation to its laughable. Laughter can refer both to events that precede or follow it, but also to events or utterances with which it overlaps. Timing parameters are not optimal as a means for inferring the referent of laughter given that significant time misalignment can occur between the laughter and the laughable, namely their lack of adjacency.

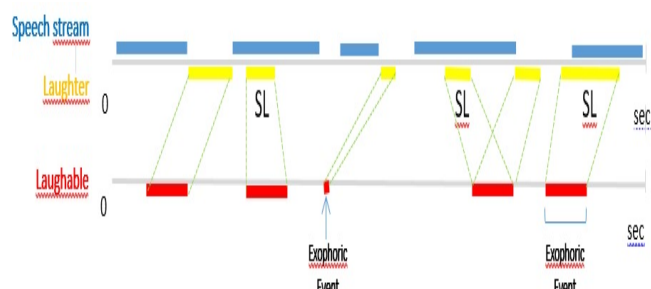


Figure 2: Temporal misalignment speech stream, laughter and laughable

Unfunny: The proposal from (Provine, 1993) that laughter is not usually related to "humorous stimuli" is made by assuming what a laughter is about is what immediately precedes the laughter. As we have already pointed out, there is much freedom in the alignment between laughable and laughter, so a laugh can be about not the preceding utterance but the utterance before, or an upcoming utterance. Moreover, even if the laugh-

able *is* the preceding utterance, funniness rarely resides simply in the utterance itself, but is most frequently in the relation between that utterance and the context, or can reside in the enriched content of the utterance not necessarily accessible to an extraneous listener. Therefore, it is misleading to conclude what laughter is about by analyzing merely what immediately precedes laughter.

Acoustically-based classification: Studies such as (Campbell et al., 2005; Tanaka and Campbell, 2014) classified the function of laughter on acoustic parameters only. (Tanaka and Campbell, 2014) asked participants to listen to the laughter bouts and judge whether it is a “mirthful” or “politeness” laughter. In the first instance we would like to point out that the names of the categories “mirthful” and “politeness” do not belong to the same level of analysis: one can feel “mirthful”, but cannot feel “politeness”; and the two categories are not mutually exclusive, i.e., one can politely laugh while feeling mirthful, and one can impolitely laugh without feeling mirthful. We believe that laughs with similar acoustic features can have different functions in different contexts. We will make a first attempt to test this issue in our data, specifically whether the function of laughter can be predicted by context *and* form-based measurements, deferring a more detailed analysis of phonetic aspects to further studies.

3 A multi-layer analysis of laughter

We have argued that the confusion in laughter type classification comes from not distinguishing different levels of analysis. An additional intrinsic problem for previous analyses is that they did not attempt to integrate their account with an explicit semantic/pragmatic module on the basis of which content is computed.² The sole recent exception to this, as far as we are aware, is the account of (Ginzburg et al., 2015), which sketches an information state–based account of the meaning and use of laughter in dialogue. We take that account as our starting point, though that account has a number of significant lacunae which we point to here and (some of) which we briefly sketch means of plugging in section 7. The purpose of the current study is to test a new method for laughter analysis whereby each laughter episode is described by

²This is not the case for some theories of humour. For example, (Raskin, 1985) offers a reasonably explicit account of incongruity emanating from verbal content. However he did not attempt to offer a theory of laughter in conversation.

means of the following: its context of occurrence both in relation to the laughable, to other’s laughter and the other’s or laugher’s own speech³; the nature of the laughable; its pragmatic use (whether laughter is used in its literal or ironical meaning); the amount of arousal perceived by the listener; and finally, in the function that it serves in the specific context of occurrence.

The account of (Ginzburg et al., 2015) views laughter essentially as an event anaphor. They associate two basic meanings with laughter, one involving the person laughing expressing her *enjoyment* of the laughable *l*, the other expressing her perception of *l* as being *incongruous*. These meanings, combined with a dialogical reasoning theory, Breitholtz and Cooper’s enthymatic approach (see e.g., (Breitholtz, 2014)), allow one to deduce a potentially unlimited set of functions that laughter can exhibit. For instance, seriousness cancellation (of an assertion or query), scare quotation, and acknowledgment.

The account focuses on the laughter stimulus or trigger, i.e., the laughable. One question to raise here is whether incongruity and enjoyment are the only two dimensions to distinguish the person laughing’s relation to the laughable. Certain uses we see below suggest, arguably, the need for a third possible relation pertaining to *ingroupness* or *sympathy*.

Be that as it may, the account due to (Ginzburg et al., 2015), abstracts away from a significant dimension of laughter, namely *arousal*. In line with (Morreall, 1983) we think that laughter effects a “positive psychological shift”. Thus, an additional dimension we identify is one which relates to arousal. This can go from very low to extremely high, and different amplitudes in the shift can depend on the trigger itself and on the individual current information/emotional state. It is important to point out that laughter does not signal that the speaker’s current emotional state is positive, merely that there was a shift which was positive. The speaker could have a very negative baseline emotional state (being very sad or angry) but the recognition of the incongruity in the laughable or its enjoyment can provoke a positive shift (which could be very minor). The distinction between the overall emotional state and the direction of the shift explains why laughter can be produced

³See (Nwokah et al., 1999; Kohler, 2008; Trouvain, 2001; Menezes and Igarashi, 2006) for detailed descriptions of acoustic features of speech-laugh.

when one is sad or angry.

We therefore claim that the "literal" meaning conveyed by a laughter (more or less genuinely) is that a stimulus y has triggered in the laughter a positive arousal shift of the value x . Like language it can be used ironically, intending to convey exactly the opposite of its literal meaning i.e., the stimulus y totally didn't trigger in me a positive shift in the arousal of any value. A more detailed analysis of ironic laughter is a topic for future study.

What about function? We distinguish the functions of laughter from its form, its meaning and its triggers, in contrast with previously proposed classifications (see section 2.1.3). As we mentioned above, (Ginzburg et al., 2015) sketch how some functions can be derived from the meanings they posit in conjunction with a theory of dialogical reasoning. However, they do not propose a systematic repertory of possible functions. Building on previous work, we conducted a detailed overview of the possible functions that laughter could serve in interaction. We believe that an efficient way to partition them is to differentiate two big classes—*cooperative* functions that promote the continuation of interaction (e.g., show enjoyment, show agreement, and softening) and *non-cooperative* functions that damage the flow of the interaction (e.g. mocking, showing disagreement)⁴. Following are some examples from our corpus exemplifying this—**film script**, **border control**, **dream apartment** are names of the tasks the participants were engaged in, further described in section 4; the laughter serves the function given in capitals and lasts throughout the text surrounded by < laughter > and < /laughter >:

1. SHOW-ENJOYMENT (**film script**) A: there is one one of my buddies stupid as he is who who put a steak on the border of the, of the balcony B: < laughter > you have weird buddies! < /laughter >
2. SMOOTHING: second laughter of B (**border control**) A: You are dealing with my visa? Then it will be very easy right? < laughter/ > B: < laughter/ > But we have to follow the rules. I have to < laughter/ > ask you some questions.
3. SHOW-AGREEMENT (**dream apartment**) A: and then in the evening we can cook a very good pasta! B: < laughter/ > yes! why not?

⁴The distinction between smoothing/softening on the one hand and benevolence induction on the other lies in whether the speaker is trying to induce agreement (benevolence induction), or to reduce intrusion (smoothing). A helpful way to look at this distinction is with reference to the notion of positive and negative politeness (Brown and Levinson, 1987).

4. BENEVOLENCE-INDUCTION (**film script**) B: actually we need to think about what we say when we hang up the phone? hi how are you? A: so then uh: < laughter > so that's going well or not? < /laughter >
5. MARKING-FUNNINESS (**film script**) uh:: oh < laughter > it is something < /laughter > uh < laughter >that happened< /laughter > to a buddy < /laughter >it is< /laughter > in fact, his chick and one of our buddies were playing (and + and) and playing they splashed some ice tea on him and we thought that he had pissed himself.

In what follows, we attempt to validate this account on the basis of a cross linguistic corpus study. We then sketch a formal theory that combines the various dimensions, stimulus, arousal, and function.

4 Material and Method

4.1 Material (corpus)

We analyzed a portion of the DUEL corpus (citation suppressed for anonymity). 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 in three tasks which in total lasted around 45 minutes. The three tasks used were "**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; "**film script**": The participants spend 15 minutes creating a scene for a film in which something embarrassing happens to the main character; and "**border control**": one participant plays the role of a traveler attempting to pass through the border control of an imagined country, and is interviewed by an officer. The traveler has a personal situation that disfavours him/her in this interview. The officer asks questions that are general as well as specific. In addition, the traveler happens to be a parent-in-law of the officer. The corpus is transcribed in the target language and glossed in English. Disfluency, laughter, and exclamations are annotated. The current paper presents analysis of a portion of the DUEL corpus (Hough et al., 2016): two dyads both in French and Chinese (3 tasks x 2 pairs x 2 languages), having a total of 657 laughter events analysed in relation to their laughable over a total of 160mins.

4.2 Audio-video coding of laughter

Coding was conducted by the first and second authors: each video was observed until a laugh occurred. The coder detected the exact onset and offset in Praat, and conducted a multi-layer analysis previously illustrated. Reliability was assessed by having a Masters student as a second coder for 10% of the material observed. Percentage agreements between the two coders for french data averaged 86.6%, with an overall Krippendorff α (Krippendorff, 2012) across all tiers of 0.652. The value is very negatively affected by the layer regarding the presence or absence of incongruity where one of the coders almost never coded a situation where no incongruity was perceived and the almost absence of one value is "strongly punished" by α . The discrepancy could also be accounted for by errors due to the coder. When excluding that tier α is 0.706. For the Chinese data, the percentage of agreement across all tiers averaged 90.5% with α being 0.752. In the Chinese coding the factor more responsible for the discrepancy observed is arousal. Acknowledging the very subjective measure that we are at the moment relying on i.e., personal perceptual judgment, we plan to use more objective acoustic and behavioural measures in future investigations.

Identification of a laughter episode

A laugh was identified using the same criteria as (Nwokah et al., 1994), based on the facial expression and vocalization descriptions of laughter elaborated by (Apte, 1985) and (Ekman and Friesen, 1975). Following (Urbain and Dutoit, 2011) we counted laughter offset (final laughter in-breath inhalation) as part of the laughter event itself, thus resulting in laughter timing longer than other authors (Bachorowski and Owren, 2001; Rothgänger et al., 1998). All laughter events were categorised according to different parameters: formal and contextual aspects, semantic meaning and functions. Coding criteria were elaborated in order to capture the difference, stressed in previous sections, between form, meaning, and functions of laughter production in dialogical interaction (Table 1). In the current study we restrict our observations about the aspects pertaining to form to the contextual distribution and positioning of a laugh in relation to others' laughter, the laughable and laugher's own speech⁵.

⁵Hypothesis and discussion of data about different be-

Formal Level	Speech and Laughter	Speech-Laugh	A laugh produced simultaneously with speech	Nwokah et al. 1999
		Standalone laugh	A laugh with not overlap with laugher's own speech	
	Temporal Sequence	Isolated Laughter	A laugh not preceded by any other laugh within 4 s	Nwokah et al. 1994
		Dyadic/Antiphonal Laughter	Reciprocal	A laugh that occurs less than 4 seconds after a laugh by the partner, but there is no occurrence or overlap of laughter
	Co-active		Two participants start laughing together and keep on laughing	Smoski & Bachorowski, 2003
	Context in relation to the inferred laughable	Before	The laughter occurs before the laughable has been uttered or occurred in the context	
During		The laughter occurs while the laughable is being uttered or while it is occurring in the context		
After		The laughter occurs after the laughable has been uttered or occurred in the context		
Semantic Level	Arousal	Low/Medium/High	Qualitative judgement	
	Presence of incongruity	Incongruity/No incongruity	Perception of elements unexpected and surprising in relation to the context (frame) of occurrence	
		Laughable	Described event	By the laugher him/herself (self) or by the conversational partner
	Linguistic form		(par) or co-constructed (both)	
	Exophoric event	Event not described or contained in the speech		
Functions for others	Coop	E.g. show enjoyment, smoothing/softening, show agreement, mark funniness, benevolence induction		
	Non Coop	E.g. offensive, mocking, threat, challenge, show disagreement/scepticism, avoid topic, evade conversation		

Figure 3: Laughter coding parameters

5 Results

5.1 General frequency, speech laughter and dyadic laughter

5.1.1 Frequency and duration

Laughter was in general very frequent. In the French data, there were 430 laughter events (lasting a total of 13.3 minutes) in 77 minutes of dialogue, giving a frequency of 56 laughter events per 10 minutes or 17% of the time. In the Chinese data, there were 215 laughter events (lasting a total of 6 minutes) in 85 minutes of dialogue, giving a frequency of 26 laughter events per 10 minutes or 7.2% of the time. A Z-test on the proportion of laughter minutes shows that laughter is marginally more frequent in French than in Chinese ($z=1.9$, $p=0.05$). Whether this is a language/cultural difference or an inter-subject one will be tested in the future with more data. There were higher proportions of speech-laughter in Chinese (47%) than in French (33%), $\chi^2=4.9$, $p=0.03$.

5.1.2 Dyadic laughter

The distributions of isolated, reactive and co-active laughter do not differ across tasks. There

behaviour across tasks is deferred to a future study when a larger set of data will be available

is more antiphonal laughter in French than in Chinese. Collapsing reactive and coactive laughers into antiphonal/dyadic laughers, these account for 44% of all laughter events in French and 36% in Chinese, showing that participants frequently join in in another’s laughter. The mean of transitional probability of antiphonal laughter in relation to the participant laughter behaviour is very similar between languages (fr: 43.5% sd 5.5, ch: 42.75% sd 24.97).

Type	Ch.no.	Ch.%	Fr.no.	Fr.%
Reactive	38	18%	107	25%
Coactive	39	18%	80	19%
Total Antiphonal	77	36%	187	44%
others	138	64%	241	56%

Table 1: Percentage of antiphonal laughter

5.2 Laughable and relative position of laughter

5.2.1 Laughable

The distribution of laughable is nearly identical in Chinese and French, with half being a self described event, and around 40% being an event described by the partner, or jointly described by both participants. Around 10% are exophoric and there were very few laughs that were only about the linguistic form or content. The task did not make a significant difference to the distribution.

laughable	Ch no.	Ch %	Fr no.	Fr %
de_self	118	55%	221	52%
de_par	67	31%	160	37%
de_both	7	3%	13	3%
ex	21	10%	31	7%
ling	2	1%	3	1%

Table 2: Laughable types distribution

5.2.2 Position of laughter in relation to laughable

Laughter can occur before (cataphoric), during or after (anaphoric) the laughable (see Table 3). Unlike lexical anaphora, laughs sometimes occur at the same time as the laughable. As illustrated in Figure 1, we found that there are big variations in the alignment of laughter and laughable. Some laughter events span from before the laughable until after the laughable. Some laughter events are more than one utterance away from the laughable⁶.

In relation to laughables, when the laughter occurs after the laughable, there are equal numbers of self described events and other described

⁶Due to such variability, we leave this tier out of the regression analysis and will investigate it in more detail in future studies analysing both the freedom in laughter-laughable alignment as well as its limits and constraints.

events. When the laughter occurs during or before the laughter, there are more self described events than other described events.

Ch							
Cntxt	de_par	de_slf	de_both	ex	ling	Ttl	%
aft	49	55	4	6	2	116	57%
dur	15	49	2	13		79	39%
bef	1	5	0	2		8	4%
Fr							
aft	145	143	6	13	3	310	74%
dur	13	66	4	16		99	24%
bef	0	8	1	1		10	2%

Table 3: Position of laughter in relation to laughable

5.3 Meaning and function: arousal, presence of incongruity and function

5.3.1 Perceived arousal

The majority of the laughs had low arousal in both languages. High arousal laughers were rare. Task did make a difference. Laughers in the more serious border control task were 100% low arousal in French and 85% low arousal in Chinese. Arousal correlates with laughter duration: mean(low)= 1.11s, mean(mid)= 2.55s, mean(high)= 4.6s.

Arousal	Ch no.	Ch %	Fr no.	Fr %
low	165	77%	265	62%
mid	47	22%	162	38%
high	3	1%	2	0.40%

Table 4: Level of Arousal percentages

5.3.2 Presence of incongruity

The majority of the laughs were perceived to communicate an appraisal of incongruity (85% for both languages). Non-incongruity laughs were perceived to communicate ingroupness with the hearer. In Chinese, there is a higher proportion of non-incongruity laughs in the border control task, while in French the distribution was consistent across tasks.

5.3.3 Functions

The distribution of functions are surprisingly consistent between French and Chinese (see figure 4), with the most frequent being *show enjoyment*, followed by *smoothing/softening*, *show agreement*, *mark funniness* and *benevolence induction*. Clustering analysis on all tiers shows that the latter two functions have similar distributions. Less frequent functions include self-mocking, apology, show sympathy and showing appreciation (to thank).

5.4 Interactions across tiers

We are interested in how the tiers interact with each other, and to what extent functions can be predicted by form and context tiers. Due to similar distributions we collapsed function "smoothing/softening" with "benevolence induction". To

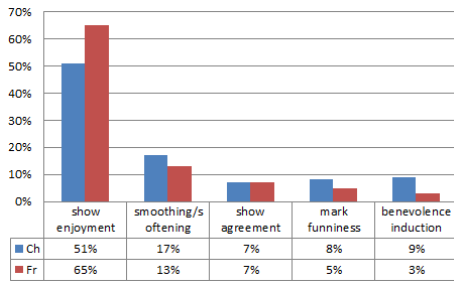


Figure 4: Function distribution

study the relations among tiers, we performed multiple factor analysis, which converts a set of possibly correlated variables into a smaller set of uncorrelated variables. Figure 5 plots the correlation of each tier in relation to the two dimensions that explain the most amount of variance (x and y axes). In Chinese, antiphonal and speech laugh contribute to the same dimension, roughly independent from arousal. The type of laughable (and to a less degree incongruity) contribute to both dimensions. Function only correlates with the first dimension. In French, arousal and antiphonal contribute to the same dimension, roughly independent from speech laugh. The type of laughable and incongruity contribute to both dimensions. Therefore the main difference between the languages is that in Chinese, it is arousal which doesn't explain the variances in function; in French, it is speech laugh.

We then performed multinomial logistic regression analysis, trying to predict the function (specifically the odds ratio of one function over another) from speech laugh, antiphonal, arousal and laughable. Figure 6 plots the distribution of functions against four tiers. In both languages, *show agreement* and *show enjoyment* are often antiphonal laughs, and they have low proportions of laughables from self. In Chinese, *mark funniness/ridiculousness* has a very distinct signature from the other functions, being almost exclusively speech laugh and having a laughable from self. In French, *mark funniness/ridiculousness* is close to *benevolence induction* apart from arousal (the former has higher arousal). Table 5 shows that in Chinese, the factors antiphonal, laughable and speech laugh have significant effects in functions, duration has a marginally significant effect (after adjusting p for multiple comparisons), and arousal doesn't have an effect. In French, antiphonal, laughable, and arousal have significant effects in functions, while speech laugh has no significant effect.

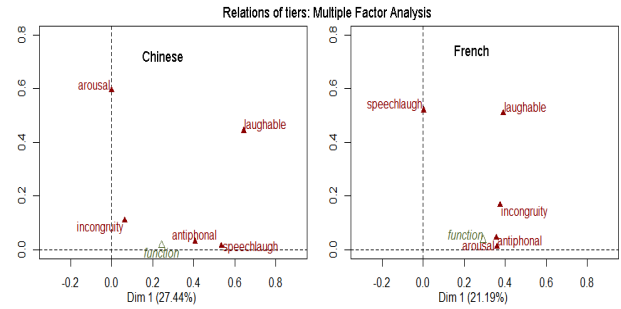


Figure 5: Relation of tiers

Tiers	value	bnvlnc/ enjoy	mrk funny/ enjoy	agree enjoy	mrk funny/ bnvlnc	agree bnvlnc	agree/ mrk funny
Chinese							
speech-laugh	coefficient	-.30	2.08*	.50	2.38**	.81	-1.58
	p-adjst	1	.02	1	.01	1	.57
antiphnl/coactive	coefficient	-1.19*	-16.58***	.28	-15.75***	1.47	17.60***
	p-adjst	.05	.00	1	.00	.24	.00
mid/high-arousal	coefficient	-.39	.99	.53	1.38	.92	-.46
	p-adjst	1	1	1	.72	1	1
laughable-self	coefficient	.94	56.56***	-1.16	23.22***	-2.10	-17.98***
	p-adjst	.27	.00	1	.00	.08	.00
duration	coefficient	-.72	-.66	-.66	.06	.06	.00
	p-adjst	.08	.26	.75	1	1	1
French							
speech-laugh	coefficient	-.14	-.17	.12	-.03	.26	.30
	p-adjst	1	1	1	1	1	1
antiphnl/coactive	coefficient	1.63***	1.75***	.38	.12	-1.24	-1.36
	p-adjst	.00	.00	1	1	.09	.16
mid/high-arousal	coefficient	-1.67***	-.60	-1.93***	1.07	-.26	-1.33
	p-adjst	.00	.90	.00	.29	1	.23
laughable-self	coefficient	1.77**	1.68*	-1.48**	-.09	-3.25***	-3.15***
	p-adjst	.00	.02	.00	1	.00	.00

Table 5: Multinomial logistic regression results: coefficients of log odds and p value (adjusted for multiple comparisons) comparing each pair of functions

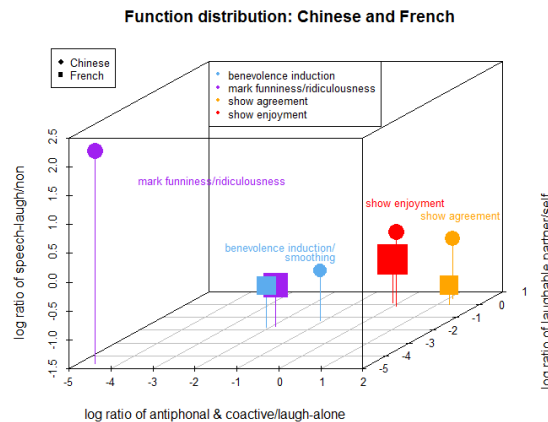


Figure 6: Distribution of functions in relation to speech laugh, dyadic laugh, laughable, functions, arousal and duration. The x, y and z axes represent log ratios of dyadic over non-dyadic laugh, speechlaugh over non-speechlaugh and laughable from partner over self. The size of dots represents the average arousal.

6 Discussion

Our multi-layered analysis of laughter in dialogue investigated the contextual forms (frequency, duration, speech-laughter, and laughter co-occurring with partner's laughter), laughable (type of laughable, position of laughter in relation to laughable, meaning (incongruity and arousal) and function.

Probably due to the cooperative and (to some extent) funniness oriented corpus, we found higher

frequencies of laughter (in French and Chinese respectively 26 and 56 laughter bouts over 10 minutes of interaction) than reported elsewhere (e.g., (Vettin and Todt, 2004)’s 5.8 (2.5)/10min)), and within that value we also reported a higher proportion of speech laughter over stand alone laughter (40%) than previously (e.g. (Nwokah et al., 1999)’s mean of 18,6%, even though they reported a variance up to 50%). However, in terms of duration, our results are similar to previous results, both for stand alone laughter (Petridis et al., 2013; Truong and Van Leeuwen, 2007; Nwokah et al., 1999; Bachorowski and Owren, 2001) and speech laugh (e.g.(Nwokah et al., 1999). We found a higher percentage both of reactive and co-active laughter compared to e.g., (Nwokah et al., 1994) (8%) and (Smoski and Bachorowski, 2003) (34%). The values are nevertheless consistent between the French and Chinese samples, having an overall mean of 43.12 transitional probability of a participant to laugh antiphonally in relation to his partner.

In terms of laughables, there are more self-described events than partner described events, suggesting that speakers laugh more than the audience. Most laughables are described events; euphoric laughables are less frequent and linguistic laughables are rare. More than half of the laughers follow the laughable, but a significant amount occur during the laughable, a few occur before the laughable. In terms of meaning, we perceived that around 85% of the laughers communicate an appraisal of incongruity, and most laughter have low arousal. In terms of the laughter’s effect or function, We identified four most frequent types in our data: *show enjoyment* (most frequent), *smoothing/benevolence induction*, *show agreement*, and *mark funniness*. The four functions have distinct distributions in measurements from form and laughable layers. The functions seem to be characterized by a cluster of layers rather than from a single one.

7 The Varieties of Laughter: interfacing with grammar and emotional state

In this section we sketch a formal semantic and pragmatic treatment of laughter that can accommodate the results in section 5. In section 3 we pointed to certain lacunae that (Ginzburg et al., 2015) faces. We briefly sketch some solutions, leaving to a more extended version a more detailed

treatment.

On the approach developed in KoS, information states comprise a private part and the dialogue gameboard that represents information arising from publicized interactions. In addition to tracking shared assumptions/visual space, Moves, and QUD, the dialogue gameboard also tracks **topoi** and **enthymemes** that conversational participants exploit during an interaction (e.g., in reasoning about rhetorical relations.)(Ginzburg et al., 2015). Here topoi represent general inferential patterns (e.g., *given two routes choose the shortest one*) represented as functions from records to record types and enthymemes are instances of topoi (e.g., *given that the route via Walnut street is shorter than the route via Alma choose Walnut street*). An enthymeme belongs to a topos if its domain type is a subtype of the domain type of the topos.

(Ginzburg et al., 2015) posit distinct, though quite similar lexical entries for enjoyment and incongruous laughter. For reasons of space in (1) we exhibit a unified entry with two distinct contents. (1) associates an enjoyment laugh with the laugher’s judgement of a proposition whose situational component l is *active* as enjoyable; for incongruity, a laugh marks a proposition whose situational component l is *active* as *incongruous*, relative to the currently maximal enthymeme under discussion.

(1)

$$\left[\begin{array}{l} \text{phon : laughterphonetype} \\ \\ \text{dgb-params : } \left[\begin{array}{l} \text{spkr : Ind} \\ \text{addr : Ind} \\ \text{t : TIME} \\ \text{c1 : addressing(spkr,addr,t)} \\ \text{MaxEud = e : (Rec)RecType} \\ \text{p = } \left[\begin{array}{l} \text{sit = 1} \\ \text{sit-type = L} \end{array} \right] \text{ : prop} \\ \text{c2 : ActiveSit(l)} \end{array} \right] \\ \\ \text{content}_{\text{enjoyment}} = \text{Enjoy(spkr,p) : RecType} \\ \text{content}_{\text{incongruity}} = \text{Incongr(p,e,\tau) : RecType} \end{array} \right]$$

(1) makes appeal to a notion of an *active situation*. This pertains to the accessible situational antecedents of a laughter act, given that (Ginzburg et al., 2015) proposed viewing laughter as an eventive anaphor. However, given the significant amount of speech laughter, this notion apparently

needs to be rethought somewhat, viewing laughter in gestural terms. This requires interfacing the two channels, a problem we will not address here, though see (Rieser, 2015) for a recent discussion in the context of manual gesture.

Given the enjoyment meaning and the topos *If X is enjoying that X/Y said that p, then X agrees that p*, (Ginzburg et al., 2015) obtain as a consequence that enjoyment laughter can be used as a positive feedback signal. We think that this can be extended to yield also the function of *benevolence induction* via the topos *if X is enjoying Y's presence, X does not want to have a disagreement with Y*.

(Ginzburg et al., 2015) explicate incongruity in terms of a clash between the enthymeme triggered by the laughable and a topos which the enthymeme is supposed to instantiate. On the basis of this they explicate seriousness cancellation in an utterance *u* as (mock) self-repair. The laughter relies on the enthymeme 'If I'm saying *u*, then I don't mean it.' This clashes with the sincerity topos 'If A says *p*, then A means *p*'. One can extend this to smoothing in an interaction between A and B as arising from a clash between the enthymeme if A is manifestly pleasant to B, A need not wish to be overly intimate with B and the topos if an individual X is manifestly pleasant to Y, X wants to be open to Y.

The dialogue gameboard parameters utilised in the account of (Ginzburg et al., 2015) are all 'informational' or utterance related ones. However, in order to deal with notions such as arousal and psychological shift, one needs to introduce also parameters that track appraisal (see e.g., (Scherer, 2009)). For current purposes, we mention merely one such parameter we dub *pleasantness* that relates to the appraisal issue—in Scherer's formulation—*Is the event intrinsically pleasant or unpleasant?*. We assume this parameter is scalar in value, with positive and negative values corresponding to varying degrees of pleasantness or unpleasantness.

This enables us to formulate conversational rules of the form 'if A laughs and pleasantness is set to *k*, then reset pleasantness to $k + \theta(\alpha)$ ', where α is a parameter corresponding to arousal. We provide a more precise formulation in an extended version of this paper.

8 Conclusions and Further Work

This paper presents a multi-layered classification of laughter based on a detailed corpus study of French and Chinese dialogues taken from the DUEL corpus. Data from the form/context layers show that laughter can occur before, during or after the laughable, which can be a described event, an exophoric event, or a metalinguistic stimuli. The freedom in time alignment between laughter and laughable demonstrates that analyzing what precedes laughter on the surface is unreliable as a means for determining what laughter is about. Data from the meaning layer show that in our corpus, laughter, with varying degrees of arousal, can communicate an appraisal of incongruity, the enjoyment of an event, or the feeling of ingroupness with the partner. The simple meaning of laughter, when combined with rich contextual reasoning, can have various effects or functions in interaction. The most frequent ones in our corpus are *show enjoyment, smoothing/benevolence induction, mark funniness and show agreement*. These types are not distinguishable by any *single* form or context layer measurement, but rather by a cluster of them (for example, benevolence induction and smoothing laughters are mostly stand-alone, low arousal laughter, when the laughable is partner produced). Cross-linguistically, the distributions of most layers of analysis are very similar between French and Chinese, suggesting tentatively that laughter is not heavily shaped by linguistic features. Based on our data, we ground the analysis in a formal framework, treating laughter as gestural event anaphora, and proposing the incorporation of emotional appraisal into the dialogue gameboard.

There is much further work to be done on all fronts addressed here. This includes a more accurate analysis of acoustic features, and those pertaining to laughables; on the formal front further integration of information state dialogue analysis with appraisal models coming from cognitive psychology and AI.

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