A Sigh of Positivity: An Annotation Scheme for Sighs in Dialogue

Christopher Cash
Trinity College, Dublin
ccash@tcd.ie

Jonathan Ginzburg
Université de Paris, CNRS
Laboratoire de Linguistique Formelle
LabEx-EFL
yonatan.ginzburg@univ-paris-diderot.fr

Abstract

In this paper, an annotation scheme is developed to investigate the emotional quality of sighs in relation to three criteria; their placement in dialogue, their reason of expression and the emotion expressed by the sigh. Plutchik's Wheel of Emotions is used to categorize the emotions and identify the extent of their arousal. We recognize two recurring kinds of sighs: those of low arousal and negative valence, and those of high arousal and positive valence. In particular, our results suggest the existence of cues indicating that a sigh is positive, as 75% of sighs *between pauses* were classified as positive and, moreover, when a sigh is classified as High arousal, there exists a 82% probability that the sigh will be positive. We conclude with a brief sketch of a formal analysis of sighs within the framework of KoS integrated with Scherer's component process model of appraisal.

1 Introduction

Sighs are non-verbal vocalisations that can carry important information about a speaker's emotional and psychological state (Truong et al., 2014). Their emotional quality is generally regarded as expressing a negative emotion, and are studied less than stereotypical positive utterances such as laughter and smiles. Truong et al. (2014) developed an annotation scheme for sighs which acknowledges their phonetic variations, in the hope of shedding light on the possibility of sighs expressing positive emotions. This scheme introduced two different sighs differentiated by whether or not they retained an audible inhalation and exhalation or just an audible exhalation. A basic finding was that not all sighs are produced in the same emotional context.

The physiological element of a sigh has been investigated thoroughly since Charles Darwin, and Straus (Straus, 1952) cites Darwin's assertion that "the movements of expression in the face and body, whatever their origin may have been, are in themselves of much importance for our welfare." Much of Straus' (1952) paper details the physiological element of the sigh, resulting in the conclusion that "the sigh, obviously, has no physiological causation." Thus, we can understand sighing as the expression of emotion as it establishes a relation between a solitary individual and the world, as it is "a variation of the experiencing of breathing." Bearing this in mind, we can discuss the expression of sighs in relation to theories of appraisal.

In cognitive theories of emotion, the general consensus is that emotions are caused by appraising events. Appraisal theories predict that emotions are elicited entirely on the basis of an individual's subjective evaluations of the event (Oatley and Johnson-Laird, 2014). Scherer (Scherer, 2009a) formulates an appraisal theory which insists that an organism's analysis of a situation correlates with their emotional reactions. Thus, it seems beneficial to analyse sighing in relation to a range of contextual criteria, such as investigating which person in a dialogue expresses the sigh and what is the topic of the dialogue— though this conflicts with Goffman's influential theory that sighs are produced by spontaneous eruptions of negative emotions (Goffman, 1978). To evaluate whether a sigh could retain a positive connotation, Teigen (Teigen, 2008) conducted three studies. He claims that a prototypical sigh is a mismatch between ideals and reality writing that "the sigh accordingly carries two messages: One of discrepancy (something is wrong) and one of acceptance (there is nothing to be done)". Hoey (Hoey, 2014), from a conversation analysis perspective, analyzes 54 sighs from the Santa Barbara Corpus of Spoken American English and from the Language Use and Social Interaction archive at the University of California, Santa Barbara. He distinguishes effects sighs have by position: speakers were found to use pre–beginning sighs for presaging the onset of talk

and indicating its possible valence; speakers used post–completion sighs for marking turns as being complete and displaying a (typically resigned) stance toward the talk. However, Hoey does not attempt any emotional analysis of the sighs.

Evidently, the categorisation of a sigh's emotional valency is complex. This paper will explore Straus' (1952) assertion that "If expressions are immediate variations of fundamental functions, every form of behaviour needs to be expressive", by analysing the intensity of the emotion expressed by a sigh. By elaborating on two recent studies conducted to investigate the effects of emotional valence and arousal on respiratory variability during picture viewing and imagery, this paper will analyse the emotional quality of a sigh in relation to its context. (Vlemincx et al., 2015). Vlemincx et al.(2015), employed a method which separated emotions into dimensions and found that these dimensions yielded significantly different results, as fear imagery increased the expiration time of a sigh. These studies highlight the importance of analysing emotions with respect to a scale and found that high arousal emotions increase sigh rate, which contrasts with Straus' theory. For this purpose, the employment of Plutchik's Wheel of Emotions (Plutchik, 1988) establishes a consistent categorisation of emotions. Plutchik's diagram (see Figure 8) highlights the existence of eight basic emotions, comprised of other emotions of various intensities. The use of this classification model can guide economists when developing a decision-making model (Gomes, 2017), highlighting the application it has for appraisal theories of emotions. It is the aim of this paper to develop a model in which the emotional quality of a sigh can be predicted.

An annotation scheme was developed iteratively and applied to a corpus consisting of conversation extracts—a sampling of the British National Corpus, thereby establishing contextual criteria for sigh classification. Using this methodology, it was found that sighs indicate a positive emotion more than other studies have accounted for.

The paper is structured as follows: A description of the corpus is given in Section 2, and the annotation scheme is clearly outlined in Section 3. An Analysis is conducted in Section 4, a Discussion is provided in Section 5, and a formal analysis is sketched in Section 6. Section 7 contains some concluding remarks.

2 Material

One hundred samples of spoken dialogue were randomly selected for sigh annotation and analysis from spoken portion of the British National Corpus(British National Corpus). This was achieved using Matt Purver's search engine SCoRE (Purver, 2001). Sighs are denoted as non-linguistic vocalisations in the corpus, and were added to the transcription scheme in 2014, as noted in the (British National Corpus 2014: User Manual and Reference Guide).

3 Development of the annotation scheme

Annotation guidelines were decided upon before analysis of samples. These guidelines focused on three dimensions;

(1) Who produced the sigh and the vocal environment of the sigh

(2) An interpretation of the reason for the sigh

(3) An interpretation of the emotion expressed by the sigh by evaluating the first two dimensions.

The annotation was conducted by the first author. An inter-annotator study was conducted using annotation by a third individual, on the entire sample, for all three dimensions; three κ values were calculated.

3.1 Annotation Guidelines

First Dimension Guidelines

1. *Determine the Speaker and Addressee in the dialogue. The Speaker is defined as the person initiating the topic of conversation in the section of dialogue that is being analysed, and the Addressee is defined as the person who is perceived to be responding to the topic of conversation in the dialogue.*

2. *Determine the vocal environment of the sigh, focusing solely on the line of dialogue in which the sigh exits, by first distributing the data between two sets: Sighs expressed in relation to Speech and sighs expressed in relation to Pause. A pause in the corpus is indicated by "<pause>" and should only be taken into account if it immediately precedes or follows the sigh. Distribute this data into three subsets; Before, Between and After.*

   —Before: *describing a sigh existing directly before speech or pause.*

   —Between: *describing a sigh existing between two forms of speech or two indicated pauses.*

   —After: *describing a sigh existing directly after speech or pause.*[1]

[1] If the sigh exists in a line of dialogue independently, distribute regularly into the set and subset however indicate that it refers to the other person's speech or pause, looking at the lines of dialogue directly preceding and following.

Distinguishing between a Speaker and an Addressee yields interesting results when informed by their emotional valence. This is further elaborated on in Section 4.

As seen in Example 1, it is clear that Andrew is identified as the Speaker as he initiates the conversation.

```
Andrew:(SPK)
1. <sigh> Well we're keen to get here aren't we?
2. <pause> We're in the right place
I suppose? <pause> <unclear>
Anon 1:(ADR)
3. Mm. <pause dur=20>
Andrew:
4. Aha <pause dur=12> Well they'll be asking
the rest of us to take
a cut in salary soon <unclear>.  <pause>
Anon 1:
5. <unclear> Well if I can <unclear> <laugh>
```

Example 1

Example 2 illustrates how a sigh is categorised as Between Pause.

```
Anon 3:(SPK)
133. Erm <pause> <sigh> <pause> (BTP)well I tried
for years to live with my second husband and it
just was impossible!
Anon 9:(ADR)
134. Mm.
Anon 3:
135. Not for just my own children but for my own health.
136. I'm now in a stable relationship with my fiancé and
it's fantastic!
137. What a difference!
```

Example 2

Second Dimension Guidelines *Determine the reason for the sigh by analysing the entire excerpt of dialogue and proposing a category for the conversation.* Building on the first dimension, it is clear from Example 3 that John is the *Addressee*, and the sigh is expressed *Before Speech* and the reason is denoted as *Answering*.

```
John: (SPK)
1594.Yeah I'll I'll check what I've got booked where
and then I'll I'll get in touch you for next week.
1595. Er
Andrew:(ADR)
1596. As long as it doesn't cause too much disruption
for you.
John:
1597. <sigh>(BS)It doesn't(Answering)
```

Example 3

Third Dimension Guidelines *Determine the emotion expressed by the sigh using Plutchik's Wheel of Emotions:*

1. *Assign the sigh to one of the twenty four emotions of varying intensity in the model*
2. *Note which of the eight basic emotions it corresponds to,*
3. *Determine whether the basic emotion is positive or negative, based on the following partition: Anticipation, Joy, Surprise* and *Trust* are positive, and *Anger, Disgust, Fear* and *Sadness* are negative.

Example 4 highlights how a sigh can be interpreted as positive, as the emotion expressed is categorised as *Joy*, and as *Neutral Intensity*.

```
Clare:
350. <laughing>:[ That's the one, yes. ] <laugh>.
Wendy:
351. <laugh>.
Clare:(SPK)
352. <sigh>(BS)After having hear his discourse on <pause>
the wonders of interchangeable brain chips and the lunar
landscape just above the ceiling border in thirty
[address] Road, I think he would probably be <pause>
quite a good candidate. (Discussing) (Joy)
```

Example 4

3.2 Results

3.2.1 First Dimension

The data indicates that 62% of the sighs were expressed by *Speakers* as opposed to 38% of the sighs which were expressed by the *Addressee*. This data highlights that a *Speaker* in a dialogue is more likely to express a sigh than the *Addressee*.

The placements of the sighs in the sample dialogues were then analysed with regard to the subsets *Before, Between* and *After*. This data is presented in Figure 1.

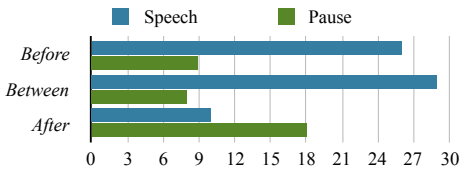

Figure 1: Placement of sigh in dialogue

Interestingly, the results indicate that 65% of the sighs were produced in relation to speech. Out of the 29 sighs produced *Between speech*, 41% of sighs were produced by a person during the other person's speech, as opposed to 59% of these sighs being produced during the person's own speech.

The results also indicated that 83% of the sighs produced between the other person's speech, were produced by an *Addressee* while the *Speaker* was speaking. Also, 11% of the sighs produced *After pauses* were produced after the other person's pause.

3.2.2 Second Dimension

The second dimension analysed the reason for the sigh. There were 29 possible reasons for sighs recorded, however only the reasons which received at least two entries were included in the data presented in Figure 2

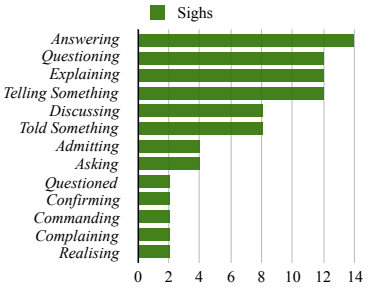

Figure 2: Reasons for expressing a sigh

These reasons were decided upon after analysis of dialogue, taking into account the words and expressions used. The results show that the most common reason for expressing a sigh is when *Answering*.

3.2.3 Third Dimension

The final dimension considered was the emotion expressed by the sigh. This data emerged through analysis of the data found in the previous two dimensions. The emotions were categorised into the twenty-four emotions, of varying intensity, on Plutchik's Wheel of Emotions, and then further categorised into the eight basic emotions, outlined in Figure 3. These eight emotions are grouped

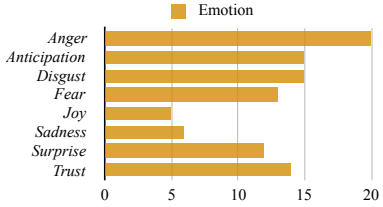

Figure 3: Classification of emotions expressed by sighs

together as polar counterparts in the parings of *Joy/Sadness, Trust/Disgust, Anger/Fear* and *Anticipation/Surprise*. This annotation scheme further distinguishes whether these emotions are either generally positive or negative. The positive emotions are *Anticipation, Joy, Surprise* and *Trust*, and the negative emotions are *Anger, Disgust, Fear* and *Sadness*. Interestingly, the results indicate that 46% of emotions recorded were positive, as opposed to 54% of emotions recorded as negative. The distribution of the sighs into the twenty-four emotions of varying intensity is given in Figure 4. Interestingly, the majority of all emotions were

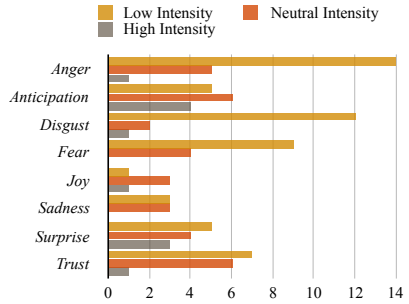

Figure 4: Distribution of emotional intensity

of *Low Intensity*, except *Anticipation* and *Joy*, in which the majority of these emotions were of *Neutral Intensity*. This indicates that it is more likely for a sigh that is expressing a positive emotion to be of a higher intensity.

3.3 Inter-Annotator Reliability

Following these guidelines, a third individual annotated 100% of the samples on all three dimensions. Cohen's Kappa Value was then computed from this inter-annotation scheme.

For the first dimension, a κ value of 0.52 was obtained for whether the sigh was expressed by a speaker or addressee. This highlights the difficulty in labelling participants when the full dialogue is not analysed. However, a κ value of 1 was obtained for the annotation of vocal environments, indicating that due to the guidelines provided by the Reference Guide(British National Corpus 2014: User Manual and Reference Guide), this dimension is deterministic as there are no discrepancies between annotators when analysing the vocal environment of a sigh.

For the second dimension, a κ value of 0.6 was obtained for analysing the reason for sighing, indicating a moderate level of agreement.

For the third dimension, a κ value of 0.62 was obtained for the emotion expressed by the sigh, suggesting that the inter-rater agreement for this study is moderately high. Interestingly, the majority of discrepancies occurred with respect to the classification of the basic emotions Anger and Anticipation. Out of the samples that were categorised as either expressing *Anger* and *Anticipation* by both annotators, it was found that in 33% of samples, the annotators disagreed about whether the emotion was *Anger* or *Anticipation*. This discrepancy could be accounted for

by the existence of eight extra emotions outlined in Plutchik's model, which are combinations of two basic emotions. The basic emotions *Anger* and *Anticipation* exist beside each other on the wheel, and their combination emotion is *Aggressiveness*. Thus, the addition of these eight combination emotions could account for these discrepancies.

4 Analysis

As indicated in Figure 5, the results show that 50% of the sighs expressed by the speaker were positive, indicating that there is no efficient way of predicting the valence of a sigh when it is expressed by the speaker of a dialogue.

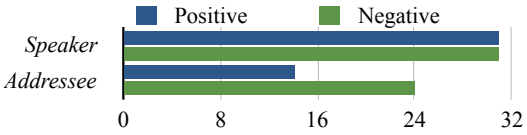

Figure 5: Distribution of sighs in all sound environments

This contrasts with the data recorded for the addressee, as the data indicates that 37% of the sighs expressed were positive. Subsequently we can deduce that it is more probable for an addressee to express a negative sigh than a speaker. Figure 6 distributes the sighs expressed between speech or pause into categories of positive and negative. It is clear that between speech, 41% of sighs are positive which contrasts with 75% of sighs expressed between pauses being positive. Thus, it is evident that it is more likely that a sigh expressed between a pause is positive than when it is expressed between speech. In Example 5, a sigh is expressed between a pause, which is positive as the emotion expressed is *Anticipation*. It's clear that the dialogue directly preceding the pause and sigh is of a positive nature, indicating that the pause is used to establish equilibrium before asking a question. This example highlights the significance of pauses when analysing sighs. From these results it is clear that the emotion of a sigh is directly related to the vocal environment that it is

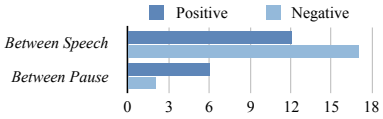

Figure 6: Distribution of sighs between speech or pause

```
Terry:(SPK)
596. <singing>:[ I wanna to take you to outer space
<pause dur=7> outer space ].
597. <pause dur=17> Reggae Hits, thirteen.
598. <pause dur=12> <sigh> <pause> How long will
it be mum? (BTP)(Asking) (Anticipation)
Mother: (ADR)
599. What?
Terry:
600. How lo , how long are you gonna be?
Mother:
601. Up the park, er for dinner?
Terry
602. Yeah.
```

Example 5

expressed in. By focusing on the second dimension, and the motivations for expressing a sigh, the data is categorised into positive and negative emotions. It is clear that the highest recorded reasons for expressing a sigh were *1. Answering, 2. Questioning, Explaining & Telling Something, 3. Discussing & Told Something* and *4. Admitting & Asking*. These reasons were categorised by valency and this data is presented in Figure 7. Interestingly, 29% of sighs expressed when *Answering* were positive, in comparison to the 58% of sighs when *Questioning*. Thus, for the most common reason it is clear that the majority of sighs expressed are negative. However, for the second most common reason, the data indicates positive values of 58%, 42% and 50%, respectively. This highlights the difficulty in predicting whether or not a sigh will be positive or negative based on the reason for the sigh. Strikingly, 75% of sighs expressed while discussing yielded a positive result, which provides an excellent probability score for future sigh interpretation. Example 6 provides an example in which the sigh is expressed while discussing money, categorised as expressing the emotion of *Acceptance*, which is *Trust* at a *Low Intensity*. Finally, by analysing the Third Dimension, the data presented in Figure 4 indicates that the most common emotion expressed by a sigh is *Anger*, found in twenty samples, followed by *An-*

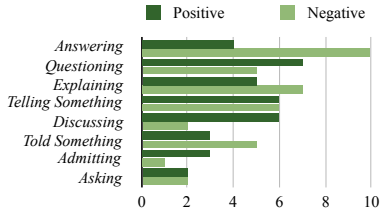

Figure 7: Distribution of the reasons for sighs by positive or negative emotions

```
Katriane:(SPK)
175. What are you gonna do, go and tell them?
<counting money>
Sandy: (ADR)
176. Give him a <pause> <unclear> this afternoon.
177. Er <pause> tell him then.
178. Twenty.
179. I'll charge six from silver.
Katriane:
180. Mhm.
Sandy:
<sigh> (BTspkS)(Discussing)(Trust)
Katriane:
181. Six, six, seven
```

Example 6

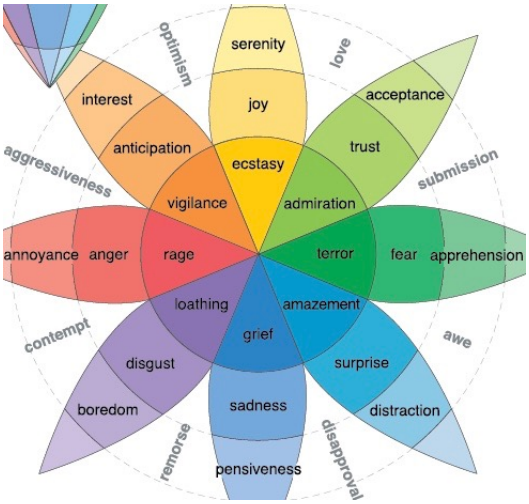

Figure 8: Plutchik's Wheel of Emotions

ticipation and *Disgust*, both found in fifteen samples respectively. Interestingly, this study found that 46% of sighs recorded were of a positive nature which contrasts with the other studies, such as Teigen(2008). Plutchik's model, displayed in Figure 8, illustrates how each of the eight basic emotions is constituted from two other emotions which exist at the extremes of the emotion spectrum. It is clear that *Annoyance* is a mild form of *Anger* whereas *Rage* is an intense form of *Anger*. Figure 9 distributes the emotions recorded into the categories of *Low, Neutral* and *High intensity*, and distributes them according to whether or not these emotions are positive or negative. The data indicates that the majority of emotions observed were of *Low Intensity*, as it accounts for 56% of the data. Surprisingly, only 11% of the data indicates a sigh of *High Intensity*, which suggests that a person rarely expresses intense emotions when sighing. The data also highlights that 82% of *High Intensity* emotions expressed were of a positive nature, contrasting to 32% of *Low Intensity* emotions that were positive. Example 7 indicates a posi-

```
Bev: (SPK)
5139. So, I don't know.
5140. They said work from eleven point three.
5141. I mean this is the last which is there.
Wendy:(ADR)
5142. Yeah.
Bev:
5143. From what I understand.
5144. I dunno!
5145. <sigh> Ah!
5146.<pause dur=9> Only I've <pause> get a
<unclear> if you want one.
5147. <unclear>. I thought there's no point
in leaving it in here.
(BS) (Discussing) (Amazement)
```

Example 7

tive sigh that was expressed of a *High Intensity*. Thus, this sigh can be categorised as a sigh of high arousal and positive valence, as opposed to the majority of low arousal sighs of negative valence. Figure 9 indicates that the majority of sighs

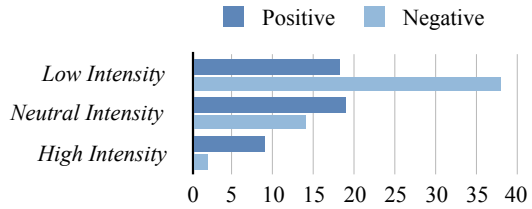

Figure 9: Distribution of intensity of emotions by positive or negative

expressed were of *Low Intensity* and negative, as these sighs account for 38% of all data. 58% of sighs expressed at *Neutral Intensity* were positive also, indicating that if a sigh is expressed above *Low Intensity*, it is more probable for it to be positive.

5 Discussion

The development of this annotation scheme in relation to three distinct dimensions informs our categorisation of sighs by their emotional valency. The results of the first dimension indicate that the vocal environment has a direct relationship with the valency of a sigh, and that the *Speaker* in a dialogue is more likely to express a sigh than an *Addressee*. Interestingly, when a *Speaker* expresses a sigh the probability for positive valence is 50%, contrasting to the probability for an *Addressee* to express a sigh of positive valence which lies at 37%. 75% of sighs expressed *Between Pause* were recorded as positive, providing an excellent prob-

ability score for future sigh interpretation. Thus, it is evident that by investigating the vocal environment of the sigh, we can predict whether or not a sigh will be positive or negative.

The results from the second dimension indicate that the most common reason for expressing a sigh is when *Answering* and there exists a 71% probability that this sigh is negative. However, for the second most popular reason, it is difficult to predict whether or not a sigh is positive or negative. The only reason which provides a great probability score is *Discussing*, as 75% of these sighs were recorded as positive.

The results of the third dimension indicate that 46% of sighs can be interpreted as expressing a positive emotion. This result is crucial in understanding the complex nature of the sigh and how subjective it's emotional interpretation is. However, it is clear that the most common emotion for expressing a sigh is *Anger* (which is negative) and the least common emotion is *Joy*(which is positive). The majority of the emotions recorded were of *Low Intensity*, accounting for 56% of sighs, and of these emotions at *Low Intensity*, there exists a 68% probability that the sigh is negative. However, of the recorded sighs at *Neutral* or *High Intensity*, the majority of sighs were positive. For emotions of high arousal, 82% of the sighs were of positive valency, making it easy to predict that an emotion of high arousal retains positive valency. By engaging with Straus' paper, it is clear that by looking at emotions of low arousal, a sigh will more likely be of negative valency. However, this paper highlights the importance of an emotional scale when interpreting the emotional quality of a sigh.

6 Formal Analysis

In this section, we sketch how lexical entries for sighs can be provided within a dialogue semantics. We follow the approach to non-verbal social signals sketched in (Ginzburg et al., 2018). Their approach involves two basic steps: (i) integrating Scherer's component process model(CPM) of appraisal (Scherer, 2009b) with the dialogical framework KoS (Ginzburg, 2012). (ii) reifying non-verbal social signal content by positing an external real world event as trigger.

Within the component process model an agent evaluates events she perceives and their consequences by means of a number of criteria or stimulus evaluation checks (SECs) (e.g., *Is the event intrinsically pleasant or unpleasant, independently of my current motivational state? Who was responsible and what was the reason? Do I have sufficient power to exert control if possible?*). Each appraisal is, therefore modelled in Type Theory with Records in terms of a type given in (8). Pleasantness is specified via a scalar predicate *Pleasant* which can be positively aroused or negatively aroused or both; Power is specified in terms of a scalar predicate *Powerful* whose lower bound arises when the arousal value is zero.

(8) Appraisal= $\begin{bmatrix} \text{pleasant} : \begin{bmatrix} \text{Pred} = \text{Pleasant} : \text{EmotivePred} \\ \text{arousal} : \begin{bmatrix} \text{pve} : \mathbb{N} \\ \text{nve} : \mathbb{N} \end{bmatrix} \end{bmatrix} \\ \text{responsible} : \text{RecType} \\ \text{power} : \begin{bmatrix} \text{Pred} = \text{Powerful} : \text{EmotivePred} \\ \text{arousal} : \mathbb{N} \end{bmatrix} \end{bmatrix}$

Appraisal is incorporated in the dialogue gameboard, the public part of information states in KoS, in terms of an additional repository MOOD—a weighted sum of appraisals. In this way MOOD represents the publicly accessible emotional aspect of an agent that arises by publicly visible actions (such as non-verbal social signals), which can but need not diverge from the private emotional state. The resulting type of DGBs is given in (9).

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

An update rule that increments by δ the positive pleasantness recorded in Mood given the weight ϵ (between new appraisal and existing Mood) is given in (10); the converse operation of incrementing the negative pleasantness is entirely analogous with the obvious permutation on the pve/nve values *mutatis mutandis*.

(10) $\text{PositivePleasantnessIncr}(\delta, \epsilon) =_{def}$

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

Given our earlier discussion, we can posit two distinct lexical entries for sighs. We distinguish non–high arousal sighs from high arousal ones, associating the former with negative pleasantness and a sense of powerlessness, the latter with positive pleasantness. Respective lexical entries are (11a,c), where p is the *sighable*, the event triggering the sigh, identified with an Austinian proposition; (11b) is an update rule associated with (11a), incrementing the negative pleasantness and setting the power arousal level to zero. The force of a positive sigh (11c) is postulated to be simply Pleasant, which makes it trigger the positive pleasantness update, like laughter and smiling do.

(11a)
$$\begin{bmatrix} \text{phon} : \texttt{sighphontype} \\ \text{dgb-params} : \begin{bmatrix} \text{spkr} : \text{Ind} \\ \text{addr} : \text{Ind} \\ \text{t} : \text{TIME} \\ \text{c1} : \text{addressing(spkr,addr,t)} \\ \delta : \text{Int} \\ \text{c2} : \text{Arousal}(\delta, phon) \\ \text{c3} : \delta < HighArousal \\ \text{s} : \text{Rec} \\ \text{p} = \begin{bmatrix} \text{sit} = \text{l} \\ \text{sit-type} = \text{L} \end{bmatrix} : \text{prop} \end{bmatrix} \\ \text{content} = \begin{bmatrix} \text{sit} = \text{s} \\ \text{sit-type} = \\ \left[\text{c4: Unpleasant-accept}(p, \delta, spkr)\right] \end{bmatrix} : \\ \text{Prop} \end{bmatrix}$$

(11b)
$$\begin{bmatrix} \text{preconditions:} \begin{bmatrix} \text{LatestMove.cont} = \\ \text{Assert(spkr,} \\ \text{Unpleasant-accept}(p, \delta, spkr)) : \\ \text{IllocProp} \end{bmatrix} \\ \text{effect} : \begin{bmatrix} \text{NegativePleasantnessIncr}(\delta, \epsilon) \\ \text{Mood.Power.arousal} = 0 \end{bmatrix} \end{bmatrix}$$

(11c)
$$\begin{bmatrix} \text{phon} : \texttt{sighphontype} \\ \text{dgb-params} : \begin{bmatrix} \text{spkr} : \text{Ind} \\ \text{addr} : \text{Ind} \\ \text{t} : \text{TIME} \\ \text{c1} : \text{addressing(spkr,addr,t)} \\ \delta : \text{Int} \\ \text{c2} : \text{Arousal}(\delta, phon) \\ \text{c3} : \delta \geq HighArousal \\ \text{s} : \text{Rec} \\ \text{p} = \begin{bmatrix} \text{sit} = \text{l} \\ \text{sit-type} = \text{L} \end{bmatrix} : \text{prop} \end{bmatrix} \\ \text{content} = \begin{bmatrix} \text{sit} = \text{s} \\ \text{sit-type} = \left[\text{c4: Pleasant}(p, \delta, spkr)\right] \end{bmatrix} : \text{Prop} \end{bmatrix}$$

7 Conclusion

In this paper an annotation scheme was developed to investigate the quality of sighs in relation to three dimensions; their placement in dialogue, their reasoning and emotion expressed by the sigh. There is clearly potential subjectivity when interpreting the data and recording the sighs, and the possibility that by using a different emotion scale, the results may differ. The inter-annotator study indicates a moderately high agreement but highlights also the discrepancies regarding emotion interpretation, indicating that broadening the categories of emotions would account for some difference in interpretation. We recognize two recurring kinds of sighs: those of low arousal and negative valence, and those of high arousal and positive valence. From our study it emerges that the probability for a sigh expressing a positive or negative emotion is almost equal, which contrasts with past research, which used fewer examples and no systematic emotion analysis. With this annotation scheme proposed, this paper hopes to have laid a firm basis for the future study and annotation of sighs. The complexity of sigh denotation could be reconciled through focus on contextual criteria of sighs and the establishment of a multitude of emotions with varying arousal. We concluded with a sketch of a formal analysis of sighs within the framework of KoS integrated with Scherer's component process model of appraisal.

Acknowledgments

We acknowledge the support of the French Investissements d'Avenir-Labex EFL program (ANR-10-LABX-0083) and a senior fellowship from the Institut Universitaire de France to the second author. We thank Tristan Stérin for providing another critical perspective on this subject which pushed us to delve further into our analysis and for continually providing kind help, support and feedback. Thank also to three anonymous reviewers for SemDial for their detailed and perceptive comments.

References

British National Corpus. British National Corpus. http://www.natcorp.ox.ac.uk. Accessed: 2019-05-15.

British National Corpus 2014: User Manual and Reference Guide. British National Corpus 2014: User Manual and Reference Guide. http://corpora.lancs.ac.uk/bnc2014/.

Jonathan Ginzburg. 2012. *The Interactive Stance: Meaning for Conversation*. Oxford University Press, Oxford.

Jonathan Ginzburg, Chiara Mazzocconi, and Ye Tian. 2018. Interaction, appraisal, and non-verbal social signal meaning. In *Proceedings of Cognitive Structures: Linguistic, Philosophical and Psychological Perspectives (CoSt18)*, Heinrich Heine University, Düsseldorf.

Erving Goffman. 1978. Response cries. *Language*, 54(4):787–815.

Orlando Gomes. 2017. Plutchik and economics: Disgust, fear, and, oh yes, love. *Economic Issues Journal Articles*, 22(1):37–63.

Elliott M Hoey. 2014. Sighing in interaction: Somatic, semiotic, and social. *Research on Language and Social Interaction*, 47(2):175–200.

Keith Oatley and P. N. Johnson-Laird. 2014. Cognitive approaches to emotions. *Trends in Cognitive Sciences*, 18(3):134–140.

Robert Plutchik. 1988. *The Nature of Emotions: Clinical Implications*, pages 1–20. Springer US, Boston, MA.

Matthew Purver. 2001. Score: A tool for searching the bnc. Technical Report TR-01-07, King's College, London.

Klaus Scherer. 2009a. The dynamic architecture of emotion: Evidence for the component process model. *Cognition and Emotion*, 23:1307–.

Klaus R Scherer. 2009b. The dynamic architecture of emotion: Evidence for the component process model. *Cognition and emotion*, 23(7):1307–1351.

Erwin W. Straus. 1952. The sigh: An introduction to a theory of expression. *Tijdschrift Voor Filosofie*, 14(4):674–695.

KARL HALVOR Teigen. 2008. Is a sigh "just a sigh"? sighs as emotional signals and responses to a difficult task. *Scandinavian Journal of Psychology*, 49(1):49–57.

Khiet P. Truong, Gerben J. Westerhof, Franciska de Jong, and Dirk Heylen. 2014. An annotation scheme for sighs in spontaneous dialogue. In *INTERSPEECH 2014, 15th Annual Conference of the International Speech Communication Association, Singapore, September 14-18, 2014*, pages 228–232. ISCA.

Elke Vlemincx, Ilse Van Diest, and Omer Van den Bergh. 2015. Emotion, sighing, and respiratory variability. *Psychophysiology*, 52(5):657—666.