What is the role of sighing behaviour in emotional expression? An analysis of sighing in narratives of people who experienced war in the twentieth century.

Loes Pepers, s0212180

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First Supervisor: Prof. Dr. G.J. Westerhof

Second Supervisor: Dr. S.M.A. Lamers

Abstract

Emotions are being expressed in different ways. This is an important issue for narrative psychology, because the emotional charge of a story might say more about its meaning than the words that are used. Generally, a distinction is made between verbal and nonverbal expression of emotions. In this study, the interaction between these two was emphasized, and a phenomenon was involved that has not yet been given much attention in scientific research; the occurrence of sighing. Twelve oral history interviews, filmed during a project called "Croatian Memories", were used, in which people talk about their experiences of war in the previous century. Verbal and nonverbal emotional expressions in these interviews were analysed by specially developed applications and these analyses were complemented with manually determined sighs. The aim of this study was to examine whether sighing behaviour is more common in narrative fragments with more verbal and/or nonverbal emotional expression. Therefore, correlations between emotional expressions and sighs were calculated. However, a coherence between sighing behaviour and other (verbal and nonverbal) ways of emotional expression could not be found. Correlations were mostly not significant and varied largely among interviews. The results indicate that sighing behaviour and its link to emotional expression are very different for each individual and might be influenced by other factors which were not considered in these analyses.

Introduction

While people talk about their life-experiences, they communicate more than just words. Consciously or not, talking about oneself seldom occurs without influence of emotions.

Emotional expression, whether it is masked, obfuscated or even exaggerated, appears to be the stuff of wonder for narrative psychology. Narrative psychology focuses on the process of telling and structuring life stories, which are proven to improve physical and mental health (McAdams, 2008). A meta-analysis by Frattaroli (2006) has shown that disclosure by talking (or writing) about experiences, has a significant positive effect on well-being. The cognitive encoding of emotional experiences through emotional expression appears to be the underlying process of this effect. During the process of expressing emotions, people attribute meaning to their memories (Pennebaker & Chung, 2011).

Relatively little of the research in emotional expression has focused on the occurrence of sighing (Teigen, 2008). Consciously or not, people do sigh every now and then. In this paper, the focus will be directed on what a sigh means while telling stories. But before approaching the subject of sighing, it is important to review existing research in the narrative psychology and emotional expression, and where these two intertwine.

Hyvärinen (2012) stated that narratives are being interpreted and analysed in different ways, depending on the research field. Narratives are not only examined by narrative psychology, they are also a point of focus in oral history research and automatic analyses of human behaviour (Truong, Westerhof, Lamers & de Jong, 2014; Truong, Westerhof, Lamers, de Jong & Sools, 2013). In this study emotional expression will be analysed in oral history interviews, using automatic analyses. Therefore oral history and automatic analyses should first be defined. Oral history generally refers to the collection of written or orated stories of real-life events or narratives. While mostly collected for archival purposes, these collections can nonetheless provide a valuable set of data for scientific research. Narratives can also be the study material for the field of automatic analyses of human behaviour. Researchers within this field have been trying to utilize the growing possibilities of technology in studying human behaviour, including communication and narrating. Although narrative psychology, oral

history and automatic analysis of human behaviour may differ in their interpretation and analysis of narratives, emotional expression is an important subject in all of them.

Emotional expression has multimodal features (Kreifelts, Ethofer, Grodd, Erb & Wildgruber, 2007). These modalities can either refer to verbal expressions or to nonverbal expressions. In narrative psychology, the investigation of emotional expression is mostly based on the verbalisation of emotions. Psychologists try to find meaning in autobiographical stories and the words they are made of, by analysing texts about personal experiences. In these texts, psychologists tend to focus on semantic aspects in order to find that meaning (McAdams, 2008). When studying emotions, texts can be analysed by searching for words or phrases that contain emotional content. To make this analysis faster and easier, the automatic analysis field has introduced several solutions. The most noteworthy solution is the Linguistic Inquiry and Word Count (LIWC), developed by Pennebaker, Booth and Francis (2007). This is an application for detecting and weighting psychologically relevant words such as; positive emotion words, negative emotion words, causal words, insights words and personal pronouns.

Gunes, Nicolaou and Pantic (2011) wrote about research in nonverbal emotional expression and distinguished between audio and visual signals to analyse nonverbal emotion. Audio signals are the acoustic and prosodic features in speech, such as pitch range, intensity or vocal effort, pauses and speech rate. Visual signals refer to bodily gestures, movements and facial expressions. Automatic analysis of human behaviour tends to focus on these nonverbal aspects of communication in analysing visually recorded data.

A lot of research in emotional expression focuses on either verbal or nonverbal cues (Kreifelts et al, 2007).. As stated previously, automatic analysis tends to focus on nonverbal behaviour. Although nonverbal cues can indicate what general types of emotion a person is feeling, they typically do not provide for detailed substantive information about that person's

emotional state. Verbal information does; because it often contains semantic information that clarifies the meaning of the emotional experience. Moreover, people are often communicating about emotions and feelings they are not personally experiencing at the time of the conversation. They at least do not experience it with the same intensity as when the original event happened. In these cases, the narratives may lack important information that was relayed by undocumented non-verbal expression (Fussell, 2002). This indicates the importance of verbal information about emotional experiences.

Yet, it is among usual procedures in narrative psychology to analyze only written language. The undocumented nonverbal expressions in written narratives, could be important for further understanding of the complete spectrum of emotional states. Archer and Arkert (1977) examined the way people interpret social situations. They presented social situations in two ways; in videotaped versions (with both verbal and nonverbal information) and in written versions (transcripts, with only verbal information). As hypothesized, the participants that received the videotaped version had significantly higher scores on interpreting the situations, than the participants that received the written version. The presence of nonverbal information on emotions seemed to contribute to a better sense of emotional expressions. Not only the participants in Archer and Arkert (1977), but also computer applications that analyse multiple modalities seem to perform better in recognizing emotional expressions than applications that analyse a single modality (Busso et al., 2006; Zeng, Pantic, Roisman & Huang, 2009; Vinciarelli et al., 2012). From this can be concluded that both verbal and nonverbal cues are important to attend to when studying emotional expression. Still, the interaction between verbal and nonverbal modalities, the way they relate to each other, remains largely unknown.

With the intention to investigate whether emotional expression (both verbal and nonverbal) relates to the type of question being asked and whether this expression increases during an interview, Truong, Westerhof, Lamers and de Jong (2014) analysed different modalities of

emotional expression in videotaped interviews. Using various applications for automatic analysis, including LIWC, by Pennebaker et al (2007), they measured voice pitch, vocal effort, pauses (nonverbal cues of emotional expression) and emotion words (words with emotional content, verbal cues of emotional expression) in oral history interviews with people who experienced war violence in Croatia. They found that the intensity of emotional expression increased during the interview and that emotional expression was stronger after open and meaning questions than after closed and descriptive questions. Different modalities of emotional expression seemed to co-occur in turns. Nevertheless, there were no strong correlations between these modalities (Truong et al, 2013).

The studies of Truong et al (2014), along with other studies in emotional expression, focuses on a usual set of emotional indicators, such as: emotion-words, vocal pitch, effort and pauses (Pennebaker et al, 2009; Gunes et al; 2011). Another common indicator is facial expression; the tension and relaxation of facial muscles (Russell, Bachorowski & Fernández-Dols, 2002). Yet, little attention has been given to the role of sighing as a possible indicator of emotional expression.

Physiologically, sighing appears to reset the body to restore homeostasis. Taking a deep breath recovers lung compliance (McIlroy, Butler & Finley, 1962), reduces stiffness of lung tissue and airway walls (Bendixen, Smith & Mead, 1964), and restores gas exchange (Cherniack, Euler, Glowgowska & Homma, 1981). By expanding the lungs, breathlessness and chest tightness are being reduced, causing temporary relaxation (Wilhelm, Gevirtz & Roth, 2001). In this line Vlemincx et al (2009) hypothesized that sighing might have the function of relieving tension. They studied whether sighing occurred during stress and during relief of stress. Their results showed that sighing behaviour was mostly found during relief. More recently, Vlemincx, van Diest, Lehrer, Aubert & van den Bergh (2010) connected sighing behaviour to healthy breathing patterns, which consist of certain respiratory

variability or breathing rhythm. When this variability gets imbalanced by various stressors, sighing causes a restoration of this balance.

Linking these findings to the psychological side of the sighing phenomenon, research has shown that participants respiratory variability can be disturbed while experiencing emotions. (Boiten, Frijda & Wientjes, 1994). This goes for positive emotions, such as fun and amusement (Boiten, 1998), as well as for negative emotions, such as anger, guilt, resentment and sorrow (Stevenson & Ripley, 1952), but also during pain (Boiten, 1998) and panic (Wilhelm, Trabert & Roth, 2001). Under influence of these emotions, sighing might play a role in restoring the breathing patterns and in this way causing relief. Moreover, sighing has been associated with relief of dyspnoea, experiencing restlessness (Hirose, 2000), relief of craving and relief of negative affectivity (McClernon, Westman & Rose, 2004), unpleasant thoughts (Finesinger, 1944) and stress (Vlemincx et al, 2009).

Teigen (2008) studied the ideas people have about the sighing phenomenon. He found that most people think sighs are passive emotional expressions, that occur when people are sad, bored, weary, resigned or disappointed. And when they realise they have to ‘let go’ of something they cherished, but just cannot have, something out of reach. Sighing seems to have some connection to emotions, at least people suppose it does. Yet, the literature review preceding the analyses of this study has not been able to find research in a narrative setting that focused on sighing.

In conclusion to this extensive literature review, research in the fields of narrative psychology, oral history and automatic analysis has shown that emotions can be expressed in different ways. Sighing is a non-verbal expression that has not yet been widely examined in the context of emotional expression. It has been demonstrated that sighing occurs when breathing rhythms are imbalanced, which can be caused by the presence of certain emotions. It could be assumed that emotional expression and sighing behaviour are connected in some

way. People might sigh when they talk about something they find painful, something that makes them angry, or memories they experience with relief. If this is the case, sighing behaviour could be a complementary indicator for the identification of emotional states.

The purpose of this study will be to investigate whether a connection can be found between the occurrence of sighing and (verbal and non-verbal) indicators related to emotional expression. The indicators of emotional expression used in the study of Truong et al (2013; 2014), will be gratefully adopted. These include positive and negative emotion words, vocal effort, voice pitch, and pauses. Truong et al (2014) also examined the effect of question type (closed-open, descriptive-meaning) and found that emotional expression is stronger after open and meaning questions than after closed and descriptive questions.

This study will connect research in the phenomenon of *sighing* to research in emotional expression. It will provide information about the function and occurrence of sighing behaviour and therefore contribute to the research field of narrative psychology. The following hypotheses will be examined: (1) Within an interview sighing behaviour is more frequent in narrative fragments with many emotion words (and thus more verbal emotional expression), than in narrative fragments with little emotion words (and thus less verbal emotional expression), (2) Within an interview sighing behaviour is more frequent in narrative fragments which also include the presence of non-verbal indicators of emotional expression (high vocal effort, high voice pitch, much pause), and (3) Within an interview sighing behaviour is more frequent in narrative fragments following open and meaning questions, than fragments following closed and descriptive questions.

For studying the expression of emotions in narratives, videotaped interviews are a great source of study material. Truong et al (2013; 2014) used a database with videotaped interviews from the project “Croatian Memories”, containing interviews with people who experienced war violence in the 1990’s Croatia. Because the interviews of the Croatian

Memories project are so full of emotional content, and because they are already analysed for pitch, vocal effort, pauses and emotion words, they will be used in these analyses.

Collaborating in the analyses of the sighing behaviour in this study, Veldkamp (2014) also examined the coherence between sighing behaviour and emotional expression. She calculated correlations between the average *sighs per minute* and the average *emotional charge* (all emotion words), *positive emotion words*, *negative emotion words*, *voice pitch*, *vocal effort* and *pause* for all the analysed interviews (N=12). Using Spearman correlation analyses, she found significant negative correlations for sighing behaviour and negative emotion words (ρ=-.529), as well as for sighing behaviour and vocal effort (ρ=-.558). A positive correlation was found for sighing behaviour and pitch (ρ=.505). This study will supplement these findings by zooming in on the separate interviews, and checking for correlations within.

Method

Participants In 2010 a project called "Croatian Memories" was started, collecting recordings of personal memories of people who experienced war and detention during the political events in Croatia in the previous century. This project was set up to obtain a deeper understanding of the events in these areas, and to initiate and strengthen personal and social processes of dealing with the past. At present, Croatian Memories has collected more than 400 video interviews (www.croatianmemories.org). The project approached more than 1,000 people, and tried to take into account age, sex, ethnicity, and origin of the interviewees, in order to provide a certain level of representative interviews. They also tried to include interviewees from different places and areas affected by the war. Particularly in those regions that had suffered severe damage and destruction, or where certain political controversies existed. Most

of the interviews took between one and two hours, some even longer, depending on experiences and memories of interviewees. The collecting of memories was based on a semi-structured interview. The interviews were transcribed and some were translated in English.

In this study, 12 translated interviews were analysed, consisting of 6 interviewed men (M = 51,2 years, SD=8,9) and 6 interviewed women (M = 65,8 years, SD=14,6). For the analysis and annotation of the sighs, the computer application "ELAN 4.6.1." was used. Interviews had an average duration of 54 minutes and 38 seconds, where women's interviews lasted a little longer (M=3437 seconds (=57m17s), SD=1131) than men's (M=3119 seconds (=51m59s), SD=816) .

Analyses of the sighs The preparative activities that preceded the statistical analyses in this study, are elaborated in the master thesis of Veldkamp (2014). In short, two researchers searched the interviews for sighs, based on a jointly developed definition of what these sighs had to be like. This part of the study contained three runs of analyses, in which the researchers analysed four interviews per run (total N=12). The definition was sharpened during the analysis of the video's and was eventually considered as following:

> "A *real sigh* contains a clear audibly or visibly inhalation and a clear audibly or visibly expiration. Audible through the mouth or through the nose, optionally with a vocal production. Visible by the movement of the chest and shoulders.
>
> A *borderline sigh* only contains a clear audibly or visibly expiration, through the mouth or through the nose, optionally with a vocal production."

Sighs were coded as "real" (code 1) or as "borderline" (code 2). Furthermore, *starting time*, *ending time* and *duration* were noted for each sigh. Both researchers analysed for sighs separately, after which the differences between the analyses were marked. Interrater reliability analysis showed a Cohen's Kappa of .36 in the second analysis run and a Cohen's Kappa of

.72 in the third. Because the differences were too large (acceptable when κ=.80), the researchers came together after the separate analysis to achieve consensus. After achieving consensus by discussing the differences, a list of sighs was drafted on which both researchers agreed. This part of the study is comprehensively described by Veldkamp (2014).

Because the definition was not yet definite after the consensus achievement of the first analysis run, these four interviews were reassessed, using the final definition. This was done by only one researcher per interview, applying the new definition rules. Because the analysing processes of these four interviews proceeded somewhat different than the analysing processes of the other interviews, it is important to be aware of possible differences in the results.

Quantitative analyses Data was used from the studies of Truong et al (2013; 2014), that suited the analysed interviews. These data contained standardized measurements of pitch, vocal effort, pauses, positive and negative emotion words, for every answer to a question (speech fragment). *Voice pitch* is referred to as the perceptional property of speech sound on a frequency based scale, quantified as Hertz and was extracted automatically. *Vocal effort* is the exertion of the speech sound, as it is perceived by the listener. This was also automatically determined, by measuring the maximum amount of energy in a time step of 0.01s. The measurement of *pausing* was based on automatic silence detection. *Emotion words*; both positive and negative were automatically detected by the Linguistic Inquiry and Word Count application, using the English translations of the interview.

Moreover, the *type of the questions* preceding the speech fragments were manually coded (reaction, closed-descriptive question, closed-meaning question, open-descriptive question and open-meaning question), using the following definitions: (a) Reaction: greetings, closures, affirmative responses, (b) Closed questions: Questions that can be answered with yes/no, with a name, a date (or a moment), a place name, etcetera, (c) Open questions:

Questions without any given answer options, that demand for more explanation. In general, these questions get longer answers, (d) Descriptive questions: Questions about facts or descriptions, and (e) Meaning questions: Questions that ask for meanings, experiences, identities, evaluations, explanations, reflections, comparisons, etcetera. The coding of the question types was manually done by Truong et al (2014), independently by two researchers. Retrospectively, the interrater reliability turned out to be .80 (Cohen's Kappa).

Because the data were divided in answer-fragments, Spearman correlation coefficients could be calculated for each interview. Therefore the amount of sighs that occurred in each fragment was listed, so *sighs per minute* could be calculated for each fragment This was done for both *all sighs* (*real sighs* and *borderline sighs*) as for only *real sighs*, to see if including *borderline sighs* made any difference. For each fragment, *all sighs per minute*, *real sighs per minute*, *emotional charge* (all emotion words), *positive emotional words*, *negative emotion words*, *pitch*, *vocal effort* and *pause* were listed.

To see whether sighing behaviour is related to verbal emotional expression (hypothesis 1) and nonverbal emotional expression (hypothesis 2), correlations between *sighs per minute* and the verbal and nonverbal indicators of emotional expression were calculated for each interview. Hypothesis 1 would be confirmed when the interviews would show significant positive correlations between *sighs per minute* and *emotional charge*, *positive emotional words* and/or especially *negative emotion words*. When *sighs per minute* would show significant positive correlations with *pitch*, *vocal effort* and/or *pause*, this would confirm hypothesis 2. Finally, an Analysis of Variance (ANOVA) was used to decide whether sighing behaviour differed significantly between speech fragments following different *question types*, as hypothesis 3 predicts there would be more *sighs per minute* in narrative fragments following open and meaning questions.

Results

Data obtained by Truong et al (2013; 2014) is summarized in Table 1. For every fragment, the z-scores of the indicators (of verbal and nonverbal emotional expression) were determined. Table 1 shows the means per interview.

Table 1. *Average z-scores of the indicators of emotional expression*

Inter-view	Z-scores*					
	Emotional charge	Positive emotion words	Negative emotion words	Pitch	Vocal effort	Pause
1	.0786271	.1896892	-.0977094	.0085644	.2120825	-.3220424
2	.0548013	-.0562670	.1412927	-.2056930	.8459528	-.0936341
3	.5800704	.0246459	.8898509	-.3167254	.8878606	-.4422149
4	-.0347609	-.0020926	-.0340740	-1.0780122	.3037444	.2377590
5	.1740781	.1632209	.0961630	-1.9262970	.5333839	-.2083510
6	.5412143	.6985898	.1623532	-.7915158	.1854207	-.2604279
7	.0470071	.0261572	.0315440	-.1419058	.1195493	.2509778
8	.0103069	.0743751	-.0747859	1.8772044	.6017222	-.1560013
9	.2324555	.1360174	.2360650	-.2595390	.2404375	.2187419
10	.3728670	.3406446	.2535158	.0502998	-.0336176	.8103979
11	.0229546	-.0995820	.1417056	-.0842327	-1.0790330	.0774980
12	.1334269	.1673339	.0075866	1.5957042	.1511210	.4228243

Note: *Z-scores were calculated, based on means and standard-deviations of a data-set with 36 interviews.

Means and standard deviations of the verbal indicators are close (for *emotional charge*: M=.1844, SD=.2079; for *positive emotion words*: M=.1385, SD=.2138; and for *negative emotion words*: M=.1461, SD=.2609). These figures show some variance, but the indicators of nonverbal expression (pitch, vocal effort and pause) are more varied, with not so similar means and standard deviations (for *pitch*: M=-.1060, SD=1.0302; for *vocal effort*: M=.2474, SD=.5088; and for *pause*: M=.0446, SD=.3604).

Information about the interviewees, the duration of the interviews, the amount of fragments and the sighs in each interview are shown in Table 2. The twelve analysed interviews contained an average of 47 speech fragments . The average *real sighs per minute* was 0.23. For *all sighs* (both real and borderline sighs) the average was 0.29 sighs per minute.

Table 2. *Sighs per interview*

	Interviewee		Content					
	Gender	Age* (years)	Duration (hh:mm: ss)	Nr. of frag- ments	Nr. of real sighs (code 1)	(Real) sighs per minute	Nr. of all sighs (code 1+2)	(All) sighs per minute
1	Male	53	01:01:06	74	17	.28	21	.34
2	Male	58	00:51:52	72	9	.17	26	.50
3	Female	88	01:14:29	60	11	.15	15	.20
4	Male	43	00:38:19	18	1	.03	1	.03
5	Female	42	00:28:34	59	12	.42	13	.46
6	Male	48	01:14:07	34	10	.13	11	.15
7	Female	64	01:08:46	40	0	.00	1	.01
8	Female	69	00:49:27	47	11	.22	12	.24
9	Male	41	00:40:45	28	8	.20	10	.25
10	Female	66	01:15:54	34	40	.53	44	.58
11	Male	64	00:45:44	38	11	.24	11	.24
12	Female	66	00:46:32	58	16	.34	20	.43
Total Means (SD)		58.5 (13.9)	00:54:38	46.8 (17.7)		.23 (.15)		.29 (.18)

Note: *Age at the time of the interview

It should be noted that interview 4 and 7 only contained one declared sign (with 0.03 and 0.01 sighs per minute respectively). These interviews may not provide very reliable results. Furthermore, there is quite some variance in duration and in number of fragments, but also in number of sighs.

To get an idea of the number of sighs per fragment, Table 3 shows the percentages of fragments with 0 to 5 or more sighs for each interview. In all interviews, more than 50 percent of the interview fragments contained no sighs at all. Fragments which did contain sighs, had only one in most cases.

Table 3. *Distribution of sighs over fragments per interview*

Interview	% of fragments with					
	0 sighs	1 sigh	2 sighs	3 sighs	4 sighs	5 sighs or more
1	75,7	20,3	4,1	0,0	0,0	0,0
2	66,7	30,6	2,8	0,0	0,0	0,0
3	80,0	16,7	1,7	1,7	0,0	0,0
4	94,4	5,6	0,0	0,0	0,0	0,0
5	78,0	22,0	0,0	0,0	0,0	0,0
6	79,4	17,6	0,0	0,0	0,0	2,9
7	97,5	2,5	0,0	0,0	0,0	0,0
8	76,6	21,3	2,1	0,0	0,0	0,0
9	71,4	21,4	7,1	0,0	0,0	0,0
10	55,9	26,5	0,0	5,9	2,9	8,8
11	81,6	13,2	2,6	0,0	2,6	0,0
12	70,7	27,6	0,0	0,0	1,7	0,0

Note: The number of sighs refers to 'all sighs' (both real and borderline sighs)

To see whether sighing behaviour occurred more during fragments with more emotional expression, Spearman correlations were calculated between *sighs per minute* and the verbal (*(positive/negative) emotion words*) and nonverbal indicators (*voice pitch*, *vocal effort* and

pauses), determined by Truong et al (2013). Regarding the correlations per interview, results are shown in Table 4.

Table 4. *Correlations between real sighs (code 1), all sighs (code 1 and 2) and indicators of emotional expression*

Interview [1] (number of fragments)		Emotional charge	Positive emotion words	Negative emotion words	Voice pitch	Vocal effort	Pause
Significant correlations							
Interview 6 (n=34)	Real sighs	.399*	.497*	.320	.245	.124	.052
	All sighs	.399*	.497*	.320	.245	.124	.052
Interview 5 (n=59)	Real sighs	-.168	-.201	-.067	.258*	.029	.295*
	All sighs	-.092	-.138	.011	.200	-.005	.284*
Interview 12 (n=58)	Real sighs	.198	-.032	.388*	.119	.100	.042
	All sighs	.244	.055	.323*	.101	.078	.087
Interview 1 (n=74)	Real sighs	.083	.025	.213	-.061	-.099	.141
	All sighs	.117	.105	.276*	-.167	-.122	.117
Interview 11 (n=38)	Real sighs[2]	.132	.133	.068	-.309	-.501*	.259

Non-significant correlations

Interview 2 (n=72)	Real sighs	-.110	-.113	-.038	.052	-.015	.100
	All sighs	.151	.091	.083	.080	-.074	.190
Interview 3 (n=60)	Real sighs	-.025	-.027	.113	-.239	-.082	.114
	All sighs	-.034	-.035	.129	-.253	-.108	.111
Interview 4 (n=18)	Real sighs[2]	-.117	-.023	-.023	-.070	-.257	-.164
Interview 7 (n=40)	All sighs[3]	-.063	-.146	.176	-.049	-.049	-.132
Interview 8 (n=47)	Real sighs	.113	-.077	.281	-.122	.223	-.123
	All sighs	.113	-.077	.281	-.122	.223	-.123
Interview 9 (n=28)	Real sighs	-.109	-.138	.092	-.084	.017	.051
	All sighs	.059	.126	.089	-.126	.019	-.078
Interview 10 (n=34)	Real sighs	-.239	-.043	-.168	-.214	-.326	.297
	All sighs	-.280	-.092	-.191	-.191	-.284	.261

Note: Calculated with Spearman Rho (ρ); Interviews are separately analysed using 'split file'; *Correlation is significant at the 0.05 level; [1]Interviews are divided with on top the interviews that show significant correlations between sighing behaviour and (non)verbal indicators of emotional expression; [2]Interviews 4 and 11 had no 'borderline sighs', so only the correlations with 'real sighs' were calculated. Moreover, these interviews only contained 1 sigh; [3]Interview 7 had no 'real sighs', so only the correlations with 'borderline sighs' were calculated.

There seem to be few significant correlations and many differences between the interviews. Only five interviews show some significant correlations. Positive correlations are found between (1) *real sighs* and *all sighs* of interview 6 and *emotional charge* (ρ=.399) and *positive emotion words* (ρ=.497); (2) *real sighs* of interview 5 and *voice pitch* (ρ=.258) and *pause* (ρ=.295), also between *all sighs* of interview 5 and *pause* (ρ=.284); (3) *real sighs* and *all sighs* of interview 12 and *negative emotion words* (ρ=.388 for *real sighs* and ρ=.323 for *all sighs*), and (4) *all sighs* of interview 1 and *negative emotion words* (ρ=.276). In addition, interview 11 showed a negative correlation between *real sighs* and *vocal effort* (ρ=-.501). However, as shown in Table 2, interview 11 contained only one measured sigh.

All in all, half of the interviews do not show any correlations. When correlations do occur (as in interviews 1, 5, 6, 11 and 12) they are very different for each interview. No patterns could be found.

With the purpose to summarize the large amount of correlations in the previous table, Table 5 shows the medians and ranges of the correlations of the interviews in Table 4. Remarkably, the highest values of the correlation ranges are more significant at the 0.05 level, than the lowest values.

Table 5. *Medians and ranges of correlations calculated*

	Correlations with only 'real sighs' (code 1)			Correlations with 'all sighs'(code 1+2)		
	Median (m)	Lowest	Highest	Median (m)	Lowest	Highest
Emotional charge	-.025	-.239	.399*	.086	-.280	.399*
Positive emotion words	-.032	-.201	.497*	.016	-.146	.497*
Negative emotion words	.092	-.168	.388*	.109	-.191	.323*
Voice Pitch	-.070	-.309	.258*	-.096	-.309	.245
Vocal Effort	-.015	-.501*	.223	-.062	-.501*	.223
Pause	.100	-.164	.297	.099	-.164	.284*

Note: *Correlation is significant at the 0.05 level

Nevertheless, most correlation medians lie between -.100 and .100, with wide ranges from negative to positive values for all correlations. This indicates the great many differences in correlation values between interviews. None of the indicators (verbal and nonverbal) showed a consistent coherence with sighing behaviour.

As for differences in sighs per minute between question types, ANOVA does not point to significances (for *real sighs*: $F(3,558)=2.471$; $p=.061$, and for *all sighs*: $F(3,558)=0.036$; $p=.991$). Means are shown in Table 6.

Table 6. *Mean sighs per minute for each question type*

Question type	Mean 'real sighs' per minute	SD	N	Mean 'all sighs' per minute	SD	N
2: Closed-Descriptive	.19	.76	239	.47	2.52	239
3: Closed-Meaning	.51	1.22	23	.51	1.22	23
4: Open-Descriptive	.40	.83	92	.41	.83	92
5: Open-Meaning	.34	.92	208	.43	.99	208

Closed meaning questions seem to have the highest means. After a closed question which demands for an answer with a meaningful content, sighing behaviour occurs more often than after other question types. Yet there are only 23 speech fragments following a closed meaning question, which makes this conclusion less reliable.

Overall, we have seen that correlations between sighing behaviour and indicators of emotional expression were very different between interviews, although most of them were not significant. Moreover, there seem to be no significant differences in *sighs per minute* between preceding question types.

Discussion

The aim of this study was to search for a relation between sighing behaviour and indicators of emotional expression (emotion words, voice pitch, vocal effort and pauses). Such a relation could improve understanding the role of sighing in emotional expression during narratives.

When sighing behaviour is a product of emotional expression, it should be more present when there is more prevalent expression of emotions, whether verbal or nonverbal.

Conclusions Before attending to the hypotheses, the overall analyses of sighing behaviour should be given some consideration. Establishing a clear definition of *a sigh* was not as easy as it seemed. When is an observably abnormal breathing pattern a sigh? When is it not just heavy breathing or deep inhaling? When studying a phenomenon that is quite new to the research field, a clear, objective definition is very important. As an attempt to do this, the following distinction was made in this study:

> "A *real sigh* contains a clear audibly or visibly inhalation and a clear audibly or visibly expiration. Audible through the mouth or through the nose, optionally with a vocal production. Visible by the movement of the chest and shoulders.
>
> A *borderline sigh* only contains a clear audibly or visibly expiration, through the mouth or through the nose, optionally with a vocal production."

Based on these definitions, sighs that occurred during the interviews were determined. Of all the annotated sighs, 79% was coded as "real". The analyses showed that there was an average of .28 sighs per minute (SD=.18), ranging from .01 to .58 (for *real sighs*, the average was .23 sighs per minute (SD=.15), ranging from .00 to .53 sighs per minute).

The first hypothesis stated that sighing behaviour should be more common in interview fragments with many emotion words (and thus more verbal emotional expression), than in interview fragments with little emotion words (and thus less verbal emotional expression). The results did not show strong evidence for this hypothesis. There were a few interviews with significant correlations between sighing behaviour and emotion words, but most interviews did not show any correlation at all. Correlations ranges reached from averagely

-.200 to .430, so there were many differences between the interviews. This means that sighing behaviour and verbal emotional expression did not show a consistent coherence.

The second hypothesis said that sighing behaviour should be more common in interview fragments which also include the presence of non-verbal indicators of emotional expression (high vocal effort, high voice pitch, much pause). For this hypothesis, the results did not provide strong evidence either. Three interviews had significant correlations between sighing behaviour and nonverbal indicators of emotional expression, but in most of these cases, this applied to only one indicator. Moreover, a relatively strong negative correlation was found with 'vocal effort' in one interview. Nevertheless, there were many differences between the interviews, with wide ranges of correlations for each nonverbal indicator.

The third hypothesis predicted more sighing behaviour in narrative fragments following open and meaning questions, than fragments following closed and descriptive questions. Although the means differed somewhat (especially for *real sighs per minute*, where *closed descriptive questions* had the lowest means of sighs per minute) the differences were not significant. Even though they were not, *open meaning questions* did not have the highest means for sighs per minute, as hypothesised.

Altogether, these findings do not suggest a clear relation between sighing behaviour and verbal or nonverbal indicators of emotional expression. The twelve interviews show very different correlation profiles, most of them lacking any significant correlation. Does this mean sighing has nothing to do with emotional expression?

Implications Literature shows that sighing occurs during relief, by restoring the balance of our breathing patterns (Vlemincx et al, 2010). While we experience emotions, our breathing patterns tend to get out of balance (Boiten et al, 1994). Then, sighing behaviour should be present when people experience these emotions. Cues that indicate the presence of emotions,

verbal and nonverbal emotional expressions, should co-occur with sighing behaviour during narratives about such negative experiences as war violence, fear and humiliation. However, this expected coherence was not found in this study.

Regarding the literature about examining emotional expression, both verbal and nonverbal expressions have been given attention. Yet, the interaction between these two modalities has been left quite unnoticed. By combining narrative and automatic analyses of verbal and nonverbal expressions in oral history interviews, Truong et al (2013; 2014) tried to put some light on this interaction. They already found that a correlation between verbal and nonverbal expressions could not be confirmed.

On the other hand, Veldkamp (2014) did find some correlations (both between sighing behaviour and emotion words, and between sighing behaviour and nonverbal expressions). She focused on the average figures, for all of the interviews. Apparently, a relationship between sighing and emotional expression does exist. Yet, when focused on the separate interviews, correlations become rare.

Maybe emotional expression, both producing and interpreting it, is more complex than we think. The manual and automatic interpreting of social situations seems to be more effective when both verbal and nonverbal cues are available (Busso et al., 2006; Zeng et al., 2009; Vinciarelli et al., 2012). Maybe both modalities are necessary to make the right judgment on an apparent expression of emotion. Russell, Bachorowski and Fernández-Dols (2002) reviewed the literature on vocal and facial expressions of emotions. They found that expressions that seem emotional are not always expressions of (the assumed) emotions. They can easily be misinterpreted.

To illustrate the complexity of the interaction between verbal and nonverbal expressions, let us focus on the appearance of smiling. We smile when we are happy or relieved, for instance when we say something like: “in the end we all survived and it made us much closer

as a family". Yet, we also smile when we are cynical. Someone might smile while saying "It is usually when men are at their most religious that they behave with the least sense and the greatest cruelty". Only focussing on the facial aspect of the expression will conclude that the expression is 'happiness'. Focusing on the content of the narrative will reveal different emotions. On the other hand, a spoken sentence (such as "the situation got out of control"), might contain a happy message (when the narrator is talking about a hobby that became a successful career), but also a fearful message (when the narrator is talking about a hostage situation). Nonverbal expressions will not be the same in these two circumstances. Regarding the possibilities of these situations, cohesion between verbal and nonverbal expressions may be less concrete.

Limitations Considering the previous implications, this study had some limitations. First of all, emotion words were automatically extracted with the Linguistic Inquiry and Word Count application from the English translations. Translations can contain different emotion words, as every language has its own emotional lexicon (Russell, 1991). It is more desirable to analyse verbal emotional expression in the original language. Moreover, emotions can be verbally expressed in a more implicit way (Wiebe, Wilson & Cardie, 2004). When someone tells about a memory, the context of used words may have a greater influence on their emotional charge. Then, the amount of emotion words that are actually used may not represent the emotional significance of the narrative.

The automatic analysis of nonverbal emotional expression may have had its flaws as well. The sound recordings were not always of perfect quality, there was a lot of noise which could have influenced the measurements. Furthermore, the interviews were divided into fragments, which contained the narrative following a question. These fragments had an average duration of 64 seconds, with fragments which lasted up to more than 12 minutes. Correlations were

calculated for each fragment, using mean sighs per minute, but also mean voice pitch, mean vocal effort and mean pause duration. Maybe correlations would be higher when smaller time intervals would have been used. Besides, only twelve interviews were analysed. A larger sample might have resulted in more correlations.

Another finding is that quite some of the sighs were found at the beginning (and some at the end) of an interview fragment. 28,1 percent of the sighs took place somewhere during the first 3 seconds of a fragment (right after a question being asked). 5,4 percent of the sighs occurred during the last 3 seconds of a fragment. This could have affected the outcomes, as the emotions that occupied the sigh, might have been expressed in the preceding or the following fragments.

Suggestions for future research It might be that sighing is more related to emotional expression than the results of this study suggest. More research is needed to answer that question. It is clear, however, that people differ in their ways of emotional expression. People differ in their use of emotion words, their regulation of voice pitch and vocal effort, in their use of pause, and also in their sighing behaviour. Larger samples of interviews, with people of diversified ages and cultures are needed to improve this representation.

On the other hand, sighing may just not be that related to emotional expression. Maybe it is only a product of the physical effort it takes to tell a story, which can be influenced by emotions, but also by deep thinking, trying to remember something, or searching for the right words. As research already has discovered, sighing causes a relief of physical tension. And although emotions can cause physical tension and a disturbance of respiratory patterns, there are more possible causes for physical imbalance.

Furthermore, this study only focused on prosodic features when it came to nonverbal ways of emotional expression, which are based on the sound of speech (Frick, 1985). Facial

features and body language were not included. Moreover, the possible interactions between verbal and nonverbal expressions (such as double meaning words or cynical smiles) were not taken into account. However, automatic analyses would have to be much more advanced to be able to do that. Manual qualitative analysis seems to be the most obvious alternative. To find out which emotion is expressed by a smile or a sentence, the context (the content of the narrative, other nonverbal expressions) should altogether be examined. Combining this with observing sighs might give a more detailed picture of the occurrence and functions of sighing behaviour.

Another important issue is the applied definition of a sigh while analysing the interviews. As described in the method section, the definition was adjusted during the analysis, because a clear definition in the literature was absent. Future research might concentrate on this definition; what exactly is a sigh? And how can it be objectively determined in analyses of narratives? The definition established in this study is far from perfect, for the interrater reliability was not sufficient.

When more insight is gained in the occurrence of sighing and its role in emotional expression, this might contribute to a greater understanding of the ways people express their emotions. In narrative psychology this might help scientists to recognise emotional content in narratives. It might also improve the understanding of the interaction between our physical and our mental condition. When we know more about this interaction, this might contribute to the development of better automatic analysis applications.

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