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Paraverbal speech stylistics in patients with chest pain and normal coronary angiography: is this method helpful in diagnosing underlying pathology?

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Paraverbal speech stylistics in patients with chest pain and normal coronary angiography: is this method helpful in diagnosing underlying pathology?

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The aim of this study was to establish whether an analysis of speech stylistics proves useful in identifying subjects with angina pectoris-like chest pain and syndrome-X (SYX) or panic disease (PD).

We studied 32 patients, 16 of them suffering from PD, and 16 having SYX. The two groups consisted of women and men, 8/8 from each sex, and were aged 58.6 + 10.8 years (mean ± SD) and 59.8 + 9.6, for PD and SYX, respectively. All patients suffered from angina pectoris (AP) and had a normal coronary angiography before this study. Whereas SYX patients had positive exercise testing (showing stress-induced ischaemia), patients suffering from PD had normal exercise testing and fulfilled the criteria for PD, anamnestically and in specially developed questionnaires.

All patients were interviewed using a semi-structured non-stress interview. In addition, 20 of them were interviewed in a stress-type interview thereafter. Speech stylistics were assessed during patients' speech sequences where they described pain and others where they spoke about non-conflict contents. To determine speech stylistics we used the method developed by ourselves and published elsewhere. The speech analysis was performed in a blinded manner as was the group allocation.

The basal movement for the two groups differed in systolic blood pressure (129.0 ± 13.6 mm Hg (mean ± SD), vs. 117.5 ± 31.8 mm Hg, ($p<0.05$) for PD and SYX respectively), and disease duration (3.3 ± 1.4 years, vs. 2.4 ± 1.2 years (p= NS) for PD and SYX, respectively). In non-stress interviews, PD patients showed a significantly lower speed of speech, in both pain and non-pain sections (200.4 ± 33.1 syllables/min vs. 208.3 ± 23.1 syllables/min for pain ($p<0.05$) in PD and SYX, respectively; and 202.8 ± 36.9 syllables/min vs. 217.3 ± 32.2 syllables/min for non-pain sections ($p<0.001$) in PD and SYX, respectively). Similar significant differences were observed in pain and non-pain sections for plosive words, repeated words, and silence latency. In simultaneous speech, only the PD group showed differences between pain and no-pain sections. No differences were noted in uneven speed of speech, speed volume, and swallowed words. Group differences were more prominent during stress-interviews in pain and non-pain sections for speed of speech, plosive words, and repeated words. Swallowed words differed only in non-pain sections.

The proposed method seems useful to differentiate between several verbal contents and their related emotive involvement as well as to identify patients without PD suffering from angina pectoris-like chest pain (= SYX). *J Clin Bas Cardiol 1998; 1: 25–9.*

Key Words: Speech-stylistics, angina pectoris, syndrome-X, panic disease

Patients with chest pain have to endure intense diagnostic investigations only to find that their symptoms do not originate form coronary heart disease [1]. The complete cardiological examination often includes a coronary angiography. However, these investigations are costly and may lead to neurotic perpetuation of the symptoms [2], especially of those not clearly attributable to a somatic pathology, such as functional oesophageal disease [3], cartilaginous or bony pathology or chest pain without visible coronary artery disease. Moreover, patients often leave the investigation procedures with the conviction, that the respective pain is still originating from the heart. However, in most cases various conceptions about the underlying cause may exist [4, 5].

In psychosomatic research, newer reports found a link between anxiety disorders and sudden cardiac death with an excess mortality of those patients [6, 7]. Even treatment with antidepressants was incriminated in this respect [8]. This raises the question when and to what extent a symptom can develop as a sign of somatic pathology – as described recently for pain [9] – and includes the obligation to identify patients early with these disorders in order to treat them in a preventative manner. Several of these patients with chest pain suffer from hyperventilation, known to elicit or to propagate pain sensations [10].

Reports on verbal semantic structure are to be found preferentially in linguistic work [11]. Another approach is the ethological one, where an analysis of mimic patterns related to speech contents and emotions is performed [12, 13]. These approaches, bearing in mind their correlative nature, seem to be highly applicable to clinical situations. In particular, the speech stylistic approach might answer the question as to what extent patients with normal coronary angiograms and angina pectoris-like chest pain may differ in their paraverbal speech behaviour. Earlier research used the same method to differentiate patients with peripheral from coronary angiopathy [14] or patients with type-A behavior [15]. However, paraverbal analysis is not universally accepted. One problem seems to be that it has first to be clarified whether the respective behaviour leading to the speech style is developing independently of the disease investigated. Support for the hypothesis that the two do not develop independently are the findings of anger and cholesterol interaction [16, 17]. Another concern might include the socially accepted learning of aggressive and competitive behaviour (as defined as type-A) which has not been related to any kind of disease. Thirdly, some flaws in interpretation and determination of the various parameters are often mentioned. The latter has led to the construction of models like hardiness [18] or thoughness [19] as a coronary

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prone pattern. Computer assisted analysis of speech has recently gained significance in analysing individual aspects of human speech, eg, in emotion research. We therefore decided to use the speech-stylistics, described by Bortner et al. [20] as a method to determinate speech-variables and eventually attribute them to a defined pathology.

In different studies [21] investigations were performed to determine the origin of pain, resembling AP but not originating from the heart itself. Equally experimental pain procedures were used in the determination of ischaemia pathophysiology [22, 23]. Obviously, the most plausible explanation is a pain memory, localized in the spinal and paleocortical brain structures, with the innervation pattern allowing fibres from the heart radiating centrally in close connections with somatosensory inputs (eg, from the left arm) [5]. To complete these concepts, we stress the work of Droste et al. revealing the insights in the respective anatomical and physiological phenomena, especially in the questions of central pain processing mechanisms [24].

Study Aims

This study was undertaken to determine whether patients with angina pectoris suffering from either SYX or having PD show different speech behaviour. Both groups were controlled for sex, age, type-A behaviour (by means of elements out of the Bortner-scale [20]), and depression (by means of the Hamilton depression scale [25]). We therefore hypothesised that speech stylistics (a) may help to identify patients with SYX or PD, both with angina pectoris and normal coronary vessels, and (b) that there may exist variables allowing a valid differentiation of these groups.

Patients and Methods

Thirty-two patients, 16 women and 16 men were studied. Sixteen of them, 8 men and 8 women, aged 58.6 ± 10.8 years (mean ± SD) suffered from panic disorder substantiated by means of a validated questionnaire (STAI) and a clinical interview (following DSM-IV diagnosis). The other group consisted of 16 patients equally, 8 women and 8 men, aged 59.8 + 9.6 with syndrome-X, diagnosed as chronic angina pectoris-like chest pain, a normal coronary angiography, and a positive exercise test revealing typical ischaemic signs in at least 3 ECG-leads. The latter investigations were done before the beginning this study at the Department of Cardiology at the University of Berne. All the patients were outpatients of the Unit of Psychosomatic and Psychosocial Medicine (PPSM) at the University of Berne, Switzerland, where the study was performed.

The patients were investigated by a semi-structured non-stress interview. Twenty patients agreed to a second similar semi-structured interview during mental stress testing. All interviews were performed by the same interviewer (KLH). From both interviews a split screen videotape was recorded, showing portraits of patient and interviewer on the same screen, in accordance with the patient. Additionally, the microphone activity was recorded and displayed on the screen in order to precisely define the beginning and end of speech intervals etc.

The study was accepted by the Ethics Committee of the University and sponsored by a grant from the Swiss Heart Foundation. All patients gave their written informed consent to the study protocol.

Interviewing was performed in the PPSM between 08:00 and 12:00 a.m. The patients were seated comfortably, and after explaining the videotaping and answering other questions the interview followed. The first part dealt with the field of complaints and the patient was allowed to answer freely. The second part of the interview focused on angina pectoris pain, including all 7 dimensions, proposed by Engel [26, 27]. Each first interview was completed with questions about non-pain topics, such as working situation, family, leisure time activities, sports etc. The interviews had a mean duration of three-quaters of an hour. Thereafter the patient was dismissed to come back for a second interview about 3 weeks later, where cardiovascular parameters were assessed in parallel. On that occasion a much shorter second interview was performed under non-specific noise stress, assessing pain again as described above. All patients had to fill in several cognitive psychometric scales, concerning pain assessment, mood state etc. (for details see [28] and below).

Interview-rating

All interviews were rated by the same person (SF), who was blind to the diagnoses and to the results of the coronary angiography and the non-invasive investigations performed before. Each of the 52 interviews (with a mean duration of 24 minutes) was examined and divided into 2 sections, the first including verbal contents of pain description or pain-related topics, the second section incorporated verbal contents about non-pain topics, mostly leisure time or non-conflictual themes. Inter-rater reliability testing was not established because of known good correlations of our speech-stylistic rating system, confirmed by another study [14].

Because of multiple interruptions in the content-ductus of patient's speech, several sections of pain description were concentrated to smaller complete time sections, usually more than 120 seconds to perform a valid analysis of speech stylistics (SPESTY). All the following values were transformed to values per minute or normalised by their respective means (see below) to ascertain comparability.

In the 32 first interviews, mean duration of the indicator (pain content) sequences was 140 seconds, and 102 seconds for the reference sequences (non-pain contents) respectively. In the 20 second interviews, mean duration of indicator sequences (IS) was 113 sec, and 51 seconds for the reference sequences (RS), respectively. In these interviews RS were unavailable in 12 cases.

Catalogue of Speech Stylistics

To classify different speech behavior, a similar set of variables was used as in our previous work [14].

The set of variables consisted of:

RW (repeated words): repetition of identical word, part of words, part of sentences, included in one of the above defined sequences. The RW were counted per effective speech of the patient and transformed in events per minute.

SW (swallowed words): number of syllables not clearly pronounced by the patient, counted as events per time of speech, normalized in events per minute.

IR (interruptions): all interruptions of the interviewer by the patient, measured as event per time (seconds).

SIM (simultaneous speech): parallel speech of the patient and the interviewer, measured as time (seconds).

SL (silence latency): the time elapsed between the end of the interviewer's question and the beginning of the patient's answer, measured as time (seconds).

SS (speed of speech): number of syllables per effective speech, counted as number per minute.

PW (plosive words): short, intense, vivacious increases of speech volume, measured as events per effective speech per minute.

SV (speech volume): average speech volume in one speech unit, rated in a 5 point Likert scale from 1 (low) to 5 (very loud).

Table 1: Basal characteristics (mean ± SD) of study patients (SYX denotes syndrome-X, PD means panic disease) during interview I (non-stress interview) and interview II (stress-interview). Significance *p < 0.005.

Parameter	Units	SYX (N=16)	PD (N=16)
Age	years	59.8 ± 9.6	58.6 ± 10.8
Sex	m/f ratio	1	1
Disease Duration	years	2.4 ± 1.2	3.3 ± 1.4
Systolic Blood Pressure	mmHg	117.5 ± 31.8	129.0 ± 13.6 *
Diastolic Blood Pressure	mmHg	76.9 ± 6.3	77.5 ± 6.3
Heart Rate	bpm	70.6 ± 8.9	70.2 ± 9.0

USS (uneven speed of speech): pronounced variability of speed in one sequence, transformed in changes per minute. Every section (IS, RS) was rated 4 times consecutively, where 3 times 2 and once 3 parameters were assessed concurrently.

Statistics

To compare the respective variables between PD and SYX groups, and referring to the two interview sessions (I = non-stress, and II = moderate stress) the ANOVA procedure for repeated measures was used. Because of simplicity, only SL, SS, PW and USS were included. To compare the different speech stylistics with the respective groups we conducted ANOVA-testing.

Results

As shown in Table 1 no statistically significant differences were found between the two populations. However, a slightly longer disease duration was noted for PD subjects (p = NS), as well as a significantly higher systolic blood pressure in the group with PD (F=5.47, $p < 0.005$).

The comparison whether the values of the different variables (see table 2) revealed significant inter-group differences for speed of speech ($p < 0.05$, higher for PD), and plosive words ($p < 0.01$, higher for PD) in interview I and II for SYX and PD respectively. A significant intra-group difference was noted only for PD between interview I and II for plosive words ($p < 0.001$), and overall speed of speech ($p < 0.05$). No significant differences were found in the group of SYX patients.

ANOVA procedure for repeated measures was performed. These included the variables SS and PW. For SYX SS showed a significant difference ($p< 0.05$) in interview I compared with interview II for the non-pain sections, as well as for the pain sections in interview II only ($p < 0.05$). The PW in SYX patients showed a significant difference in interview II for the no-pain sections ($p < 0.01$) and for interviews I and II for either ($p < 0.05$).

In PD patients only no-pain sections revealed significant differences in interview I, and II for SS and PW ($p < 0.01$).

Discussion

Our results show that a differentiation of patients with SYX and those suffering from PD is possible by means of paraverbal speech stylistics. In particular, the parameters PW, RW and SS seem to be very useful in this respect. They are maximally different in these patient populations in pain as well as in non-pain description parts of the interview. For SS a clear cut significant difference was seen between patients with PD and SYX in the stress-interview, whereas the latter had a higher difference in pain and no-pain sections than the former ($p < 0.05$). This finding underscores the usefulness of stress-interviews in the two patient populations. For PW the differences in the two populations were significant in pain sections, where in SYX a lower response-rate to stress was found than in PD ($p < 0.001$). In no-pain sections there were similar group differences. These groups were even more pronounced, and PD patients showed a reduction of PW during stress-interviewing in contrast to SYX who had more PW ($p < 0.001$ for groups). RWs were found increased in both populations during the stress-interview in pain and no-pain sections equally with significant differences between the two interviews only in no-pain sections ($p < 0.01$). No group effect was found.

In another study with a group of similar patients [28], differences were found in affective adjectives used for pain description.

An earlier study by Melamed et al. [29] showed, that noise stress is an option to differentiate patients with type-A behaviour to those with type-B in blood pressure and heart rate analysis. When type-A and B behaviour is excluded, as in our study, the variables PW and SS are nevertheless helpful even in

Table 2: Mean Values (± SD) of Speech Analysis in Patients with Syndrome-X (SYX) or Panic Disease (PD) during pain (P) and no pain (NP) description

Criterion	Acronym	Unit	Non-stress-Interview SYX		PD		Stress-Interview SYX		PD	
			P	NP	P	NP	P	NP	P	NP
Speed of Speech	SS	syllables/min	208.2 ± 23.1	217.3 ± 32.2	200.4 ± 33.1	202.9 ± 36.9	168.5 ± 42.4	172.1 ± 19.3	197.1 ± 77.2	135.1 ± 83.6
Silence Latency	SL	seconds per question	3.5 ± 2.7	1.3 ± 1.5	4.6 ± 3.0	1.3 ± 0.9	4.1± 3.6	0.8 ± 0.6	3.5 ± 3.0	1.4 ± 0.7
Uneven Speed of Speech	USS	change of velocity per min	5.1 ± 2.3	3.4 ± 1.5	4.9 ±2.2	3.3 ± 1.5	4.3 ± 1.9	3.5 ± 2.2	4.6 ±2.3	2.1 ± 1.9
Plosive Words	PW	number per min	3.4 ± 1.3	2.3 ± 1.2	4.4 ± 3.7	2.4 ± 1.9	3.7 ± 2.5	3.3 ± 3.2	7.4 ± 4.1	0.9 ± 1.2
Repeated Words	RW	number of syllables per min	3.7 ± 1.7	2.8 ± 1.3	5.4 ± 3.3	3.7 ± 2.5	3.7 ± 2.1	5.2 ± 2.5	7.5 ± 4.7	3.5 ± 1.3
Swallowed Words	SW	number of syllables per min	3.8 ± 3.3	3.2 ± 2.1	2.7 ± 1.1	1.9 ± 1.5	4.9 ± 2.9	5.6 ± 2.8	5.0 ± 4.7	1.7 ± 1.3
Simultaneous Speech	SIM	syllables per min	0.6 ± 0.5	0.6 ± 0.8	1.1 ± 1.2	0.4 ± 0.6	0.5 ± 0.6	0.2 ± 0.4	0.5 ± 0.6	0.3 ± 0.3
Speech Volume	SV	1=low to 5=very loud	2.7 ± 0.6	2.6 ± 0.5	2.6 ± 0.5	2.4 ± 0.5	2.4 ± 0.4	2.3 ± 0.4	2.4 ± 0.6	2.7 ± 0.5

Table 3: Significances (df- and p values) in the study population. For abbreviations see Table 2

	SS	SL	USS	PW	RV	SW	SIM
P-SYX non-stress vs. P PD non-stress	NS	NS	NS	NS	NS	NS	NS
NP-SYX non-stress vs. NP P non-stress	NS	NS	NS	NS	NS	NS	NS
P-SYX stress vs. P-PD stress	NS	NS	NS	df=24.8 p=0.0081	df=20.8 p=0.0077	NS	NS
NP-SYX stress vs. NP-PD stress	NS	df=15.5 p=0.0143	NS	df=19 p=0.0111	df=23.6 p=0.0244	df= p=0.0001	NS
P-SYX non-stress vs. P-SYX stress	df=12.4, p=0.0182	NS	NS	NS	NS	NS	NS
NP-SYX non-stress vs. NP-SYX stress	df=24.0 p=0.0020	NS	NS	NS	NS	df=15.3 p=0.0025	df=23.2 p=0.0413
P-PD non-stress vs. P-PD stress	NS	NS	NS	NS	df=12.2 p=0.0359	NS	NS
NP-SYX non-stress vs. NP-SYX stress	df=10.8 p=0.0328	NS	NS	df=24.0 p=0.0211	NS	NS	NS
NP-PD non-stress vs. NP-PD stress	df=11.2 p=0-0335	NS	df=24.0 p=0.0211	NS	NS	NS	NS
NP-SYX non-stress vs. NP-PD stress	df=10.7 p=0.0130	NS	NS	df=19.3 p=0.0092	NS	df=24 p=0.0339	NS
P-PD non-stress vs. P-SYX stress	NS	NS	NS	NS	NS	df=10.6 p=0.0429	NS
NP-PD non-stress vs. NP-SYX stress	df=23.5 p=0.0104	NS	NS	NS	NS	df=12.3 p=0.0023	NS

diagnosing SYX and PD. Speech stylistics as a diagnostic tool could eventually be optimised when stress application could become more standardised. Moreover, speech stylistics turned out be a useful instrument in diagnosing chest pain, as various studies in our work have shown.

Scherwitz [30] compared 193 patients suffering from CHD to a healthy control group of 384 individuals and was able to show that speech stylistics associated with type-A behaviour are significantly associated with CHD. The respective parameters were voice emphasis representing in part our PW and latency of answering, parameters that showed no association

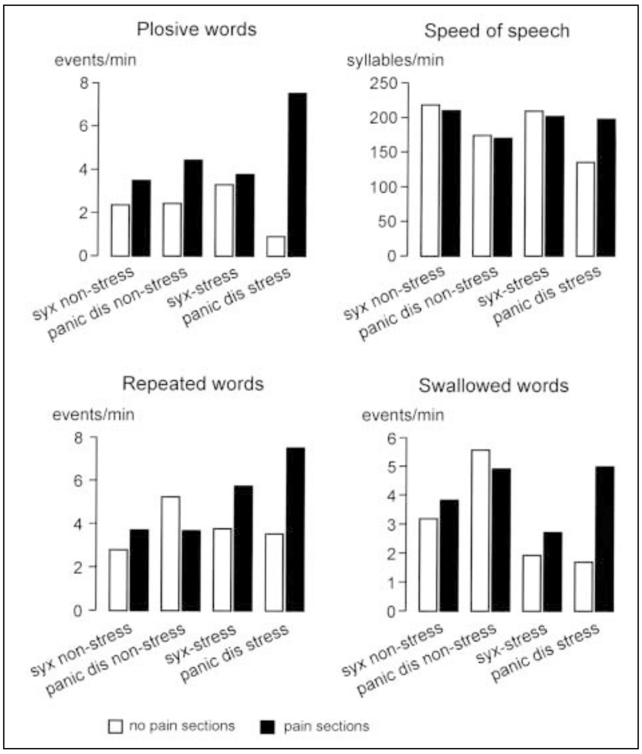

Figure 1: Plosive words (left upper figure), speed of speech (right upper figure), repeated words (left lower figure), and swallowed words (right lower figure) in patients with SYX and PD during non-stress and stress-interviews. Open bars denote no-pain sections,

to PW or SYX in our study population. More than ten years ago a study investigating patients during a non-stress interview found that those suffering from type-A behaviour had a higher uneven speed of speech, plosive words, and uneven speed of speech, as well as a more controlled and hesitating speech style, compared with non-type-A patients. Chesney et al. [31] compared type-A to type-B individuals with the FACS of Eckman and Friesen [32], and included speech stylistics. They found a correlation of the some FACS-parameters with syllabic emphasis, loudness of voice, hostility, and speaking rate. The respective results of this study may apply on SYX patients only when the symptoms (as pain) are clearly caused by a disturbed coronary circulation – which is by no means certain in our population [5].

In an epidemiological survey, Katon et al. [33] found patients with normal coronary angiography and typical or atypical angina pectoris to be significantly younger, often of female gender, and having more psychopathology such as panic attacks, depression, phobias, or vegetative concomitant symptoms. However, in our study patients with overt panic disease were not included. McCroskery [34] analysed in their work patients with negative coronary angiography and showed, that psychometric tests may show a positive correlation to a negative coronarography.

The question as to whether linguistic instruments are useful in the evaluation of chest pain has been raised by several researchers. In 1977 Schucker et al. [15] found a positive association of paraverbal speech stylistics: patients with coronary heart disease expressing type-A behaviour had more plosive words, a faster speed of speech, and a higher overall volume of voice. However, later scientific reports found a strong association of type-A behaviour and speech-stylistics in another patient group suffering from peripheral arterio-occlusive disease with pain [14], and the usefulness in pain assessment was highly doubtful. Nevertheless, our work revealed that even with exclusion of type-A patients these parameters may show a supplementary reliability in measuring pain.

It has often been suspected, that patients with PD and AP might have different pain origins. If this hypothesis is true, pain processing must be influenced by psychosocial elements, certainly having repercussions even onto other central nervous systems, auch as speech generation. This thesis had been formulated by Friesen & Ekman [32] and others [5, 21, 35].

Thus, our results show that in comparison with the results of another study where patients with CAD and SYX were investigated, the latter behave differently to CAD in respect to pain parameters even in verbal analysis [36].

In our study, patients were selected in respect to sex, age, and educational level. It has been suggested in the past, that a sex-difference in several of the speech stylistics may exist. This has been found by Nicholson & Kimura [37], who reported a higher speed of speech and a higher repetition rate in males than in females. Their study population consisted of normal young people without any disease. In addition, an analysis of our data showed, that no such difference exists in our population which has moreover a well balanced sex ratio of 1:1. Equally no patients with personality disturbances and important psychic dysfunctioning were included in our study.

Conclusion

After exclusion of confounding factors such as sex, age and educational level, as well as overt type-A or B behaviour, some aspects of speech stylistics seem useful in differentiation between patients suffering from SYX and PD, both complaining of angina-like chest pain. Nevertheless, a quite simple, and in future even computerised method, might be to count syllables per minute (speed of speech), repeated words, and plosive words in a stressed patient and to compare the difference of these values to the resting evaluation.

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