STRESS EVALUATION BY VOICE

A novel stress evaluation technology

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Introduction

Self-administered questionnaire is used to screen for stress in general. However, questionnaire is not able to be excluded reporting bias, which means that registrant changes the nuance of answers consciously (Table 1). Indicators to know objectively the effect of medicine is required. Additionally, when screening a large number of subjects, inspection simple and rapid method is needed. Recently, the technology of emotion recognition has been developed rapidly and highly. Therefore, we have developed software for stress evaluation using speech emotion recognition technology.

Table 1 : Example for the Self-administered questionnaire results

Case	Diagnosis	Outcome	General Health Questionnaire (GHQ)			
			Pre	On mission	Post	After 3Ms
1	Depression	Rest in home	7	7	1	2
2	Depression	Admission	-	-	-	-
3	Depression	Recover	-	-	-	-
4	Depression	Recover	16	16	21	0
5	Depression	Admission	2	2	0	15
6	Unknown	Suicide	0	0	0	0
7	Depression	Suicide	-	-	-	-

The data from the investigation of soldures after some humanitarian military mission. Some subjects refused to answer (-), and some subjects answered perfectly which seems reporting bias (blue).

ST Technology

In voice recognition analysis, power, fundamental frequency (F0), and their transition are usually used for parameters as well as information of speed and intonation of speech. Our system uses mainly power and F0, an involuntary or non-verbal element in voice, to isolate the emotional elements from human voice. F0 and power mean the vibration of vocal codes and may be an expression of natural human emotion. The autonomic neural system related to the function of vocal cords, which independent of high-level language processing that occurs in the cortex (Fig 1). Therefore, our system possible detects change of the feelings or emotion that the person himself does not notice. In other words, the person cannot role character which he wants like an actor against his system.

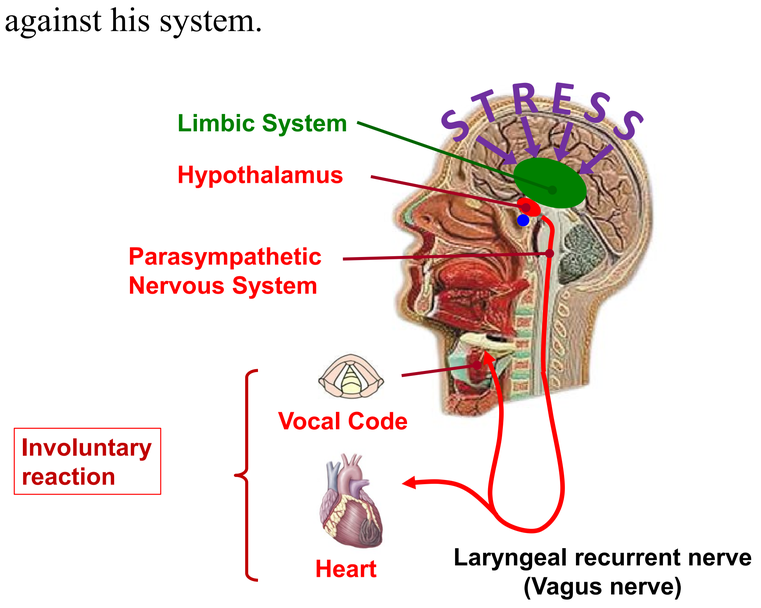

Fig 1 : Laryngeal recurrent nerve reactions

Vocal code is related with autonomic neural system , and effected emotion or stress involuntary.

The functional link was made in a following method (Fig 2). First, naïve subjects were asked to utter in free conversation. Then, the third person who was not related to speakers heard utterance and was asked to classify one's own utterance into individual emotional elements.

The classified data were clustered in selecting phonetic parameters of phonetic elements such as voice, namely, the components of upraise, peak, and decay, as well as absolute amplitude and average F0 values as determinants of emotional elements. Logical tree structures (dendrogram) were determined for labeling utterance and determining parameters, for each emotional element, respectively.

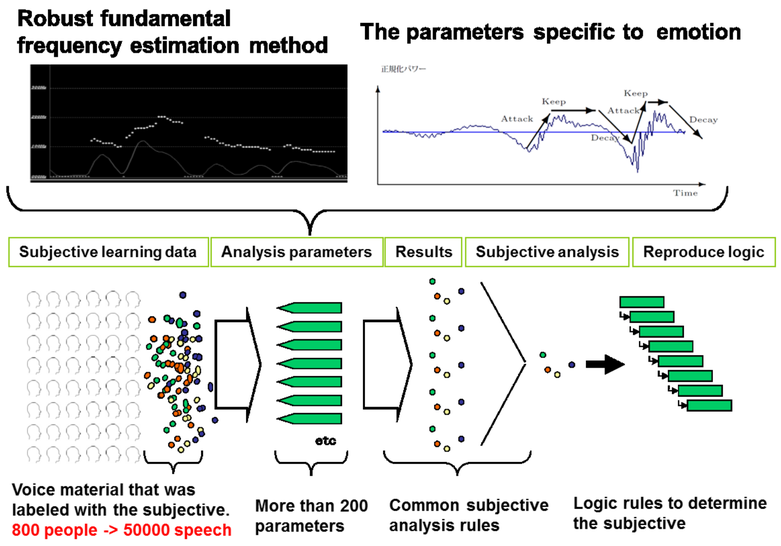

Fig 2 : Development of ST technology

Method

Subject

The subject is 1004 soldiers dispatched to the Great East Japan Earthquake and 444 soldiers to do a routine mission in Japan Ground Self Defense Forces. All of them had taken the stress analysis by voice and psychological testing by questionnaire.

The evaluation by interviewing was carried out for 225 soldiers who showed an abnormal psychological testing, and obtained the consent.

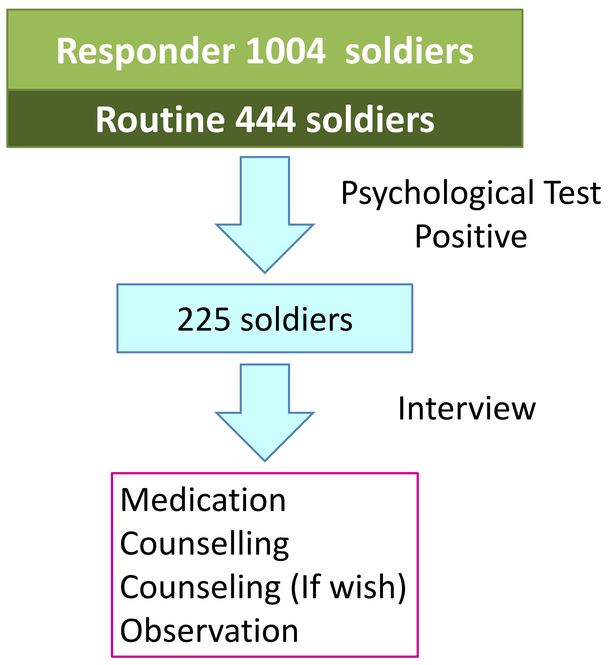

Fig 3 : Classification of subjects by interview

Voice Recording

Voice recorded by small IC voice recorder (PCM format).

The voice was recorded reading the short phrases written in Japanese.

Fig 4 : IC voice recorder

1. I-ro-ha-ni-ho-he-to
   (no means like "a-b-c")
2. I-ro-ha-ni-ho-he-to
   (no means like "a-b-c", repeat)
3. Watashi ha jieikan de, nihon kara kiteimasu.
   (I belong to the Self-Defense Force and come from Japan)
4. Tsukarete guttari shiteimasu.
   (I am tired and am dead tired.)
5. Totemo genki desu.
   (I am very cheerful.)
6. Kinou ha yoku nemuremashita.
   (I was able to sleep well yesterday.)

⋮

Stress Analysis

We used "Psycho-Analyzer" (AGI Japan Inc.) as base software for stress analysis system. This software determines emotional elements as including anger, joy, sorrow, and calmness. It also measures feeling of excitement and mood of depression. To evaluate the performance of the program, we compared with the psychological test (GHQ-30) or interviews.

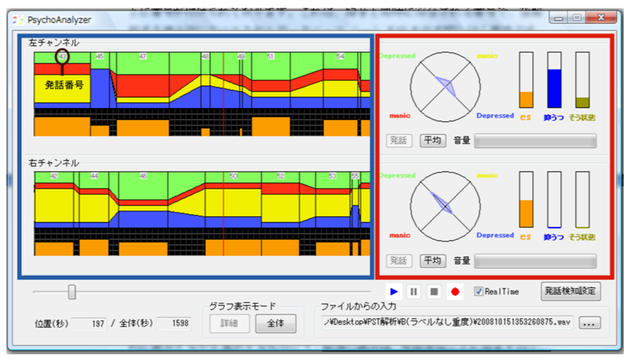

Fig 5 : "Psycho-Analyzer" (AGI Japan Inc.)

Result

29 soldiers in 225 were diagnosed to need medical intervention or counseling. GHQ-30 detected 27 of them and its sensitivity was 0.931. Voice analysis detected 26 of them and its sensitivity was 0.897. Additionally, the reporting bias was not observed in it.

Table 2 : Comparison with Voice analysis and Questionnaire

Voice Analysis		Medication & Counseling		
		+	-	
Score	50<=	26	162	188
	50>	3	34	37
		29	196	

Sensitivity: 0.897, Specificity: 0.173

GHQ=30		Medication & Counseling		
		+	-	
Score	7<=	27	123	188
	7>	2	73	37
		29	196	

Sensitivity: 0.931, Specificity: 0.372

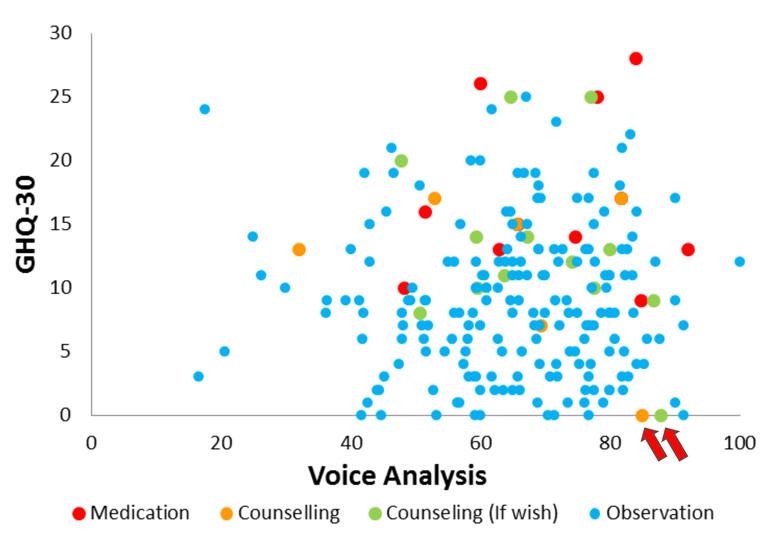

Fig 6 : Comparison with Voice analysis and Questionnaire

Red arrows; 2 cases who needed counseling showed low score in GHQ-30 (reporting bias), but voice analysis detected them.

Conclusion

The sensitivity of stress evaluation by voice was similar to that of the GHQ-30, and was able to eliminate the reporting bias. However, it is necessary for this system to improve in order to increase the accuracy.