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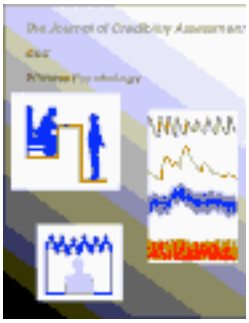

The Use of Voice in Security Evaluations

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The Use of Voice in Security Evaluations

Introduction

- The analysis of voice and speech can lead to the identity of the speaker, explanations of the speakers behavior and, perhaps, if the speaker is lying.
  - It is 2c (stress) and 3 (deception) that are of interest here.
- But if identification of deception by voice analysis is to be attempted, one **must** first consider the effects of stress on voice. In most cases, this progression has not been properly carried out.
- While it is recognized that lying does not always result in stress (due to sociopathic conditions, stress muted by chemicals and so on), stress constitutes the substrata for deception in the great majority of instances.

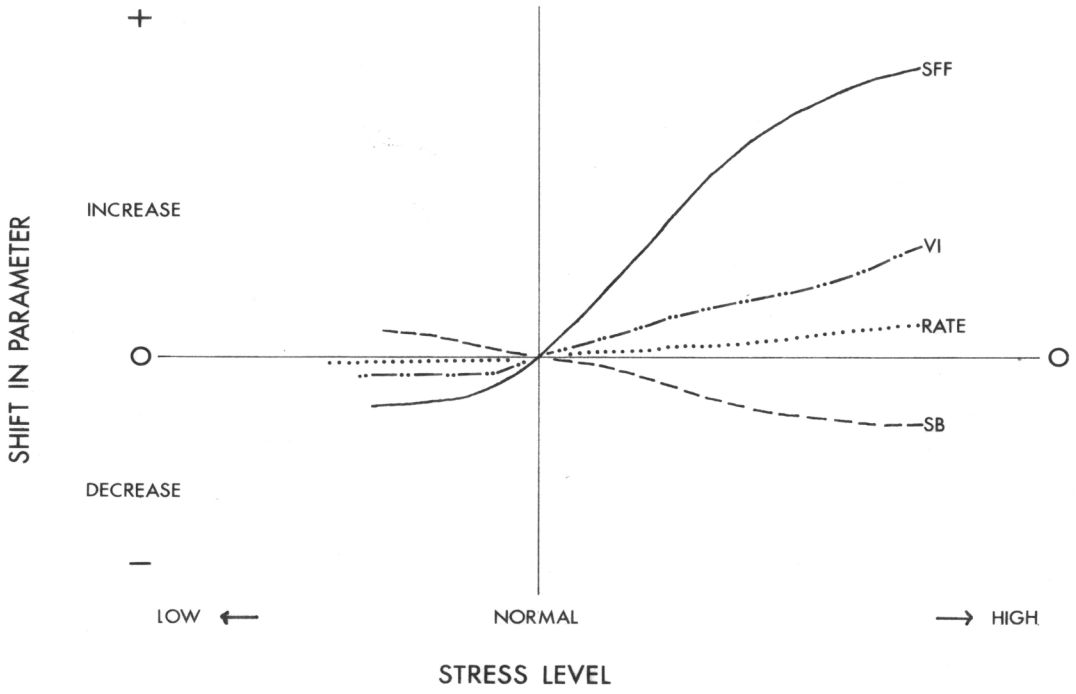
1. **Speaker Verification**
2. **Behavioral States**
   a. **Emotions**
   b. **Intoxication**
   c. **Psychological stress**
   d. **Illness, fatigue, etc.**
3. **Deception**

- It is **first** necessary to study and understand psychological stress as it is reflected in phonatory output.
- One problem to be faced is that stress is most often defined on the basis of the particular stressor involved.
- Actually, stress should be defined as a psychological response to a perceived or actual threat (as modified by coping behavior).
  - Unfortunately most research on vocal stress has been based on the former assumption -- not a useful approach.

Stress and Voice Model

- The model in Figure 1 has been gleaned from data analysis and the distillation of the available literature. Included is our own research. It involves curves of four acoustic (voice) parameters as they shift from low stress utterances through normal speech to that reflecting high stress. They are:
  - **SFF or speaking fundamental frequency:** This factor tends to rise with stress due to muscle tension and increased pulmonic airflow.
  - **Vocal intensity:** This factor tends to be reduced for low stress; quiet speech also rises -- as does speaking rate (**RATE**).
  - **Speech bursts:** The reverse trend is found for speech bursts (**SB**) and intervocalic pauses. There is an elongation, and reduction, of the number of phonatory bursts as stress rises.
  - In addition, **non-fluencies** tend to increase as a function of greater stress.

Stress and Voice Model: Figure 1



- If this model was both stable and universal, it would prove to be a boon to the study of deception as it is reflected in speech and voice.
  - Most investigators and practitioners contend that stress states provide the undergirding for the identification of deception. Unfortunately, this model is more in the nature of a hypothesis than a law.

Problems

- For example, while the data trends reported by most authors conform to the SFF and most vocal intensity curves, a few report little change or even some reversals.
- On the other hand, although the shift in speaking rate is not extensive, it appears stable.
- So do the trends for non-fluencies and speech bursts. Yet even these relationships are not universal.
- The cited across-study problems do not simply result from basing the experiments on the different types of stressors, they also appear to be created by marked differences in experimental design and variation of stressor **intensity** (i.e., the electric shock, induced anger, task complexity, threat of punishment and so on).
- Worse of all, few if any of the investigators were able (or willing) to determine the level of stress being experienced by the speakers
  - Sometimes they did not even know if their subjects were actually stressed.

A Response

- It now appears necessary to respond to all of the cited problems (particularly, the past failure to verify stress level experienced by human subjects).
- No research designs to date appear to have been robust enough to detect deception in speech samples.
- The ideal program would consist of basic research on the relationship between deception, stress and speech articulation

- Such a program should be conducted prior to testing developed products that purport to detect deception in speech.

- In the interim, we are now carrying out research which we believe will provide a reasonable and sophisticated response. We require that our stressors be powerful enough to induce a marked -- and measurable -- stress response and this **presence/level be independently verified**.

Current Study

- Specifically, we are currently conducting a study of a relatively large sample of men and women (N>40) ranging in age 20-55 years and drawn from many population subclasses.
  - These (paid) "volunteers" are carefully screened (psychiatric, hearing, speech, dialect, reading competency and so on) and for firmly held beliefs/opinions.
- The experimental conditions include speaking under high stress:
  - 1) threat of electric shock (after conditioning)
  - 2) lying with jeopardy (two conditions)
  - 3) lying with jeopardy **and** threat of shock
- Sampling procedures (see also *Speaking Conditions*)
  - Subjects are tape recorded and videotaped and told they will be heard/seen by their contemporaries -- even their friends -- espousing the lies (a proper debriefing comes later).
  - The high jeopardy lies involve intense invective and criticisms of a strongly held belief (e.g., Marines re: the Marine Corps, pro-gun activists re: the NRA, religious individuals re: their religious beliefs, etc).
  - A second type of high jeopardy lie is one that involves substantial embarrassment (e.g., men indicating they are wearing women's undergarments, women describing public menstrual accidents).
  - Also spoken/read are:
    - several repetitions of a standard passage (baseline),
    - a low stress truthful passage
    - a low stress lie
    - a truthful statement while simulating stress.
  - All passages are 25-35 seconds long and contain a long carrier (or neutral) sentence embedded within the passage.

Speaking Conditions

A. High Stress
1. Truthful passage: Stress induced by fear of electric shock
2. Lie passage: Jeopardy induced by passage content.
3. Combined high jeopardy lie with fear of shock

B. Low Stress
1. Baseline: Standard passage
2. Truthful passage
3. Lie passage
4. Truthful passage with stress simulated

Current Study (cont.)

- Stress level is being established by seven indicators:
  1. Change in heart rate
  2. Variation in galvanic skin response
  3. Oxygen usage
  4. Shifts in cortisol level (from saliva)
  5. Self reports of responses to stress (Hamilton test)
  6. Self reports of felt states (anxiety, anger, etc)
  7. Investigator observation of speaker response (sweating, flushing, trembling, etc)
- These data are being normalized and profiles developed to permit the selection of those individuals who can be used in the several studies planned.
- Preferably, we would carry out basic research in this area. However, the stated compromise at least provides (for the first time) a robustly controlled series of studies on stress and lying.

Conclusions

- Basic research in the relationship between voice, stress and deception is required in order to develop deception detection models and their ultimate security applications.
- Stress levels, both in the presence and absence of deception must be verified in both basic research and in testing existing commercial applications.

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