

ATTACHMENT 4

**Reprint from an American accident report concerning speech analysis in the investigation of a
1991 general aviation accident
(7 pages)**

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY (AS-30)
Washington, D.C. 20594

May 8, 1992

SPEECH ANALYSIS REPORT

A. ACCIDENT

Airplane: Piper Arrow N8144J
Date: August 9, 1991
Time: 1334 Central Daylight Time (CDT)
Location: Midland, Texas
NTSB No.: FTW-91-FA-144

B. HUMAN PERFORMANCE INVESTIGATOR

Malcolm Brenner, Ph.D.

C. SUMMARY OF ACTIVITIES

Recordings of the pilot's speech before the accident were collected from the available air traffic control (ATC) tapes. Attachment 1 provides a transcript of the pilot's statements as obtained from ATC tapes. The first 8 statements were made during the takeoff period and were recorded by Roswell Air Traffic Control Tower ("Roswell tape"). The last 7 statements were made during the landing period about 50 minutes later and were recorded by Midland Airport Traffic Control Tower ("Midland tape"). A composite tape was prepared that collected all the pilot's statements onto a single recording for easy comparison.

The composite tape was reviewed by two individuals familiar with this pilot, including one of his former flight instructors. Their comments are included as Attachment 2.

The composite tape was reviewed by a panel of medical authorities, including aeromedical physicians. They agreed that the pilot's speech on the Midland tape sounded different than his speech on the Roswell tape in a way that could be consistent with medical issues. A team of physicians characterized speech during the Midland tape period as "lower, slower, sounds strained or tired."

Laboratory measurements were made at the Safety Board's audio laboratory of the pilot's speaking rate. Using a high-capacity host computer (Digital Equipment Corporation MICROVAX II), the composite tape was recorded digitally at a rate of 16 kilohertz (using a Data Translation Board, Model DT1771). Statements were played back and examined visually and aurally using a color graphics workstation to display the waveform (Tektronix 4107A workstation)

and professional speakers to listen to the selection being played. When the exact start and stop times of a desired statement were captured, these times were recorded and provided a precise measurement of segment duration. The software for the system was written primarily in Fortran with several routines using VAX assembly language.

Attachment 2 is a mathematical table that summarizes speaking rate information for the airplane call signs uttered by the pilot. In some cases, the pilot uttered the full call sign "Arrow eight one four four juliet" (9 syllables); for others he uttered "four four juliet" (5 syllables); while for others he uttered only "four four jay" (3 syllables). The table shows the measured duration of each call sign and the derived speaking rate (no data are reported for statements 10 or 12 because the spoken call sign was interrupted). During the takeoff period (Roswell tape), the average speaking rate was 6.7 syllables per second. During the landing period (Midland tape), the average speaking rate had slowed down substantially to 3.8 syllables per second. This difference, a slowing to 57% of the earlier speaking rate, was statistically significant at the $p < .01$ level (meaning that such a result would occur by chance fewer than one time in one hundred observations).

The same slowing of speech was observed when longer statements were measured. For example, statements 1 and 3 from the Roswell tape were found to be spoken at an average rate of 5.5 syllables per second. Statement 9 from the Midland tape, which was similar in content, was spoken at an average rate of 3.2 syllables per second or only 58% as fast. It appeared to make no difference whether the pilot was saying a well-rehearsed phrase such as the call sign or a longer statement which required thinking. During the landing period he was speaking about 58% as fast as he spoke during the takeoff period.

D. ANALYSIS

There were major differences between the pilot's speech during the takeoff portion of the flight on the Roswell tape and his speech about 50 minutes later during the approach to landing on the Midland tape. Individuals familiar with the pilot identified speech on the Roswell tape as characteristic of the pilot's normal quality of voice communications. By contrast, they felt that "a different Don Stevens is piloting the aircraft" during the Midland portion and noted that "the crispness in his voice is lost, it lacks the firmness it had in Roswell. He seems confused and does not realize it." A panel of medical authorities also noted differences, and described speech on the Midland tape as "lower, slower, sounds strained or tired." Laboratory measurements established that the pilot was speaking only 58% as fast on the Midland tape as on the Roswell tape, even with a phrase as well rehearsed as the call sign.

Speaking rate often reflects psychological factors on speech (NTSB, 1990; Ruiz, Legros, & Guell, 1990). For example, previous research has indicated that slowing of speech is a characteristic response to alcohol use by the speaker (NTSB, 1990). However, even high levels of alcohol (approximate blood alcohol level of 0.25%) have been found to slow speech to

about 75% the rate of sober speech. The slowing of speech shown by the present pilot is more dramatic than that shown for alcohol exposure. In addition, the present pilot does not display obvious speech errors or changes in vocal quality such as are characteristic of alcohol use (NTSB, 1990). His statements are responsive to the air traffic controller's demands and the aviation situation. Based on his speech, the pilot appears to be straining or having difficulty concentrating during this period rather than having difficulty understanding.

The pilot was 62 years old and had a history of hypertension. Evidence from the investigation suggested that he stopped speaking on the radio shortly after the Midland transmissions and that he also stopped responding as a pilot. The airplane overflowed the intended airport, descended under a power line, touched down in flying configuration at an undesirable landing site and impacted a fence. Thus, there is strong circumstantial evidence that the pilot became incapacitated shortly after he made the transmissions recorded on the Midland tape. Details of the investigation tend to rule out hypoxia as a source of impairment since the flight was short and was flown below 10,000 feet (and the transmissions recorded on the Midland tape were made below 6,100). Details of the investigation tend to rule out normal fatigue as a source of impairment since it should not have such a dramatic effect over such a short time period. As noted above, speech evidence tends to rule out alcohol impairment. Speech evidence suggests that the pilot was having difficulty speaking but not necessarily understanding just before he stopped speaking on the radio. Such a result, uncharacteristic of drug effects, could be consistent with a major medical impairment such as a heart attack or other major incapacitation in which the victim was speaking over pain or physical discomfort. The speech evidence further reinforces other information from the investigation that the pilot became incapacitated as he was preparing to enter the landing sequence.

E. REFERENCES

National Transportation Safety Board. Marine Accident Report: Grounding of the U. S. Tankship EXXON VALDEZ on Bligh Reef, Prince William Sound near Valdez, Alaska, March 24, 1989. Washington, D.C.: National Transportation Board, 1990; NTSB/MAR-90/04.

Ruiz, R., Legros, C., & Guell, S. (1990). Voice analysis to predict the psychological or physical state of a speaker. Aviation, Space and Environmental Medicine, 61, 266-71.

~~Malcolm Brenner, Ph.D.~~
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Human Performance Investigator

AS-30
5-8-92

Attachment 1. Transcript of pilot statements, N8144J accident

Tape 1 -- Roswell Air Traffic Control Tower
(Takeoff at 1724 GMT)

1. Roswell ground Arrow eight one four four juliet Great Southwest taxi for takeoff southeast bound with bravo.
2. Four four jay one two.
3. Roswell tower Arrow eight one four four juliet ready for takeoff one two india intersection.
4. Four four jay rolling.
5. Four four juliet climbing to niner thousand five hundred.
6. Four four jay one point five mile ... rather one five miles southeast.
7. Four four juliet is one five miles southeast at seven point two.
8. Four four juliet good day.

Tape 2 -- Midland Airport Traffic Control Tower

9. (1816:17 GMT) Midland approach Arrow eight one four four juliet at six point one descending inbound for Air Park with the information.
10. (1816:35 GMT) Zero two five three for four four j(ay).
11. (1817:27 GMT) Four four jay.
12. (1820:47 GMT) (Cher ...) ah ah Arrow four four (juliet two five three).
13. (1821:58 GMT) Four four juliet.
14. (1823:06 GMT) Four four juliet looking.
15. (1823:13 GMT) Four four jay.

(Accident at about 1834 GMT)



April 27, 1992

Mr. Warren V. Wandel
National Transportation Safety Board
1200 Copeland Road Suite 300
Arlington TX 76011

Dear Warren,

I and Bob Corn (our Director of Operations) have reviewed the tape recording of the communication with 8144J on August 9, 1991. Bob and I have well over 1000 hours of flight experience with Don Stevens in various aircraft he owned and operated over the past 13 years. For example, I acted as his instructor for his instrument and multi-engine ratings. All three of us attended Flight Safety for the initial and refresher courses on the PA-31T. My point being we had more than a casual relationship with Don and his flight experience.

Bob Corn and I have a common analysis of the tape. That portion representing the Roswell portion of the flight represents Don's normal quality of voice communications. His transmissions are clear, precise with an "in charge" attitude being reflected. We also noted the lack of background noise because he was holding the hand mike properly.

Immediately into the Midland portion of the tape we both reacted that a different Don Stevens is piloting the aircraft. The crispness in his voice is lost, it lacks the firmness it had in Roswell. He seems confused and does not realize it. There is substantial background noise in the mike, which indicates to us it was far away from his lips or he had trouble holding it. During one transmission with Midland he had trouble remembering or saying the word "Arrow" the aircraft type. He acknowledged the "squak" code but didn't get it into the transponder. That in itself is not significant (we all have done it) but didn't surprise us because of his voice quality and apparent confusion.

The Don Stevens reflected by the voice in the latter portion of the tape is not the Don Stevens that Bob and I knew and had flown with over the years. The voice reminded both of us of someone in an altitude chamber, who has had their mask off too long. Don reported to Roswell Departure he would fly at 9500 ft., so hypoxia in itself should not have

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been the problem.

I had a business/personal conversation with Don immediately prior to his departure from Roswell. He did not indicate verbally or visually any health problems which would have led up to the "Midland" voice changes.

Bob Corn asked me to relate that with Don's background and experience, he should not have had any problems flying the aircraft.

We hope the above information is of some assistance in your investigation. We would ask for you to send us a copy of the accident report, once it is published.

Sincerely,


Mr. L. Drew
President

Attachment 3. Summary of speaking rate measures for the spoken call sign information.

Statement Number	Number of syllables spoken	Measured duration (seconds)	Speaking rate (syllables/second)
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Roswell Tape

1.	9	1.388	6.5
2.	3	0.732	4.1
3.	9	1.156	7.8
4.	3	0.500	6.0
5.	5	0.622	8.0
6.	3	0.480	6.3
7.	5	0.747	6.7
8.	5	0.610	8.2

Midland Tape

9.	9	2.479	3.6
11.	3	1.007	3.0
13.	5	1.235	4.0
14.	5	1.067	4.7
15.	3	0.854	3.5