Unnatural Practices, Unspeakable Actions: A Study of Delayed Auditory Feedback in Schizophrenia

Terry E. Goldberg, Ph.D., James M. Gold, Ph.D., Richard Coppola, Sc.D., and Daniel R. Weinberger, M.D.

Objective: *It has been suggested that auditory hallucinations and delusions of control in persons with schizophrenia could involve a disconnection between an "intention center" and a "monitoring center." Method: To test this model directly, the authors used a delayed auditory feedback paradigm in which the subject hears his or her own speech delayed electronically by a fraction of a second. In normal subjects this produces dysfluency, which is thought to occur because an expectancy about the perceptual arrival of speech, formed in a monitoring center on the basis of corollary discharge from an intention center, is violated. If, however, a disconnection were present in schizophrenia, such an expectancy would not be formed; hence, less dysfluency should occur. Fifteen patients with chronic schizophrenia (10 of whom experienced auditory hallucinations and/or delusions of control) and 19 normal subjects were studied. Results: Rather than exhibiting less dysfluency than the normal subjects, patients with delusions and/or hallucinations exhibited significantly more dysfluency. Conclusions: These results do not support a cognitive model of disconnection.*

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There have been several recent attempts to specify cognitive mechanisms that might underlie hallucinations and delusions in psychotic patients. In an influential account, Frith (1) proposed that auditory hallucinations, as well as certain types of delusions in which patients feel themselves to be controlled by alien forces, may be related to a disconnection between a cognitive system responsible for willed actions and a system that monitors actions. Under normal conditions, when a person deliberately speaks or acts, the monitoring center is thought to receive information from the intention center, by way of corollary discharge, indicating that such an event is to occur. In this situation, an intended act would be attributed to an internal source. However, if the monitoring center did not receive such information because of a disconnection, then the genesis of the act might be misattributed to an external source.

The goal of the present study was to test the "disconnection" hypothesis directly by using a delayed auditory feedback paradigm in which a subject hears his or her own voice a fraction of a second after speaking. Under these conditions normal subjects slow their speech and become dysfluent (2). The presence of dysfluency suggests that a speech monitoring center receives information that an act of speech is about to occur, and when the resulting expectation as to when self-generated speech should be heard is violated by a delay, fluency becomes disrupted as attempts are made to reimplement synchrony between speech output and perceived input (3). We reasoned that if in schizophrenia a disconnection between intention and monitoring centers were present, then patients should be "abnormally" unperturbed by delayed auditory feedback during connected speech and, in essence, perform "better" then normal subjects.

Three earlier groups investigated delayed auditory feedback in adult patients with schizophrenia (4–6). While none of these studies found patients to be less disrupted than control subjects, the results can be considered inconclusive, since the relations between symptom type and the effect of delayed auditory feedback were unspecified. This is a crucial issue, as only schizophrenic patients with certain types of positive symptoms might be expected to perform "well" on delayed auditory feedback tasks. In the present study, we attempted to control for such distinctions by ascertaining symptoms with the use of a structured interview.

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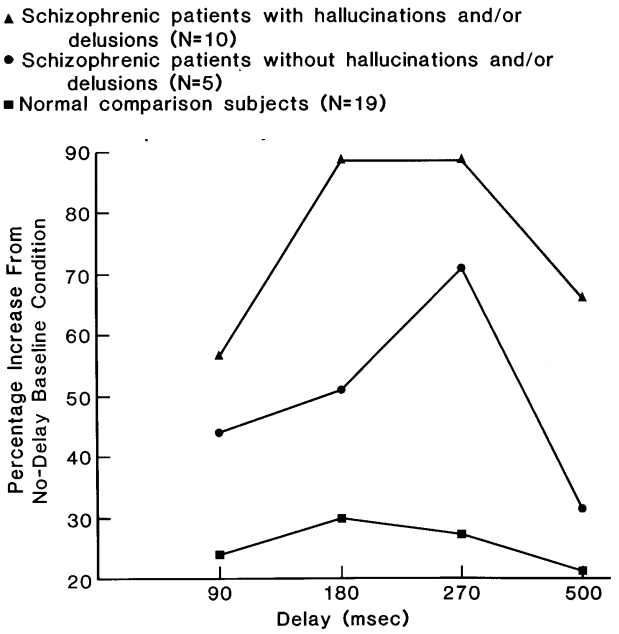
FIGURE 1. Effects of Different Delayed Auditory Feedback Conditions on Composite Speech Scores of Schizophrenic Patients and Normal Comparison Subjects



METHOD

Nineteen normal subjects (seven female and 12 male; mean age=32.5 years, SD=7.1; mean years of education=18.1, SD=3.1) and 15 patients with schizophrenia (two female and 13 male; mean age=32.7 years, SD=7.9; mean years of education=14.6, SD=1.8) participated in the study. Age did not differ significantly between the groups, whereas education did (t=6.51, df=32, p=0.0001). Thirteen of the 15 schizophrenic patients were receiving neuroleptic medications. The mean duration of illness was 12.6 years (SD=8.5). After a complete description of the study, the subjects gave written informed consent.

The delayed auditory feedback device was custom-built and used a digital delay line for precise timing control. An Electraret microphone and Grass model 10H headphones were used for speech input and reception. Subjects spoke into the microphone; their voices were delivered to the headphones at a constant and comfortable listening level of about 70 dB. Feedback delays were set at 90, 180, 270, and 500 msec.

For each delay subjects read a paragraph, recited months of the year, recited days of the week, and counted forward by twos to 30. For these measures, the dependent variable was time in seconds. All scores were converted to percentages of increase or decrease from the no-delay baseline condition. Delays were administered in counterbalanced order, and tests in a fixed order. Because these tasks were highly interrelated, we used a composite performance mean.

Susceptibility to distraction, a possible confounding factor, was measured on a digit span task designed by Harvey and Pedley (7). Distractibility was considered to be the difference between the number of correct trials in a condition in which an extraneous voice was to be ignored and the number in a condition in which no such voice was present.

Psychopathology was assessed with the Comprehensive Assessment of Symptoms and History (8), an instrument with detailed probes for and ratings of auditory hallucinations and delusions, including those of control. It was administered within 2 weeks of the date of delayed auditory feedback assessment. Scores ranged from 0 (absent) to 5 (present and severe). Patients who received a rating of 3 (moderate) or higher were considered to manifest a symptom.

Five patients experienced delusions of control and auditory hallucinations at the time of the delayed auditory feedback procedure. Five other patients experienced only auditory hallucinations. These 10 patients constituted one study group. Five patients who experienced neither symptom constituted a second group, and the third group was composed of the normal comparison subjects.

RESULTS

The means for the composite measure of connected speech under delayed auditory feedback conditions are illustrated in figure 1. A repeated measures analysis of variance revealed a main effect for diagnosis (F=7.27, df=2, 31, p=0.003). The delusional, hallucinating schizophrenic group showed consistently larger percentage increases in time than did the normal group. The results of post hoc Tukey t tests for the difference between these two groups were significant ($p<0.05$) for each delay. No other post hoc between-group contrast reached significance. A significant main effect of delay was also found (F=5.38, df=3, 29, p=0.005), and there was a significant delay-by-diagnosis interaction (F=2.53, df=6, 58, p=0.03). The Spearman correlations between susceptibility to distraction (on the digit span task) and the effects of delay were nonsignificant in the schizophrenic and normal groups.

DISCUSSION

A heuristically important advance in schizophrenia research has been the development of a disconnection hypothesis to explain positive symptoms in terms of cognitive mechanisms (1). We tested this proposal using delayed auditory feedback; our results were not in keeping with the hypothesis. The performance of the patients was actually the opposite of what was predicted, in that it was more disrupted by delayed auditory feedback than was the performance of the normal subjects. The possibility that our results were caused by distractibility is unlikely, because susceptibility to distraction on a digit span task was not correlated with susceptibility to the effects of delayed auditory feedback, and because the patients' performance was less impaired at the delay of 500 msec, contrary to what one might have predicted if distractibility were the cause of impairment.

Results from the application of delayed auditory feedback to neurological groups may be helpful in furthering the interpretation of our results. Chapin et al. (9) found that in patients with conduction aphasia—a model disconnection syndrome in which the anterior speech zone is disconnected from the posterior language zone (i.e., a speech intention center from a speech monitoring center)—delayed auditory feedback did in fact produce less perturbation than in normal control subjects. This is in keeping with our original hypothesis that "real" disconnection should result in less speech perturbation under conditions of delayed auditory feedback. While our results do not rule out the possibility that there may be other types of self-monitoring fail-

ures, they do raise an alternative possibility: processing modules themselves may be dysfunctional.

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