northerly responses predominated in the normal viewing condition and southerly responses predominated in the stabilized condition. This result has been analyzed and its basis established in several further experiments which are described elsewhere (*7*). It is also shown there that the result is consistent with the eye movement interpretation for autokinesis.

A neurophysiological basis for our results is suggested by recent work in which electrical recordings were made from single units in the striate cortex of cats (*8*). This work shows that some cortical cells are differentially sensitive to different directions of movement of a pattern across their receptive fields. Thus, for example, some units which are stimulated most effectively by movement in either direction along a given retinal meridian do not respond at all to movement along the meridian perpendicular to the given one and yield small responses to movement along intermediate meridians. A unit of this type may be most sensitive to vertical movement, horizontal movement, or movement along a particular diagonal meridian. Further, some units may be least sensitive to movement at 180 degrees from the direction of movement to which they are most sensitive (see also *9*).

The reduction of horizontal movement during our stabilized viewing condition may be related to the fact that those neural units sensitive to horizontal movement are not being adequately stimulated, while those sensitive to movements in other meridians are still being stimulated. The response of the group sensitive to diagonal movement would be expected to be attenuated, however, since its stimulation now results mainly from vertical movements rather than from movement in those directions to which it is most sensitive. This interpretation of our results, of course, depends on the existence, as yet undemonstrated, of single unit movement detectors in the human visual system, similar to those in cats, and also on the requirement that the output of such detectors be coded in perception so as to retain direction-specific information in the sense of a modern version of specific nerve energies.

LEONARD MATIN
G. ERNEST MACKINNON
Department of Psychology,
Johns Hopkins University,
Baltimore 18, Maryland

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5. Preliminary work showed that two alignment criteria were essential: (i) it was necessary that the stablized view be foveally centered; (ii) when the stablized view was substituted for the normal view, it was necessary that no shift of target location be observed by the subject. These criteria will be discussed more fully in a paper by L. Matin, G. E. MacKinnon, and D. Pearce, in preparation.
6. The autokinetic movements we observed could, without difficulty, be separated into (i) small, short-lasting, jerky, or oscillatory movements which appeared to be of considerably lesser magnitude than the diameter of the fixation target, and (ii) prolonged, slower drifts of larger apparent magnitude. We did not attempt to obtain information on the first type—when such movements do occur, changes in direction are too rapid for the subject to record. The data reported here concern the drifts.
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Speech Durations of Astronaut and Ground Communicator

Abstract. *Laboratory studies suggest that an interviewer can influence the speech duration of an interviewee by modifications in his own speech duration. What appears to be a related association between the speech duration of communicators on the ground and an astronaut in orbital flight was found.*

In a recent paper (*1*) we reported that an interviewer apparently can influence the duration of interviewee speech by changes in the duration of his own speaking times. The results of the three experiments done in that study are summarized graphically in Fig. 1. In the experiment shown at the top of this figure, an interviewer conducted individually a 45-minute nondirective employment interview with each of 20 normal interviewees. Unknown to the interviewee, the interviewer, while appearing to carry out a straightforward interview, modified his own speaking time per speech unit by limiting each of his comments to 5 seconds for the first 15 minutes, then switching to 10-second comments in the second 15-minute period, and finally returning to 5-second speech durations each time he spoke in the last 15-minute period. The interviewer did not attempt to control the content of the 45-minute interview. Rather, the content of the interview was allowed to flow spontaneously into a number of categories with each interviewee. The results in Fig. 1 show that as the interviewer's mean speech durations in the three periods of the interview averaged 5.3, 9.9, and 6.1 seconds ($p = .001$) as he aimed for 5, 10, and 5 seconds, the corresponding mean speech durations of the 20 interviewees were 24.3, 46.9, and 26.6 seconds ($p = .01$). Durations of single speech units for interviewer and interviewee were recorded on a Chapple Interaction Chronograph (*2*) by an observer watching the live interview through a one-way mirror.

To further establish that interviewee speech durations were amenable to influence by the interviewer, we conducted a second study, utilizing 20 additional interviewees and an interviewer speech sequence of 10, 5, and 10 seconds. The results are shown in Fig. 1 (middle) and indicate that as the interviewer's mean speech durations averaged 9.5, 4.9, and 9.5 seconds ($p = .001$), the corresponding interviewee speech durations were 41.1, 22.8, and 48.2 seconds ($p = .001$). A third group of 20 subjects, not previously reported, served as a control group and the means are shown at the bottom of Fig. 1: 5.0, 5.2, and 5.2 seconds (p not significant) and 30.0, 30.5, and 28.1 seconds (p not significant). In a fourth group of 20 subjects, also not previously reported, the interviewer aimed for 5, 15, and 5 seconds duration for his individual speech units in the three periods of the interview. The results, not shown in Fig. 1, were as follows for interviewer and interviewee, respectively: 5.0, 15.2, and 5.5 seconds ($p = .001$) and 30.9, 64.5, and 31.9 seconds ($p = .001$).

A question that we have raised (*1*, pp. 455–456) about the results shown in Fig. 1 is whether they are, in fact, due to an increase in the duration of the interviewer's own speech, or whether they are the result of some methodological artifact. The evidence so far indicates they are not an artifact. The results in Fig. 1 also could be a function of the observer's error (or bias), or the interviewer's error (or bias). That is, the interviewer could remain silent for periods of time to bear out his preconceptions of the relationship between the duration of his speech and the duration of the interviewee's speech. Or, the observer could record interviewee speech durations beyond the point at which the interviewee stops speaking. That the latter explanation is unlikely is inferred from an earlier study wherein we had two observers each record the same interview through one-way mirrors placed at opposite ends of an interviewing room, thereby insuring independent observations of the same interview events by the two observers. For units of speech and durations of speech the observed means for 17 such interviews were identical, and the Pearson correlation coefficients were .985 and .998, respectively, which indicates that recording such speech units and durations is a highly reliable, almost mechanical affair (*3*, p. 271).

Chapple and Goldman-Eisler independently have reported the same high reliability for their observers' ability to determine what constitutes a unit of speech (*2*, pp. 362–364), although different investigators, each for his own purpose, may differ in what they define as a speech unit (*4*, p. 416). Interviewer bias, on the other hand, is not possible if the observer is faithfully recording an interview. Nevertheless, since an interviewer and observer could both be biased in the same direction, we have sought independent evidence that this dual bias was unlikely. The bulk of this evidence has come from the fact that Chapple in Boston, Goldman-Eisler in England, and our group (utilizing four different interviewers in different cities in one study) all have reported this previously unsuspected (by the investigators) apparent interviewer effect on interviewee speech durations (*1*, p. 456). Nevertheless, in each of these studies, the apparent interviewer effect was an incidental finding arising from noncontrolled, free clinical interviews, and not the result of a laboratory study such as the one shown in Fig. 1.

However, recently, Dinoff, Morris, and Hannon (*5*) have independently cross-validated one of our earlier interviewee reliability studies, and also have provided even stronger evidence that our interviewer-interviewee speech duration effect is not the result of our own group's interviewer expectancy, or bias. Although not mentioned by them, in their Table 2 (*5*, p. 281), there is clear evidence that their interviewees'

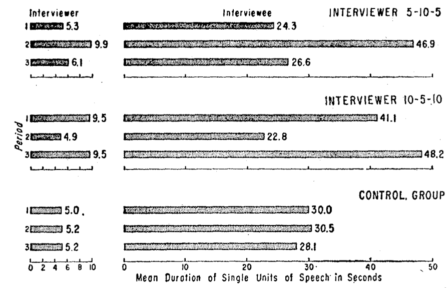

Fig. 1. Interviewer influence on duration of interviewee speech.

mean speech duration (action) was a function of the planned, controlled changes in their (two) interviewers' own speech behavior. Interestingly, as also reported in one of our earlier studies (*6*, p. 489), the duration of speech of their schizophrenic patients (their Table 2) was longest under conditions of interviewer silence. Thus, their schizophrenic patients and our own schizophrenic patients differ from other patient groups and normals, including the normals represented in our Fig. 1, all of whom shorten their durations as the interviewer shortens his own speech durations. From these findings of several independent investigators, and especially the results in Fig. 1, we have concluded that there is increasing evidence to suggest that interviewee speech durations are a function of the speech durations of the interviewer.

The detailed recording of many variables in the orbital flights of the Mercury Space program of the National Aeronautics and Space Administration presented us with an opportunity to test the generality of these observations with still another two-person communication unit, and with the two-person communication taking place at a distance. After two of the space flights (herein labeled astronaut A and astronaut B), NASA made available to us a tape recording of the voice communications between the spacecraft and the ground stations. Counting time spent

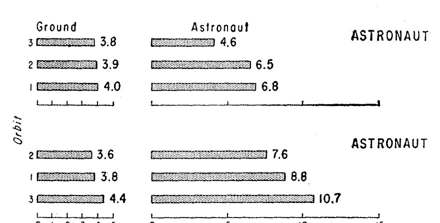

Fig. 2. Relationship between mean speech duration of ground communicator and astronaut.

in recovery after impact, these lasted 5 hours and 5 minutes and 4 hours and 56 minutes, respectively.

In all, 14 different ground communicators talked with astronaut A during his three orbits, one at each of these 14 ground stations: Cape Canaveral, Bermuda, Canary, Atlantic Ship, Kuno, Zanzibar, Indian Ocean Ship, Muchea, Woomera, Canton, Hawaii, Guaymas, California, and Texas. The fact that 14 different men made up the ground end of the two-person communication system introduced uncontrollable variance in our study of the potential influence of ground communicator on astronaut speech. Nevertheless, our curiosity as to whether or not the results from a laboratory study, shown in Fig. 1, could be demonstrated in space made us proceed with the present study.

In all, the 14 ground communicators spoke a total of 254, 265, and 313 individual times in orbits 1, 2, and 3, respectively. Astronaut A's number of single speech units during the same three orbits were 290, 276, and 369, respectively. Measurement (from the tape recording) of these single units of speech and the corresponding duration of each also was made by a listener activating a Chapple Interaction Chronograph (*2*) and, simultaneously, our adaptation of this instrument, an Interaction Recorder. Although the fidelity of the tape recording of the orbital flight was excellent, the listener's accuracy was facilitated further by providing him with a published printed transcript (*7, 8*) of a chronology of the flight, which he scanned while recording from the tape itself. (The reader interested in the earlier discussion of what constitutes a unit of speech should consult these NASA verbatim transcripts where he will find each speech unit clearly demarcated.) Subsequently, since the printed transcript included a verbatim record of each utterance by both astronaut and ground communicator(s) and NASA's record of the elapsed time at which each utterance began and its duration, it was possible to compare, unit by unit, the mean durations of speech of both astronaut A and his ground communicators, during all three orbits, as recorded (i) in the NASA printed transcript and (ii) by our listener using the Interaction Recorder. For the total three-orbital flight of astronaut A the product-moment correlation between the unit and duration data obtained from our own "live" interaction recording from the NASA tape and the comparable speech data from the NASA printed typescript was .996. Similarly, the correlation between the two types of speech data for the ground communicator(s) was .985. Thus, we concluded that our own "live" measurement of duration of speech units from the tape recording was identical to the measurement made by NASA personnel and reported in their own printed typescript record (*7*). (It should be pointed out that the time measures we were making from the NASA tape were "contaminated" little, if at all, by our observer's scanning of the NASA printed transcript.) With such high reliability, we felt it unnecessary to carry out a similar tape and printed typescript reliability study of the data with astronaut B.

For astronaut A the 14 ground communicators spoke a total of 1025 seconds during orbit 1 which, when divided by the 254 times they spoke during that orbit, yielded a mean speech duration of 4.0 seconds. The mean speech duration in orbit 2 was 3.9 seconds, and in orbit 3 it was 3.8 seconds. Astronaut A spoke a total of 1986, 1782, and 1698 seconds in orbits 1, 2, and 3, respectively. When divided by his speech units per orbit (290, 276, and 369), his average speech durations were 6.8, 6.5, and 4.6 seconds, respectively.

In order to facilitate interpretation, the mean speech durations of the ground communicator(s) are shown in Fig. 2, not in sequence by orbit (1, 2, and 3), but, rather, in sequence from the lowest mean duration to the highest mean duration (orbits 3, 2, and 1).

Although the mean differences from one orbit to another are slight, it is clear from Fig. 2 that an increase in mean duration of speech by the ground communicator is associated with an increase in mean duration of astronaut speech: 3.8, 3.9 and 4.0 seconds is associated with 4.6, 6.5, and 6.8 seconds, respectively.

The flight of astronaut B provided an opportunity to check still further on this apparent correspondence between speech behavior of astronaut and of ground communicator. Only 12 ground communicators were involved in that space flight (Atlantic Ship and Texas not being utilized).

Our procedure and method of analysis of the speech data of astronaut B were similar to that for astronaut A. Number of speech units, total speaking duration, and mean speech duration for ground communicator(s), respectively, were orbit 1, 168 units, 630 seconds, and 3.8 seconds; orbit 2, 264 units, 940 seconds, and 3.6 seconds; and orbit 3, 132 units, 582 seconds, and 4.4 seconds. For astronaut B these were orbit 1, 237 units, 2092 seconds, and 8.8 seconds; orbit 2, 277 units, 2105 seconds, and 7.6 seconds; and orbit 3, 196 units, 2098 seconds, and 10.7 seconds. These mean values, again graphed from smallest to largest, and not by orbit, also are shown in Fig. 2. It is clear from these results that the data from astronaut B cross-validate the findings with astronaut A.

Taking the three pairs of means for astronaut A's flight and the three pairs of means for astronaut B's flight (Fig. 2), it is seen that, without exception, a relationship appears between mean speech duration of the ground communicator and the corresponding mean duration of speech of the astronaut. Direct probability analysis, using conditional probability and sampling without replacement, yields a p value of less than .05 for six correspondences, but such statistical analysis of these data appears to be overly refined at this time. Unlike the earlier laboratory study (Fig. 1), wherein we knew that planned changes in the interviewer's behavior appeared to be producing changes in the interviewee's duration of speech, in the astronaut data we are dealing with an "experiment of nature" and are unable to determine whether changes, from orbit to orbit, in the ground communicator's speech caused changes in astronaut's speech, or vice versa.

This association between the behavior of the two speakers is also demonstrated by the correlation between the ground communicators' mean duration of speech units at each station and astronaut A's mean duration of speech units at the same station. For orbit 1 this coefficient of correlation is .693 ($p = .02$); for orbit 2 it is .616 ($p = .05$); and for orbit 3 it is .065 (p not significant). Thus, for two orbits this association is demonstrated, whereas for orbit 3 it is not.

The association between ground communicators' and astronaut B's speech duration revealed a correlation for orbit 1 of .450 (p not significant); for orbit 2, of .361 (p not significant); and for orbit 3, of −.314 (p not significant). Again it is of interest to note that, while just short of statistical significance, the direction of the correlations follows the same trend as for astronaut A. For the present, no single basis for the failure of correlation of mean speech durations for orbit 3 has been recognized by us (especially in the presence of the correspondence in the three-orbit pairs of means shown in Fig. 2). Possibilities include a waning of conversational interaction with prolonged flight time, with relatively more predominant standardized operational transmissions, including systems checks and major standard operational sequences, such as retrofire, and biasing effects of high priority information exchanges in preparation for descent.

In any event, whether determined by correlational analysis for orbits 1 and 2, or by the mean speaking times per orbit for all three orbits as shown in Fig. 2, the finding of some relationship between astronaut speech and ground communicator speech appears to be an interesting extension of the more controlled findings shown in Fig. 1.

JOSEPH D. MATARAZZO
ARTHUR N. WIENS, GEORGE SASLOW
University of Oregon Medical School, Portland

RICHARD M. DUNHAM
University of Houston, Houston, Texas

ROBERT B. VOAS
National Aeronautics and Space Administration Manned Spacecraft Center, Houston, Texas

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