Facilities for the Sound Recording and Observation of Interviews

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IN the last two decades, the electronic recording of speech for use as scientific data in investigations of human behavior has rapidly increased. Earl F. Zinn made the first consistent attempt at recording psychotherapeutic interviews. In the 1930's at the Institute of Human Relations, Yale University, he recorded lengthy cases on Ediphone cylindrical disks. Carl Rogers and coworkers were pioneer psychologists in the systematic use of the technique and data in the study of psychotherapy. This group has continued to use them intensively. Especially since the end of World War II, sociologists, psychologists, and psychiatrists have increasingly exploited sound-recording techniques. Technical advances in recording devices and the improved methods of acoustically treating interviewing rooms have made it possible to realize the desire of many for objectivity of interview data.

At Yale, as elsewhere, the first attempts to record interviews utilized low-fidelity recording systems operated under noisy conditions. The early recordings by Redlich, Dollard, and Newman (*1*) were replete with sounds of flushing toilets, footfalls, rumblings of trucks, and so forth, which were transmitted into the clinic interviewing room where the recording occurred. To obtain useful speech recordings in these noisy surroundings, it was necessary for both therapist and patient to speak directly into individual microphones. At one time these were even held close to the participants in a halter.

A great deal can be learned, and was, from low-quality systems. Transcripts can be made and subjected to detailed content analysis. One can monitor live interviews or listen to these recordings for self-teaching and the instruction of small groups. But frequently crucial verbal productions, for example, near-whispers, are lost even in transcripts, and the general intelligibility is such that listening in small groups becomes a fatiguing and unpleasant task, with reasonably satisfactory reproduction before a clinic group or class of 30 or 40 students virtually impossible. Emotional nuances in the voices are not easily detected, and the people engaged in the interview in a room with poor acoustical characteristics must work so near the microphone that they are generally "mike bound." In addition, poor-quality recordings are not satisfactory for subsequent reproduction, in the form of long-playing phonograph records, for example, and distribution to the professional and scientific public. This was regarded as one of the main advantages of the use of recording procedures in interviewing. Gill *et al.* (*2*) have published such records now. Early experiences with these difficulties have increased the interest of the behavioral scientists in reasonably high fidelity recording systems—comparable to a good original radio production.

The limitations cited in the preceding paragraphs can be overcome by carefully planning the entire system and by the availability of adequate funds. Many behavioral scientists who contemplate building facilities for reasonably high quality sound recording are not aware of the problems and solutions involved. This article describes essential features of a system (*3*) designed for use primarily by psychologists and psychiatrists. It is hoped that others may profit from this description as we did by inspecting facilities elsewhere and by the advice of others. It is not intended to present a plan to others that will dispense with the need for expert advice or to endorse in blanket fashion equipment found suitable in these particular circumstances.

Once the decision was made to build high-fidelity facilities, experts in the field of speech, speech recording, and acoustical architecture were consulted. Very valuable advice was obtained from the research staff of the Bell Telephone Company, the Psycho-Acoustic Laboratory and Department of Social Relations of Harvard, C. V. Hudgins of the Clark School for the Deaf, and the Haskins Laboratory. Recommendations from these sources, the services of an expert consultant (*4*), and the previous experience of Redlich, Dollard, and Newman resulted in the sound-recording rooms, which are illustrated diagrammatically in Fig. 1. Our experience has been that the steps followed have resulted in a generally satisfactory, though not perfect, instrument. The basic requirements for recording interviews in which speech varies in volume from mere whispers to loud talking may be briefly outlined as follows:

1) The background noise must be reduced to permit a very wide dynamic range reproduction and still have the reproduced sound louder than the background noise of the entire recording system. (This includes all noise introduced in the acoustical, mechanical, and electrical portions of the recording and playback systems).

2) A uniform reproduction (through the entire system) of all tones from the lowest base to the highest pitch of the overtones of the recorded sounds is required. These overtones carry much of the meaning and intelligence in the afore-mentioned emotional nuances.

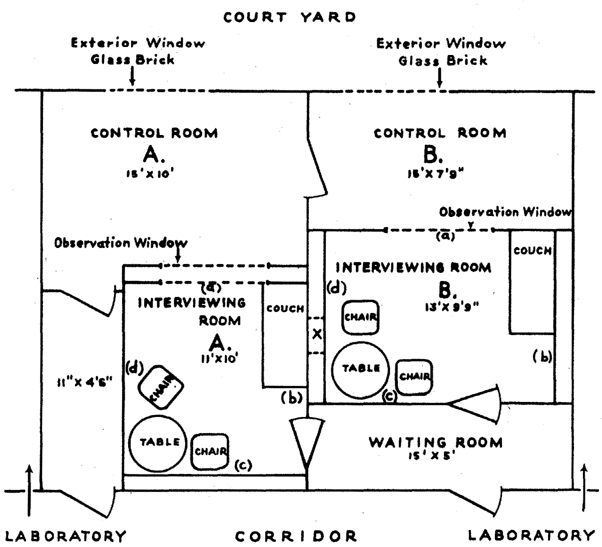

Fig. 1. Diagrammatic illustration of facilities. Point X is illustrated in detail in Fig. 2.

3) There should also be a minimum distortion of the wave-shape of the recorded sound waves. An excessive amount of wave-shape distortion disturbs the relative intensity relationships of the fundamental tones and their associated overtones, thereby reducing the ability to interpret emotional nuances correctly.

Location of the Suite

The location of the suite was the first decision and was carefully considered. The location was easily accessible and relatively quiet in comparison with other feasible areas. There was not another storey overhead. The site was reasonably distant from large pieces of machinery, such as elevators and ventilation blowers. Inspection of the building blueprints and the actual location showed that the walls of the area did not, as many do, contain pipes of the general heating, plumbing, or ventilation systems, which would be sources and transmitters of noise. The initial average noise level of the area was 58 to 60 db of acoustic power (*5*).

Plan and Construction of the Suite

A common waiting room and two interviewing rooms with adjacent control rooms for monitoring and observing make up the suite. Control room A was intended to serve also as a high-fidelity listening room. Each interview-control room unit is equipped with its own microphone-tape recorder-monitoring-playback systems. All rooms are air-conditioned.

Sound isolation of the interviewing rooms. The goal was to have an average noise level of 35 db in the interviewing rooms and to eliminate frequent loud noises caused by impact. With the type of construction described in this section, the average noise level is 46 db in acoustic power. The sound level, which is the apparent loudness to the human ear of this noise level, is less than 24 db, the lower limit of measurement of a standard sound meter used in making the measures. These measures were taken 2 years after the use of the facilities started, with no readjustments of the doors to the interviewing rooms being made to insure maximal sound isolation.

Maximal sound isolation is achieved by "floating" one room with another. This plan was not followed because we had chosen a reasonably quiet location and had decided to reduce impact noises at their source when such noises became objectionable. We felt that under these particular circumstances the cost of the floating-room construction was too great for the gain in sound isolation that would result. Double-wall construction was required, however, and if there had been another floor above, a double ceiling and a specially constructed floor would have been required. Interviewing room A is isolated on all sides by double walls. On three sides the construction is of the type shown in Fig. 2. On side *d* (Fig. 1) the "double walls" are separated by a 4.5-ft air space, which also serves as a corridor to the control rooms. Interviewing room B is separated on two sides by double-wall construction as is shown in Fig. 2. The waiting room on side *c* (Fig. 1) serves as a double wall or sound lock. Sound-absorbent tile covers the ceiling of the waiting room. Side *a* (Fig. 1) separating the interviewing and control rooms B is only a single masonry wall. It was the original intention to use this control room for only quiet observation and to use suite A if the observation was to require loud monitoring or conversation among observers. The single wall is a serious limitation to the use of control room B, and it is desirable to add a second wall. Double doors separate each interviewing room from the waiting room. One of each pair is a heavy door designed to produce a transmission loss of 35 db. All doors are "weather-stripped" with rubber and felt gaskets and are equipped with bottom closures. After proper adjustment, they all close with the gasketing under compression.

Steps were taken to reduce noises originating in and transmitted through the corridor. A layer of 3/8-in. foam rubber faced with durable plastic covers the corridor floor and acoustic tile covers the ceiling. All the

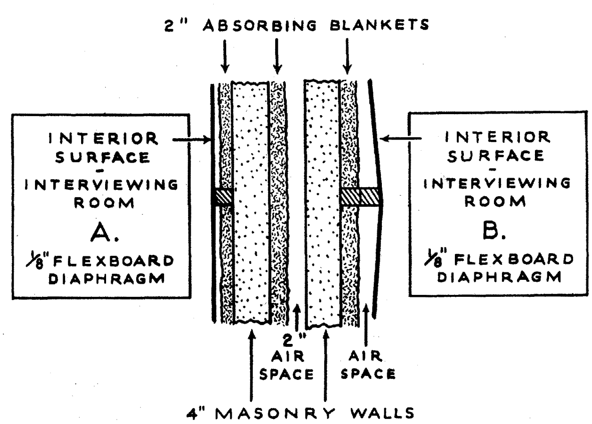

Fig. 2. Diagrammatic sketch of double-wall construction at point X in Fig. 1 (horizontal plane).

frames of doors opening out into this corridor are equipped with rubber cushions to reduce the noise of door closing.

The air-conditioning system is designed so as not to raise the background-noise level of the interviewing rooms. The following are the essential specifications of the system. (i) The maximum velocity of air at the supply and return grills is 150 ft^3/min. (ii) The compressor, plumbing, and blower are by most standards quite far from the supply grills, 35 to 50 ft. (iii) The mechanical units are separated from the building structure and from the duct system by vibration isolators and are in a closet with acoustic tile on the ceiling. (iv) The entire duct system is lined with sound-absorbent materials. There are at least two right-angle turns in each supply and return line. (v) The ducts are isolated for vibration from the walls of the interviewing rooms. (vi) The supply and return systems of the combined control areas, each interviewing room, and the waiting room connect only at the blower. Feature i eliminates high-velocity air-whistle noises; ii, iii, iv, and v reduce to a minimum the noise transmitted into the interviewing rooms from the blower and compressor as well as air-velocity noises; iv and vi prevent the transmission of noises from one room of the suite to another by way of the air-conditioning ducts.

Interior acoustic treatment of rooms. Rooms that are relatively isolated from external noises still must be treated on the interior to obtain satisfactory reverberation characteristics—a minimum of deadness, boominess, and so forth. The desire was also to have rooms as natural looking as possible. The major items in achieving these ends are the type and amount of sound-absorption material applied to the interior of the rooms. Figure 2 illustrates the type of treatment used on the interior surfaces of the rooms. The 2-in. absorbent blanket referred to in this figure covers the entire ceiling and all walls down to a height 36 in. above the floor. (Of course, the furniture, rugs, and occupants of the room also contribute to the total sound-absorption properties of each room).

Sound waves striking the thin flexboard are transmitted diaphragmatically to the absorbing blanket fastened to the interior surface of the masonry walls behind the diaphragm. Some of the lower frequency sound waves are absorbed by the blanket, while most of the higher pitch sounds are reflected back into the room. The proportion of sound at various frequencies absorbed by this diaphragm-blanket treatment varies and is dependent upon the resonance of the diaphragm. This is indicated in Table 1 by the varying absorption coefficients at various frequencies. Most room furnishings and peoples' clothing absorb high-pitch sounds to a greater degree than low tones. The diaphragmatic treatment, having opposite characteristics, compensates for this effect, thereby equalizing the reverberation time of the room at various frequencies in the critical range. Theoretical reverberation times of the furnished rooms occupied by two people are also presented in Table 1.

As a result of the relatively sustained reverberation time at the higher frequencies, these reasonably quiet rooms with low average reverberation time sound "natural and lively" rather than ominously quiet. The material customarily used for interior acoustic treatment has absorption properties that are just the reverse of the diaphragm-blanket. When the former is used in a quiet room, the result is often a "boomy" or "cavernous" sounding environment. This is unsatisfactory, both from the standpoint of the immediate experience of participants in the room and the quality of the speech recording and reproduction. Our selection of this type of treatment was also determined by the flexibility for using the uniform and paintable surface of the diaphragm panels in the interior decoration plan.

Two precautions were taken to reduce standing waves in the rooms that contribute to distorted recordings. First, the dimensions of the rooms were chosen so that the resonating properties would be spread throughout the sound spectrum. Second, there are no opposing parallel surfaces within the interviewing rooms. Slight "zigzagging" of the flexboard surfaces of two adjacent walls and the ceiling accomplished this. The peaks and valleys in these surfaces are 4 ft apart, and the pitch is 2 in./4 ft (Fig. 2). The irregularity of these surfaces is not noticeable to most people except upon close examination. This feature also permitted the use of the microphone at a much greater distance from the participants than would be otherwise possible. The interior treatment described for the interview rooms was also used in control room A to increase the listening quality.

The observation windows. The construction of the window for the A suite is shown in Fig. 3. The other window differs in that the second masonry wall and its corresponding thermopane unit are omitted. The one-way vision mirror transmits approximately 10 percent of the light falling on its surface. When the control room is darkened and the interviewing room is illuminated, the light transmission into the control room makes it possible for observers to see the people in the interviewing rooms. The latter cannot see the former under these illumination conditions, for there is no appreciable light to be transmitted from the control room to the interviewing room. The one-way vision mirror itself provides practically no sound isolation. The sound isolation is provided by the thermopane units. They are especially necessary if there is to be freedom of movement and conversation in the observation areas. The thermopane units are mounted at angles, each slightly different, to improve visibility and to decrease resonating vibrations in the thermo-

Table 1. Theoretical absorption coefficients of diaphragm-blanket treatment and theoretical reverberation times of interviewing rooms.

Frequency (cy/sec)	*128*	*256*	*512*	*1024*	*2048*	*4096*
Absorption coefficient	0.33	0.26	0.20	0.20	0.09	0.05
Reverberation time (sec):						
Room A	.21	.24	.26	.25	.33	.34
Room B	.40	.45	.42	.35	.45	.45

pane and mirror elements. Each of these glass elements is mounted in felt under compression.

The height of the window is such that a person of average height seated in the interviewing room must look up at an angle if he is to see an inadvertently illuminated observer. This in turn requires that the observers' chairs be somewhat elevated for complete visibility of people in the interviewing rooms.

The window is large enough to accommodate six seated observers. Three of them sit in comfortable upholstered occasional chairs, all placed on a platform, and three on tall stools. Each window is equipped with a shade, which is raised only if an interview is actually being observed. Otherwise it is drawn, and the control area may be illuminated for other activities while an interview is recorded.

Recording-Playback System

The recording-playback system is of reasonably high fidelity to match the acoustic quality of the interviewing rooms (*6*).

Microphone and microphone placement. The microphone is one of the highest fidelity commercial units. It is omnidirectional and free of transients over the relevant frequency range. A single microphone is mounted in a table lamp in each interviewing room. The table tops are covered with a cork mat, which does not reflect enough sound to distort the speech signal near the microphone. The porous lamp shade permits

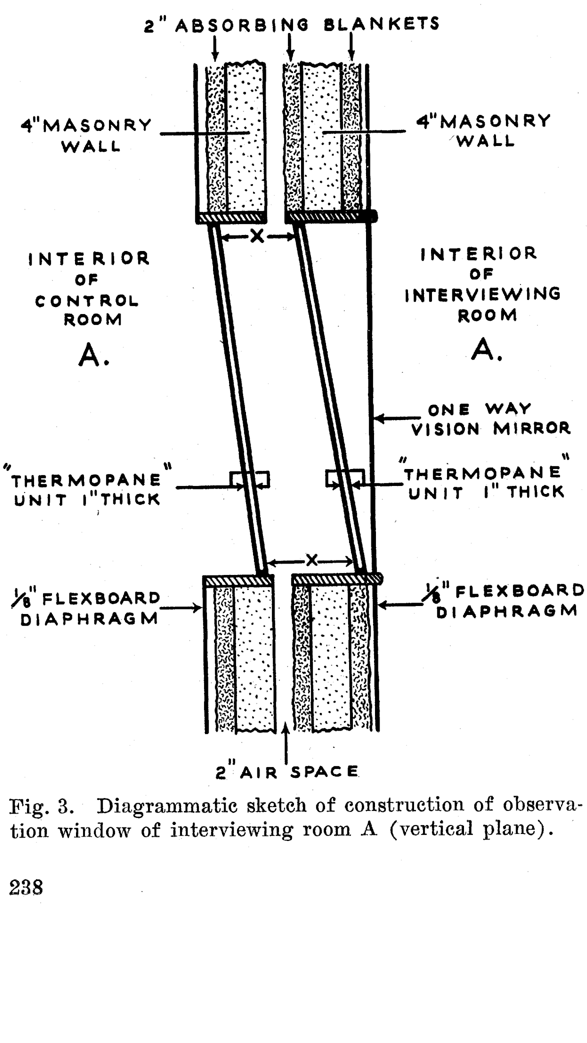

Fig. 3. Diagrammatic sketch of construction of observation window of interviewing room A (vertical plane).

passage of the signal to the microphone. It will be recalled that the absorption blanket stopped 36 in. above the floor. The microphone is placed so that the sensitive element is 10 in. higher than this point. Under most recording conditions involving two people, the microphone is 3 to 4 ft from their mouths and is at lip level.

The only reason for placing the microphone in the lamp is to remove it as a constant visible stimulus. No attempt is made to conceal its presence from the patients. They are told of it and, upon close inspection, can see the microphone cable running from the base of the lamp.

Wall sockets and conduits for connecting the microphone with the recording equipment were built in the masonry walls as they were constructed. Each room is equipped with three wall sockets for flexibility in microphone placement. If necessary, all three may be used simultaneously.

Recording equipment. Each control room is equipped with a tape recorder. The amplification-recording system has a signal-noise level ratio of 35 db, and it records and plays back with no significant variation in decibel level and other forms of distortion up to 7500 cy/sec when the tape speed is 7.5 in./sec. This frequency range is adequate for high-fidelity speech recording. The recorder handles 2400-ft reels that give 1 hr of continuous recording at a tape speed of 7.5 in./sec. The recorder will also operate tape at 15 in./sec, but it has not yet been necessary to use this recording speed.

Playback and monitoring. The system provides for (i) listening to and observing an interview without recording it, (ii) simultaneously recording, listening to, and observing, (iii) doing either of the preceding and also recording comments by observers on a second recorder, (iv) recording only. Twelve-inch speakers are used for monitoring and all later listening in the control room. The fidelity of the speakers and their amplifiers is commensurate with the rest of the system.

Remote control. Some interviewers wish to have a technician in the control room start the recording equipment. Other interviewers prefer to start and stop the recording equipment themselves, in the presence of the patient. Each interviewing room is equipped with remote-control switches that may be used for this purpose. When not in use, these remote control units may be handily removed from the rooms.

Additional Features

At the time of construction, continuous copper shielding was placed on the masonry walls, floor, ceiling, and door of interviewing room A. A shield for the observation window may be inserted into the continuous shield. Also a blank 2-in. conduit in wall *d* (Fig. 1) connects this room and its control room. These features provide for pneumatic and electronic polygraphic recording, which may be synchronized with speech recording.

The facilities are used for both research and teaching by and for psychologists and psychiatrists. Research is given first priority in these rooms. The overflow of teaching needs is met by the use of additional lower fidelity facilities. Transcripts of recordings, recordings, and live observations have been instrumental in pursuing such problems as the investigation of supervision of psychotherapy, clinical and objective studies of the intake interview, clinical and objective analyses of continuously recorded individual and group psychotherapy, an experimental study in hypnosis, and an investigation by structured interviews of the psychodynamics of pregnant women. Recordings and/or live observations are used for individual supervision of psychotherapy and psychological testing, for teaching to small observation groups as well as larger seminar and clinic conference groups, and for self-teaching.

References and Notes

1. F. C. Redlich, J. Dollard, and R. Newman, *Amer. J. Psychiat.* **107**, 42 (1950).
2. M. Gill *et al.*, *The Initial Interview in Psychiatric Practice* (International Universities Press, New York, 1954).
3. Grants by the John and Mary R. Markle Foundation and the Social Research Foundation, Inc., to Dollard and Redlich made possible the construction and use of these facilities. The preparation of this description was possible because of aid from the Foundations Fund for Research in Psychiatry.
4. E. J. Content, registered acoustic and radio engineering consultant, Stamford, Conn., was our expert consultant for both the acoustic and electronic aspects of the project. He was also kind enough to check the technical details in this article. Robert Coolidge, New Haven, Conn., designed the decor. E. J. Behler, superintendent of maintenance, construction, and stores of Yale University cooperated in the project. We wish to express our appreciation to these individuals.
5. Acoustic power, or intensity, is commonly measured in watts per square centimeter. Because such measurements have an extremely wide range of values, they are converted into and expressed in decibels for convenience. The conversion relationship is defined as follows: decibels $= 10 \log_{10}\frac{I_1}{I_0}$. In the decibel measurements in this paper, $I_0 = 10^{-13}$ w/cm² and I_1 is the energy level in the interviewing rooms. The sound meters are calibrated and equipped with scales to give the decibel readings directly.
6. We selected Ampex and Altec equipment at all points in the system.

The Rare Human Isoagglutinin Anti-Tj^a and Habitual Abortion

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IN 1951, Levine *et al.* (*1*) described a remarkable isoantibody in the serum of a 66-yr-old female patient suffering from gastric adenocarcinoma which hemolyzed or agglutinated each one of more than 5000 random bloods of all groups and Rh types except the blood of her 45-yr-old sister who was physically normal (family I, Virginia, U.S.A.; cases 1 and 2; see Table 1). It was assumed that the antibody, anti-Tj^a, by virtue of its hemolytic nature was of the immune variety, in spite of the fact that the patient was never transfused and none of her four full-term pregnancies ended in hemolytic disease. Since the antibody could not be demonstrated in the serum of the compatible sister (case 2) when tested in 1951, it was suggested that the tumor could perhaps supply the antigenic stimulus. Indeed, absorption experiments on a limited scale carried out with minute amounts of the dried tumor cells and antibodies for several different human blood factors seemed to indicate a specific affinity of the tumor and anti-Tj^a.

In 1952, the same antibody was identified by Zoutendyk and Levine (*2*) in the serum of a 38-yr-old white South African patient (case 3) who had four consecutive miscarriages. This observation and the fact that in 1953 the antibody could be demonstrated in the serum of the physically normal sibling of the Virginia family I (case 2) made it necessary to reappraise the relationship of the tumor and the presence of anti-Tj^a.

In any event, anti-Tj^a is found in the serum of individuals who are homozygous for the very rare gene, Tj^b, that is, Tj^bTj^b. It was assumed that both parents are heterozygous, that is, Tj^aTj^b, so that 25 percent of the offspring may be Tj^bTj^b and could possess or potentially produce anti-Tj^a. The presence of the very rare gene Tj^b in both parents suggested the possibility of consanguinity, and indeed a history of cousin marriages was elicited in family I and in family V.

In rapid succession anti-Tj^a was found in five other families in Australia (*3*), Poland (*4*), the United States (*5*), Canada (*6*), and Japan (*7*). In two of these families, this rare antibody was present in two siblings each, and in the Japanese family it was found in four siblings. Some of the essential details in the seven families with 13 examples of anti-Tj^a are listed in Table 1.

The Australian family was reported by Walsh and Kooptzoff (*3*), who demonstrated anti-Tj^a in the serums of two young physically normal sisters, not married when the first observations were made. The serum of the older sibling agglutinated every one of 2900 random bloods tested, 1208 whites and 1692 natives of South Korea and the Pacific islands. The older of the two siblings, now married, lost her first pregnancy and is currently in her second pregnancy. Walsh and Kooptzoff (*3*), however, failed to confirm the specificity of the absorption of anti-Tj^a by tumor cells from the Virginia patient (case 1).