Human behavior is a functional relationship between a person and a specific social or mechanical environment. If the behavior is deficient, we can alter either the individual or the environment in order to produce effective behavior. Most previous attempts to restore behavioral efficiency by retraining, punishment, or physiological treatment have focused on only one side of this relation, the deficient individual. This approach implies that normal individuals can function in all currently existing social environments, that deficient individuals can be normalized, and that there are ordinarily no deficient environments. Scientists have only recently directly focused on the environmental side of deficient behavior functions and on the design of specialized or prosthetic environments to restore competent performance.

Prosthetic environments are not new, however. For centuries specialized environments have supported or reinforced the behavior of infants and children. Special foods, feeding devices, bedding, furniture, and clothing for infants are commonplace. Special entertainments—toys, primary colors, simple books, music, games—have been less clearly recognized in their behavioral role of reinforcers designed particularly for children. All of these are provided by society in expectation of the services the child will provide as an adult.

Read at Second Annual Symposium on Old Age, Cushing Hospital, Framingham, Mass., May 21, 1963, and dedicated to my grandmother, Mrs. James Ogden Lindsley, who lived well beyond her environment and died in an institution at age 89.

Research was conducted in the Behavior Research Laboratory, Department of Psychiatry, Harvard Medical School, located at Metropolitan State Hospital, Waltham, Mass., and was supported by research grant MH-05054 from the Psychopharmacology Service Center, National Institute of Mental Health, U.S. Public Health Service.

The cooperation of the Department of Psychiatry (Jack R. Ewalt, M.D., Chairman) and the staff of Metropolitan State Hospital (William F. McLaughlin, M.D., Superintendent), the able assistance of our laboratory staff, and, most especially, the participation of our patients have greatly facilitated our research.


Psychotic and aged patients could be made much less aversive by cosmetic attention. Also, if prosthetic devices were developed which would permit them to communicate with normal people and produce positive, though limited, products for the use of society, they would become much more reinforcing to normal individuals and suffer much less neglect. By permanently removing the aversive causes of social neglect, this approach would be more lasting than the current attempts to reduce social neglect by repeated compensatory verbal appeals and the generation of guilt in others.

Conclusion
Since 1953, more than 100 applications of free-operant methods to human behavioral pathology have been published. Continuing, systematic investigations are being conducted in psychoses (15,21,24,28), mental retardation (6,18,33,35), neurological disorders (4), and neurosis (7,16). These experiments have demonstrated that free-operant principles and methods have wide applicability in social and behavioral research.

The method shows promise for analyzing and prosthetizing geriatric behavioral deficits. The time and money spent in developing behavioral prosthetics should be more than compensated by reduced management costs as more aged patients are made capable of caring for themselves and their peers. A properly engineered geriatric hospital, maximally utilizing the behavior of the patients, should require little more than supervisory non-geriatric labor.

At this time, no systematic applications of operant methods to geriatric behavior have been made. However, the method is ready and the hour is late. Organic medicine has shown great progress in keeping our bodies alive well past the point where behavioral medicine is able to keep our bodies behaving appropriately.

Until we can halt the process of aging, we owe our grandparents, our parents, and eventually ourselves, the right not only to live, but to behave happily and maximally. Until behavioral medicine catches up with organic medicine, terminal boredom will fall to those unfortunate who live beyond their environment.

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Continuity of aging
Even though the severe deficits characteristic of aging do not show up until very late in life, the process of aging might develop much earlier. The behavioral debilities produced by this continuous process of aging may not appear because there are ample devices available for middle-aged persons to use in prosthetizing their milder behavioral deficits. For example, our recent memory may become poorer either because our ability to remember simply decreases with age or because our storage system becomes filled or overloaded. The older we become, however, the more we use prosthetic devices such as notebooks, address books, the telephone information operator, and mnemonic devices. The young executive relies on his accurate recent memory, but the older and still highly productive executive relies heavily on his young secretary. It may be that it is only when he loses his secretary that he loses his “recent memory.”

In other words, the age at which we see marked, severe behavioral deficits in older persons may only be the point at which appropriate prosthetic devices are no longer available. In this sense, forced retirement or “disengagement” may not only deprive a man of necessary reinforcement, but rob him of his prosthetic devices at the time they are most needed. A justification of retirement by comparing his productive efficiency before and after retirement would therefore erroneously self-validate itself unless reinforcement and prosthetic devices were equated in each condition.

Social neglect of the aged
The problem of the aged has only recently become a major one. This is not only because more people are living to an older age because of the marked success of organic medicine, but because our more urban and complicated society provides situations in which the deficits of the aged are more debilitating. The increased complexity of the behavioral tasks required of modern society members is displacing not only the less skillful aged, but also the less skillful middle-aged person.

Since our aged citizens are less able to produce in this more complicated society, they have fewer reinforcers for the rest of society and will suffer greater social neglect. They have nothing with which to reinforce social attention from either their peers or the rest of society.

Even patients with organic illnesses may have social responses with which to reinforce their attendants, nurses, physicians, and family visitors. The plucky words and weak smile of the organically ill patient are extremely strong reinforcement to a nurse or visitor.

An infant has little behavior with which to acquire reinforcing objects to distribute among his family, but people are so constituted that the gurgle, smile, and primitive movements of an infant are strong social reinforcers for adults. The infant also promises genetic and cultural immortality to the adults who contribute to his genetic constitution or cultural education and training. These genetic and cultural immortality factors are also strong social reinforcers.

The retarded individual, although he has little future and does not promise much genetic or cultural immortality, has much behavior which is very similar to the infant’s and therefore provides society with social reinforcers to satisfy what might be called “maternal instinct.” The smile or caress of a retarded child is a strong social reinforcer for those who attend him or visit him. This is probably why the retarded have always been fairly well treated by society and considered the “children of God” or the “holy innocents.”

The psychotic, of course, has fared less well. And this may be because his behavior is not only less rewarding to normal adults, but in many cases is socially aversive. It is a strong attendant who can withstand the verbal onslaught of a sensitive paranoid who criticizes and verbally attacks the attendant’s weakest spot. This aversive behavior of the psychotic, coupled with his inability to be a productive member of society, may be why the psychotic has been for centuries maligned, rejected, and considered “possessed by the devil.” Family visits to chronic psychotics are much less frequent than visits to the mentally retarded. It is much more difficult to maintain volunteer groups to assist in the care of psychotics than it is to maintain those to care for the retarded. And again, among a group of chronic psychotics it is the laughing, joking, pleasant patient—the classic hebephrenic—who receives the most attention on the ward and is the most welcome at hospital parties and home visits.

And so with the aged, the patient with laugh wrinkles, a full head of white hair, and clean white dentures receives more attention and is more reinforcing to attendants and family than the tragic oldster with a scowl, vertical worry wrinkles, a toothless smile, and skin lesions. The aged person whose countenance and behavior present aversive stimuli to other individuals is bound to be avoided and neglected. When he also has behavioral deficiencies, so that he no longer can produce in society or reinforce us with pleasant conversation, he becomes extremely aversive and subject to severe social neglect.

A realistic approach to the social neglect of the psychotic and the aged would accept the fact that they are just too aversive for us to expect highly motivated social response to them from normal middle-aged individuals. Rather than spend a great deal of time and money trying to talk people into overcoming this aversion in charitable attempts to help the psychotic and aged, it may be more economical to remove the source of aversion.
Clearly, the fact that a complicated response can be emitted appropriately is no indication that a new response of equal complexity can be acquired. Retarded children with learning deficits since birth have had no opportunity to acquire complicated repertoires. Therefore, since they never exhibit complex behaviors, casual observation of their behavior is not as misleading in predicting current learning ability as it is with psychotics or the aged. Furthermore, some involutional psychotics are very skillful at “covering up” their severe current learning deficits. In brain damaged patients, less skillful attempts at “covering up” are well known.

These data suggest that we may find severe current learning deficits more frequent among older people than in retarded individuals. These data also suggest that current learning deficits will be very difficult to ascertain by sampling current behavioral repertoires or by ward observations. Moreover, with geriatric patients we should expect general reinforcers to be less adequate because of the historical aging of appropriate reinforcers and because of the need for reinforcer expansion.

There is little doubt that each aged individual can and should have his current behavioral abilities and deficits measured in the laboratory so that an individualized prosthetic environment could be prescribed to support his particular behavioral deficits. Possibly, the patient could be assigned to a ward specializing in patients with similar, but not necessarily the same, patterns of behavioral deficits. On the other hand, we may find wards that are more efficiently designed to cover a wide range of deficits. On these vertically organized wards, the more skillful patients could act as leaders and programmers for their more deficient peers. In hospitals with a vertical ward design, patients with similar deficits could be assigned similar roles about the hospital, but on different wards.

Theories of aging

It is my opinion that theories of behavioral deviation in the grand or inclusive sense are academic luxuries unless they help us prevent or reduce the behavior pathology, or make it less debilitating. Nevertheless, there are people who insist that theories are not only useful but necessary. To validate their own position, they attribute theories to those researchers who actively state that they have none. The important points seem to be how inclusive and general theories are, how strongly they are held, and whether they are descriptive or explanatory.

The developmental theory of aging presented by Kastenbaum is an explanatory theory (20). It attempts to explain how and why aging develops as a small part of a larger general process in the behavior of man. This general developmental process is assumed to be found in both the ontogenetic development of the infant and in perception.

Geriatric behavioral prosthetics

The same process is found reversed or in regression in the delusions of the psychotic and in the deterioration of the aged. In this sense, the inclusive property of this explanatory theory is historically related to the schools of philosophy which attempted to describe all things by the simplest possible set of laws or statements. In contrast, I find the disengagement theory presented by Cumming more descriptive than explanatory (12). She describes the process of aging as disengagement with society and the dilemma of the aged whose behavior is no longer supported by society. In my terms, disengagement means mostly the abrupt cessation of reinforcement, or extinction.

My own approach to aging is even more finely descriptive than Cumming's disengagement theory and might be described as a descriptive multiple cause-deficit-repair theory of aging. In other words, the aged person has an accumulation of behavioral deficits in all areas, each patient with his own pattern of multiple deficits. In physiological deterioration of the aged, there is rarely a single cause of organic debility, although one specific debility may be more outstanding at a given moment in time than the others. Similarly, we may locate syndromes or patterns of specific behavioral deficits which later will be related to deterioration of specific behavioral function, and most older people have suffered so many traumas, periods of disease, abuse, and poor environments, that most will have several measurable deficits in differing degrees, and each specific deficit will undoubtedly have multiple causes.

Also, as with organic illness, there undoubtedly is more than one way of treating a specific behavioral deficit. Therefore, we face not only multiple causation and multiple deficit, but multiple treatment, in both organic and behavioral medicine. In general, we now use the term old age whenever performance becomes less efficient without any known disruptive factor other than time and practice.

When specific geriatric behavioral deficits have been accurately measured and prosthethized, a fuller experimental analysis may permit the development of explanatory theories of specific deficit syndromes. Involved in the development of these explanatory or etiologic theories will be the experimental induction or catalysis of geriatric deficits and symptoms. I know of only one experiment of this sort which has been conducted to date. Cameron placed senile patients in dark rooms and was able to catalyze or induce senile nocturnal delirium (9). This experiment showed that senile nocturnal delirium was not due to fatigue at the end of the day as had been previously supposed, but was due to the darkness which also came at the end of the day. Further research in which the environmental variables which precipitate and control geriatric behavioral deficits are isolated will do much to produce useful explanatory sub-theories of aging.
If appropriate historical or expanded reinforcers could be located for each aged individual, newer and more generally available events might even be conditioned to the idiosyncratic reinforcers—that is, the adequate but idiosyncratic reinforcers might be used to develop or restore value to the general conditioned reinforcers currently used in society. By gradual shaping and conditioning, an old person could be given a new interest in contemporary life.

Long-range personal reinforcers, such as education, development of a skill, or the building of a reputation, would have little value for an old person. Each step in the development of skill or reputation would have little conditioned reinforcement value, since it would merely be a step on a stairway which an old person could hardly hope to scale completely. He might reasonably ask, “Build a skill for what? To die tomorrow?”

A child is almost completely under the control of the immediate environment because he has not yet acquired long-range personal reinforcers. An old person may be solely at the mercy of the immediate environment, not only because of severe recent memory loss, but because long-range personal reinforcers are made impotent by brief and uncertain life expectancy. This dependence of both old people and children on immediate personal reinforcers may be why aged persons are often described as “childish.”

Long-range social reinforcers which would be of value to society no matter when the older person died might be more useful with the aged. The conditioned reinforcement would be the contribution to the next generation. However, the development of this type of reinforcer would be extremely complicated, would require the participation of the members of society at large, and would still have to be conditioned to immediate personal reinforcers.

Extremely powerful, immediate personal reinforcers might be located. We should try highly compelling expanded musical and visual narrations, exciting foods, costly and beautiful clothing, and so forth. Reinforcers of this nature are costly, but they might generate such high rates of behavior in aged persons that their high dollar cost would be compensated by savings in medical care and ward management.

Geriatric reinforcement schedules

In most social situations, reinforcement occurs intermittently (14). Not all responses are immediately reinforced; only a small portion are followed by a reinforcing episode. Nevertheless, in normal individuals, responding continues at high, predictable rates which are presumably maintained by conditioned reinforcement from the occasionally reinforced responses. In our long-term experiments with psychotic children and adults, however, we have found many patients who are unable to maintain high rates of responding on intermittent schedules of reinforcement, even when adequate reinforcers are used (24). These deficits in responding for intermittent reinforcement are probably attributable to deficits in recent memory and in formation of conditioned reinforcement.

It is very possible that many geriatric patients will also prove unable to maintain high rates of responding on intermittent schedules and will have to be kept on regular reinforcement contingencies in which every response is immediately followed with a reinforcing episode. Other patients may have to be reinforced on conjugate programs in which the intensity of a continuously available reinforcer is a direct function of the response rate. Conjugate reinforcement permits the use of narrative social reinforcers and appears to go deeper into sleep, anesthesia, infancy, and psychosis than does episodic reinforcement (22, 25, 51). Conjugate reinforcement may also go deeper into aging and generate behavior in geriatric patients who would not behave on any episodic schedule of reinforcement.

Individualized prosthetic prescriptions

If a geriatric hospital were equipped with a behavior laboratory, each aged patient could visit the laboratory upon admission. His specific behavioral deficits would be measured, and prosthetic stimuli, responses, reinforcers, and reinforcement schedules prescribed. The laboratory would determine the patient’s current learning ability and assess the extent to which his current behavioral repertoire could be used in place of newly acquired responses.*

In our own laboratory, we found that 90% of our involitional psychotics, 85% of our chronic psychotics, and only 65% of our retarded children had deficits in acquiring new discriminations and differentiation (6, 28). The severe deficits in current learning ability in involitional and chronic psychotic patients were surprising, since many of these patients had large repertoires of complex behavior which they could emit at a moment’s notice. Laboratory measurements proved, however, that their current learning abilities in a novel situation were extremely deficient. These patients had apparently acquired their complicated behavioral repertoires prior to developing their severe learning deficits.

* Barrett has recently stressed the need for individualized prosthetic prescriptions based upon laboratory behavioral measurement for use in designing and selecting different programs of instruction for retarded children (5).

† For a conclusive review of the experimental literature on learning deficits in elderly patients, see Inglis (18).
The standard electrical typewriter, sensitive to the slightest touch, is an example of a device which maximizes the efficiency of a normal person for whom accuracy and placement are no problem, but which is probably the most poorly designed typewriter for operation by an older person. The older person would make many errors of placement, and in trembling would jam the sensitive machine by depressing two keys simultaneously.

Rate switches, which operate only when repeatedly pressed above a certain rate, would be useful in maintaining high constant attention from aged persons with intermittent or weak attention. Most complicated and dangerous manufacturing machinery previously was operated by single-throw hand switches. The machine operated as long as the switch stayed in the "down" position. An inattentive operator could mash his fingers or cut off his arm. Stationary switches of this sort were found to be too dangerous even for normal individuals. They were replaced with spring-loaded switches which require continuous force in order for the machine to operate. Foot switches which must be continually depressed by the operator have greatly reduced industrial accidents, because when the operator turns away or leaves the machine, he takes his foot off the control switch and the machine stops.

An even higher degree of attention could be demanded by using a switch which had to be pressed repeatedly at a high rate in order for the machine to operate. A high rate of pressing demands closer attention than does continual depression of a switch. Impulse shorteners in the circuits of operant conditioning response levers are used for this purpose. Remember that a sleeping, dozing, or even dead person could operate a spring-loaded switch and its connected machinery by the weight of his inactive body. A switch that must be continually pressed should reduce the accident hazards of machine operation for many older persons with mild attention disorders. When their attention drifted so that they failed to press the switch at the required rate, the machine would automatically stop.

Response feedback systems should be developed so that response location errors can be corrected before they actually occur. For example, if an older person could not always control his fingers, he could be prevented from pushing a wrong button or placing his finger at the edge of a saw by a loud tone which sounded whenever his finger was moving away from the appropriate response location. Such response feedback systems could greatly compensate for a reduced kinesthetic ability. In effect, they would substitute for the deficient afferent input from the aged limbs which once guided the hands so accurately.

If a little time, money, and thought were applied to the problem, I am sure that a wide range of imaginative and successful devices could be developed for helping aged persons overcome their fairly obvious response deficits.

**Geriatric reinforcers**

The generally low interest or motivation of the aged is very familiar. The elderly person appears capable of behaving but has lost his "will to live." We assume that he is able to respond, because on occasional brief instants he "lights up" and behaves appropriately. Rather than interpreting brief periods of appropriate behavior as normal episodes or phases in the aging process, we usually attribute them to special circumstances which temporarily increase motivation.

In precise behavioral terms, this means either that the reinforcers currently programmed in his immediate environment are no longer adequate or that the old person has simply lost the ability to be reinforced. The difference is of great importance and should be tested experimentally by attempting to reinforce his behavior with a wide range of events.

**Individualized historical reinforcers.** We should look closely at a geriatric patient's rare moments of high behavioral rate. Is some unusual, more appropriate reinforcer operating—something from the past—an old song, an old food, an old friend? If parts of such individualized historical reinforcers were recorded and presented on audio tape or closed-circuit television, an old person might perform regularly at high rates to hear and see them.

**Expanded narrative reinforcers.** Melrose's recent research suggests another possibility (32). If an aged person can comprehend expanded speech but not speech presented at a normal rate, he might be reinforced by expanded music and narrative themes, when the same themes presented at the normal rates would not be reinforcing. In seeking more adequate reinforcers for aged persons, we should explore music, movies, and video tapes expanded in both the audio and visual dimensions; for example, video tapes could be used to expand visits from family and friends.

Casual observation of music preferences of different generations supports this notion. Today's older, who prefers the waltz, did the turkey trot as a youth. Today's middle-ager prefers ballads and ballroom tempos, but did the Charleston or big-apple in high school and college. Today's teenage twister may also be waltzing a few decades from now. The perennial reinforcing value of the waltz to older persons may be due to their need for a slower, more expanded auditory reinforcer. Conversely, the high interest of youngsters in the chipmunk-singing, sound-effects records suggests that very young children might be more reinforced by compressed music presented at extremely high rates.
It is amazing, for example, that although we give children books with large type, we force elderly people with deficient vision to use heavy eyeglasses or hand magnifying lenses to read normal-size type. We might find that even with large type, certain aged persons with deficient vision develop headaches or become nervous while reading. If we provided Braille or "talking books" for these individuals, we might find an increase in their usefulness to us and to themselves.

*Multiple sense displays* should be investigated in attempts to design geriatric discriminative stimuli. While an older person might not respond appropriately to a loud sound alone or to a bright light alone, he might respond appropriately to a simultaneous combination of loud sound and bright light. A normal person under the high control of a small portion of his environment is much more likely to respond to a multiple sense display than to a single sense display in the rest of his environment. Similarly, an aged person with generally weakened attention might respond more appropriately to a multiple sense display.

*Expanded auditory and visual narrative stimuli* should also be investigated. Melrose has found that many aged persons who cannot understand normal speech can understand expanded speech (32). Expanded speech does not differ in intensity or tone from normal speech. It is just spread out more in time, being truly slower. Melrose's finding suggests that old people cannot integrate rapidly presented information. It is the frequency of the *words*, not the frequency of the sounds, which they cannot integrate. This suggests that the visual discriminative response to a pictorial drama might also be deficient when the drama is presented at the normal rate. By using video-tape recording systems to expand visual materials, we might restore understanding of and interest in visual narration to many aged people. The possibility of using expanded auditory and visual materials as reinforcing stimuli is discussed below.

*Response-controlled discriminative stimulation* should be tried as a prosthetic device for geriatric patients who appear to have intermittent attention. If a patient is periodically unresponsive to stimulation, the stimuli which occur during these "dead" periods in his attention may as well not be presented. To him the world has missing portions, as if a normal person were watching a movie and periodically the projector lens was covered for brief periods of time while the narration continued. There would be many important portions of the movie narration to which he would have no opportunity to respond.

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* I have been told that Lord Amulree of University College Hospital, London, arranged for stronger odors to be added to utility gas so that aged persons with decreased senses of smell would know when the gas heaters had blown out and would not be asphyxiated.
analysis of their effects and consequently more specific behavioral analysis, as well as the study of nonverbal patients. Free-operant methods thus provide prognostic data and reliable, valid behavioral measures which can be included in case histories even more confidently than blood pressure and blood cell count, which usually involve observer bias.

Long-term laboratory measures of the type and degree of behavioral deficits of individual patients permit exact evaluation of the effects of therapeutic variables on each patient’s behavior. The behavioral effects of medications, as well as the effects of such social variables as ward reassignments, home visits, and deaths in the family, can be readily determined.

Since records are available on each patient, objective, high quality behavioral research can be conducted by physicians in charge of medication by occasionally referring a patient to the behavior laboratory for a current evaluation. Therapeutic dosage can be accurately adjusted to the deficit and drug-response of each patient. Individualized behavioral treatment can then be conducted with the same precision with which individualized physiological treatment is now conducted in well-staffed general hospitals.

Design of prosthetic environments
There is little hope of retarding the aging process at this time, but we can reduce its behavioral debilitation by designing environments which compensate for or support the specific behavioral deficits of each aged person.* Because we will not actually alter the deficits, but merely provide an environment in which the deficits are less debilitating, these environments cannot be considered purely therapeutic. Therapeutic environments generate some behavior which is maintained when the patient is returned to the normal or general social environment. Therapeutic environments are essentially training or retraining centers for the generation of behavioral skills which maintain themselves once the patient has left the therapeutic environment. Prosthetic environments, however, must operate continually in order to decrease the debilitation resulting from the behavioral deficit. Eyeglasses are prosthetic devices for deficient vision, hearing aids for deficient hearing, and crutches and wheel chairs for deficient locomotion.

* The American Psychiatric Association (1959) conducted a survey on the care of patients over 65 in public mental hospitals and gleaned the following suggestions for improving the design of geriatric facilities: tilted bathroom mirrors for wheelchair patients; better lighting with no glare; ramps and short stair risers; guardrails, hold-bars, and non-skid floors; draft-free radiant heat; higher chairs to eliminate stooping to sit; facilities for daytime naps; and work, recreational, and social activities geared to the physical abilities of the patients (1).

To describe suggestions for geriatric prosthetic environments as accurately as possible, I will use the analytical categories of the laboratory behavioral scientist: 1) discriminative stimuli; 2) response devices; 3) reinforcers; and 4) reinforcement schedules. The number of different types of special stimuli and devices required for a prosthetic device in each of these categories must be determined by the analysis of each aged individual. The types of environmental alteration required to support a behavior cannot be determined until the number, degree, and range of behavioral deficits are determined. It may be that a given prosthetic device can be used to prosthete more than one type of behavioral deficit. Adequately detailed analysis may also show that a single behavioral deficit can be prosthete by more than one device. In these cases, the most economic and most general devices would be selected first.

My suggestions for the design of specific prosthetic environments for aged individuals are certainly not exhaustive. They are only suggestions for the direction of future research, examples of the kinds of things we should try in searching for new prosthetic devices. The range of prosthetic devices is limited only by the creativity and ingenuity of the investigator and the time and funds at his disposal. His time and funds are, in turn, limited only by society’s interest in providing devices for restoring effective behavior to its older citizens.

Geriatric discriminative stimuli
The environmental events which signal when a response is appropriate and when it should not be made are extremely important in controlling behavior. Traffic lights are a familiar example. These colored lights are useful discriminative stimuli to a person with normal color vision, much less useful to a color-blind person, and of no use to a totally blind person. The geriatric patient may well have behavioral deficits which, like blindness, limit the range of discriminative stimuli in the normal environment which can control his behavior. The full and exact nature of geriatric behavioral deficits has not yet been determined.

The intensity and size of discriminative stimuli for the aged has received some prosthetic attention. Eyeglasses have been developed for amplifying and correcting visual responses. Hearing aids have been developed for amplifying sounds to serve as discriminative stimuli for people whose hearing is deficient. Touch, smell, and taste amplifiers have not yet been developed, probably because our basic knowledge of these senses is more limited.

Simple and dramatic patterns, long durations, and higher intensities of stimulation should be investigated, for we can increase the intensity of the environmental stimulus when prosthetic amplifiers are not avail-
Functional definition of stimulus, response, and reinforcement focuses the attention of the nurse or attendant on the relationship between the behavior she is attempting to manage and her management procedures. When she realizes that an event may be a stimulus for one patient but not for another, and that a second event may be reinforcing to one patient but punishing to still another, then she recognizes the full complexity of human behavior and in behavioral management no longer makes errors based upon misplaced empathy and generalization. For example, the socially deprived patients found in large hospitals may be rewarded by any attention from the nurse, even scolding for misbehavior. Consequently, a patient will continue to do the thing for which he was scolded in attempts to obtain the social contacts from the nurse, even though the nurse designed the topography of these contacts as punishment for what the patient was doing.

Attention to the behavioral processes of positive reinforcement, extinction, satiation, and mild punishment has proven extremely useful in engineering a ward for maximal behavioral accomplishment. Ayllon and Michael successfully trained ward nurses to increase patients' self-feeding by talking to patients only when they fed themselves (5). Ayllon also trained nurses to satiate a towel hoarder by filling her room with towels, and to punish the wearing of extra clothing by letting a patient eat only when she was below a certain weight with her clothes on (2).

Important for generating maximal behavior on a geriatric ward is the early establishment of a conditioned general reinforcer, or token, which must be used to purchase all items and opportunities of importance and reinforcing value to the patients. The ward tokens are used by the attendants and the nurses to reinforce appropriate behavior. The patients can then use the tokens to purchase personal articles, cigarettes, afternoon naps, television and record playing time, talks with chaplains and volunteers, and all other opportunities of value and importance to them. The patients will readily perform custodial duties on their ward in order to earn the tokens. Ayllon has successfully used tokens in this way in managing a ward of chronic psychotic patients.*

High on the list of types of behavior that it is desirable to generate in a geriatric patient are very mild physical exercise and sun-bathing. The patient is immediately reinforced with a token for each exercise period and for small daily gains in his exercise achievement. Such exercise, shaped very gradually and watched carefully by the ward physician, can do much to restore physical health and well-being to a geriatric patient.

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* Personal communication from T. Ayllon, State Hospital, Anna, Ill., 1963.

Laboratory description, prognosis, and evaluation

Free-operant conditioning methods can be used to develop a behavior research laboratory for the accurate measurement and description of behavior deficits found in the aged. Inglis has found that psychometric tests are almost useless in these applications and recommends that experimental methods be applied to geriatric problems (19).

Over the past 10 years, we have clearly demonstrated that a free-operant conditioning laboratory is useful in describing, prognosticating, and evaluating psychoses (24,28). In brief, our laboratory consists of several small experimental rooms which provide controlled environments for automatically recording behavioral deficits. Patients are brought to the rooms by a technician and permitted to behave freely in them for a period of time long enough to determine accurately the presence and degree of certain behavioral deficits.

The rooms differ from one another only in the equipment necessary for measuring different behavioral deficits. One room, for example, may have a chair and a wall panel with a single knob on it. Pulling the knob is reinforced by the illumination of a television screen mounted in the panel. The rate at which a patient pulls the knob indicates the reinforcing power of the narrative material presented to him via the televisions system. The material televised can be standard commercial broadcasts, specialized programs recorded on audio-visual tape, or a family visitor seated in front of a closed-circuit television camera in another part of the laboratory. In this room, the differential reinforcing value of audio-visual narrative reinforcers can be objectively determined by the continuous, automatic, cumulative records of knob-pulling. Similar rooms have been developed for recording behaviors as disparate as hallucinating and pacing in chronic psychotics, social deficits, and a patient's interest in his psychotherapist or visitor (11,26, 27,28).

Fully automatic programming of stimuli and recording of responses insure completely objective measurement. Technicians who do not differentially involve themselves with the data handle the patients and equipment and therefore do not introduce complicating observer bias. Furthermore, longitudinal studies are not disrupted when technicians are changed. Because there is no observer bias, cross-hospital and cross-cultural comparisons can be made. Because a fully controlled environment and automatic recording dispense with observer ratings, longitudinal studies can be conducted without the loss of observer sensitivity which occurs with closely repeated ratings (21). With automatic programming and recording, verbal instructions can be used or not. This opportunity to dispense with verbal instructions permits
More recently, prosthetic environments have been extended to the physically handicapped. Blind persons use Braille books, noise-making canes, seeing-eye dogs, and specially designed houses. Paraplegic veterans of war have specially designed homes provided by a grateful public for relatively brief service to society.

But what of the aged, veterans of an entire lifetime of social service? Are they provided with special environments designed to support their behavior at its maximum? Are we using their behavior most efficiently?

To prolong health, physicians offer aging persons a wide range of physiological prosthetics, from vitamins and hormones to increased oxygen utilization, for their internal environment (8,10,17). Beyond providing eyeglasses, hearing aids, dentures, cribs, and crutches, however, science has done little to modify the external mechanical and social environments of the aged. The skills of current behavioral science, and free-operant conditioning in particular, can provide more than compound lenses, audio amplifiers, and mechanical restraint and support. Behavioral engineers can design prosthetic environments to support the behavior of the aged as crutches support their weight.

In this chapter, I will offer suggestions, developed from the methods and discoveries of free-operative conditioning, for developing geriatric prosthetic environments.*

In free-operant conditioning the frequency of performance of an act is altered by locating and arranging suitable consequences (reinforcement). The person being conditioned is at all times free to make the response and receive the arranged consequences, or to make other responses. By isolating the individual within an appropriate enclosure, the behavior specialist can empirically—rather than merely statistically—control all environmental events which can affect the behavior he is studying. The behavioral response and any environmental manipulations whose effects on the response are being studied can be automatically and continuously recorded. This environmental control and automatic, continuous recording mark the method as a laboratory natural science, comparable to modern chemistry, physics, and biology.

Free-operant methods are suited to behavioral geriatrics for several reasons:† Concentrating on motivational aspects, or consequences, of behavior, free-operant conditioning alters the immediate environment to generate and maintain behavior. The sensitivity of the methods to subtle changes in such aspects of the person's performance as response rate, efficiency, and perseverance makes these methods appropriate to the study of single individuals. Because the sensitivity does not decrease with very long periods of application with the same individual, reliable longitudinal studies are possible. Free-operant conditioning methods for the analysis of functional and dynamic relationships between individuals and their social and non-social environments can produce separate measures of mechanical dexterity, intellectual functioning, and social adjustment.

Free-operant principles and techniques may provide behavioral geriatrics with 1) a fresh theoretical approach; 2) laboratory description, prognosis, and evaluation; 3) design of prosthetic environments; and 4) individualized prosthetic prescriptions. Although I know of no free-operant experiments on the aged, and research in our laboratory with senile psychotics has not been extensive, preliminary suggestions can be well supported by the results of extensive experiments on the behavior of psychotic, neurotic, and mentally retarded individuals, whose behavioral deficits are usually as debilitating and challenging as those of aged persons.*

A fresh theoretical approach

Free-operant conditioning principles can provide a highly relevant approach for increasing the efficiency of ward management and patient care routines. In this new approach, ward attendants do not perform custodial tasks. They are instead trained to act as behavioral engineers in arranging appropriate behavioral programs and reinforcements, so that the patients themselves maintain their ward and their persons.† Most important in this application of free-operant methods are 1) precise behavioral description; 2) functional definition of stimulus, response, and reinforcement; and 3) attention to behavioral processes.

Precise behavioral description facilitates communication between behavioral engineer and ward supervisor. It not only focuses attention on the actual behavioral movement which is occurring at either too high or too low a rate, but also permits observing and counting the response and directly reinforcing it with suitable consequences.

* For an excellent review of these experiments see Rachman (34).
† Research scientists suggesting new approaches for managing patients often overlook the crucial administrative problem of recruiting and training personnel. It is a good idea, but if it works who will put it into practice? An excellent source of behavioral engineers who could train and supervise attendants and nurses in these new prosthetic procedures would be Special Educators. Their current training, motivation, and philosophy are ideal for operant prosthetic methods. A few graduate courses and some ward experience under the supervision of an expert should make Special Educators into excellent Prosthetic Behavioral Engineers.