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Making Behavioral Technology Transferable

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The paucity of transferred behavioral technologies is traced to the absence of strategies for developing technology that is transferable, as distinct from strategies for conducting research, whether basic or applied. In the field of engineering, the results of basic research are transformed to candidate technologies that meet standardized criteria with respect to three properties: quantification, repetition, and verification. The technology of vitrification and storage of nuclear waste is used to illustrate the application of these criteria. Examples from behavior analysis are provided, together with suggestions regarding changes in practice that will accelerate the development and application of behavioral technologies.

Key words: technology transfer, basic research, behavioral technology

In 1986, the senior author called attention to the possibility of transferring behavioral technologies to the larger culture for the benefit of that culture (Pennypacker, 1986). An extensive example was given of a technology of manual breast examination for early detection of cancer that was being successfully transferred. The intended implication was that other behavioral technologies could be developed and similarly transferred. In retrospect, the analysis provided in 1986 was incomplete. The present paper is an attempt to supplement that presentation with a set of proposals that were at best implicit and were perhaps missing entirely from the earlier effort.

Since the 1986 publication, there has been considerable discussion and not a little polemicizing, but very few additional behavioral technologies have been transferred to the marketplace. This is not, in our view, the result of any shortage of potentially transferable technologies. There has been extensive technological development in the areas of industrial safety, highway safety, organizational performance management, animal training, and educational service delivery, among others. In the main, this development has taken the form of application of the fruits of applied research (Johnston, 1996), but only a few efforts have been made to transfer these technologies to the larger market.

The consensus among academic behavior analysts seems to be that there exists an insufficient research base to engender vigorous technologies. Therefore, no technologies exist with sufficient maturity to be transferred. It is our purpose to examine this argument in some detail and to suggest some alternative strategies for stimulating the development and transfer of behavioral technologies. Specifically, we will analyze the strategies successfully followed by a more mature discipline, engineering. We will then at-

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tempt to show how many results of the science of behavior analysis may be adapted to these strategies. First, however, let us consider some prevalent views of the problem from within the discipline of behavior analysis.

In 1991, a special section of the *Journal of Applied Behavior Analysis* entitled "Science, Theory, and Technology: Varied Perspectives" was devoted to dissecting the proposition that applied behavior analysis might be "technological to a fault" (Geller, 1991). Amid many thoughtful discussions of that issue and the role of applied science in the academic enterprise, one contribution seemed particularly lucid: "The problem, as I see it, is that we do not have a clear understanding of how technologies proficiently evolve" (Mace, 1991, p. 433). This contributor described in some detail the process by which a new AIDS drug is developed and finally gets to market. He goes on to state, "I have believed for some time that behavior analysis would benefit greatly from the adoption of a deliberate strategy for technology building appropriate to our discipline" (p. 434). He concludes by extending the metaphor of medical technology transfer to a hypothetical behavioral procedure and calls for greater integration of the basic and applied sectors of our discipline.

Subsequently, Mace (1994) specified in considerable detail the areas of basic research that should receive attention in order to enhance the effectiveness of applied behavioral research. He provided an excellent overview of the contemporary field of behavior-analytic research, both basic and applied, and it is easy to recommend this article to students for exactly this reason. Mace suggests two explicit strategies for strengthening the connection between the basic and applied research communities: (a) using deliberate animal models to analyze human behavior problems and (b) increasing replication of basic findings through human operant research. He believes that these strategies will lead to effective technologies and concludes with an example from his own collaboration with J. A. Nevin in which the concept of behavioral momentum has been extended to work with normal adults and hospitalized children.

One can scarcely quarrel with Mace's (1994) excellent overview and analysis. His is a prescription for orderly progress in the science. Indeed, if most researchers adopted as their programs one or more of Mace's suggested areas of inquiry, we would move rapidly toward a mature and complete science. Would we be any closer to launching effective technologies? Not necessarily.

Basic Science, Applied Science, Technology, and Technology Transfer

To understand the necessity but not the sufficiency of an adequate scientific base for transfer of effective technologies, we must examine the entire process in more detail. Using Mace's (1991) example of the development of a new AIDS treatment, the role of the basic and applied sciences is to get a finding from virology or molecular genetics to the stage of testing at the animal level or perhaps to the level of a Phase 1 clinical trial with a small group of human volunteers. Thereafter, larger scale clinical trials are conducted with careful collection of data on efficacy and side effects. Eventually, the Food and Drug Administration issues approval and the new treatment appears at the pharmacy. Before conducting the large-scale clinical trials, some very important events must take place to transform the research finding into a potential technology. These steps are largely missing from the activities of either basic or applied behavior analysts, and their absence accounts for the lack of technologies that could transfer.

Figure 1 presents in some detail the steps involved in taking a research idea from initial concept to the threshold of commercialization. Our concern here will be primarily with the first two

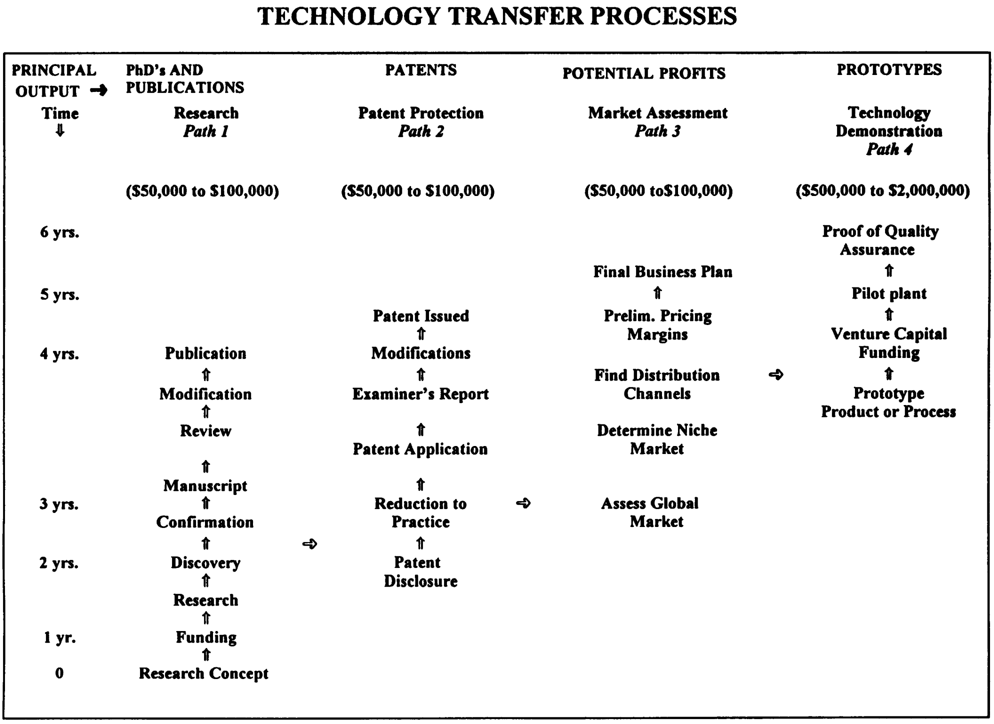

Figure 1. Major paths and milestones of the technology transfer process. (Adapted from Hench, 1990)

pathways, beginning with the original idea and concluding with the issuance of a patent or some other form of protection of intellectual property. Sometimes we will give examples from one or two of those rare behavioral technologies (e.g., MammaCare®; Pennypacker, 1986) that have made it through Path 4.

We are all familiar with the first pathway, research. Whether we are considering basic or applied research, the principal products are the same: doctoral degrees and publications. Research in behavior analysis, whether basic or applied, focuses on analysis (Pennypacker, 1981). There are two common meanings of this term. The first refers to the separation of a compound or composite into its constituent elements. Thus, we analyze blood or urine to determine what substances, and in what relative proportions, reside therein. The second meaning refers to the isolation of determinants or causes. A crime scene is analyzed to determine the proximal causes of the crime. This is closer to the meaning of analysis in the phrase *behavior analysis*. Behavior analysis seeks to identify, through controlled experimentation, the causes of observed behavioral phenomena. Through such techniques as reversal and replication, the reliability and generality of statements relating behavior to specifically isolated and controlled causal agents can be estimated. The primary difference between experimental and applied behavior analysis, then, is usually in the subjects and the setting, not in the objective of the enterprise. Applied behavior analysis is frequently concerned with extending the generality of basic findings to different species (usually, but not always, human) under less controlled conditions. To be sure, questions arise from this effort that are best addressed in the basic laboratory. In this context, Mace's (1994) appeal is especially cogent; cooperation will hasten progress toward the common objective.

The products of science, whether basic or applied, do not constitute technology. To take the first step toward launching a technology, the research finding must be reduced to practice (Path 2). Once this occurs, it becomes prudent to seek intellectual property protection in the form of patents, trademarks, service marks, or copyrights. These often form the basis of capital formation, as we shall see. They also provide a legal mechanism for insuring quality control as the product or process is conveyed to the consumer. This element is essential in the transfer process; without it, we are left with application in practice that is subject to dilution and deterioration. We shall examine this issue in more detail below.

Reduction to practice is a complex process that results in exact specification of a set of procedures that will produce a product or outcome to predetermined specifications. We have chosen to illustrate this process with an example from engineering for two reasons. First, the process is well established in engineering, and the principles are well understood. Second, the details of the example will be unfamiliar to many readers. This should serve to focus attention on the process; the specific details are relatively unimportant except to provide a context that illustrates the process. Later, we illustrate the process with respect to technologies that emanate from behavior analysis.

Procedures that constitute reduction to practice must meet three explicit criteria: quantification, repetition, and verification. Let us see how these operate in a specific example of considerable national interest: storing and disposing of nuclear waste. The problem has two major components. First, how does one transform nuclear waste into a minimally radioactive material and, second, where and how does one store that material?

Since the 1950s, it has been known that nuclear waste, whether in liquid or sludge form, can be vitrified; that is, transformed into a glassy, solid material. The process may be likened to transforming sugar syrup into candy. A new material that could be used to fashion adequate solid blocks containing nuclear waste was clearly needed. The first question therefore became: How does one define *adequate*? The answer to this question involves the first of our three criteria: quantification.

Quantification. In engineering, there are organizations that establish testing standards for various products. We are all familiar with the Society of Automotive Engineers that sets, among other things, the standards for viscosity of lubricants (SAE 50, etc.). In the materials field, the American Standards for Testing and Materials and the International Standards Organization usually serve this function. However, when the possibility of nuclear waste vitrification first emerged, no such standards existed. In fact, no agreement existed even as to the unit of measurement that should be applied. There was, however, agreement that superior materials would be those that minimized the leach rate of radioactive material under conditions of underground storage. Various laboratories had their own preferred materials, ranging from silicate glasses to various ceramics to complex cements and grouts. They each used their own standards and units of measurement, so there was almost no basis for comparison. Such a situation can be tolerated, even encouraged, in the conduct of basic research, but for obvious reasons, an important technological application such as storage of nuclear waste must be guided by independently established standards.

The federal government appointed a commission to identify and approve one standard method of testing candidate materials for nuclear waste vitrification; this body completed its assignment in 1 year. After 3 years, all but two candidate materials had been eliminated and a billion-dollar plant was subsequently commissioned in Savannah, Georgia. We note that the standards were developed by the scientific community and were not imposed by the government.

Repetition. Once measurement procedures and standards are established, a candidate technology can be evaluated with respect to repetition. Reducing a process to practice means, in part, that the outcome, or product, is repeatable. The materials selected for nuclear waste storage, for example, were the result of advances in physical chemistry that, in turn, spawned a production process that could be duplicated with predictable results. In evaluating the repetition factor, one collects a large sample of the items or outcomes, measures each according to the established procedures and standards, and describes the results in terms of a mean and coefficient of variation. If the mean meets the quality standard and the coefficient of variation is sufficiently small, the process is said to be repeatable.

Verification. The third criterion to be met by a candidate technology before it can be transferred is verification, or reproducibility. This refers to the degree to which the process or procedure, not the outcome or product, can be replicated. The process of applying for a patent forces clarification of this aspect of the technology. One is obliged to state precisely, in terms of specific claims, how one does whatever it is that produces the product or outcome. To the extent that the statement is clear and the process is reproducible, it can and should be protected for the benefit of the discoverer or inventor. An issued patent serves this function and permits negotiation of the resources necessary to proceed to market analysis and prototype manufacturing.

The process of establishing verification with respect to the nuclear waste storage technology illustrates the lengths to which it is sometimes necessary to go to satisfy this criterion. Verification of the reliability of nuclear waste glasses was obtained by launching a multinational collaboration in testing and evaluation. A coordinated group of research projects with participation of Belgium, Canada, France, Germany, Japan, Sweden, Switzerland, and the United States was started to test the relative surface reactions of nuclear waste glasses under a variety of simulated repository conditions. The studies included 1-, 3-, 6-, 12-, 24-, and 32-month deep burial in granite boreholes in the Stripa mine in Sweden at 90 °C and 10 °C. Nearly 2,000 interactive interfaces are being studied in salt in the Waste Isolation Pilot Plant site in the United States. Several glasses from these tests were also evaluated in clay in Belgium and limestone in the U.K. Comparisons of the simulated burial conditions with glasses containing radioactivity close to that expected for commercial operations at La Hague, France, were made by a Japan-Sweden-Switzerland consortium from the Commissariat a l'Energie Atomique, Marcoule, and the Hahn Meitner Institute, Berlin. These studies have helped create an international consensus on the relative performance of high-level waste forms including borosilicate glasses, waste packages, and repository variables (Hench, 1986).

These studies have also established the stability of such variables as leach rate under many conditions for many glasses and other composites. One of the most encouraging features of this truly collaborative international program is that each participant is responsible for fabricating their waste glass samples in compliance with commonly agreed-to procedures. They are also responsible for some pre- and postburial characterization. In this manner, an enormous volume of data can be generated without a complex administrative structure. This program should contribute significantly to the goal so many of us want: an international consensus on the safety-related performance assessment of high-level waste forms.

Application to Behavior Analysis

Is it possible for behavior analysis to foster technologies that will meet standards similar to those observed in engineering? We consider each of the above criteria as they might be applied to a discovery made in either basic or applied behavior analysis. Before doing so, however, we offer some general considerations concerning behavioral technologies and how they differ from the extant fruits of behavior analysis.

The essence of technology development is *control.* Skinner often remarked that the objective of a science of behavior was prediction and control of the subject matter. In practice, however, the science has generated a series of functional relations in which measured behavior is the dependent variable. As such, behavior has been shown to vary in orderly ways as a result of the exertion of experimental control of designated independent variables.

As we attempt to incubate a behavioral technology, we must refocus our efforts on the control of behavior. In other words, a successful technology will produce behavior to predetermined specifications, just as material science technology produces, say, ceramics to predetermined specifications or the pharmaceutical industry produces chemical compounds to predetermined standards of consistency and purity.

We will have established adequate control over a given class of behavior when we are able to generate instances of the behavior that are sufficiently specific and within levels of tolerance to achieve some socially desirable outcome, such as reduced mortality from breast cancer or reduced recidivism by parolees from prison. An example of such a technology was Skinner's demonstration of the benefit of pigeons guiding bomb-laden missiles (Skinner, 1979) or Verhave's (1966) demonstration that pigeons can serve as quality control inspectors in a pharmaceutical assembly line. In both cases, the behavior in question was generated to specifications of very high tolerance.

A current example illustrates this subtle but important point. In a study that generated considerable concern in the popular media, Thomas et al. (1997) reported the results of a major trial purporting to show the effects of breast self-examination (BSE) on breast cancer mortality. Two large groups of female workers in the Shanghai textile industry were randomly assigned to two conditions, one to receive training in BSE and the other to serve as a control. After 5 years, there was no statistically significant difference in mortality between the two groups. Does this support the conclusion (drawn by some members of the media as well as some in the medical profession) that BSE is ineffective? In fact, the independent variable subjected to clinical trial by the Thomas group, BSE *training,* was not tied to BSE *performance.* In order to evaluate properly the role of BSE on breast cancer mortality, it would be necessary to produce BSE performance to a specified level of proficiency and frequency (e.g., monthly) on the part of each and every participant in the experimental arm of the trial. This would be extremely expensive and has not, to our knowledge, been attempted. In order to be attempted, however, there must exist a behavioral technology that is capable of generating the required performance in every case to be included in the cohort.

By systematically applying the three criteria that define successful engineering technologies, we believe it is possible to develop large-scale technologies that, unlike the Skinner and Verhave examples, would transfer broadly because of the extraordinary benefit that could be realized. How would these criteria apply?

Quantification. Behavior analysis enjoys a distinct advantage with respect to this criterion because it has long employed the measurement strategies of the natural sciences (Johnston & Pennypacker, 1980). As Osborne (1995) put it,

> Physical standards of measurement bind behavior analysis to the physical and natural sciences. Interpretation of dependent variables need not

> change from experiment to experiment. It is a feature of our idemnotic measures that response frequencies on a particular parameter of a fixed-ratio schedule of reinforcement can be compared validly within sessions and across sessions, within laboratories and across laboratories, within species and across species. (p. 249)

Thus our measurement practices allow us to specify in precise and unambiguous quantitative terms the characteristics of the behavior to be produced by a candidate technology.

Perhaps it is time to follow the lead of our colleagues in various branches of engineering and form groups to establish standards for measurement of behavior. For example, we should now agree that academic performance is best measured in terms of both speed and accuracy of responding, not accuracy alone. We can therefore begin to establish quantitative standards of fluency for basic skills (Johnson & Layng, 1992; Pennypacker & Binder, 1992). Thereafter, instructional technologies would be validated in terms of these standards, and the extent to which they reached these standards could be publicly disseminated. By virtue of its extensive reliance on the measurement system of precision teaching, the Morningside Model of Johnson and Layng is now on the verge of successful transfer (Johnson, 1997).

Repetition. With the standards established and measurement procedures agreed to, it becomes possible for investigators to show the extent to which their techniques generate repeatable outcomes. For example, we should be examining large collections of fluency outcomes across schools, disciplines, and so forth, and note the means and coefficients of variation. Such data should routinely accompany budgetary proposals and be subject to external audit and review.

Many other applications of behavior analysis are sufficiently advanced to permit evaluation with respect to repetition. Animal training procedures yield outcomes that are quantifiable and highly repeatable (Pryor, 1994; Wilkes, 1996). Schedule-controlled operant behavior plays an important role in the field of behavioral toxicology (Newland, 1994) by providing standard behavioral baselines against which to assess the effects of toxic agents in the environment. The quantitative features of such behavioral baselines (terminal rates, index of curvature, interresponse-time dispersion, etc.) are well known, but have never, to our knowledge, been subjected to the kind of quantitative summary description for which we are calling. If data like these were to become available, comparisons across fields would be immediate, and efforts to achieve increased precision would become better focused. For example, is the coefficient of variation describing a collection of frequencies of second graders' correct arithmetic facts larger or smaller (and by how much) than the coefficient of variation of a group of monkeys' lever pressing frequencies under fixed-interval schedules of food presentation?

Verification. Two issues surround the criterion of verification: specification and generality. With respect to specification, the basic literature of experimental behavior analysis is more than adequate. Descriptions of experimental spaces, manipulanda, reinforcers, schedules, experimental phases, and so forth are presented in sufficient detail to insure replication. Replication is therefore routinely accomplished. Further, such descriptions are adequate to permit assessment of generality as, for example, when different species or different environmental settings are investigated (Branch & Hackenberg, in press).

The situation is less comforting in applied behavior analysis. Peterson, Homer, and Wonderlich (1982) document the lack of concern with what they term "the integrity of the independent variable" in the applied research literature. Detailed specification of the procedures is often lacking, as is any documentation of efforts to insure that whatever the procedures, they were consistently applied. These authors go on to call attention to the cost of these failures for the scientific enterprise as a whole and point out that infrequent replication is but one inadequacy of this literature. We have begun to see the emergence, however, of subspecialties such as the treatment of autism, industrial safety training, direct instruction, and precision teaching that rely on standardized materials and procedures. These subspecialties are well on the way to creating transferable technologies.

Building an applied science without clear specification of procedures is admittedly difficult; however, building a technology under those circumstances is impossible. Recall the lengths to which the international material science community went to establish the durability of various nuclear waste disposal media under widely varying conditions of burial and temperature. Imagine trying to establish similar parameters for a behavioral technology that requires precise intervention at specific times and under specific conditions if no attention is paid to the details of the intervention, control over the timing of the interventions, or detailed description of the environment in which the intervention is to occur.

The solution to this problem is attainable, as Peterson et al. (1982) point out. Much greater emphasis must be directed at the problem of identifying, observing, quantifying, and thus controlling the independent variable in applied research. Similarly, any resulting technology must focus primarily on those factors. They must be isolated and refined to the point where they can be reproduced by others under a variety of circumstances and their expected effects obtained. We have already noted a few of the areas in which such development is under way. Let us briefly examine another contemporary example.

A Current Example

The technology described in Pennypacker (1986) grew out of a collaborative effort to develop a system for teaching and performing manual breast examination with a level of sensitivity that approached the limits afforded by the human tactile sensory system. The research team consisted of behavior analysts, physicians, and materials science engineers. The latter group was responsible for developing a set of procedures for fabricating synthetic breasts with specifiable physical characteristics, including simulations of normal nodularity and tumors (Madden et al., 1978). Patents covering these innovations were issued in 1977 (Figure 1, Path 2). The behavior analysts developed training methods that incorporated both the models and actual breast tissue in a series of exercises that routinely generated specifiable, quantifiable levels of proficiency (Pennypacker & Iwata, 1990). These procedures were christened the MammaCare® method of breast self-examination, and trademark protection was obtained.

The patents and trademarks were transferred to a corporation and became its assets. On the basis of these assets, a public stock offering raised sufficient capital to support a sustained attempt to begin transferring the technology to the women of the world (Figure 1, Paths 3 and 4). Currently, a factory that manufactures the breast models is fully operational, and a variety of training delivery systems are being marketed to physicians, hospitals, public health agencies, and corporations as well as directly to women ("Best Breast Self-Exam," 1997).

As with most innovative technologies, many features of MammaCare® are both anchored in basic research (Pennypacker & Iwata, 1990) and represent departures from conventional practice. For example, research has shown that allowing women to palpate the models without concurrently examining their own tissue causes an increase in the likelihood of false positive responding. False positive responding exposes the woman to potential ridicule and may cause her to cease self-examination entirely. In that case, she would return to her initial level of risk of disfigurement or death due to breast cancer. For this reason, our firm corporate policy is not to sell breast models without concurrent training, either by a qualified professional or via videotape. Although this policy annoys many professionals who have routinely allowed women to palpate models made by other manufacturers or who insist that their competence at breast examination cannot be enhanced by exposure to MammaCare® training, it allows us to maintain a level of quality control over our ultimate product—a proficient skill—that could not be achieved in its absence. This policy would not exist, of course, without the corporation, which in turn would not exist without the patents and trademarks. Thus, the devices by which intellectual property is protected become essential to the design of practices that ensure the quality of the transferred technology at the level of the end user. The alternative is cumbersome regulation through licensing by governmental agencies, certification, accreditation, and so forth.

Soon after the technology for teaching and performing breast self-examination was introduced on a national scale, an investigator from the University of North Carolina approached us about developing a set of breast models that could be used to document the proficiency of physicians in the skill of manual detection of breast lumps. Another cross-disciplinary collaboration occurred and resulted in six models that contained, in total, 18 lump simulations ranging in size from 0.5 cm to 1.0 cm and in firmness from that of a ripe strawberry to that of a piece of popcorn. Using this series of models, this investigator and her colleagues determined that house physicians at a major medical school could detect, on average, 44% of the lump simulations (Fletcher, O'Malley, & Bunce, 1985).

There followed a sustained effort to improve the lump detection performance of health care professionals. Several published studies documented the effects of various training protocols on various populations (Campbell, Fletcher, Pilgrim, Morgan, & Lin, 1991; Campbell, McBean, Mandlin, & Bryant, 1994; Fletcher, O'Malley, Pilgrim, & Gonzalez, 1989; Pilgrim, Lannon, Harris, Cogburn, & Fletcher, 1993). Most recently, we have adapted these procedures to the challenge of training physicians on an in-service basis, providing controlled instruction during an evening meeting following a free dinner. Table 1 presents some data from this effort, along with comparable data from the other investigations cited.

The measures of sensitivity and specificity presented in Table 1 are consistent with the use of these terms in diagnostic testing. Sensitivity refers to the ability of the instrument or procedure to detect true positive instances of the disease or condition. In our example, sensitivity is calculated as the ratio of the number of lumps detected to the number of lumps available. Specificity refers to the ability of the instrument or procedure to detect *only* instances of the disease or condition and is therefore inversely related to the occurrence of false positives. Following Fletcher's practice, we compute specificity using the formula $1 - (F/N)$, where F is the number of models in which at least one false positive detection occurred and N is the total number of models examined.

The data presented in Table 1 constitute an example of verification at several levels. First, the breast models used in all the studies cited are manufactured to the same physical specifications. Thus, variations in measures of sensitivity from study to study are due to variations in subjects or training procedures. Second, the studies represent a systematic search for the limits of generality across subjects and settings, from medical students to nurses to physicians in practice. Finally, the similarity of the sensitivity measures across these studies suggests that procedures have been isolated that will generate behavior to predetermined

TABLE 1

Comparative measures of performance on a standardized series of silicone models

Study	Sensitivity (%)	Specificity (%)	Exam duration (minutes per model)
Fletcher, O'Malley, Pilgrim, and Gonzalez (1989) (no training control)	58	52	2.5
Campbell, Fletcher, Pilgrim, Morgan, and Lin (1991)	65	33	2.3
Pilgrim, Lannon, Harris, Cogburn, and Fletcher (1993)[a]	93	78	3.0
Campbell, McBean, Mandin, and Bryant (1994)	71	48	
Present study			
October 1994	80	63	3.4
June 1995	78	67	3.1
Total	79	65	3.3

Reproduced from Pennypacker et al. (1996).

[a] Used only one model containing five lumps.

quantitative levels. We can now begin to entertain the question, "Will regular performance of proficient clinical breast examination lead to reductions in breast cancer mortality?" Previously such a question had little meaning in the absence of controlled performance of the examination.

Some Suggestions

If it is the collective wish of the members of our discipline to foster the development of behavioral technologies, a few changes in our own behavior may be indicated. Following is a list of a few of the most obvious, based on the success of established fields like engineering and the few behavioral technologies that have emerged:

1. A group should be established within the existing disciplinary structure to establish units and standards of measurement. This group could be associated with the Cambridge Center, with the Society for the Advancement of Behavior Analysis, or with the Society for the Experimental Analysis of Behavior, but it should have provision for wide distribution of its work product.

2. We should broaden our conception of what constitutes publishable research to include demonstrations of repetition and verification. This is not a new idea. Hawkins and Hursh (1992) advocate using treatment-only designs to demonstrate that satisfactory change is occurring without necessarily isolating the cause of the change (cited in Moxley, 1995). Coupled with use of standardized measurement units and practices, collections of behavior changes could be published in short reports with emphasis on the exact descriptions of the procedures employed, together with evidence that these procedures remained as described (Peterson et al., 1982).

3. We must eventually begin to publish information of the type just described in journals of wider circulation than our own archival scientific journals. This means becoming comfortable with editorial review rather than peer review. It also means reaching a far wider audience, possibly including representatives of organizations who can provide assistance in navigating Paths 3 and 4 of Figure 1. It would be helpful if this type of publication could be encouraged, or at least not punished, by enlightened university administrators.

4. We should continue to forge alliances with other disciplines, such as medicine and engineering, that have established mechanisms for technology transfer. In the health care field, for example, there are frequent calls for lifestyle changes that will lead to reductions in health care costs. We regard these as calls for effective behavioral technologies that can be marketed to large subsets of the population with confidence in the predictability and stability of the outcomes. Without question, if benefits can be assured, such technologies will be purchased by managed health care organizations (Pennypacker, 1986, 1992).

The first challenge of technology transfer, then, is to create transferable technologies. To do this, we must move beyond research into the arena of explicit technology development. In this paper, we have outlined the process as it has evolved in a mature discipline (engineering) and have illustrated its applicability to one behavioral technology with which we are familiar. We encourage others to broaden their efforts and thereby hasten the arrival of the day when the discipline of behavior analysis finally fulfills its promise of benefit to the species.

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