Programming training across complex skills.

PROGRAMMING TRAINING ACROSS COMPLEX SKILLS

A Thesis Presented

By

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ABSTRACT

Our present technology of training skills by individual task analyses may not be capitalizing on the overlapping components common to many skills. The purpose of this study was to examine the acquisition of four complex skills--collage-making, toothbrushing, potholder making and shoe-tying--by programming instruction across a number of topographically related sub-components. Two profoundly retarded, institutionalized women served as subjects. Baseline 1 consisted of probes on each of the four skills. Baseline 2 was identical to Baseline 1, except the order in which the skills were assessed was randomized. During Operations phases, related components were taught to the clients, using materials different from those required to perform the target skills. Probes were conducted during this phase to determine the degree to which training generalized to the four target skills. Training phases consisted of chaining components unique to a particular target skill. Follow-up data were collected from 2-1/2 to 5 months after training was terminated. During all phases, the prompt level--independent, verbal, gesture or physical--necessary to occasion each sub-component of a complex task was recorded, as well as duration to complete each complex skill. Approximately 1/3 to 1/2 of the sessions were independently scored by observers who were present in the training rooms. Inter-observer agreement ranged from 78-100%, with a mean of

approximately 91%. The results appear to support the efficiency of determining components common to skills, and then training across skills.

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CHAPTER I

INTRODUCTION

The development of effective, comprehensive curricula for severely and profoundly disabled individuals is a major challenge. These individuals comprise a heterogeneous population, with a wide range of physical and sensory deficits. Furthermore, these persons generally could benefit from instruction in a wide variety of skills. There is probably insufficient time during their lifespans to teach systematically the skills they lack (Holvoet, Guess, Mulligan & Brown, 1980). Some decision-making framework is therefore needed for the construction of curricula composed of the most functionally useful skills for a given handicapped individual. Currently, little empirical evidence is available to guide the construction of good curricula, thus rendering this undertaking more of an art than a science (Williams & Gotts, 1977).

Recently within the developmental disabilities field, Guess, Horner, Utley, Holvoet, Maxon, Tucker and Warren (1978) wrote a conceptual paper that described two basic frameworks within which curricula for the developmentally disabled may be constructed--the remedial approach and the developmental approach. The remedial approach involves training skills selected on a primarily functional basis that will improve a handicapped person's ability to interact with the environment (e.g., Adams, 1975; Anderson, Hodsen & Jones, 1975;

Kaufman & Snell, 1977; Walls, Zane & Werner, 1978; Wheeler, Miller, Duke, Salisbury, Merrit & Horton, Note 1). Skills are selected primarily to foster a given client's improved adaptation to everyday situations.

An example of a remedial approach is the use of various task analyses to train needed skills, in some cases irrespective of prerequisite behaviors. Skills are selected because their acquisition will result in clients progressing to less restrictive living situations. If a given institutionalized client is toilet trained, then he/she will require less staff assistance and may be moved to a higher functioning unit in an institution. If more activities of daily living and vocational skills are learned, the same client might be targeted for deinstitutionalization.

The remedial approach is characterized by treating each skill as a separate entity and further assumes that any complex behavior can be taught if objectively task analyzed (Guess et al., 1978). It is referred to as a "vertical sequencing model," in that a complex behavior is taught separately by either backward or forward chaining of component subskills.

In contrast, the developmental approach assumes a uniformity in skill acquisition, wherein persons progress through fixed developmental levels (e.g., Haring & Bricker, 1976; Myers, Sinco & Stelma, 1973; Snell, 1978; Stephens, 1977; Umbreit, 1980; Uzgiris & Hunt, 1973). Skills at any one level serve as prerequisites for acquisition of skills at the next level. Guess et al. (1979) refer to this as a "horizontal sequencing model" because groups of skills are assumed to

be interrelated.

There is one drawback, however, in that maturational determinants of learning are emphasized that are in turn inferred from the developmental progress of non-handicapped persons. Snitzky, Rotatori, Miller and Freagon (1979) maintained that the developmental model might depend on cultural as well as biological determinants of behavior. The expectation that handicapped persons' learning will follow a set developmental sequence may not be an accurate representation of how learning best occurs.

Thus, Guess et al. (1977) have proposed an alternative programming approach that combines the logic of both vertical and horizontal sequencings of skills. Their Functional Curriculum Sequencing Model (FCS) is based on the phenomenon of "response generalization" which stresses that "responses of similar topographical and/or functional components can best be taught within behavior classes; and importantly, the transfer or generalization of one response to the other is most likely to occur within that class" (Guess et al., 1979, p. 205).

In 1953, Skinner discussed the fact that increases in the strength of one behavior might also improve the strength of other behaviors. Often this response generalization or transfer is not abetted by arbitrarily selected units of behavior. Guess et al. (1979) refer to this phenomenon as <u>functional similarity</u> between responses. This refers to very different physical responses that have the same "meaning" to a person. An example is offered in which a child may point to a ball while discriminating it from other objects and orally

saying the word "ball." While these responses (pointing to and saying "ball") drastically differ, they are considered functionally similar because they tend to produce similar effects upon the environment.

It should be noted that the term "functional" has thus far been used with two very distinct connotations. Functional is most used in the field of applied behavior analysis as referring to clients' adaptive living skills, as in developing a client's functional living skills program. In contrast, the term functional is technically used to imply "immediate effect on the environment." In other words, this latter version is a more simplified, direct attempt to clarify the relations within a class of responses. In this paper the term "adaptive" will apply to the former definition, and the word functional will be preserved for its more technical meaning.

Another type of response similarity, topographical similarity, is also described by Guess et al. (1979). This is characterized by the actual physical similarities of various responses, regardless of the function of these responses. For instance, twisting a lid off a jar and twisting the knob of a door are topographically similar despite apparent differences in function within the environment. At present, the usefulness of examining classes of responses in terms of topographical and/or functional similarities and of incorporating the findings into comprehensive curricula for training the handicapped remains to be investigated empirically.

As a step in this direction, the theoretical FCS Model was devised to incorporate the interrelatedness of groups of skills as in developmental approaches, and the individual needs of specific clients

to maximize their adaptive ability, as in remedial approaches. Since a strictly developmental approach tends to base selections of skills on a client's assessed physical developmental level, the skills may lack adaptive importance. In contrast, the remedial approach may be employed successfully to train new behaviors but says little about the order in which skills should be trained. In effect, each new complex skill tends to be taught separately without considering potential overlapping components that are often common to many skills. For example, grasping, twisting, turning and pulling are common components within many tasks and yet are not systematically taken into account in the formulation of instructional plans for the severely and profoundly disabled. Instruction programmed across skills according to the FCS model, consequently, might better enable teachers to teach a wide range of related but different complex skills in a more comprehensive fashion.

Holvoet et al. (1980) have provided an excellent example of the possibilities of integrating the remedial and developmental approaches in teaching "walking on a line." Although this skill is useful for balance and eye-foot coordination as an end in itself, a teacher can generate instructional situations so that teaching this skill will have beneficial effects for the client. For instance,

> the student could be taught to walk on a narrow path without straying, to walk next to someone without bumping into them, to go through a checkout counter at a store, to walk through a narrow doorway, etc. (Holvoet et al., 1980, p. 339).

Williams and Gotts (1977) have similarly described a curriculum model, referred to as a "longitudinal skill sequence" which also

incorporates vertical and horizontal skills sequencings. This model is flexible, enabling it to be revised under three kinds of circumstances: (a) changes in levels of student performance; (b) more advanced empirical data of human behavior; as well as (c) the changing values of society. Additionally, some advantages to the use of a longitudinal skill sequence were delineated: first, personnel turnover, a common problem in the developmental disabilities field (Zaharia & Baumeister, 1978) may restrict client gains through lack of continuity in teaching. Longitudinal skills sequences would alleviate problems caused by this inconsistency. Second, these sequences should facilitate both the development of more efficient curricula and the individualization of instruction. Finally, since skills are precisely delineated on a dimension from no measurable ability to adult competence, Williams and Gotts (1977) suggested that each skill taught would serve as a prerequisite for the next skill.

Transfer of Learning

Although the FCS and the longitudinal sequence models are relatively new to the field of developmental disabilities, the issue of whether or not learning within one stimulus context affects subsequent learning has been extensively addressed elsewhere. The literature may be subsumed under various headings: transfer of learning (Deese & Hulse, 1967; Ellis, 1965; Gagné, 1965; Osgood, 1949; Royer, 1979); stimulus generalizations (Reynolds, 1968; Rilling, 1977; Terrace, 1966); response generalization or induction (Baer, Peterson & Sherman, 1967; Garica, Baer & Firestone, 1971; Garcia & DeHaven, 1974;

Skinner, 1953; Stokes & Baer, 1977; Stokes, Baer & Jackson, 1977); and learning to learn (Harlow, 1949; Sahakian, 1970). Horner and Bellamy (1979) noted that some of the research conducted within these areas, in part, stressed stimulus similarity between training and transfer tasks; that is, if similar responses are required of two tasks and similar stimuli are intrinsic to these responses, then training on the first task will facilitate acquisition of the second task.

Both Deese and Hulse (1967) and Royer (1979) considered that the general topic of transfer has been ignored in the recent psychological and educational literature, and yet the importance of transfer for optimum learning cannot be overstressed. While it is beyond the scope and intent of this thesis to extensively elaborate the areas of research mentioned above, some aspects do appear to be particularly relevant for the development of improved curricula.

In a comprehensive review paper on the transfer of learning, Royer (1979) described a number of theories on this topic which were derived from earlier research. The specific types of transfer delineated included: lateral and vertical transfer, specific and non-specific transfer, literal and figural transfer, as well as near and far transfer. According to Royer, the distinguishing features of these various kinds of transfer are not readily apparent; that is, at times their various features tend to overlap.

A description of the conditions of both lateral (horizontal) and vertical transfer has been provided by Gagné (1965). Lateral transfer was described as "making it possible for the individual to execute some performances that are not directly learned but are in some

sense similar to those that are learned . . . it refers to a kind of generalizing that spreads over a broad set of situations at roughly the same 'level of complexity'" (Gagné, 1965, p. 231). Vertical transfer is simply described as the effect of simpler learned capabilities on the learning of more complex behaviors. Lateral and vertical transfer provide the basic framework for the curriculum models mentioned earlier by Guess et al. (1979) and Williams and Gotts (1977).

Royer (1979) asserted that vertical transfer has historically received the focus of attention from both psychologists and educators, and that this type of transfer theory has provided the basis for our entire educational system. He further stated that lateral transfer, in particular, has long been dismissed by educators because an environmental perspective orientation is not suited to addressing this issue. He suggested that an analysis of stimulus elements may be too complex to be accomplished, especially given many instances in which no apparently similar stimuli can be detected between original and transfer learning situations. Royer stated

> Consider, for example, the difficulty in identifying the defining features of a concept. What are the defining features of love or magnitude? Even concepts having concrete referents prove to be difficult. What, for example, are the defining features of vehicles or balls (e.g., footballs) or games? . . . At an even high [sic] level of complexity is the problem of identifying the defining features of a class of tasks to which a learned skill or bit of knowledge might be transferrable. Imagine, for example, trying to isolate the defining features of all the situations (both real-world and school based) where one's long division skills are called for (Royer, 1977, pp. 58-59).

On the other hand, it may be that the lack of empirical research in applied settings has lent a great deal of credibility to Royer's

contention. Perhaps further research may lend support to the efficacy of the "environmental perspective."

Royer (1979) also described the distinctions between specific and nonspecific transfer. In the specific case, there are direct similarities between the stimulus elements of the original learning and transfer tasks. It is assumed that the learner will discriminate these similarities and acquire the transfer task more rapidly. With non-specific transfer, there are supposedly no similar elements shared by the original and transfer situations. Harlow's work on "learning to learn" (Harlow, 1949) is offered as an illustration of non-specific transfer. Royer (1979) suggested that nonspecific transfer could be attributed to cognitive events taking place within the learner.

Literal transfer is referred to as the transfer of an intact skill to a new learning situation. Various theorists have viewed most instances of lateral and nonspecific transfer as possible instances of literal transfer (Royer, 1979). Figural transfer is supposedly the "use of some segment of our world knowledge as a tool for thinking about, or learning about, a particular problem or issue" (Royer, 1979, p. 55). The phrase "man is like a computer" is an example in which our knowledge of the world serves as an aid in understanding this metaphor. Skinner (1957) noted that traditional accounts of metaphors ". . . have generally assumed that like generic extension, (the) metaphor is a special achievement requiring a special faculty of analogical thinking. But the basic process is again represented by our three-term relation; the only difference between metaphorical and generic extension is in the kind of property which gains control of the response" (Skinner,

1957, p. 92).

Another type of transfer distinguished by Royer (1979) is that of near and far transfer. Near transfer refers to those situations in which the stimulus elements of the original and transfer situations are highly similar. In terms of education, transfer of training from one school activity to another is described as near transfer. Far transfer, by contrast, refers to somewhat different stimulus situations between the original and transfer tasks. The generalization of information acquired in the school environment to real life situations illustrate "far transfer." Royer noted that educators in general have not been particularly concerned with how well skills learned in school apply to the real world, but acceded that this lack of focus is changing with the advent of "minimum competencies" presently required by many high school students to graduate. (It is important to note that Royer referred to the educational system as a whole and not to the training of the developmentally disabled. The program plans of these individuals have traditionally focused on the application of school-learned skills to adaptive community living.)

Another aspect of the transfer issue has been the historical focus on the theory of identical elements. Royer (1979) referred to this as an "environmental theory" in that the learner must discriminate the stimulus similarities between the original and transfer tasks in order for transfer to occur. Although he conceded that the identical elements theory accounts for many transfer situations, it does not account for some transfer situations (i.e., far transfer, figurative transfer and, in particular, nonspecific transfer). Because these

unaccounted-for transfer situations are deemed too complex to be analyzed in terms of common stimulus elements, Royer (1979) proposed a schema theory of transfer derived from cognitive theory. Schema are hypothesized to be abstract structures storing both frequently experienced events, concepts, and procedural information. These schema are supposedly activated by information and then serve as a way to analyze that information. In a transfer situation, learning on a transfer task will not occur unless an individual has previously acquired schema for the concepts to be utilized.

This theory is generally considered by cognitive psychologists to be a more sophisticated account of the transfer process, and furthermore, to describe the actual physiological processes used during transfer. Since our concern is on a functional analysis of behavior, it is preferable to focus on objective observations of transfer situations rather than posit internal hypothetical constructs which may not be systematically manageable. In applied attempts to promote transfer in real life situation, one must still rely on the identification of both common stimulus elements and procedures for promoting generalization to new situations.

Skinner (1953) discussed the traditional explanation of transfer as one in which responses supposedly have identical elements. Although Royer (1979) identified the identical elements theory as representing the environmental perspective, it should be noted that Skinner proposed some difficulties with this type of theory. Skinner (1953) asserted that this type of description served to maintain the

notion of a unit of response. He proposed it was more useful to emphasize that similar elements were strengthened, thus identifying the element, rather than the response, as being the unit of behavior. Rushall and Siedentop (1972) supported Skinner's argument by suggesting an example. An identical elements concept would assume tennis to be a behavioral unit which would transfer to badminton, due to their similarity. However, this is an erroneous conceptualization since artificial behavioral units (i.e., tennis and badminton) were established. Instead, component elements reinforced during playing tennis would strengthen similar elements in the context of badminton.

Johnston and Pennypacker (1980) provided the most up to date account of the "unit of behavior." They stated that:

> . . . selecting a unit of analysis or response is a matter of experimental necessity, not philosophical approbation. Defining a class of responses for purposes of a particular experimental analysis is never tantamount to asserting the validity of the selection as the ultimate, irreducible unit of behavior analogous to the molecule or atom of the earlier sciences of matter . . . the existence and nature of the "behavioral atom" is a theoretical, even philosophical, issue of no immediate concern to the practicing investigator (Johnston and Pennypacker, 1980, p. 97).

In other words, Johnston and Pennypacker (1980) are in agreement with Skinner (1953), and are reluctant to permit exact units of a response to be pinpointed, lest this notion be misleading to researchers.

Before leaving the general topic of transfer, it is appropriate to briefly discuss Osgood's transfer surface (Osgood, 1948), a three dimensional form representing the effects of response and stimulus similarity on the extent of transfer. Three types of generalizations about transfer are represented by this form: (a) positive transfer

(the performance on one task which may facilitate performance on a second task) increases with more stimulus similarity when stimuli are varied and the responses are kept the same; (b) negative transfer (the performance on one task which may inhibit performance on a second task) is fostered but decreases as similarity between responses increases when responses are varied and stimuli are the same; and (c) negative transfer is obtained but increases as the similarity of stimuli increases in the case where both stimuli and responses are varied.

The degree of transfer in a learning situation is derived by determining the degree of stimulus and response similarity. One could determine the extent of positive or negative transfer by projecting the degree of stimulus and response similarity on the three-dimensional form, and then determining the point of intersection. An obvious limitation to the use of this three-dimensional form is determining and measuring the amount of response and stimulus similarity (Ellis, 1965).

In sum, however, the notion of positive and negative transfer in the relations between various skills has been a prominent view in the transfer of learning literature. Deese and Hulse (1967) have noted that previously learned components may have both detrimental and beneficial effects on performance in new tasks. They have summarized three overall ways that positive transfer might occur: (a) a task may consist largely of earlier learned component skills; (b) two tasks may be related by some underlying common principle; and (c) two tasks might be related by similar but not identical components. These three ways in which positive transfer can be enhanced could form the basis for further research in the applied setting.

The background literature related to the FCS and longitudinal skill sequence models seems to overlap with the transfer of learning theories. Stimulus generalization is a case in point. Ellis (1965) supported this view by recognizing that stimulus generalization and transfer are examples of the same class of events, and that stimulus generalization has been a means by which to explain transfer. In a traditional stimulus generalization experiment (e.g., Guttman & Kalish, 1956), transfer of unreinforced responses to stimuli that are similar to the conditioned stimulus are measured. There is a distinction, however, in that transfer is more specifically concerned with either acquisition of new responses or of previously learned responses to new stimuli. Therefore, it is asserted that "stimulus generalization is most similar to performance on the first trial in a test of transfer" (Ellis, 1965, p. 25).

Transfer of learning appears to be the overall term whether one is referring to response generalization or stimulus generalization. Response generalization describes those instances concerning the acquisition of new responses; stimulus generalization is reserved for those demonstrations of prior learned responses in new stimulus situations.

Applied Considerations

Reynolds (1968), as others (Deese & Hulse, 1967; Osgood, 1948), has delineated two rules derived from basic experimental research on stimulus control which predict the directions generalization might take: (a) generalization will occur to stimuli sharing the same

physical parameters and will differ as these parameters differ and (b) generalization will occur to stimuli that share obvious aspects in common with theoriginal stimulus that occasioned reinforcement. He noted that these two rules are more difficult to apply outside the experimental laboratory since it is not easy to determine which stimuli actually control behavior in complex situations. Reynolds (1968) cautioned that we must not be misled by mistaking stimulus similarity as an explanation of generalization, but rather our labeling various stimuli as similar is more an indication of our own tendency to generalize between various stimuli.

In the applied field, maintenance and generalization of behavioral gains is a topic of major concern, and yet there is relatively little research demonstrating how best this transfer can be facilitated (Kauffman & Snell, 1977). Transfer to new situations or across related classes of behavior will not be facilitated by teachers through wishful thinking (Kazdin, 1975; Stokes & Baer, 1977); rather, teachers should specifically devise programs which will increase the likelihood of generalization. There is a necessity for applied researchers to have procedures available for fostering transfer or generality.

Pierce and Epling (1980) provided a useful distinction for the differences in how the term "generalization" is used in the experimental analysis of behavior as opposed to applied behavior analysis. They asserted, in a review of applied articles, that

> . . . the term generalization, . . . is employed as a descriptor by several authors when they refer to the generality of treatment effects from one setting to another. There were no

> instances of generalization used as a reference to a stimulus generalization gradient . . . the term is therefore an equivalent of Campbell and Stanley's (1963) external validity and not a reference to relevant principles or behavioral process. (Pierce & Epling, 1980, pp. 5-6)

Thus, most of the techniques developed in the applied field of the advancement of generalization refer to the external validity of treatment effects. A number of authors (i.e., Kaufman & Snell, 1977; Kazdin, 1975; Reese, Howard & Reese, 1978; Sulzer-Azeroff & Mayer, 1977) have delineated sets of specific techniques which will enhance maintenance and generality of treatment effects in real life situations. According to Kaufman and Snell (1977), most of these procedures have been derived from laboratory research and appeals to common sense. Although the intent of this thesis is to more specifically examine the enhancement of response generalization within curriculum development, it is useful to briefly overview the current focus in the applied field vis à vis the fostering of generalization in habilative gains.

Among the procedures mentioned by those concerned with applications are: (1) gradually removing contingencies, (2) shifting to natural reinforcers, (3) shifting to an intermittent schedule of reinforcement, (4) increasing the delay of reinforcement, (5) varying the training setting, (6) providing staff and parent training, (7) teaching self-management, (8) providing more than one instructor, (9) incorporating natural settings and (10) selecting goals supported by the community (see Kaufman & Snell, 1977; Kazdin, 1975; Reese, Howard & Reese, 1978, and Sulzer-Azaroft & Mayer, 1977 for exact descriptions of these techniques).

An excellent example of the provision of more than one trainer is demonstrated in a study conducted by Stokes, Baer and Jackson (1974). Four institutionalized retarded children were taught a social greeting response (i.e., hand-waving) through prompting and shaping. Little generalization and maintenance of the hand-waving response was demonstrated to other staff members when only one trainer worked with the children. However, when a second experimenter trained and maintained this response, a high degree of generalization to other institutional staff was demonstrated.

Some researchers in the applied field have conducted studies that more specifically examined generalization of trained skills to either new responses or stimuli. For example, a study conducted with developmentally delayed youngsters demonstrated that teaching subjects to match to sample was facilitated by a pretraining session (Hamilton, 1966). One group was required to identify slide items as either animal, person, or thing while another group was asked to name items specifically (e.g., dog, cat, boy). A third group simply observed the slides. After pretraining and mastery of the first task, performance was measured on a second match to sample task. The three groups mastered the second task faster than the first, with the first group mastering the initial match to sample task faster. The results of this study demonstrated how the teaching of a class of stimuli could aid acquisition of responses.

Guess and Baer (1973) conducted a transfer study involving verbal learning, in which they taught subjects to identify singular and plural cases of pictures in two different modes. Two subjects were

taught the receptive mode in which they pointed to the singular or plural case while another two subjects responded in the productive mode by identifying pictures using the correct singular or plural ending. Then, one subject from each mode was taught to pronounce plurals ending with "s" and to point to pictures of objects whose spelling ended with "es" while the remaining subjects were taught to do the opposite (i.e., to pronounce plurals ending with "es" and to points to objects whose spelling ended with "s." When novel items were presented, all the subjects generalized only in the modes in which they were trained. This finding suggested that more variety in the original training task might have promoted greater generalization within modes.

Similarly, Sailor (1971) taught two subjects to form the plurals of nouns ending with either an "s" or a "z" sound. One subject was trained with the "s" ending words first and probed concurrently with "z" ending words to determine the degree of generalization. The second subject was taught "z" ending words first, while in a second training session the procedure was reversed for each subject. Both subjects demonstrated transfer to the unlearned task, and reached criterion more quickly in the second training session.

In another study conducted by Garcia, Baer, and Firestone (1971) four severely retarded children were taught to imitate a number of motor and verbal responses by shaping three topographical types: small motor, large motor, and short vocal responses. Probes for these topographies were instituted, as well as for a fourth: long vocal responses. Results indicated that generalized imitation was observed

only for the trained topographies, a finding that parallels the results of Guess and Baer's (1973) study.

An intriguing adaptation of providing a technology of generalization is to treat generalization as a unitary response class itself (Stokes & Baer, 1977). Goetz and Baer (1973) illustrated this by reinforcing generalized responses. Three children were taught to generalize building block structures by reinforcing the criterion of new block forms--implying that generalization would be obtained when it was reinforced (i.e., was adaptive).

Gagné (1965) suggested that the more widely based the training of a response, the better the transfer to new and different situations. This idea is substantiated by the aforementioned studies. Similarly, Markle and Tiemann (1970) asserted that no concept could be learned from a single example. This notion is consistent with the literature on learning-to-learn, whereby one can improve learning by practicing a number of related tasks (Harlow, 1949). Behavior cannot be understood in terms of single learning situations but by changes that are facilitated through related multiple learning problems.

Perhaps this idea might account for one limitation in a study conducted by Cuvo, Leaf, and Borakove (1978), in which six developmentally disabled students were taught janitorial skills. The students were taught the twenty most difficult steps of the cleaning process with a procedure that initially started with a great deal of prompting. The students next were taught the remaining 161 steps through initially little or no prompting. Although the students learned rapidly and generalized their janitorial skills to another school

bathroom (i.e., stimulus generalization), there was no generalization across subtasks for bathroom cleaning (cleaning mirror, sink, urinal, toilet, emptying trash, sweeping and mopping floor). Perhaps if the students had been trained with many stimulus examples for the subtasks, response generalization would have occurred.

Ellis (1965) recommended, as have others, that teachers should provide wide experiences with original training tasks and maximize similarities between the original and transfer situations in order to enhance generalization. In a general sense, this same type of endeavor has been used in recent years in applied programs to promote generalization to both new responses and situations.

Current Applications in Vocational Training

Given the background literature concerning the transfer of learning and generalization previously reviewed, it will be most useful to examine some current research more directly related to supporting the FCS and longitudinal sequencing models. Much of this work reported here is concerned with the training of generalized responses and the subsequent effects on the attainment of untrained skills, in the area of vocational training (Bellamy, Oliver & Oliver, 1977; Gold, 1976; Prill, 1977; Walls, Sienicki & Christ, 1981).

The basic rationale behind the emphasis on the teaching of generalized skills in vocational setting is that due to the changing requirements of vocational contracts in workshops clients need to learn quickly. Thus, if clients learn generalized responses, this would facilitate future acquisition and performance of jobs involving these

responses. Clients possessing a wide range of generalized skills will have increased chances at competitive employment (Bellamy, Inman & Schwartz, 1977; Horner & Bellamy, 1977).

Gold (1972) was one of the pioneers in the vocational field in training responses which would generalize to new tasks. He taught sixty-four retarded individuals to assemble a fifteen piece bicycle brake. The subjects were able to transfer their learning to the task of assembling a twenty-four piece bicycle brake. During the initial training task, half of the clients used color-coded pieces and reached criterion faster than those clients who used non-color coded parts. No color-coded parts were utilized in the second task. An effect was noted in that clients who relied on color-coded parts in the first training task took longer to master the second tasks. Although the difference was not significant, it seemed to indicate that clients had relied on the color-coding to complete the assembly task. Without it, they encountered difficulty. This and other research (i.e., Gold, 1976) paved the way for consideration of the important role of antecedent stimuli in the occasioning of a group of responses.

Prill (1977) investigated how use of tools--in this case a socket wrench set--might be taught by training tasks that incorporated a range of response and stimulus components. The subject was a thirty-three year old male with Downs Syndrome classified as profoundly retarded. A multiple baseline design was used to determine if training was related to the acquisition of specific tasks, and if training on some tasks transferred to untaught tasks. The results, as measured on pre- and post-training probes, demonstrated that training

of generalized responses did indeed improve the acquisition of specific tasks and that generalization to untrained tasks did occur. Generalization to new tasks seemed to be a function both of the similarity of new tasks to the previously trained tasks as well as the number of tasks trained. Thus, as Gagné (1965) and Ellis (1965) had stated, the more situations an individual encounters in training, the greater the probability of generalization.

Another study conducted with three severely retarded subjects (age range: 26-28) attempted to demonstrate and evaluate acquisition of a small parts sample-matching operation (Bellamy, et al., 1977). Performance was measured in untrained and reinforced tasks. Results from this study were generally encouraging: the development of the sample-matching operation was functionally related to specific training procedure, although generalization of matching responses was limited to the stimulus configuration of the sample's position. In general, however, Bellamy, et al. (1977) demonstrated that teaching individuals to discriminate in several different dimensions of a required tasks improved their performance on other related tasks.

A recent group study (N=15) was conducted by Walls, et al. (1981) in which developmentally disabled subjects were trained on either wood or mechanical generalized responses and then subsequently trained on two wood and two mechanical tasks. It was found that significant savings in both error and time occurred if subjects were first trained on the generalized responses incorporated in the tasks, rather than on just the tasks alone. This positive cost/benefit ratio lends support to the training of generalized responses.

The overall purpose behind the use of generalized responses is to design curricula in which a set of stimulus classes gain control over a class of responses, regardless of irrelevant variations within either of these classes (Bellamy, Wilson, Adler & Clarke, 1979). The focus of the previously mentioned vocational studies is that performance on novel tasks is functionally related to two variables--similarities of a new task to previously learned tasks, as well as the extent to which a general response with respect to stimuli (commonly referred to as a "concept") or to responses (referred to as an "operation") was learned in previous training (Becker, Engelmann & Thomas, 1975; Prill, 1977). Thus, performance of a generalized response might occur in spite of variation in either the stimulus situation or response characteristics.

Horner and Bellamy (1977) proposed a vocational training model for severely retarded individuals that involved teaching response topographies (i.e., specific movement or manipulations required to complete a task) and then bringing them under stimulus control. Becker, et al. (1978) suggested that operations be taught in a variety of orders so that individuals will not learn to respond to simuli in only one sequence. Additionally, they suggested a general class of skills be taught by chaining the component skills of that operation. Once mastered, it would then be more efficient to teach other skills by emphasizing concept(s) common to the whole class of skills. In this manner, an individual would master the components of one operation and would also learn the concepts that govern the class of skills. Thus, when presented with an operation that had not been taught, an

individual would be able to generalize to the new situation.

Four steps have been identified by Bellamy et al. (1979) in programming for the training of "operations" (in addition to being termed programming for "response generalization," Bellamy also refers to this method as "general case programming"): (a) Identifying component skills, (b) determining the antecedent stimulus and behavioral requirements, (c) sequencing instructional content and (d) designing instructional tasks.

The component skills are those classes of responses which result in the same effect on the environment, when performed appropriately. As noted earlier, these classes of responses may be topographically and/or functionally similar. When one specifies behavior requirements, one needs to determine what behavioral requirements, plus a range of topographical variation, are necessary to achieve the generalized responses. To determine the stimulus control requirements of a class of responses, one should analyze the environment to pinpoint the essential features for skill requirements. This step is particularly crucial in programming for generalization (Bellamy et al., 1979). Finally, when instructional content is sequenced shaping, physical and verbal prompting, as well as modeling are typically incorporated. To establish stimulus control, differential reinforcement is utilized while stimulus features are manipulated to facilitate discrimination of relevant dimensions (Bellamy et al., 1977), such as emphasizing a critical stimulus element. For example, the assistance of the trainer may be faded.

The Use of Generalized Responses Across Domains

The FCS model is intended to stimulate research both within and across several domains of behavior (i.e., self-help, sensory motor, socialization, language, academics, and vocational). The question here is how findings from the vocational domain may be applied to training within and across other skill domains. A consideration in the use of self-help skills is that the rationale for the teaching of generalized responses to facilitate clients' adaptation to changing work demands is not relevant. Performance of self-help skills (e.g., grooming, toileting, and dressing) may not need to be as flexible as vocational skills, since the latter may require frequent modification to accommodate various vocational contracts. It could be argued, however, that clients should be trained to adapt to a host of environments--such as in various living situations and different home and school settings, while interacting with teachers and peers, etc. Certainly, clients possessing a wide range of generalized component skills are more likely to adapt to community living.

A strong case could be made that our present technology of training skills in isolation may not be capitalizing on the overlapping responses common to many skills. A contributing factor to the typical approach of training skills independently of one another is the current use of task analysis in training and educational settings for the developmentally disabled. Mithaug (1979), in a comparison of task analysis and programmed instruction, emphasized that task analyses are useful only for specific outcomes. In other words,

the use of task analyses identifies the sequence for performing a given task. In contrast, programming instruction across tasks enables the coordination of skills in the performance of a wide range of related but different tasks. This idea is emplified by Holvoet et al. (1980) in their approach to training "walking on a line," as cited earlier. It is interesting to note that the possibilities of integrating task analyses of different but possibly related complex skills has been long overlooked. Over a decade ago, in human factors research, Fleishman (1967) emphasized that tasks should be described in terms of the common abilities required to perform them.

Thus, it might be useful to begin to develop research that will attempt to demonstrate empirically the extent of overlap between various complex skills that traditionally have been taught, and conceptualized, as separate. Since severely and profoundly handicapped individuals usually lack a myriad of skills required for independent functioning, then the grouping and instruction of skills within a comprehensive curriculum might eventually enable clients to acquire a number of diverse skills. Further, this approach would permit greater generalization and adaptation both to new settings and to instruction of novel complex skills.

A method by which to study this issue is to teach across complex skills composed of topographically similar sub-components. Although a functional analysis of the relation between responses might prove more useful eventually, the instruction of topographically similar responses is more immediately accessible. According to Johnston and Pennypacker (1980),

> . . . It is not always possible outside of the laboratory to follow the considerations urged by functional response definitions. The correlations of movement classes with stimulus classes may be multiple or too subtle for realistic detection . . . it is obviously possible to ignore such functional relations by using form alone as the desired definition of homogeneity for describing response classes. Specifications of a response class solely in terms of the form in three dimensional space of all instances constitutes a topographical definition. In one sense, this is an easy means of specifying the limits of response classes because the form of a response is often its most obvious characteristic. It is only necessary to describe some limits to the form, and observation is relatively straightforward . . . Complications may appear at later stages of the investigation, however, because topographical definitions may engender all of the difficulties by subsuming different functional response classes under a single topographically defined class. (Johnston & Pennypacker, 1980, p. 108)

A topographical approach might permit a preliminary analysis of the scope and outcomes of teaching a class of responses rather than the single instance of a response within only one task analysis. Furthermore, some valuable information might be discovered that will greatly enhance our knowledge base of how the instruction of a class of responses is related to other components subsumed under various complex skills.

The intended long-range goal of such an analysis, assuming some beneficial effects are reliably demonstrated, would be to improve the decision-making abilities of teachers and other professionals who plan and implement curricula for the severely and proufoundly handicapped. It might be demonstrated that, although existing normative developmental data is useful in planning some skill sequences for this population, more basic information about the relationship of non-normative skill sequences in fostering adaptive client change may

greatly enhance the construction of more effective curricula. In other words, not all stages and sequences of normative development need to be followed in order to teach developmentally disabled persons (Switzky et al., 1979). Research in programming across skills on the basis of topographical similarities of groups of responses, might minimize the need to teach non-essential skills thought to be pre-requisites. If a given disabled client requires insturction on a multitude of tasks, then related groups of complex skills, empirically demonstrated to be related in terms of sub-component responses, could be taught simultaneously. In order to employ this type of programming, complex skills trained should be socially validated as important for a client's improved adaptation to less restrictive environments.

A number of questions could be posed concerning the strategy of programming across various complex skills. There is a question as to how to define a response class (Johnston & Pennypacker, 1980 have said, "An arbitrary criterion for response class membership may be avoided by referring to the optimum orderliness of changes in the correlations as stimuli and responses are added or subtracted from the classes. Individual responses sharing classes of defining stimulus properties constitute generic response classes," p. 101).

A second question is to whether topographical similarity is an adequate criterion for conceptualizing a group of responses as being related, or if a functional analysis will be necessary. Third, is the notion that various complex tasks are related, as indicated by topographically similar sub-components. If so, how can this similarity

best be utilized in an attempt to train across a number of related skills?

It will not be feasible to provide definitive answers to these questions with a single research project. A number of assumptions, however, could be posited and empirically tested. From both a logical and theoretical perspective, it would seem that some complex skills apparently have a number of related or identical component steps. One could begin by assuming that this similarity indeed exists. However, it might be quite some time before an adequate and sufficient technology of teaching is developed to capitalize on best promoting the use of similarity of sub-components while instructing across tasks.

The primary purpose of this study was to examine specifically how programming instruction across a number of sub-components, which seem to be topographically related, may influence the rate of acquisition of a set of complex skills. Each of the "related" sub-components were taught by varying antecedent stimuli that were not identical to the materials needed for each complex skill. This approach was taken to assess the effect of this training on transfer across skills, as well as on the acquistion of each specific complex skill. Afterwards, the unique components of a particular complex skill that remained were trained in order to assess how subsequent training of single-stimulus instances contributed to learning the skills. Additionally, this latter step was designed to assure that each client attained a relative level of independence in performance of the complex skills.

CHAPTER II

METHOD

Subjects

Two women, designated as profoundly retarded, participated in the training procedures of this study. Both clients resided in a large residential institution in Massachusetts and have lived there since early childhood (average length of institutionalization: 39 years). Client #1, aged 49, was diagnosed as having epilepsy, although her seizures have been under control for the last five years. Overall, her vision is quite poor. She has one bilateral cataract, a dislocated disc in the other eye, and is described as legally blind. A Vineland Social Maturity Scale administered in March, 1980, yielded an age equivalent of 1.94 and a social quotient of 8. At present, client #1 is incontinent approximately 10% of the day.

Client #2, aged 42, had also been diagnosed as epileptic although her seizures have been controlled for twenty years. She is described as microcephalic and her vision is within normal limits. A Vineland Social Maturity Scale administered six years ago indicated a social quotient of 7. Client #2 currently is incontinent about 25% of the time. It was indicated in both clients' program plans that additional training in self-help skills was a priority.

Signed informed consent forms were obtained from the clients'

social worker, and the nature of the study was explained to them.

Setting

A small room, approximately 2.09 x 2.7 m in size was used to conduct all the operations training as well as the training of three of the four complex skills. The furnishings included a table, several chairs, and two bureaus. Training materials were kept in the bureau and taken out, when appropriate, to teach a particular skill. It was necessary to train the fourth complex skill in a bathroom, also approximately 2.09 x 2.7 m in size, located adjacent to the training room.

The sessions were scheduled approximately three afternoons per week, between the hours of 2:00 and 4:30 PM. Sessions lasted 30 to 45 minutes per client depending on the particular phase of the study. The clients were accompanied by the experimenter from their third floor day hall to the training rooms, which were located on the second floor of the unit.

Beginning with session 40 for client #1 and session 30 for client # 2, renovations conducted on site necessitated a move to a second training room which was used for the remainder of the study. This was a large L-shaped room, approximately 6.1 x 3.6 cm in size. The room contained a long, oblong table and chairs, a sofa and a rocking chair. Additionally, open shelves lined two of the walls. Sheets were placed in front of the shelves to keep the various materials on the shelf from distracting the clients.

The bathroom setting remained the same throughout the study,

with one exception. During the last follow-up probe for client #1 for toothbrushing, and the one follow-up conducted for client #2, another bathroom was utilized to assess generalization of training. It was essentially a mirror-image of the bathroom in which training was conducted.

Experimenter and Observers

The experimenter, a doctoral student in educational psychology and developmental disabilities, conducted all the training procedures and collected data. Three undergraduate psychology majors were also present, at different times, to collect inter-observer agreement data. Each of these three research assistants received instruction within applied behavior analysis prior to data collection. More specifically, they were taught observational techniques, research design, reinforcement, stimulus control, as well as shaping and chaining. One of the assistants also aided in the training of component responses during the operations phases, to provide the clients with the experience of receiving instruction from a second trainer.

For the last follow-up sessions conducted for each skill, a fourth observer was present. He was the clients' regular psychologist in the unit and held a master's degree in experimental psychology. Since he was naive to the outcomes of the study, his observations were valuable in assessing the effects of training.

The observers were present in the training room(s) during the phases of the study. They were instructed to avoid interacting with the clients. For the most part, all observers successfully kept their

eyes averted, attending to their stopwatches and clipboards when the clients looked over at them. The experimenter sat at one end of the table with a client to her immediate right. An observer was seated at the opposite end of the table, directly across from the experimenter.

Skills

Initially, a number of skills were assessed to determine which would be most beneficial for both clients to learn. The original focus of this study was on the teaching of self-help skills. The skills assessed included various dressing (i.e., pants, shirt, and jacket), hygiene (i.e., face washing, hair washing, hand washing, and hair combing), and pre-vocational skills (i.e., bagging objects in plastic bats with twist ties, packing boxes). A number of other skills were also considered (i.e., clothes washing, floor sweeping, bed making, and cooking skills), but were judged not feasible due to the lack of acceptable facilities. Regular personnel were responsible for cleaning and cooking duties for the clients.

A further complication was the experimental requirement that neither client could demonstrate any prior acquisition of the same four complex skills to be trained. This led to the rejection of dressing and hygiene skills. Additionally, the four skills required for this study needed to be grouped into two sets of related skills; that is, each pair of skills was required to share the same or similar topographical components.

The final four skills selected (two self-help, two leisure) were: toothbrushing, collage-making, shoe-tying, and pot-holder making.

A few direct care staff were informally polled and they all agreed that these skills would be useful. While there was no opportunity for the clients to engage in either collage-making or pot-holder making, it was hoped that follow-up negotiations with the recreational therapist might foster the programming of these and other leisure activities for the clients. During the course of the study, both clients typically spent the bulk of their time sitting on their own in the day hall, with no materials available to them. Due to the clients' low level of functioning, it was unlikely that they could engage in vocational training. Leisure activities, on the other hand, seemed justifiable since the clients could begin to spend their day more productively.

The training of self-help skills was potentially valuable for aiding the clients one day to reside within a less restrictive living situation. As with the leisure skills, the clients had no opportunity to brush their teeth independently or tie their sneakers. The staff literally performed both of these tasks for the clients, and these skills were not part of their general programming.

The skills were task analyzed into the following steps: toothbrushing, 14 steps; collage-making, 12 steps; shoe-tying, 11 steps, and pot-holder making, 19 steps. Table 1 lists the four task analyses. It should be noted that both recreational skills, collage-making, and pot-holder making include a number of repetitive steps. Therefore, although these repetitive steps were accounted for and scored on each task analysis, the number of independent steps (e.g., distinct component responses) differs from the total numbers of steps

TABLE 1

TASK ANALYSES OF FOUR COMPLEX SKILLS

TOOTHBRUSHING

1. Take toothbrush out of holder
2. Pick up toothpaste
3. Unscrew top
4. Place top on counter
5. Put paste on brush
6. Brush teeth
7. Turn on cold water
8. Rinse toothbrush
9. Fill cup with water
10. Rinse mouth
11. Turn off water
12. Wipe mouth and hands with towel
13. Replace toothpaste cap
14. Replace toothbrush in holder

COLLAGE-MAKING

1. Pick up jar of paste
2. Unscrew lid
3. Brush paste on paper
4. Place stick back in jar
5. Pick up cut-up paper piece
6. Place on pasted area
7. Press down firmly
8. Repeat steps 3-7
9. " " "
10. " " "
11. " " "
12. Screw lid back on jar

SHOE-TYING

1. Grasp a lace in each hand
2. Pull laces tight
3. Cross one lace over other
4. Hold intersection (w/ thumb & forefinger)
5. Pull left lace under & through
6. Pull both laces tight
7. Form left loop
8. Wrap right lace around right loop
9. Push right lace through opening
10. Grasp loop coming through
11. Pull both loops tight

POT HOLDER-MAKING

1. Pick up loop
2. Place one end on loom
3. Hold end on loom in place
4. Stretch & pull to other side
5. Attach other end on loom
6. Release hands
7. Repeat steps 1-6
8. " " "
9. " " "
10. " " "
11. Turn loom ¼ turn
12. Pick up loop
13. Place one end on loom
14. Weave through
15. Attach end on loom
16. Repeat steps 12-15
17. " " "
18. " " "
19. " " "

in these two tasks analyses. For instance, there are actually only eight distinct steps in pot-holder making since "pick up loop" is repeated twice, "place one end on loom" is repeated four times, and steps 7-10 and 12-15 are "repeat" steps of previous cycles. Similarly, collage-making also only incorporates eight distinct steps, not twelve. This also is due to the four "repeat" steps of earlier cycles (steps 8-11).

The materials needed for each of the four skills were:

1. Toothbrushing--toothbrush, holder for toothbrush, tooth-paste, plastic cup and towel.

2. Collage-making--8 1/2 x 11 inch sheet of colored construction paper, five cut-up paper pieces (approximately 2 x 2 inches in size, cut from different colored construction paper, and a jar of paste.

3. Shoe-tying--laces, shoes with eyelets.

4. Pot-holder making--multi-colored loops, a loom (brand name: HI-RISER) with one side containing higher prongs for easier weaving.

The criteria for what constituted a finished "collage" or "pot-holder" were scaled down for both of these skills. This decision was necessary due to the repetitiveness of steps needed to finish each skills, as well as to limit the length of time needed to complete both recrea-tional skills. Therefore, the criterion of five cut-up paper pieces pasted on the larger construction paper sheet was used for collage-making. For pot-holder making, five loops stretched across the loom with five more loops laced perpendicularly through was selected.

Criteria for performance of toothbrushing and shoe-tying were also set. For toothbrushing, the actual step "brushes teeth" was minimized. If a client put the toothbrush to her teeth independently and brushed for at least three seconds, the step was considered "independent." The remaining steps needed to be performed without assistance, in the proper order, to be considered independently performed. For shoe-tying, assessment and training was always conducted on the right shoe. Both clients were sitting, with the right foot propped on an adjacent chair. Double knots were not taught.

Operations

As mentioned previously, the four complex skills had been separated into two groups of related skills, based on topographical similarities. Toothbrushing and collage-making comprised the first pair whereas shoe-tying and pot-holder making constituted the second. Table 2 indicates some of the component response similarities between these "related" pairs of skills.

The rule for selecting which "operations" or related component responses to train was derived from assessment of baseline data for each client. The responses used were those that each client could not demonstrate independently. Both clients needed to work on the same operations for all four tasks. For collage-making and toothbrushing, the operations designated for training were: (1) opening caps, (2) closing caps, (3) picking objects up, and (4) placing objects down. For shoe-tying and pot-holder making, the four component responses seemed to be arranged in a more hierarchical order of difficulty:

TABLE 2

RELATED COMPONENTS OF COMPLEX SKILLS

TOOTHBRUSHING

1. Opening tube of toothpaste
2. Applying paste to brush
3. Placing cap down on sink
4. Picking up (materials)
5. Closing tube of toothpaste

COLLAGE-MAKING

1. Opening jar of paste
2. Applying paste to paper
3. Placing stick back in jar
4. Picking up (materials)
5. Closing jar of paste

SHOE-TYING

1. Pulling laces tight
2. Grasping lace w/ thumb & forefinger
3. Wrapping one lace around other
4. Pulling loops to finish bow

POT HOLDER-MAKING

1. Stretching loop
2. Grasping loop w/ thumb & forefinger*
3. Pull one loop over other*
4. Pulling loop from under another*

* during weaving

(1) grasping with both hands, (2) pulling with both hands, (3) wrapping one lace over another, and (4) pulling with thumb and forefinger.

A stipulation set for the materials used during operations training was that these materials could not be exact duplicates of materials needed for skills training. In other words, although a paste jar was used during collage-making, and a tube of toothpaste during toothbrushing, no paste jars or toothpaste tubes were used during operations training. The bottles and jars used during this training differed both in size and color from those used in the training of the four complex skills.

Materials used for the operations training for toothbrushing and collage-making were: fifteen plastic bottles and tubes, of different colors, shapes, and thicknesses (height range: 2 to 13 inches), with lids or caps ranging in size from 1/4 inch to 3 inches in diameter; a pencil and pencil sharpener, and plastic bags with twist ties. The materials used for the operations training of pot-holder making and shoe-tying were: a 2 1/2' x 5" x 1/2" wooden board on which was tied one ribbon; ribbons that varied in color, width, and length, including ribbons 5/8 inch wide, grosgrain texture in assorted colors (i.e., red, blue, orange, green, yellow, and white), yarn ribbons, approximately 1/4 inch thickness in an assortment of colors, and finally, black and white plain shoe laces which were wider and longer than the ordinary dark brown or black laces used in the actual training of shoe-tying.

Design

The design employed was essentially a multiple-baseline of two pairs of related skills across subjects. There are many factors which could be controlled to some extent by the use of this type of intensive design. History, maturation, and regression to the mean were less likely to be a threat to internal validity due to the inclusion of different baselines and changing experimental phases sequentially at different times. Further, other threats such as instrumentation and testing were minimized through the uses of repeated measurement and inter-observer agreement.

The phases of the study were as follows (see Table 3): Baseline 1 consisted of probes (Horner & Baer, 1978) on the prompting levels necessary to occasion each of the four complex skills. Client #1 received the following skills order: collage-making, toothbrushing, pot-holder making, and shoe-tying. During the Baseline 2 phase, the skills order was randomized. A random order of skills was generated by the investigator and two of her research assistants. This was accomplished by writing either COLLAGE, TOOTH, POT H, or SHOE on four pieces of paper, mixing well, and selecting one paper at a time. This process (i.e., mixing well and selection of papers) was completed for each skill order. A list of different random orders was compiled for each client. This Baseline 2 phase evolved after the initiation of the study to control possible order effects in the presentation of skills. The random sequence of skills was used throughout the remainder of the study. If, for example, only two skills were probed

TABLE 3

THE EXPERIMENTAL DESIGN

Baseline 1:	Assessments (probes) on each of the four skills.
Baseline 2:	Same as Baseline 1, except the order in which the skills were assessed was randomized.
Operations:	Related components to a pair of skills taught, using a range of materials which differed from those required to perform the target skills.
Training:	Chaining components unique to a particular target skill.
Follow-up:	Collected either 2 1/2 or 5 months after training on a given skill was terminated.

on a given day, the order for these two skills was taken from the random skill sequence for that particular day. With the exception of the random order, this phase was the same as Baseline 1.

During the first Operations phase, client #1 received training on the related components of collage-making and toothbrushing which baseline measurement indicated she could not demonstrate independently. These operations were: opening, closing, picking up and putting down. Probe sessions were also conducted during this phase, after the client had demonstrated independent acquisition of an operation. These probes were conducted to determine the effect of operations training on the attainment of collage-making and tooth-brushing, before direct training was initiated.

Next, a Training phase was begun with collage-making, while a return to Baseline 2 was conducted with toothbrushing. This phase consisted of backward chaining of the responses in toothbrushing, as well as training responses unique to that complex skill. Since only single instances of component responses were now being trained for collage-making, one could determine if there were possible carry-over effects to performance in toothbrushing. Once training for collage-making reflected near-criterion levels, training was then commenced on the related complex skill (i.e., toothbrushing).

Finally, another Operations phase was conducted for the second pair of complex skills--pot-holder making and shoe-tying. Again, probes were conducted when the client had demonstrated mastery of one operation. As in the earlier phases of the study, Training took place for pot-holder making while Baseline 2 probes were conducted for

shoe-tying. Once training on pot-holder making reached an independent level that was judged to be clinically significant when compared with baseline measurements, training commenced on shoe-tying as well.

Follow-up data were collected for all four complex skills. For client #1, the first probe for collage-making and toothbrushing as well as the probes on pot-holder making and shoe-tying were conducted 2 1/2 months following termination of training. The second probe for collage-making and toothbrushing represented 5 month follow-ups.

Client #2 received the same sequences of phases with three exceptions. First of all, she initially was given a different task order for Baseline 1--pot-holder making, shoe-tying, collage-making, and toothbrushing. Secondly, she received a longer Baseline 2 phase initially than client #1 to allow for an across subjects comparison. Third, she received operations training with the second pair of related skills--pot-holder making and shoe-tying--first. Once training of these two skills was terminated, she received operations training on toothbrushing and collage-making.

Measurement

During baseline and training of each of the four complex skills, each step was scored as either independent (I), verbal (V), gesture (G) or physical (P). A step was scored independent if the client performed that step with no prompting from the trainer, verbal if a verbal prompt was needed to occasion that response, gesture if the trainer either pointed to or modeled a response, or physical if some

degree of physical assistance was needed to occasion the response.

Examples of independent responding stipulated every component response for the four complex skills at the beginning of the study. Most importantly were a response performed appropriately, it could not be scored as independent if it deviated from the sequence set by the task analysis. For example, suppose a client independently picked up a towel to wipe her face after brushing her teeth (see Table 1) and neglected to rinse her mouth and turn off the water. If later on she needed a gestural prompt to occasion picking up the towel after turning off the water, wiping mouth with towel was scored as "G."

In addition, the beginning and end time of each probe on a particular skills were recorded to determine a duration measure for each skill per session.

Measurement was also conducted for operations training. Individual responses were scored as either independent, verbal, gesture, or physical. However, a varying number of trials were conducted on the training of various operations. The total time spent on operations training, as well as the time spent on trials during training of a particular operation, was also recorded.

Inter-Observer Agreement

Inter-observer indices were calculated for each of the four skills, and for both clients. These agreements were interspersed through all phases of the study. The amount of agreement was calculated by comparing the trainer's and observers' prompting levels for each step in a task analysis. Prompting levels needed to be exact to

be considered as agreement. For example, in toothbrushing comparisons were made to determine whether or not the same prompting levels were assigned to each of the steps. If the trainer had scored "V" on "fill cup with water" and the scorer had scored the same step as "G," then this was designated as a disagreement. Inter-observer percentages of agreement were calculated by dividing the number of agreements by the number of agreements and disagreements and then multiplying by 100.

Twenty-one probe sessions were conducted on collage-making for client #1, with inter-observer agreement probes calculated for twelve of these sessions. Agreements ranged from 76% to 100% ($\overline{X}$ = 89%; median = 88%). For toothbrushing, inter-observer agreement was calculated for fifteen of the twenty-nine sessions (range: 83% to 100%; $\overline{X}$ = 90%; median = 90%). Fourteen of the thirty-seven probes for pot-holder making were scored by observers, the range being 88% to 100% ($\overline{X}$ = 98%, median = 100%). Finally, inter-observer agreement was derived for fourteen of the forty-four probe sessions on shoe-tying, ranging from 91% to 100% ($\overline{X}$ = 99%; median = 100%). In general, the more physical prompting required in a given task, the better the inter-observer agreement indices.

For client #2, inter-observer agreements were derived for 8 of the fourteen probes on pot-holder making, all yielding agreement indices of 100%. Similarly, 8 indices were also derived for the fourteen probes on shoe-tying, ranging from 91% to 100% ($\overline{X}$ = 99%; median = 100%). For collage-making, eleven inter-observer agreements were conducted during the thirty-one probe sessions (range: 75% -

100%; $\bar{X}$ = 89%; median = 87.5%). For toothbrushing, eleven of the thirty-eight sessions yielded a range of 77% - 100% ($\bar{X}$ = 89%; median = 92%).

Inter-observer agreements were also calculated for duration measurement for each of the four complex skills. This index was derived by dividing the lower duration (in seconds) by the higher duration (also in seconds). The following indices were calculated for client #1: collage-making--thirteen of twenty-one sessions, range, 80% to 100% ($\bar{X}$ = 92%; median = 94.5%); pot-holder making--thirteen of thirty-six probes for duration, range, 81% to 100% ($\bar{X}$ = 96%; median = 99% and shoe-tying--twelve of forty-four probes, range, 78% to 99% ($\bar{X}$ = 80%; median = 83%).

For client #2, the various indices were as follows: pot-holder making--eight of thirteen recorded durations, range, 86% to 99% ($\bar{X}$ = 96%; median = 98%); shoe-tying--nine of fourteen durations, range, 75% to 99% ($\bar{X}$ = 88%; median = 91%); collage-making--twelve of thirty-one probe sessions, range, 92% to 99% ($\bar{X}$ = 98%; median = 99%) and finally toothbrushing--twelve of thirty-seven duration measures, range, 85% to 99% ($\bar{X}$ = 94%; median = 96%).

Assessment Procedures (Complex Skills)

A general format was adhered to during the assessment of the four complex skills for both clients. The general overall procedure for conducting probes on collage-making, toothbrushing, pot-holder making, and shoe-tying was as follows:

Arrangement of training room. The trainer would place the materials in several drawers of the bureau. Only materials pertinent to assessment of a particular skill were left on the table. After assessment of a given skill, those materials were placed back in the bureau and the second set of materials were withdrawn, and so on. This procedure was followed consistently to minimize distractions for both clients. If the skill to be assessed was toothbrushing, the appropriate materials were taken to the bathroom. In this case, the materials were placed on the sink, and the towel was hung on an adjacent partition.

Similarly, in the second training room (acquired after the first one was lost due to renovations) materials were placed on the open shelves and were hidden behind the hanging sheet. Materials were also withdrawn and replaced to assess one skill at a time.

Sequencing of skills. The trainer determined in what order skills would be assessed at a given session. As mentioned previously, during Baseline 1, client #1 and client #2 each followed a different pre-set order of skills. Beginning with session 5, a random order of skills assessment was followed. One hundred random orderings of skills had been generated for each client. The trainer only needed to look at a clients' list and follow the next random order for that session.

Sequencing of general procedure. All probes on skills were conducted first, before any operations training or skills training was conducted at a given session. It soon became apparent that there was a limit of

45 minutes during which each client could attend to task in a session. Thus, although it was originally intended to probe on all four skills at each session in addition to any scheduled training, probes began to be held more sporadically to allow more time for training (i.e., one probe every third training session or so).

Reinforcement. Praise was delivered during each of the probe sessions to promote optimum client performance. Praise was not delivered contingent upon specific responses of the complex skills; instead, it was delivered specifically for attending to task, sitting in chair, and so on. Typical comments such as, "you're sitting very nicely" and "you're working very well" were given intermittently during the course of the assessments. The numbers of statements ranged from 1 - 2 for shoe-tying, which took only about a minute to assess, and 4 - 6 for the remaining three skills.

Specifics of probes. Performance on the skills was assessed throughout all phases of the study. A verbal prompt was delivered to occasion the overall skill (i.e., "____, brush your teeth"; "____, make a collage"; "____, make a pot-holder"; or "____, tie your shoe"). The trainer would then wait three seconds to determine whether or not the client would independently carry out the first step of a given task. If the step had not been initiated within three seconds, a verbal prompt was given for the first specific response (i.e., "pick up the toothbrush"). After another three seconds, a verbal prompt would be delivered along with a gestural prompt. Finally, if the gesture failed to occasion the response, the least intrusive physical prompt necessary to occasion

the response would be given. The particular step would then be scored as I, V, G, or P, indicating the most intrusive prompt used. The remaining components of each complex skill were assessed in this manner until the chain was completed.

Pacing prompts. Two general pacing prompts were used in each session, if necessary, throughout all phases of the study. These prompts consisted of the query "what's next?" and were not recorded as a verbal prompt. They were used to keep a client on task.

Rapidity. Assessment and training (both operations and skills) occurred as quickly as possible. The three second criterion was rigidly adhered to during all assessments. If a client lingered on a particular step, a prompt was given to occasion the next appropriate step. During training, successive approximations of speed in performance were reinforced. The time factor was an important consideration, in that the experimenter wanted to complete all aspects of assessment and training scheduled for a given day, lest the clients' attention wandered.

Operations Training (Collage-Making and Toothbrushing)

The generalized responses trained were: opening, closing, picking up, and putting down. For all these responses, the bottles were kept in a large plastic bag on the floor to the left of the trainer to be selected one at a time. Reinforcement delivered following correct responses was praise for client #1, caramel (canned condensed milk cooked down to a sweet, thick texture) or Sara Lee cheesecake for

client #2. From initial assessments of skills conducted before the initiation of the study (i.e., hygiene, dressing skills, etc.), praise was determined to be an adequate reinforcer for client #1. However, for client #2, praise did not function effectively as a reinforcer over time. A number of reinforcers were piloted for client #2 (beginning at session 21) but none proved successful. These reinforcers included apples, bananas, ice cream, pudding, crackers, cookies as well as a music box, tape recorder, walks, etc.). Finally, during a talk with her regular psychologist, he suggested cheesecake or caramel. He had used these successfully in the past. These reinforcers were tried, and either one was used for the remainder of the study in training collage-making and toothbrushing. The use of either of these reinforcers depended on availability at the institution.

Twice during this operations phase a second trainer also worked with each client. Additionally, after an operation was performed independently, the clients were also given twist ties (to twist or untwist around plastic bags) and pencils to sharpen in a hand-held pencil sharpener. These arranged to provide more varied circumstances for both the opening and closing responses.

A gradual shaping procedure was used along with various prompting levels to teach opening and closing. A bottle was placed in front of the client with a loosely paced cap (i.e., could simply be placed on the bottle). This step was repeated in as many trials as necessary to occasion "opening." Verbal, gestural, and then physical prompts were given as necessary, and the prompt level necessary to occasion each trial was recorded. Next, three other

different-sized bottles were placed before the client (one at a time) to test the generality of the "opening" response, again with a loosely placed cap.

Next, a bottle was placed in front of the client with a slightly tighter cap (ie., turned approximately 1/16 of an inch). Again, this step was taught with prompt levels gradually faded. As previously, different bottles were placed in front of the client, with the cap or lid at the same degree of tightness.

This same procedure was continued until caps were screwed on extremely firmly. When the client had demonstrated independent opening on all the different sized bottles for several sessions in a row, then the "opening" response was assessed less often to allow for more time to work on the other operations.

A similar format was conducted for the "closing" response. At first, simply placing the cap on a bottle was trained. Once the client could independently demonstrate this aspect of the closing response, three or four different sized bottles were introduced, one at a time. The positioning of a small cap proved to be exceedingly difficult for both clients. This step of the training consumed a large amount of time. Trials were conducted for each bottle, with the most intrusive prompt necessary recorded on the data sheet.

Next, gradually tighter and tighter approximations of twisting the cap closed were reinforced with different sized bottles. Prompting was also used as necessary.

"Picking up" and "Putting down" were less of a priority in training. Basically, different sized bottle caps were used to train

these responses. One size was used until independent responding occurred and then various sized caps were utilized, one by one.

Operations Training (pot-holder making and shoe-tying)

A board, approximately 2 1/2' x 5" x 1/2",was placed on the table, in front of the client. One ribbon was tied around the middle of the board. The remaining different-sized colored ribbons were kept in a plastic bag on the floor to the left of the trainer.

All four operations--"grasping with both hands," "grasping and pulling," "wrapping one lace over the other," and "pulling through" were taught through prompting. Both clients, for example, were first instructed to "hold the ribbons." A series of trials were conducted on this response, and the lowest prompt necessary to occasion each response was noted. When the response was demonstrated independently, different colored and/or sized ribbons were then used, one at a time. This same procedure was followed for "grasping and pulling."

The "wrapping around" response was defined as "holding one lace with thumb and forefinger, grasping the other lace with thumb and forefinger, and pulling it around the first lace." Similarly, other ribbons were used as independence increased.

Finally, the "pulling through" response consisted of "grabbing the knot with thumb and forefinger, grasping the other lace with thumb and forefinger, and bringing it under the knot. The fingers then released the lace and pulled it through from the other end of the knot." This response was similarly extended to different colored and/or

sized ribbons and laces.

Both clients' increased independence was followed by contingent praise for all four responses in this latter operations set. Also, a second trainer was utilized--once during this phase for each client.

Client #2 evidenced no systematic increases in learning either pot-holder making or shoe-tying. In addition to the number of reinforcers piloted at this time, other activities were attempted to strengthen her fine motor coordination: squeezing a clothespin, rolling a pencil between thumb and forefinger, a rubber band, and opening a latch on a change purse. Eventually, these operations sessions for client #2 were terminated.

Training (complex skills)

Training for each of the four complex skills was conducted by backward chaining. At the end of the chain, client #1 received praise while client #2 received caramel or cheesecake, in addition to praise.

The training step consisted of the last step in the task analysis which was not performed independently (as based on previous probes). This step was trained using the hierarcy of prompts ranging from verbal to physical. A client had to demonstrate a step independently before proceeding to the next step. This second step was then combined with the final step before reinforcement was delivered.

Steps which had been trained through operations training were generally demonstrated independently in the context of the skill. These steps were then quickly chained with the subsequent steps.

CHAPTER III

RESULTS

The following section is structured within a number of headings. First, the transformations of data section provides information concerning what data were plotted and why. Next, general results are presented to pinpoint the salient aspects of the data. Finally, each of the fifteen graphs are presented, by client, to provide a closer look at the specific findings and variations across clients.

Transformations of Data

Data were collected and plotted for both client #1 and client #2 in three basic forms--prompt levels necessary to occasion each of the four complex skills (collage-making, toothbrushing, pot-holder making, and shoe-tying) during baseline, operations and training sessions; prompt levels used during repeated trials of operations training of topographically related responses; as well as the duration for completing each complex skill throughout each phase of the study.

Prompt levels were used as a measure of the clients' independent acquisition of both the complex skills and the component responses, but were plotted in several ways to highlight different aspects of clients' performance. Primarily, independent acquisition was of most interest in demonstrating the efficacy of the training approach taken

in this study. Therefore, several figures were plotted solely in terms of percentage of independent performance. These data were transformed by determining the percentage of component responses (or "steps") within each skill that were demonstrated independently. Since the number of component responses varied between the complex skills (i.e., 8 component responses for collage-making and pot-holder making, 11 component responses for shoe-tying and 13 responses for toothbrushing) this necessarily provides a somewhat biased view of the amount of each skill actually demonstrated independently. Therefore, one figure for each client also each presents the same independent performances except that the data were graphed in terms of the number of independent steps the clients performed for each complex skill. And finally, one figure for each client reflects all four prompting levels necessary to occasion each complex skill. These figures provide a more sensitive presentation of the gradual shift to less intrusive prompts during the course of operations and training sessions. These data were plotted simply in terms of percentage of the total number of component responses for each prompt level. The total percentages of prompts for each session sum to 100%.

Operations training was only graphed by percentage by all four prompt levels. This was the most comprehensive way to represent these data, since the number of trials used during operations tended to vary from session to session. Each percentage for a particular prompt level was determined by calculating the percent of trials that particular prompt level represented for a given session.

Finally, duration during all phases of the study for each

complex skill was also plotted for both clients. This measure provided a rough estimate of the rate of the clients' performance as they each became less dependent on trainer assistance to complete the complex skills. Although this was a measure in some cases influenced by a host of variables, it did tend to provide another indication of the potential benefits of this training approach.

General Results

Baseline assessments for both client #1 and client #2 demonstrated a low level of independent performance in collage-making, toothbrushing, shoe-tying, and pot-holder making. Furthermore, a large percentage of physical prompting generally was needed to occasion each of these four complex skills.

As can be seen by referring to figures 1 and 8, operations training appeared to promote major increases in independent performance of the complex skills, despite the fact that materials used during this phase were not identical to those required to carry out the target complex skills, and that direct training of these complex skills had not yet been initiated. In other words, a great deal of generalization was evidenced in a pair of complex skills while operations training was taking place.

Direct training of one in a pair of complex skills was effective in training responses unique to that particular skill; however, little generalization occurred during this phase to the second complex skill of the related pair. This Training condition differed from operations training in that only single instances of the

component responses were taught.

In general, follow-up data tended to demonstrate good maintenance of independent performance of the complex skills, although the clients had no opportunity to practice these skills at their place of residence. Additionally, duration measures at follow-up sessions of each of the four skills were, in some cases, actually lower than times needed to perform the same skills during baseline. It is noteworthy that shorter durations or durations slightly longer than baseline assessments were achieved even though clients were performing at a clinically significant independent level.

Specific Results--Client #1

The data for client #1 are presented in Figures 1 through 7. Figure 1 reflects client #1's percentage of independent acquisition of the four complex skills--collage-making, toothbrushing, pot-holder making, and shoe-tying. As compared to baseline, probes conducted during all Operations phases demonstrated dramatic increases in independent performance of each complex skill. Client #1 demonstrated a high of 62.5% independent acquisition for collage-making, approximately 50% for both toothbrushing and pot-holder making and 27% for shoe-tying during this phase.

Specific training of the components pertinent to a particular skill was effective in promoting evidence of still further independence as compared to operations training sessions. During Training sessions of both collage-making and pot-holder making, there was not the same amount of generality to the related skills (e.g., toothbrushing and

Figure 1. Percentage of independent acquisition of collage-making, toothbrushing, pot holder-making and shoe-tying for client #1.

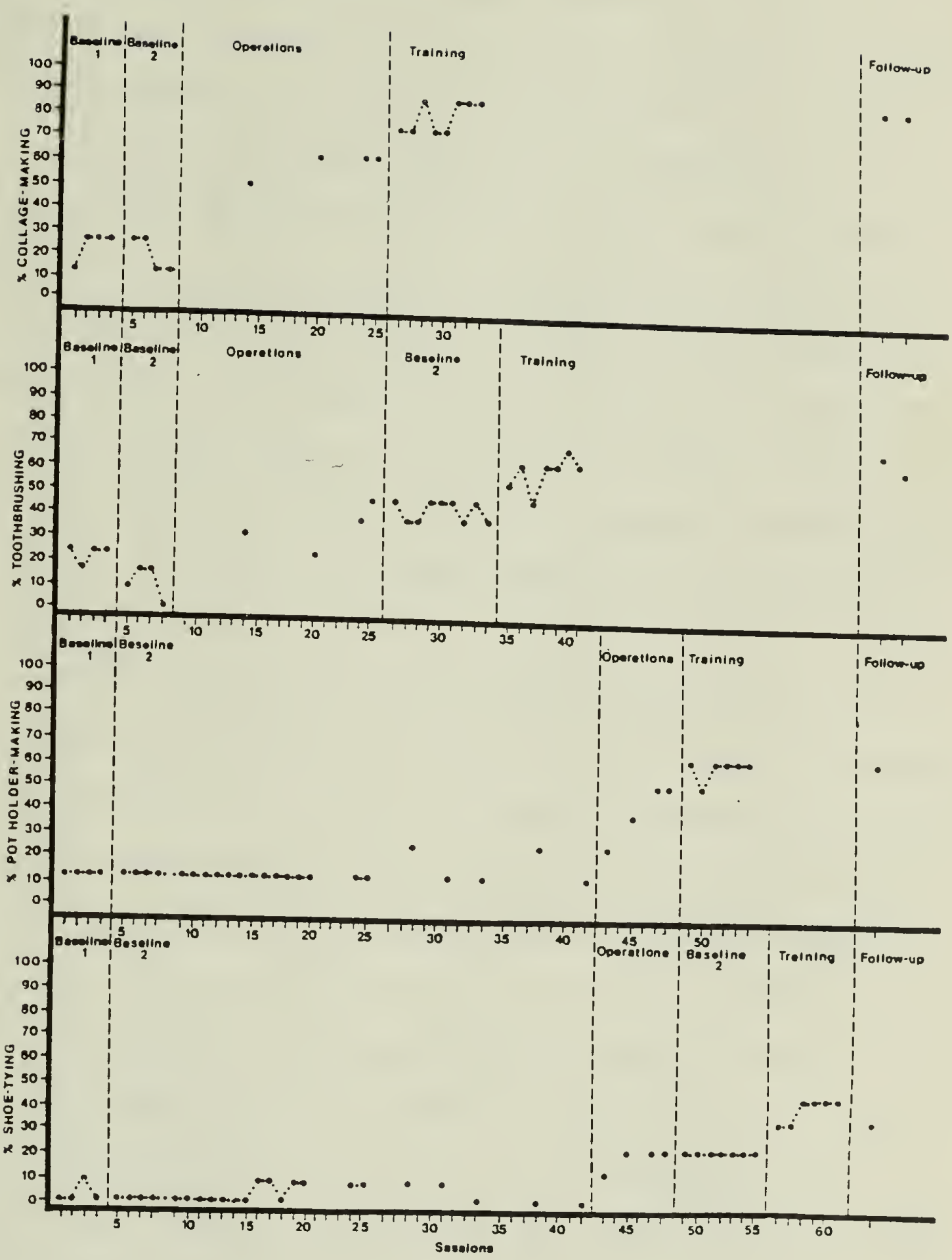
% COLLAGE-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
% TOOTHBRUSHING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
% POT HOLDER-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
% SHOE-TYING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
Sessions

Fig. 1.

shoe-tying, respectively) as demonstrated during Operations. Recall that during these Training phases, the trainer was now teaching specific component responses by single instance which did not appear to share any topographical relatedness to the other skill of the pair.

Training of the second related skill--toothbrushing and shoe-tying--again demonstrated increases in independent acquisition of those skills. Follow-up data at 2 1/2 and 5 month intervals for collage-making and toothbrushing and 2 1/2 month intervals for pot-holder making and shoe-tying demonstrated retention of the highest skill level atatined during training for three of the four skills. There was a slight drop at the 2nd follow-up session for toothbrushing. This session was conducted in a novel bathroom and a new observer was also present.

Figure 2 presents the same independent acquisition data of the four skills for client #1, but in terms of the numbers of component steps independently demonstrated (as opposed to percentage acquisition). As mentioned previously, this type of presentation allows for a more accurate representation of the actual number of component responses independently performed in any phase of the study, as opposed to the potentially misleading percentage independent acquisition data.

For example, client #1 performed 6 component steps of tooth-brushing independently by session 25 during the Operations phase. Note that only 5 steps of collage-making were achieved during the same Operations phase, while in Figure 1 the percentages achieved during Operations seem greater for collage-making than toothbrushing due to the lesser number of steps in the former. Similarly, although the

Figure 2. Number of component steps independently demonstrated for the four complex skills, for client #1.

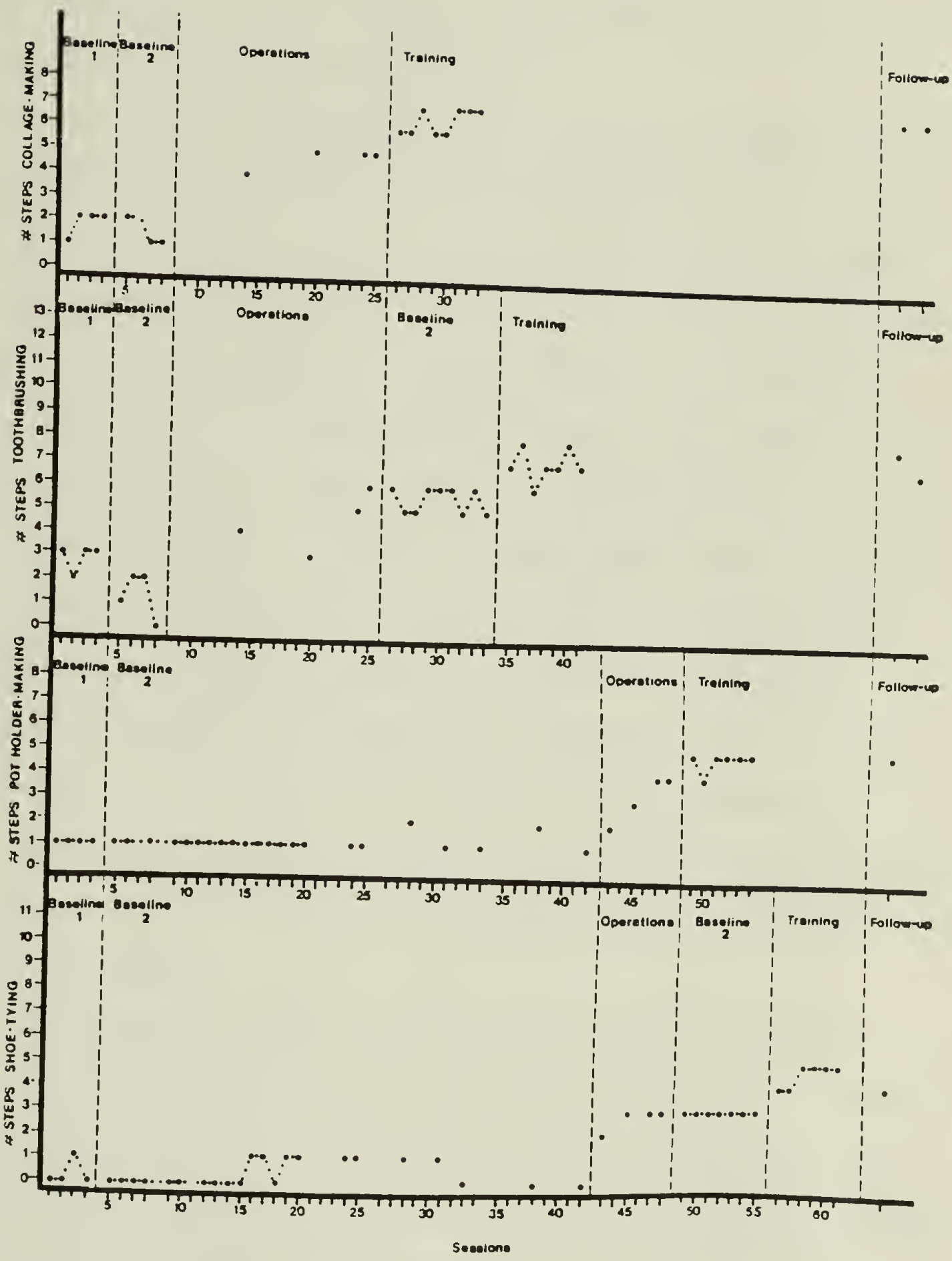
STEPS COLLAGE-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
STEPS TOOTHBRUSHING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
STEPS POT HOLDER-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
STEPS SHOE-TYING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
Sessions

Fig. 2.

client demonstrated 88% of collage-making independently during Training, this was in actuality an achievement of 7 steps. In comparison, the client's performance was as high as 9 steps during toothbrushing although this was only 69% of this skill.

For both pot-holder making and shoe-tying, the client reached 5 independent steps for both skills during Training sessions. Again, in terms of percentages, client #1 had achieved 62.5% of pot-holder making as opposed to only 45% of shoe-tying despite having independently demonstrated the same number of component responses in both skills.

Figure 3 depicts percentage acquisition of the complex tasks by three prompt levels--verbal, gesture, and physical--as well as independent percentage. Overall, the three prompt levels decreased during independent acquisition of the four skills, especially for collage-making and toothbrushing. The lowest level of physical prompting was achieved and subsequently maintained at both follow-up sessions for collage-making. The remaining three complex skills still required a substantial amount of physical assistance by the termination of training, although the levels of physical prompting were lower than baseline assessments.

Most notable is that client #1 began to position both the toothpaste cap and the paste jar lid independently in the context of toothbrushing and collage-making by session 20. However, she failed to firmly close both of these lids according to the original criterion developed for this study. The component step "closing" was not originally broken down to two more basic components--"positioning" and then "twisting firmly closed" in the task analysis. Rather than

Figure 3. Percentage acquisition of the four complex skills by three prompt levels--verbal, gesture and physical--as well as independent percentage, for client #1. The totals of prompt level percentages per session sum to 100%.

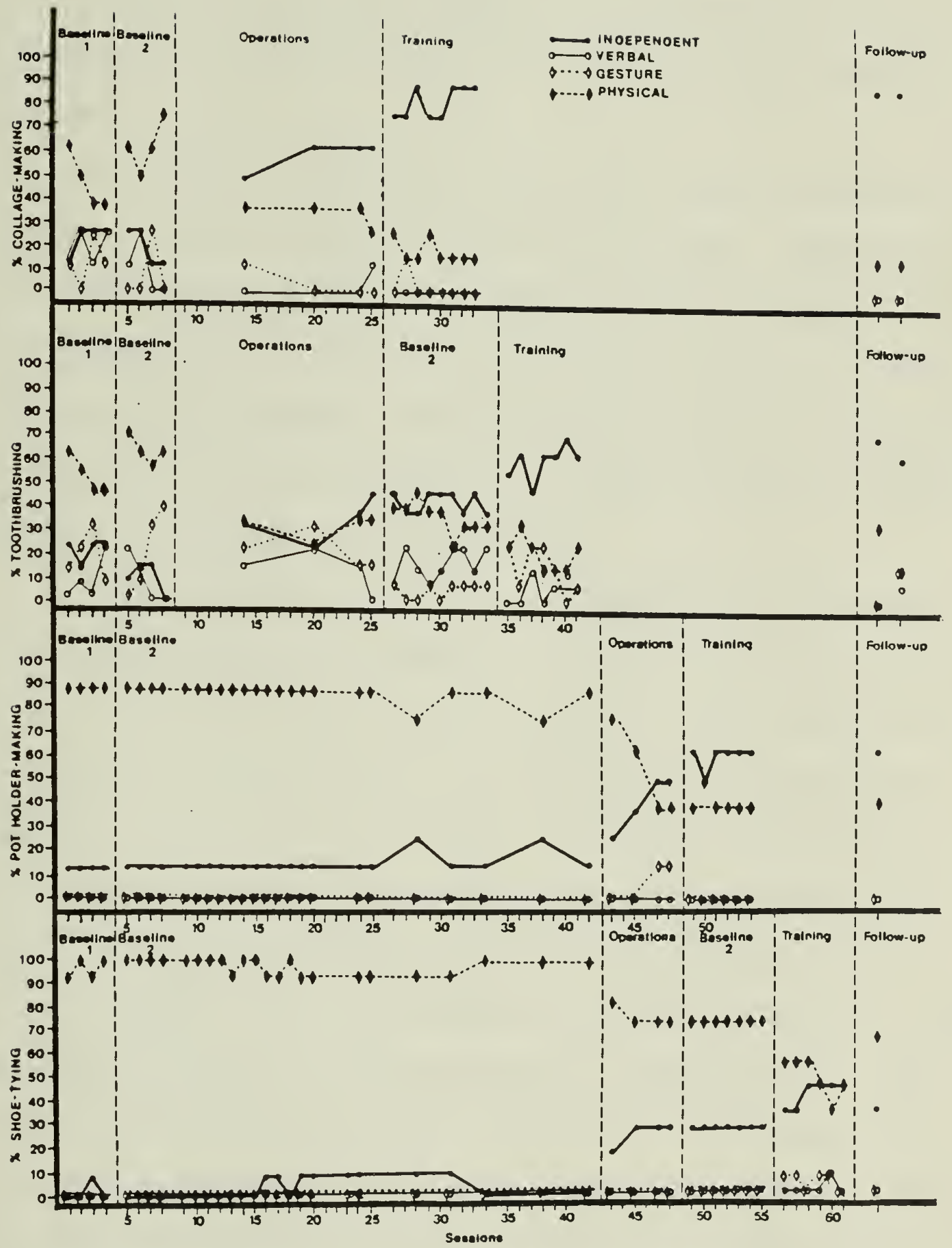
Baseline 1
Baseline 2
Operations
Training
Follow-up
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
% COLLAGE-MAKING
% TOOTHBRUSHING
% POT HOLDER-MAKING
% SHOE-TYING
Sessions

Fig. 3.

change the original criterion, the client was scored as needing physical prompting for closing despite her exhibiting greater independence in this response as compared to baseline. Thus, the amount of physical prompting reflected in Figure 3 for both collage-making and toothbrushing is an underestimate of the client's actual independent performance.

As for pot-holder making and shoe-tying, verbal and gestural prompts very rarely occasioned either of these skills. Approximately 9% of shoe-tying was occasioned by either of these two prompts during the Training phase, although it was necessary to drop back to physical prompting during follow-up. Generally speaking, component responses of pot-holder making and shoe-tying were either occasioned by physical prompts or were demonstrated independently.

Figure 4 depicts the operations training data of client #1 for the opening and closing responses, in terms of all four prompting levels. Each level is depicted as percentage of trials accomplished per operations training session, since the number of trials varied depending on the client's performance. Independent opening ranged from 0 to 100%, eventually remaining at this 100% level from session 15 onward. During sessions 19 and 20, the client was presented with extremely tightly closed bottles and opened these successfully. Since independent opening was reliably achieved by session 19, this operation was not conducted again until sessions 22 - 24, allowing more time for training different operations. Verbal prompting of closing ranged from 0% to 100%, but remained at the 0% level from session 15 onward. Gestural prompting stayed at the 0% level throughout the

Figure 4. Operations training for the opening and closing responses, by percentage of trials per prompt levels for client #1.

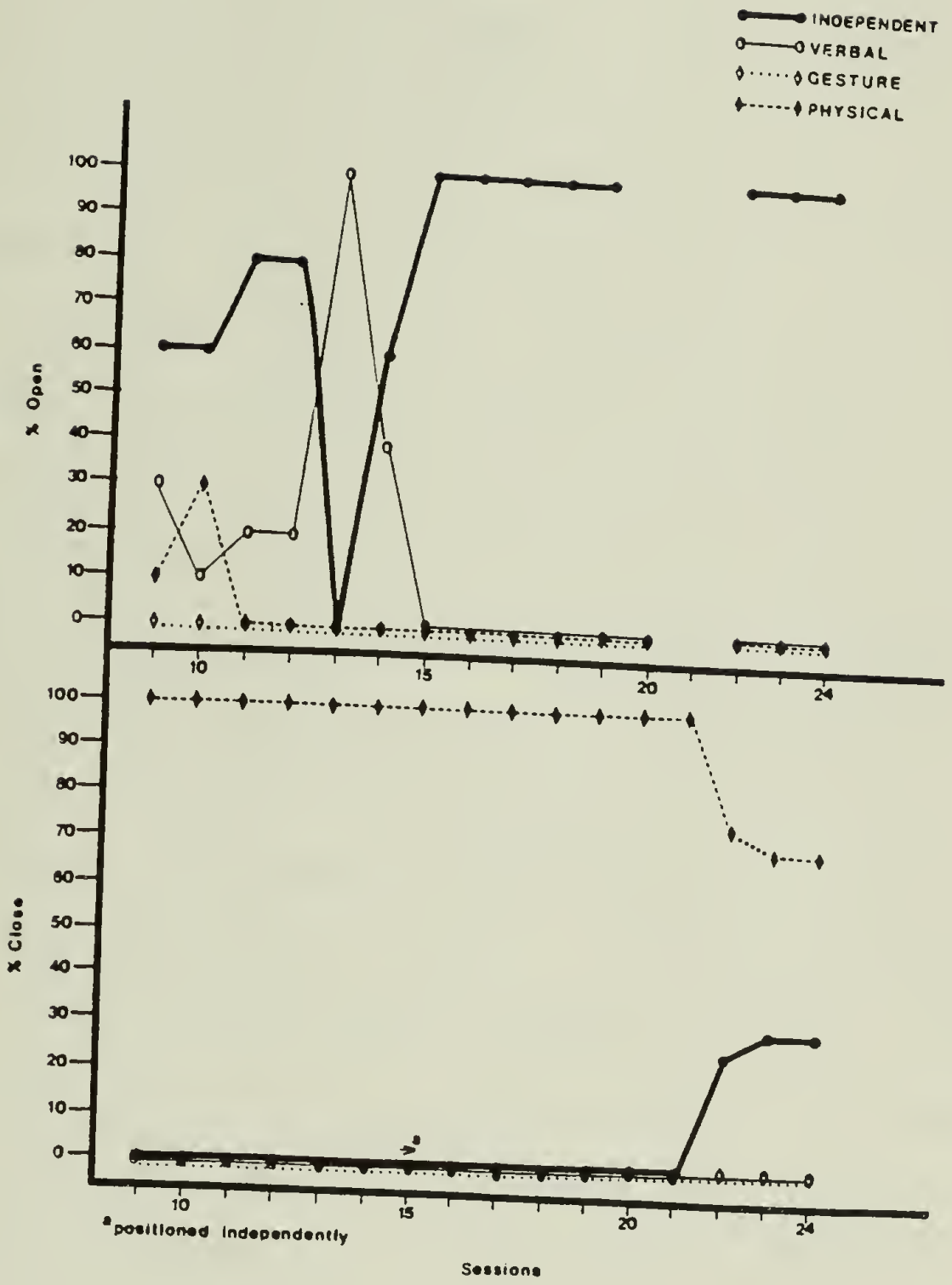
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
% Open
% Close
100
90
80
70
60
50
40
30
20
10
0
10
15
20
24
a
a positioned independently
Sessions

Fig. 4.

sessions. Physical prompting ranged from 0% to 30%, but was maintained at the 0% level beginning with session 11.

Independent performance of the closing response stayed at 0% until session 21, and increased to 30% on sessions 23 and 24 (it should be noted that the client began to position independently from session 15 onward, but encountered extreme difficulty in firmly closing the different sized caps. She typically would position the cap on the bottle, twist it several times but not to the point where it always was firmly closed. At session 24, it was decided to move ahead into training of collage-making since further work on closing seemed difficult to carry out at that time). Both verbal and gestural prompting remained at the 0% level during all closing operations sessions. Physical prompting stayed at 100%, and finally decreased to 70% by sessions 23 and 24. Most importantly, the decision to initiate the collage-making Training phase was heavily influenced by the tremendous independent percentage increases in both collage-making and toothbrushing (refer to Figure 1). The other two operations trained during the first Operations phase for client #1, "putting down" and "picking up" are reflected in Figure 5. By session 25, there was excellent responses to generalization probes in both tooth-brushing and collage-making; in other words, the client encountered little difficulty with "picking up" and "putting down" when appropriate to the context of the target complex skills, as compared to baseline. Physical prompting eventually decreased to 0% for both the picking up and putting down responses during the Operations sessions. Training on the picking up response was delayed until session 13 to

Figure 5. Operations training for the picking up and putting down responses, by percentage of trials per prompt level, for client #1.

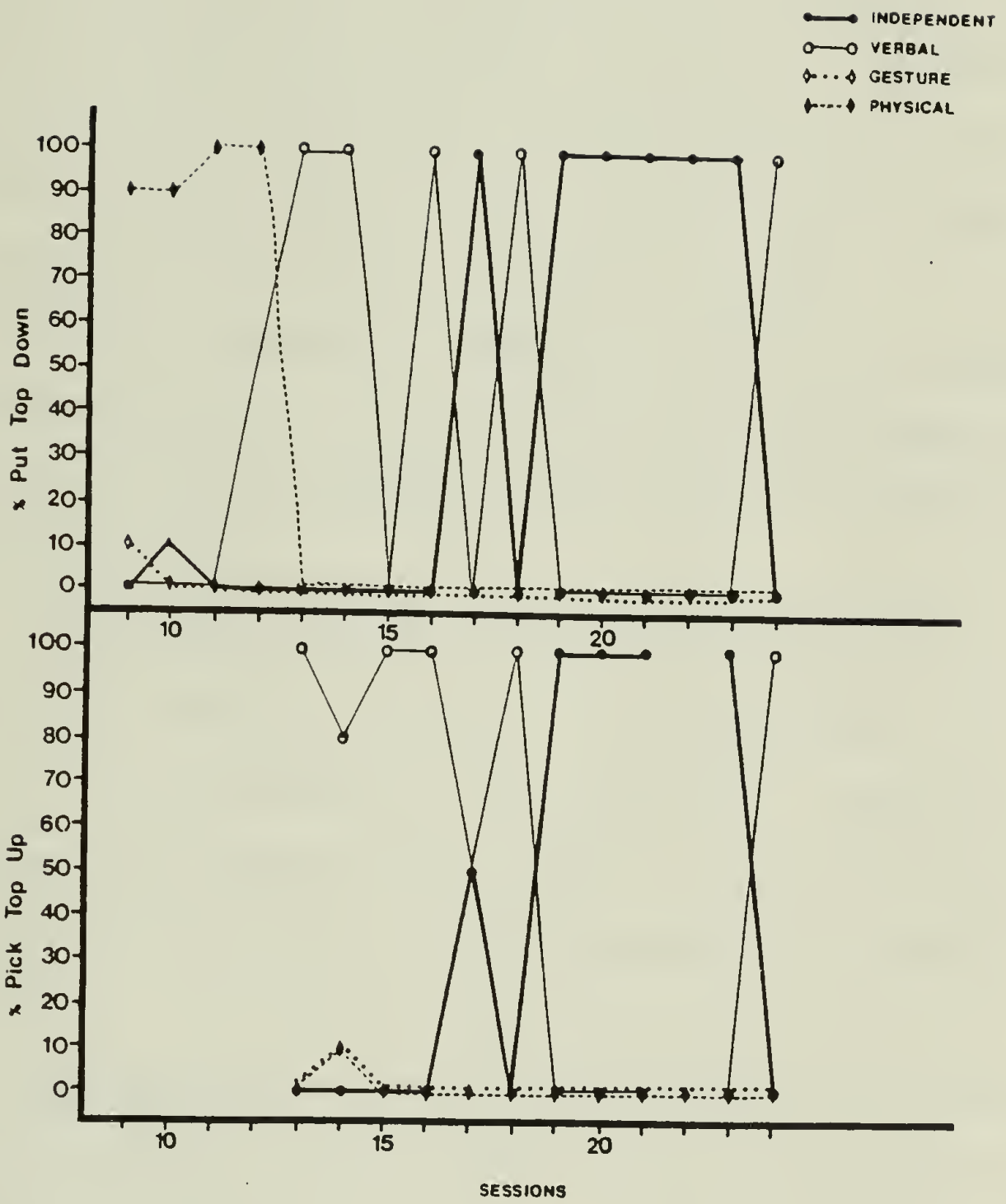
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
% Put Top Down
% Pick Top Up
100
90
80
70
60
50
40
30
20
10
0
10
15
20
SESSIONS

Fig. 5.

allow more time to work on opening, closing, and putting down.

The percentage of prompt levels for all four responses taught to client #1 during the second set of Operations are reflected in Figure 6. These four operations, which pertained to pot-holder making and shoe-tying, were: grasping, grasping and pulling, wrapping around and pulling through, as described previously. Independent grasping ranged from 0% to 100%, eventually maintained at the 0% level during sessions 46, 47, and 48. Physical prompting stayed at 0% throughout all these training sessions of grasping.

Likewise, independent "grasping and pulling" and "wrapping around" reached 100% by session 48. With both of these component responses, the initially necessary amount of physical prompting was gradually phased out.

Independent performance of the "pulling through" component response never increased beyond 62.5%. Verbal prompting of this response eventually decreased to 0% by session 47. Considerable gestural prompting (25%) was still needed to occasion the response by session 48, whereas physical prompting decreased to a relatively low level (12.5%). A decision was made at this point, as with the earlier Operations phase, to continue with training of pot-holder making at session 48, despite the fact that "pulling through" was not performed at 100% independent level. It seemed that further training would need to be quite extensive. Again, the probes during the 2nd Operations phase on both pot-holder making and shoe-tying evidenced large increases as compared to baseline (see Figure 1).

Figure 7 depicts the number of minutes it took for client #1

Figure 6. Operations training for grasping, grasping and pulling, wrapping around and pulling through. These data refer to the second Operations phase conducted for client #1, and are depicted by percentage of trials per prompt level.

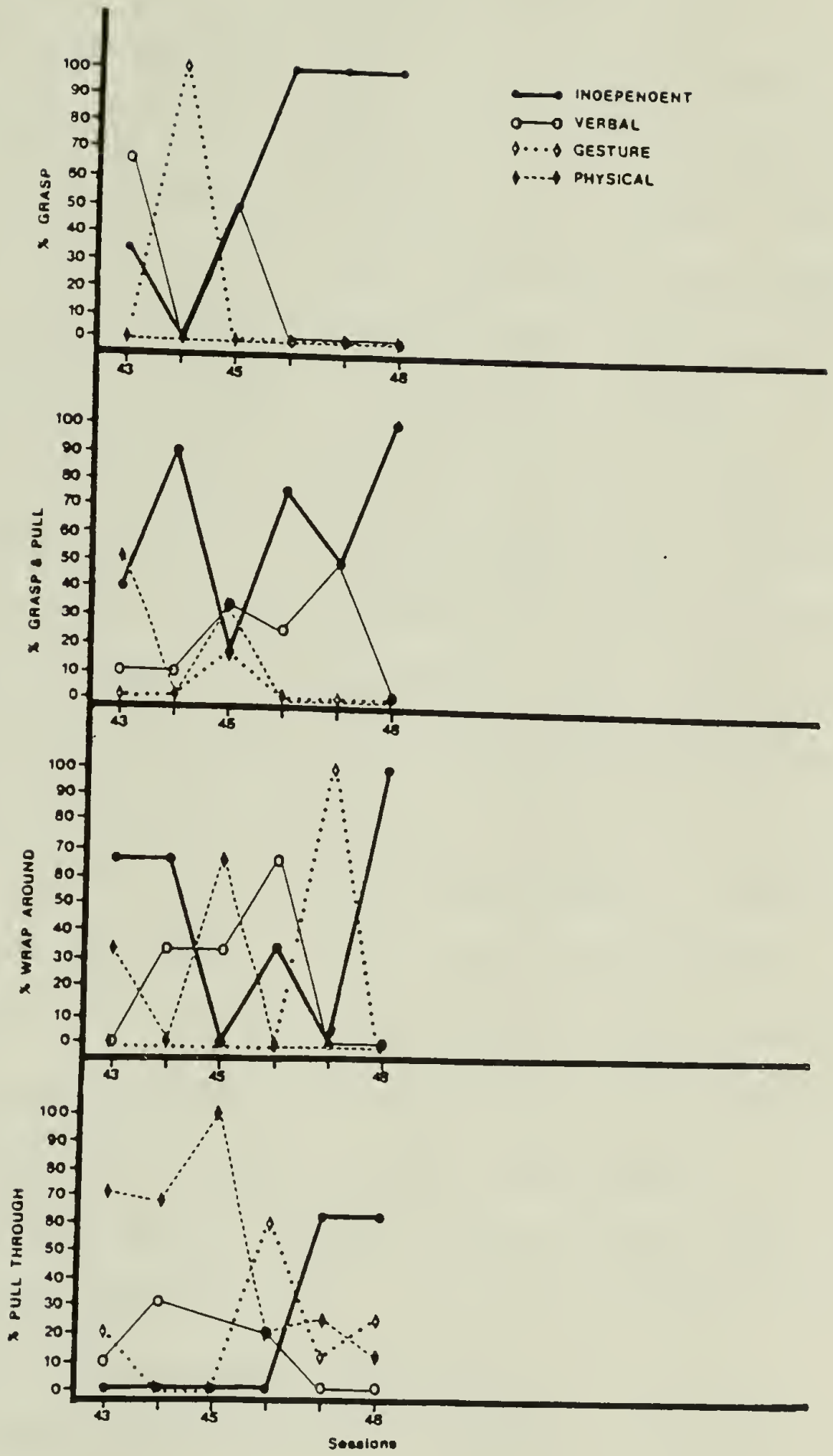
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
% GRASP
% GRASP & PULL
% WRAP AROUND
% PULL THROUGH
43
45
48
Sessions

Fig. 6.

to complete each of the four complex skills. As mentioned earlier, while the duration measure is subject to a number of influences (i.e., extraneous noises, presence of different observers, etc.) it is also an important rough estimate of the rate of client performance. Without wuch a measure, it would be difficult to evaluate the significance of the independent performances achieved. If, for example, overall performance of the complex skills took a great deal longer independently than with trainer assistance, the skills might not be maintained within the natural environment of the client's residence.

The most surprising results of the duration measure occurred during follow-up sessions. For collage-making, the client made the collage in 4' 55" when assessed during the 2 1/2 month follow-up and in 5' 27" at the 5 month follow-up session. These follow-up duration measures were well within the baseline durations limits which ranged from 3' 53" to 5' 20" during Baseline 1 and 4' 30" to 5' 47" during Baseline 2. These follow-up durations were dramatic, especially since the client also performed at the 88% level of independence.

Similarly, follow-up durations for toothbrushing were even more impressive. Both follow-ups, 3' 50" and 3' 24" respectively at 2 1/2 and 5 months were both lower than during baseline. It is also noteworthy that an entirely different bathroom (mirror-image) was utilized at the 5 month follow-up, and yet this particular duration was the lowest of all toothbrushing measures.

The time it took client #1 to complete a pot-holder at the 2 1/2 month follow-up was 5' 20", which was also within baseline levels (range: 3' 07" to 5' 45") albeit towards the higher end of the

Figure 7. Duration to complete each of the four complex skills, for client #1.

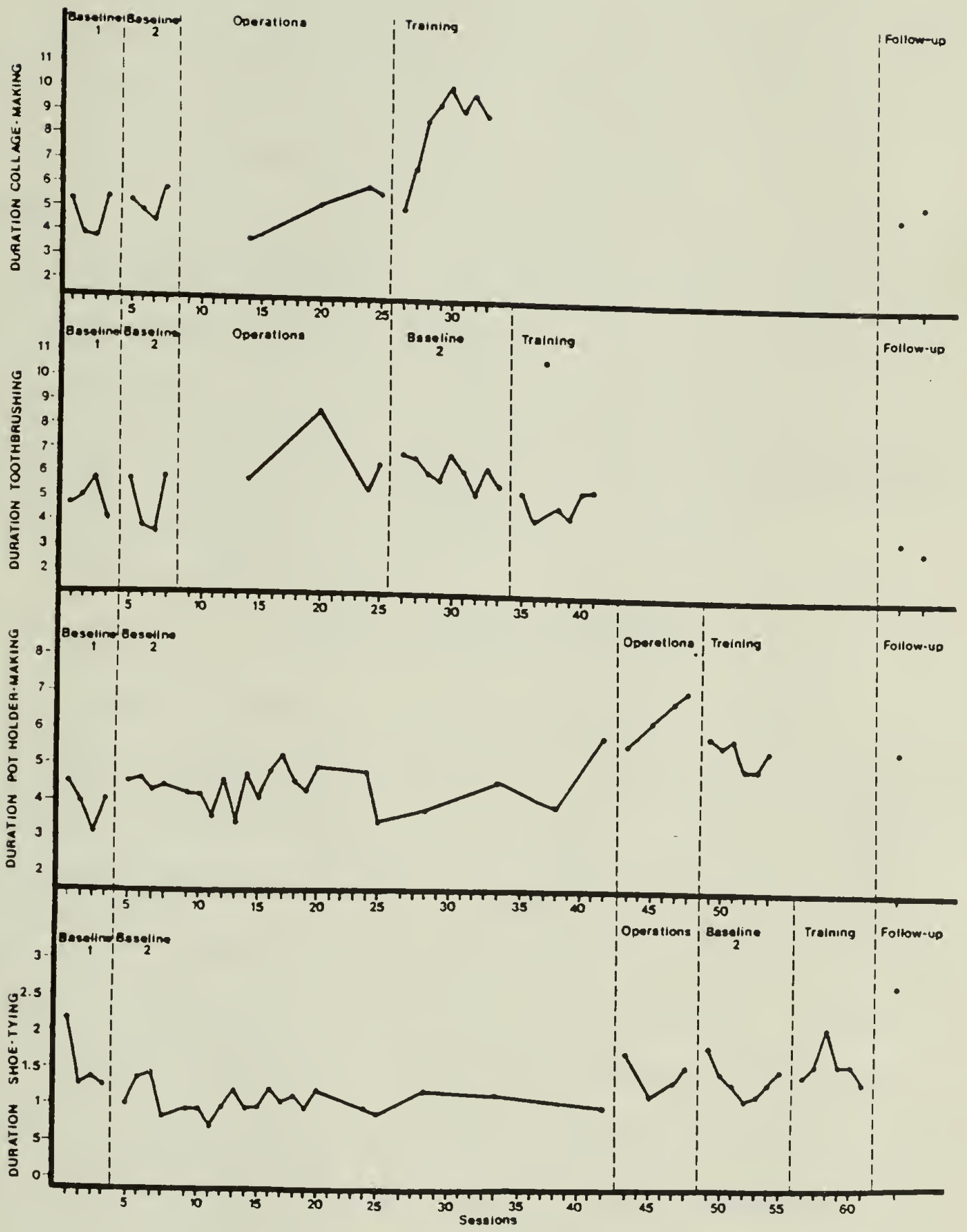
DURATION COLLAGE-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
DURATION TOOTHBRUSHING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
DURATION POT HOLDER-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
DURATION SHOE-TYING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
Sessions

Fig. 7.

range. Again, the client also demonstrated a 62.5% independent level at follow-up, the highest level achieved during training.

Conversely, the time to complete the shoe-tying skill was 2' 35", the longest time the client had ever required. However, this was the first of the four skills on which she received probes that day and she seemed very distracted by the presence of a new observer (her regular psychologist on the unit) in the room. She kept stopping to either wave at him or show him the shoe. Similarly, she was also somewhat distracted by his presence during pot-holder making, the second skill assessed at follow-up. By the time collage-making was assessed (the third skill), she barely paid attention to the observer. The shorter time measured during collage-making and then during toothbrushing seem to support this observation.

Specific Results--Client #2

Figures 8 through 14 present the data for client #2. The percentage of independent acquisition data for client 2 are displayed in Figure 8. Note that the order in which the skills were presented to client #2 differ from that of client #1 (see Figure 1). The sequence for client #2 was pot-holder making, shoe-tying, collage-making, and toothbrushing for the first four sessions. Starting with session 5, the order of skills assessment was then randomly arranged, as with client #1. The only remaining difference was that client #1 received operations training for related components of pot-holder making and shoe-tying first, while the operations training for the remaining two skills was delayed.

Figure 8. Percentage of independent acquisition of pot holder-making, shoe-tying, collage-making and toothbrushing for client #2.

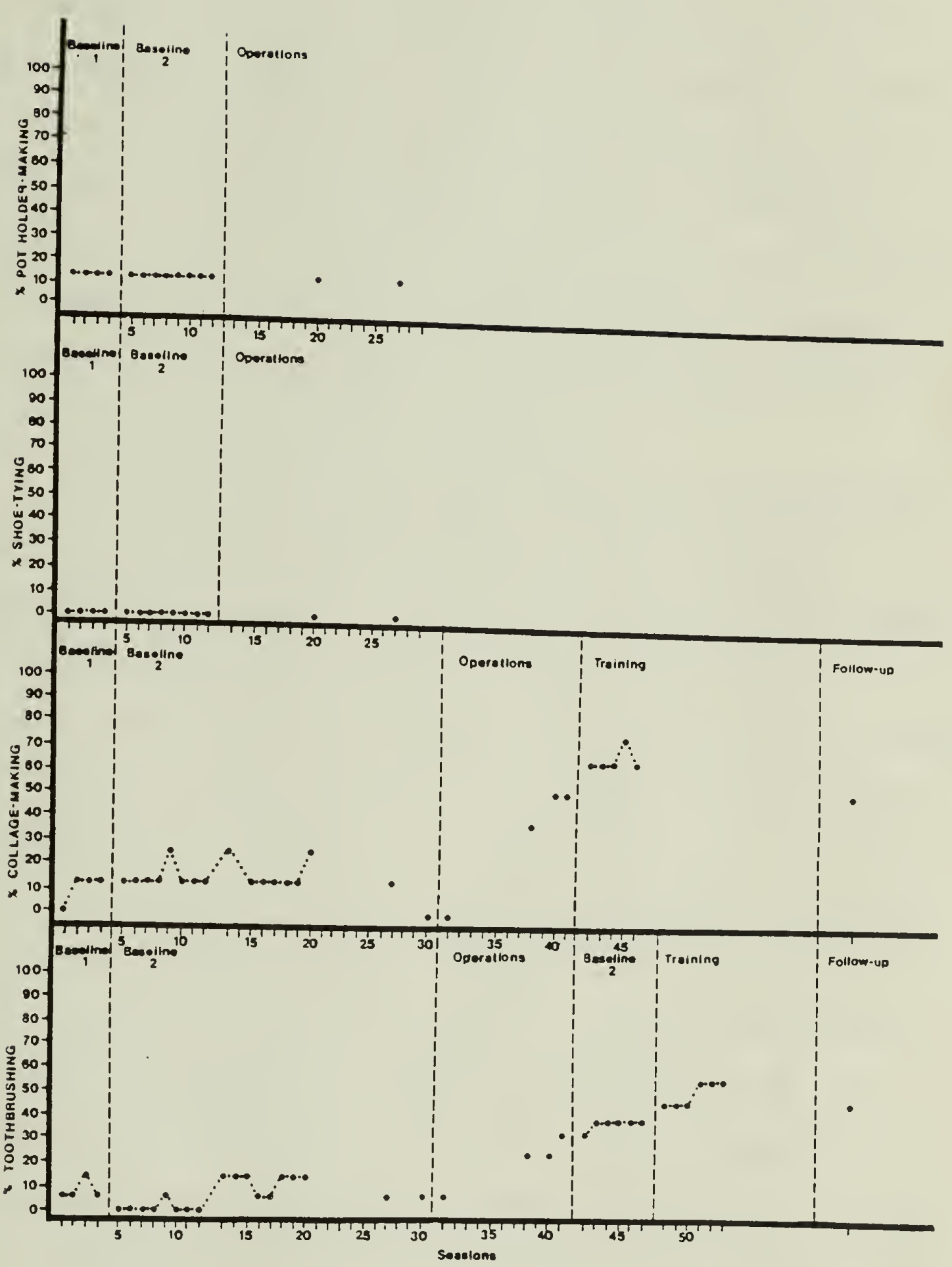
% POT HOLDER-MAKING
Baseline 1
Baseline 2
Operations
% SHOE-TYING
Baseline 1
Baseline 2
Operations
% COLLAGE-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
% TOOTHBRUSHING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
Sessions

Fig. 8.

No systematic increases were made during training pot-holder making and shoe-tying and thus, the training of these two skills was eventually terminated. Some other procedures were attempted during sessions 21 through 29 but none proved successful. Client #2 would sporadically indicate some independent performance during these activities, but would then quickly revert to the need for physical prompting. She would also vocalize quite loudly and become uncooperative. Finally, it was decided to focus on training the remaining two skills, collage-making and toothbrushing, both of which involved less fine motor coordination.

Client #2's independent performance during the Operations phase of collage-making and toothbrushing evidenced dramatic increases as with client #1. There were two exceptions: (1) during the return to Baseline 2 for toothbrushing (sessions 42 - 47) still further increases in toothbrushing occurred, although direct training of collage-making was taking place at that time. Client #1 had not evidenced even one increase in skill attainment during this phase. The data for client #2 tend to qualify the implications that in contrast with operations training, direct training would promote little generalization, (2) follow-up sessions for client #2 demonstrated decreases over independent levels achieved during training. For follow-up of collage-making, client #2 was performing at the 50% independent level, as opposed to a high of 75% achieved on session 45. Likewise, the 2 1/2 month follow-up for toothbrushing evidenced a drop to 46% as opposed to the 54% level reached during the Training phase. Again, the client did appear to be distracted by the process

of a new observer.

Figure 9 presents the data for client #2 for collage-making and toothbrushing only, by number of steps independently demonstrated. As with Figure 2, Figure 9 qualifies to some extent the impressions given by relying solely on depictions of percentages attained. Most noteworthy, the client demonstrated 4 independent steps by session 41 for both collage-making and toothbrushing, as compared to the 50% and 31% levels depicted in Figure 8. And similarly, client #2 had demonstrated 7 independent steps of toothbrushing by session 50 (54%) as opposed to the 6 steps achieved for collage-making on session 45 (75%). In other words, client #1 had demonstrated more independent steps in toothbrushing although the percentages were lower due to the length of the task analysis.

The data for all client #2's skills are presented in Figure 10 in terms of percentage of the three prompting levels plus independent performance. Physical prompting remained at 100% for both pot-holder making and shoe-tying, with the exception of session 20 where gestural prompting rose to 9%; physical prompting rose to 91%.

The prompting levels for collage-making and toothbrushing basically demonstrate the major decreases in physical prompting as independent performance increased. As with client #1, client #2 also failed to firmly close a bottle top although she, too, learned to position tops on bottles independently. Her behavior also generalized to positioning both the paste jar lid and the toothpaste cap independently, but was still scored as "physically prompted" due to her inability to completely close either top. Thus, the data

Figure 9. Numbers of component steps independently demonstrated for collage-making and toothbrushing for client #2.

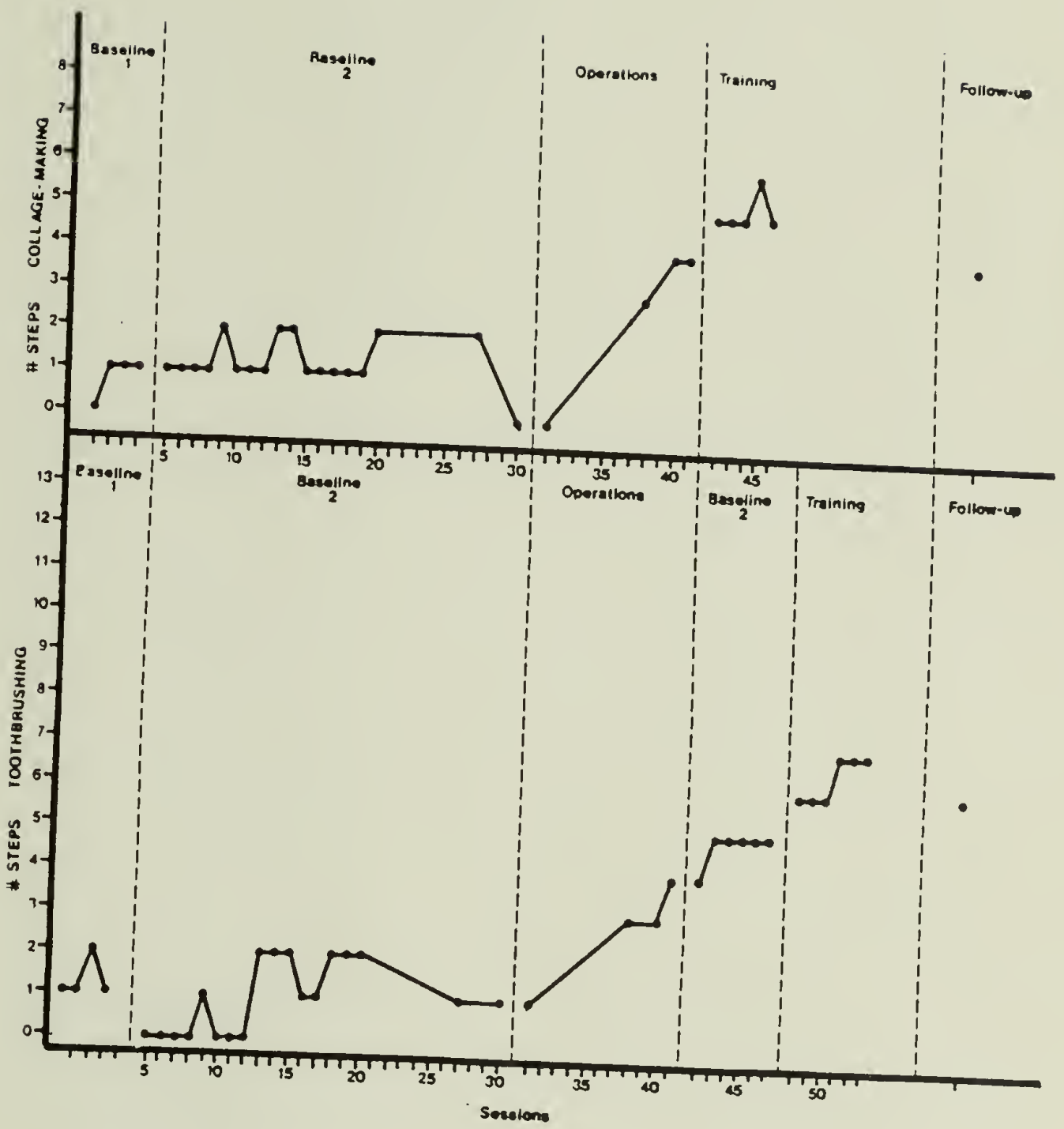
STEPS COLLAGE-MAKING
Baseline 1
Baseline 2
Operations
Training
Follow-up
STEPS TOOTHBRUSHING
Baseline 1
Baseline 2
Operations
Baseline 2
Training
Follow-up
Sessions

Fig. 9.

Figure 10. Percentage acquisition of two complex skills by three prompt levels--verbal, gesture and physical--as well as independent percentage, for client #2.

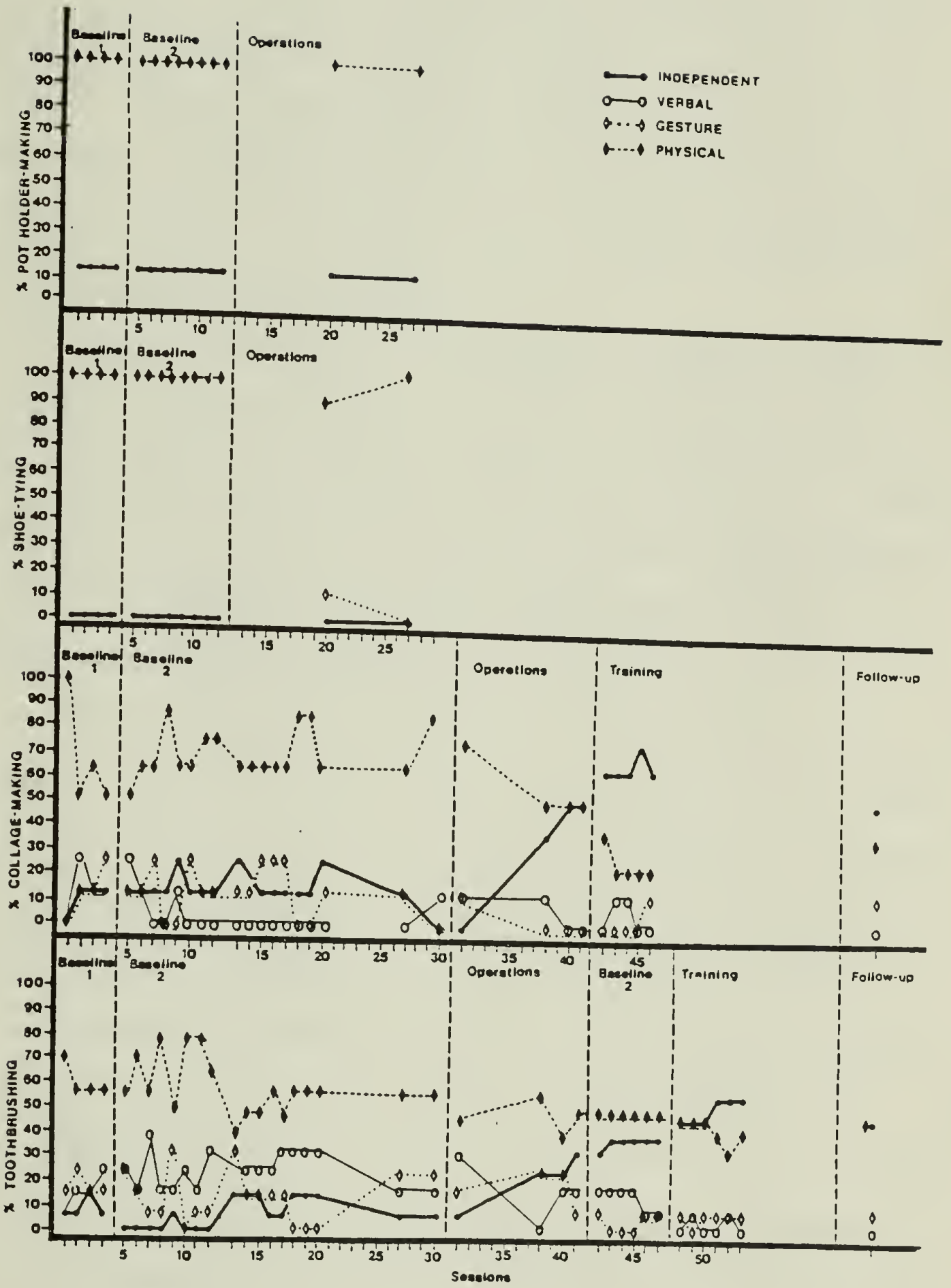
% POT HOLDER-MAKING
% SHOE-TYING
% COLLAGE-MAKING
% TOOTHBRUSHING
Baseline 1
Baseline 2
Operations
Training
Follow-up
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
Sessions

Fig. 10.

reflected in Figure 10 also underestimate the client's level of independent performance.

Figure 11 reflects the operations training date of client #2 for two of the component responses--"grasping" and "grasping and pulling." The data were graphed by percentage of trials for each prompt level. Although there were times when physical prompting was quite low, overall, no systematic gains were made in transferring control to less intrusive prompts.

Figure #12 depicts the second phase for client #2, for two of the responses trained--opening and closing. Independent prompting of closing ranged from 0% to 100%, reaching 43% by session 41. However, as with client #1, client #2 did begin to position independently on session 35. Furthermore, this skill began to generalize well to both collage-making and toothbrushing by session 40.

Verbal prompting ranged from 0% to 100%, ending at 29% by session 41, whereas the range for gestural prompting was 0% to 50%. On session 41, 28% of the closing response was prompted by gestures. Most importantly, although the range for physical prompting was 0% to 100%, physical prompting was no longer necessary by session 41.

Independent opening was 0% for all the operations training sessions, with the exception of session 41 when it reached 75%. Verbal prompting ranged from 0% to 85%, likewise at the 0% level by session 41. The range for use of gestural prompting to occasion the closing response was 0% to 50%, remaining at 0% by session 38. Physical prompting ranged as high as 100% for approximately 1/3 of the sessions, but dropped to the 25% level by session 41. The decision

Figure 11. Operations training for the grasping and grasping and pulling responses, by percentage of trials per prompt level, for client #2.

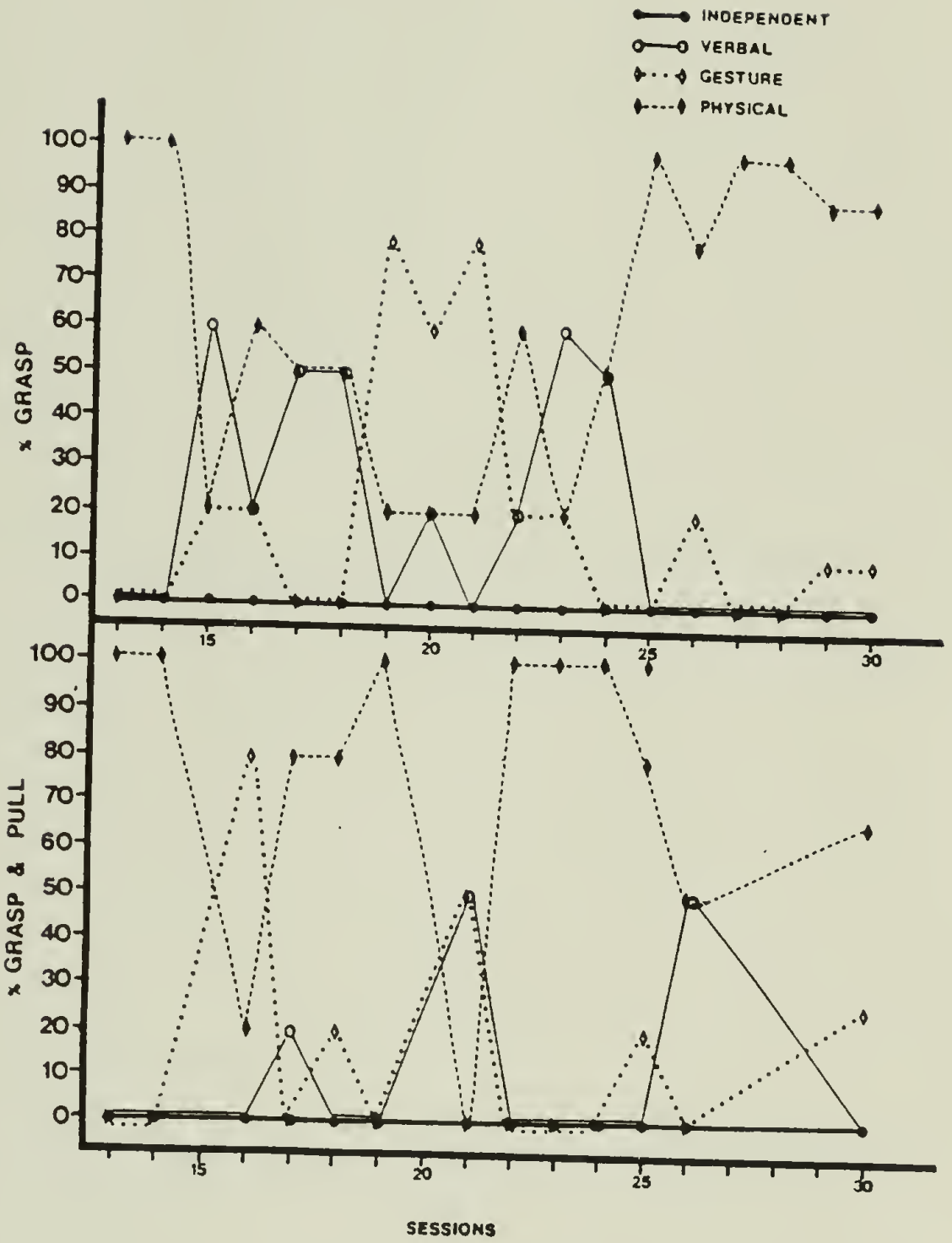
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
% GRASP
% GRASP & PULL
100
90
80
70
60
50
40
30
20
10
0
15
20
25
30
SESSIONS

Fig. 11.

Figure 12. Operations training for the opening and closing responses, by percentage of trials per prompt level, for client #2.

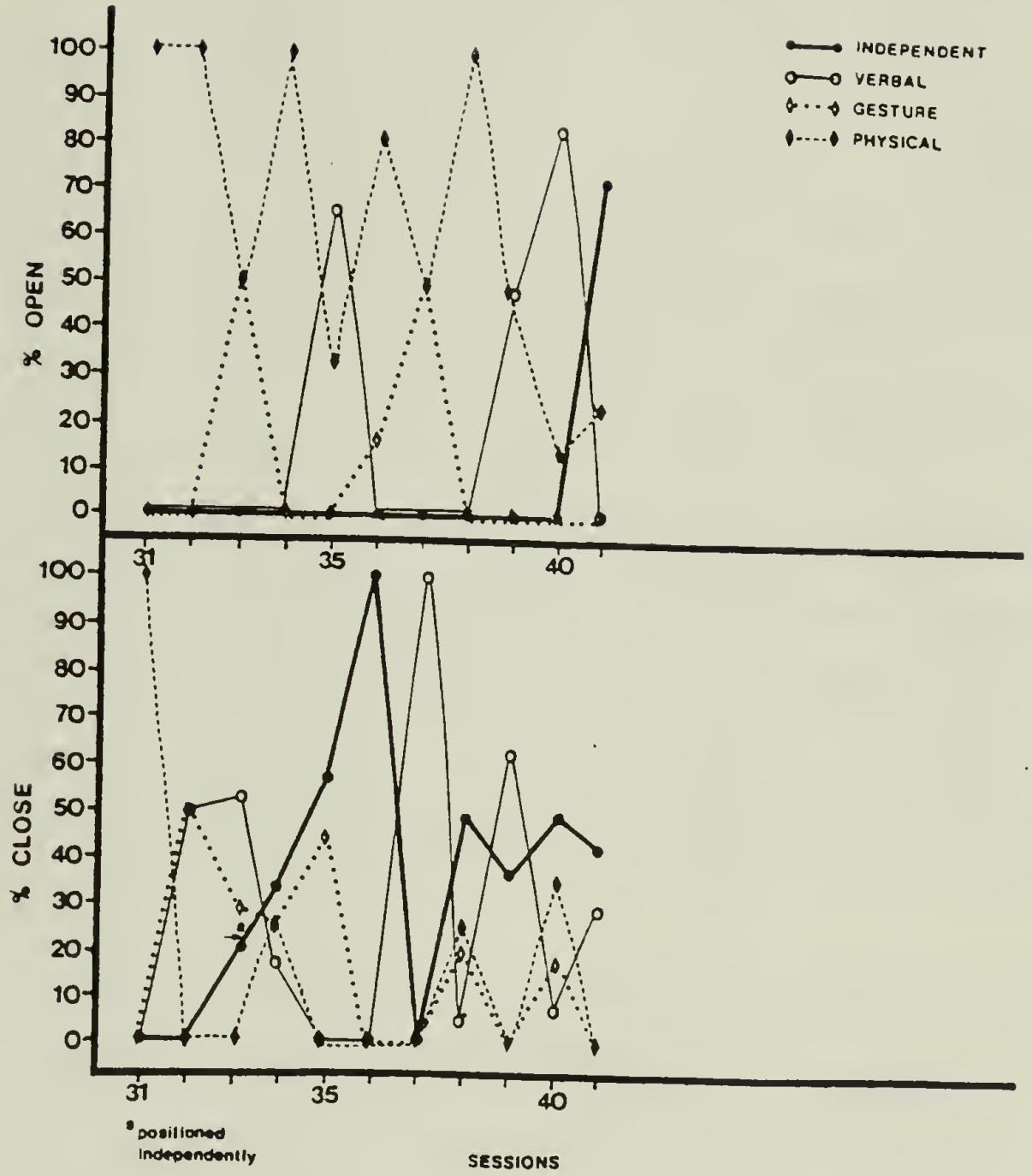
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
% OPEN
% CLOSE
100
90
80
70
60
50
40
30
20
10
0
31
35
40
SESSIONS
*positioned independently

Fig. 12.

to terminate operations training and proceed to direct training of the target complex skills was heavily influenced by both the degree of prompting necessary over time during operations training and the generalization to the actual target skills, as evidence by probes on collage-making and toothbrushing.

Figure 13 portrays the other two responses trained during the second phase of Operations for client #2, again by percentage achieved for each of the four prompting levels. Independent "picking up" ranged from 0% eventually to the 75% level during session 41. Verbal prompting ranged from 0% to 75%. Many of the operations sessions reflected a 0% level for gestural prompting, although the range was as high as 25%. Physical prompting was always at 0%.

Independent prompting stayed at 0% until session 38 for "putting down," but reached 25% during the last three sessions. Verbal prompting ranged as high as 50% in session 41. Gestural prompting was necessary for most of the sessions, finally decreasing to 25% during the last operations session. Physical prompting was 0% at all times.

Durations necessary to complete both toothbrushing and collage-making by client #2 are reflected in Figure 14. Baseline 1 durations for collage-making ranged from 3' 36" to 5' 10", and 3' 40" to 6' 25" during Baseline 2. During Operations, the time necessary to complete a collage reached as high as 7' 40", while a high of 7' 20" was attained during Training. The 2 1/2 month Follow-up session reflected a duration of 5' 16", well within the levels of Baseline 1 and Baseline 2 although client #2 demonstrated 50% of the skill independently at

Figure 13. Operations training for picking up and putting down, by percentage of trials per prompt level, for client #2.

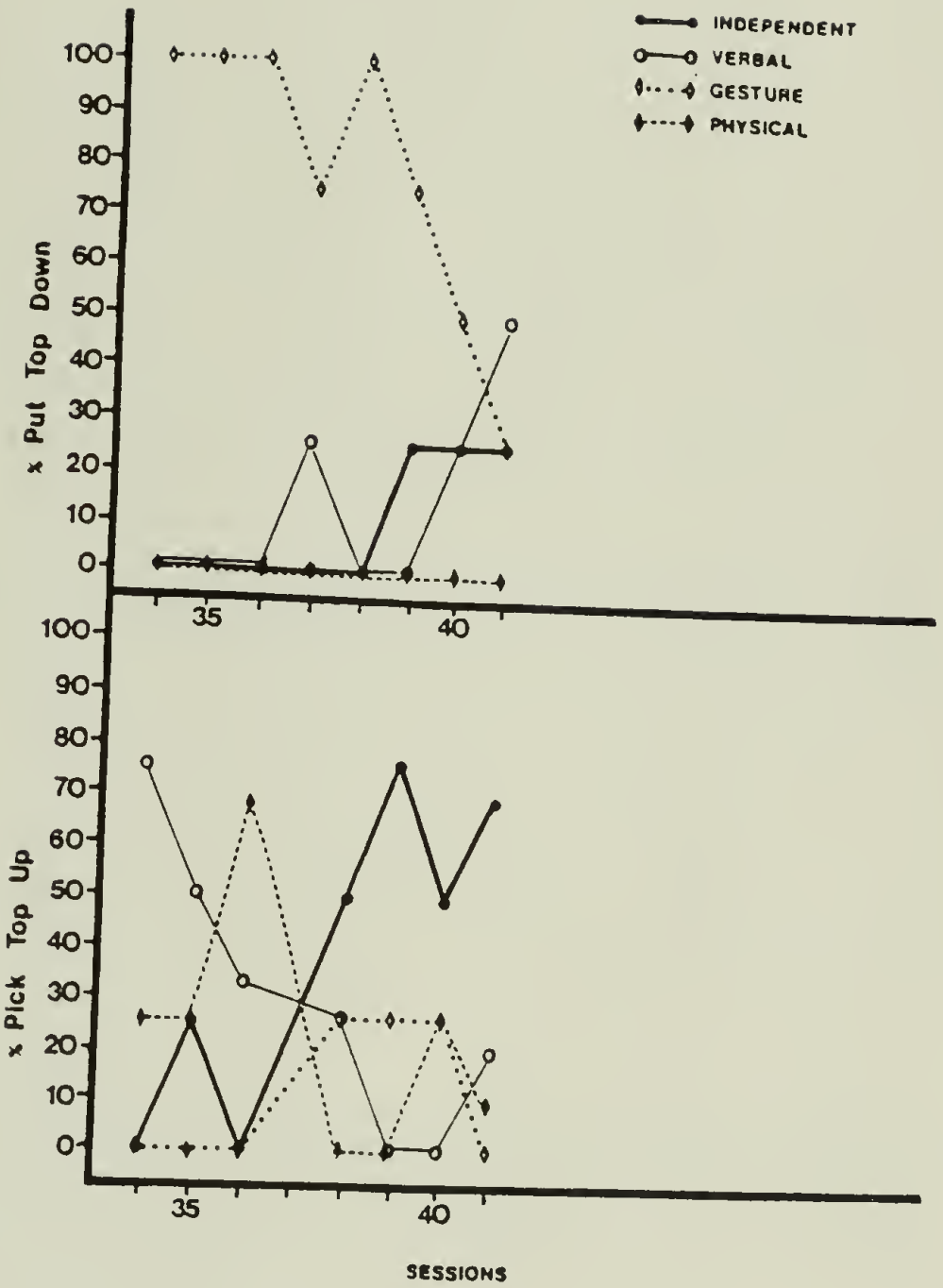
INDEPENDENT
VERBAL
GESTURE
PHYSICAL
x Put Top Down
100
90
80
70
60
50
40
30
20
10
0
35
40
x Pick Top Up
100
90
80
70
60
50
40
30
20
10
0
35
40
SESSIONS

Fig. 13.

Figure 14. Duration to complete collage-making and tooth-brushing, for client #2.

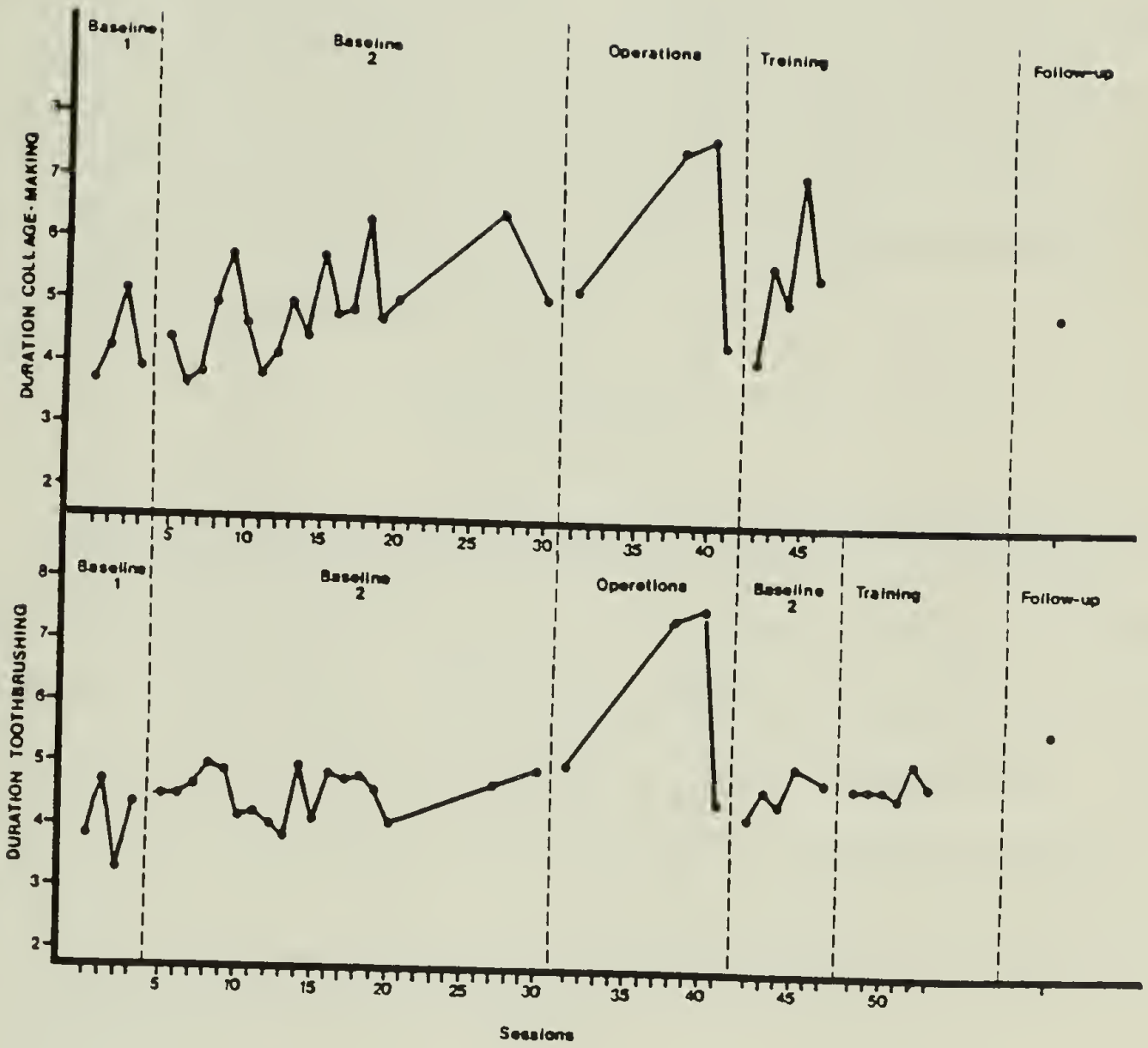
Baseline 1
Baseline 2
Operations
Training
Follow-up
DURATION COLLAGE-MAKING
DURATION TOOTHBRUSHING
Sessions

Fig. 14.

this time.

For toothbrushing, durations ranged between 3' 20" and 4' 40" during Baseline 1 and 3' 55" to 5' 00" during Baseline 2 probes. Durations ranged quite high during Operations, reaching 7' 40". A return to Baseline 2 reflected a high of 5' 10", while the highest duration was 5' 15" during Training. The 2 1/2 month Follow-up session produced a duration of 5' 46", despite that the client paused periodically to either adjust her pants (which kept falling down) or to look at the observer. This duration attained during follow-up was higher than baseline levels, but the client also performed 46% of toothbrushing completely independently.

Across Clients

Figure 15 reflects the independent percentage attainment for both collage-making and toothbrushing for client #1 (top) and client #2 (bottom). Both clients' performance evidenced dramatic increases over baseline levels in the attainment of each of these skills. Since these data have been presented previously and discussed extensively earlier (see Figures 1 and 8) only details pertinent to this graphic presentation will be discussed here.

Both clients reached the 50% level of independence during operations training of collage-making. When the Training phase was in effect, however, the return to Baseline 2 produced different effects for client #1 and client #2. During training of collage-making for client #1, no further increases in toothbrushing were evidenced in the Baseline 2 phase. In fact, the independent levels during Baseline 2

Figure 15. Percentage of independent acquisition of collage-making and toothbrushing for both client #1 and client #2.

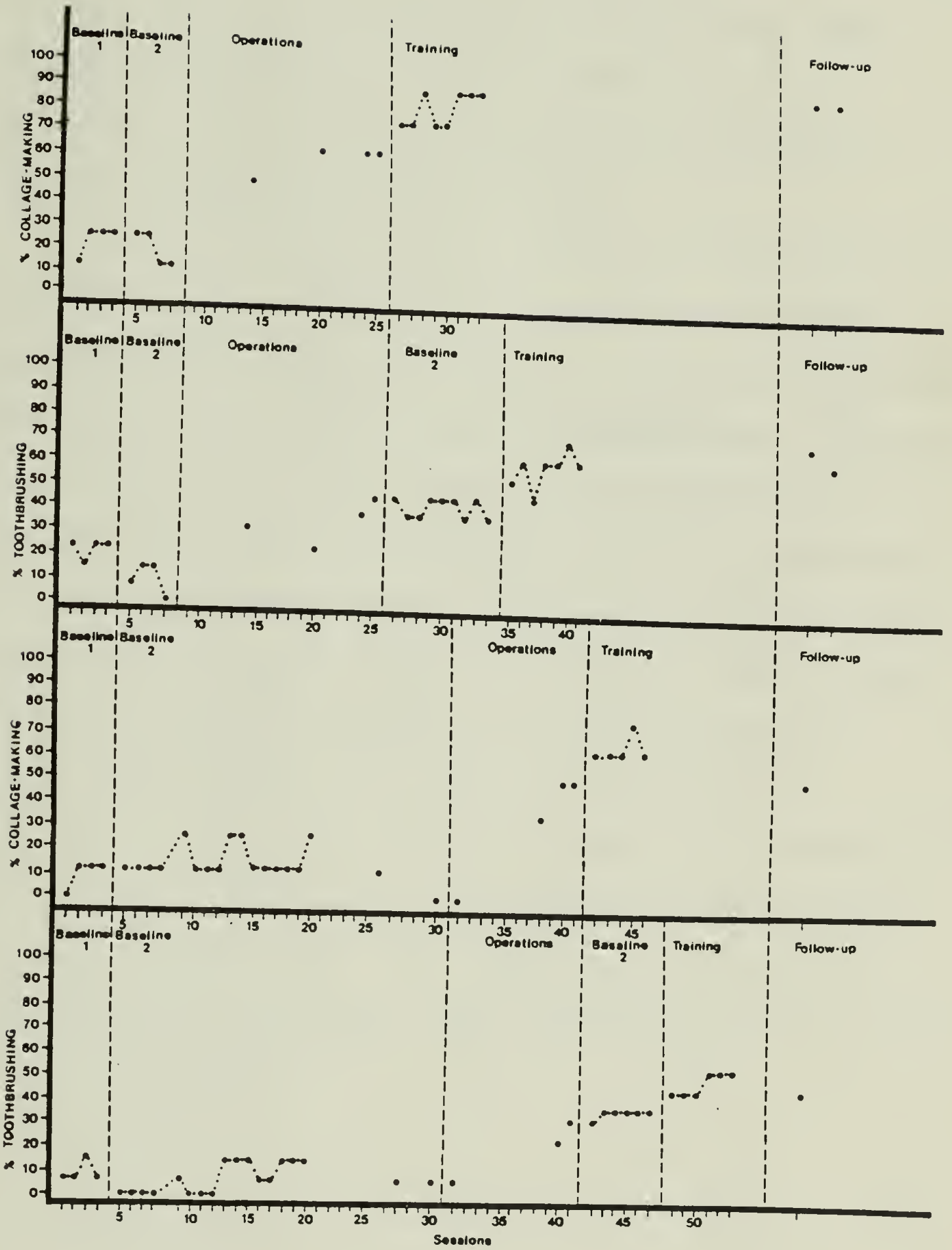
% COLLAGE-MAKING
% TOOTHBRUSHING
Baseline 1
Baseline 2
Operations
Training
Follow-up
Sessions

Fig. 15.

varied systematically between 46% and 38%. In other words, no further generalizations of any effects of training occurred during this phase. Conversely, client #2's data reflected a further increase during Baseline 2 for toothbrushing, while collage-making was in the Training phase. There was further generalization to independent attainment of toothbrushing during this time.

Also note that both follow-up sessions of collage-making for client #1 remained at the highest level achieved during training, whereas client #2's follow-up performance of collage-making decreased to the highest level achieved during the Operations phase. Similarly, although client #1's first follow-up session for toothbrushing was at the highest level attained during Training, there was a decrease to the next highest independent level achieved during Training, at the 5 month follow-up session. Client #2's follow-up session for toothbrushing also reflected a decrease to the second highest level achieved during Training. Both clients, however, received no opportunity to engage in any of the four complex skills during either the times the training of these skills occurred or during the 2 1/2 to 5 month follow-up period. Thus, despite that the clients had no further practice in doing these skills, maintenance of gains achieved was fairly high overall.

CHAPTER IV

DISCUSSION

The results of this study appear to support the efficacy of determining components common to complex skills and then programming training across these skills. The procedure used may be summarized as follows: first, a group of complex skills was analyzed into component responses to determine the degree of topographical similarity between various aspects of these complex skills. Next, specific common component responses in two sets of skills were identified. These responses were then trained in isolation with presentation of a range of antecedent stimuli that varied along several continuums. This approach was taken to teach the clients topographically similar response classes that would generalize to the complex skills, prior to specific training. Finally, components unique to a particular skill were trained sequentially to promote a higher degree of independent acquisition for each of the four complex skills.

This procedure resulted in systematic increases in independent acquisition of the four complex skills for one client and two complex skills for the second client. Follow-up data generally indicated that maintenance of training occurred despite the lack of any opportunity for engaging in these activities during the interim. Additionally, it took no longer for the clients to perform the skills independently than during baseline assessments. These findings would support this

approach to training in applied settings, in terms of feasibility and effectiveness.

Curriculum Development

The results suggest a number of implications for the development of comprehensive curricula for profoundly and severely handicapped individuals. It would seem that our present technology of training skills by isolated task analyses may be failing to capitalize on the overlapping components common to many complex skills (Mithaug, 1979). A better strategy might be to look at groups of skills and consider ways in which various component responses might be related.

It is clear from these data that these groups of skills need not be restricted to one domain (i.e., self-help). Almost by accident, a situation occurred in which a limited number of self-help skills were feasible to train. Another domain of skills (i.e., leisure) was thus necessitated. The generalization promoted by training was obviously not restricted to within a domain. Teachers might begin to plan curricula that will span a number of domains, and yet provide needed instruction on groups of responses and/or complex skills, as suggested by various authors (i.e., Guess et al., 1979; Holvoet et al., 1980).

Further, teachers need not be restricted to training skill domains to the developmentally disabled within fixed developmental sequences. Self-help skills are often seen as the most crucial domain in which to teach the profoundly retarded. It is almost as if this domain serves as a rite of passage for the opportunity to be taught

other types of skills. The profoundly retarded are, in some ways, confined to certain patterns of programming. They may not be considered appropriate candidates for learning vocational skills, because they haven't as yet learned the necessary pre-requisite academic skills (i.e., color and shape discrimination, counting, money skills, etc.). Of course, they might in turn be considered as too low functioning to receive instruction in academic skills because they may not be toilet trained.

Therefore, emphasis tends to be placed on the development of self-help skills which, if acquired, will provide the profoundly retarded with access to less restrictive environments--living situations, day activity or vocational programs, and yes, even programming. This is an artificially imposed sequence of instruction. Priorities for instruction do need to be established. At some point, there should be a decision concerning which skills will be most adaptive for a given client. However, learning can be facilitated across domains and result in more exciting and beneficial lesson plans.

The general approach to teaching the severely and profoundly handicapped to date has generally been to break down tasks into very small steps. These steps are intended to represent the entering behavior of a client so that the steps need only be chained together to perform the overall complex behavior (Anderson & Faust, 1973). However, this use of task analyses may not be actually performed with the profoundly handicapped. Often, each step is completely taught to independence and then sequentially chained to the other component responses (Wheeler et al., Note 1). It becomes impossible to train each

and every component. Now teachers can have a head start in teaching various complex skills by not having to train each and every component individually within a task analysis. By using operations training to teach a group of responses, clients need no longer begin a task analysis with zero or little entering behavior. Less training will be required on a specific task analysis. The individual responses need only be chained together to perform the overall complex skills. And as each complex skill is acquired, subsequent related complex skills will require less and less specific programming.

Limitations

There are, however, questions which need to be addressed before an adequate curriculum framework can be developed from the strategies employed in this study. First of all, it was hypothesized that little or no generalization would occur to a second related complex skill during training of the first skill. Recall that during specific Training phases, unique components (i.e., not topographically related to component responses in a second skill) were being taught to the clients using more traditional, single instances of each component response. Client #1 evidenced no increased acquisition of the second related skill during this phase, while the independent performance of client #2 did increase one step.

Although this amount of generality was not great, it does tend to qualify the original hypothesis to some extent. Of course, that various related components were targeted by the investigator does not necessarily imply that these responses comprised all the related aspects

of two given complex skills. It may be virtually impossible to determine and/or account for all possible transfer effects across skills. However, the fact remains that more traditional types of training require additional generalization and maintenance procedures to promote generality of treatment effects. Operations training systematically takes generalization into account as part of the procedure.

A goal of this study was not to directly compare the cost/benefit in promotion of generalization between traditional training and operations training. At this point it is not known for sure whether or not an operations training approach is more beneficial in programming across skills as opposed to direct training of each skill. The results do seem promising however.

Second, independent acquisition of the complex skills was measured in terms of the trainer's behavior (e.g., prompts delivered), not the client's. While this measurement was deemed a more appropriate indication of overall client performance, it does not account for the specific topographical movements necessary to perform a range of responses. Thus, little information was obtained concerning the range of topographical movements contained in specific operations. This type of information might be useful in attempting to define the limits of a topographically-defined response class.

Conversely, Johnston and Pennypacker (1980) suggested that the limits of a response class need only be defined by the investigator, as was done in this case. That both clients were successful in learning responses during operations training and demonstrated the similar responses necessary in the context of the complex skills may provide

enough information that will support the theoretical underpinnings of this approach.

Third, the plotted prompt levels for each complex skill conveyed a limited picture of the variability present during acquisition. Even though a client demonstrated, for example, 60% of a skill independently in one session and obtained this same level at the next, she might not necessarily have performed the same components independently each time. While the prompt levels were very stable during collage-making, shoe-tying and pot holder-making, this was not the case for toothbrushing. Both clients exhibited stability in the number of components scored independently, but which exact components were independently performed varied considerably from probe to probe. Often, this was due to confusion about which response followed in the sequence of the test analysis. On one occasion a client might have turned off the water independently in the appropriate sequence, while a verbal or gestural prompt was necessary to occasion the response during another occasion.

The order in which the steps were to be performed during probes on toothbrushing was overall not a problem, however. The clients appeared, for the most part, to follow the order necessary to perform the overall skill. The two general pacing prompts (i.e., "what's next") most likely had some effect on the client's independent performance. Despite that no contingent reinforcement was delivered during the probe sessions, both clients were very successful in increasing demonstrations of independence. It is also difficult to account for their past learning in this situation. Although they were not permitted to brush their

teeth independently in the unit, they had undoubtedly observed the procedure of toothbrushing time and time again.

A final note concerning order in task analysis is needed. Some of the sequencing in task analysis is arbitrary. It was often the case that a client would independently perform a step which would still result in completion of the overall skill (i.e., picking up the toothpaste first instead of the toothbrush). Unfortunately, this performance would result in at least a "verbal" scoring of "picking up toothbrush," since a verbal prompt would be necessary to occasion the correct response. This procedure was followed due to a strict adherence to the specific order delineated in the task analysis. However, it might be useful to reinforce demonstrations of steps out of sequence, with the stipulation that any steps performed out of sequence would still result in performance of the whole complex skill. In this manner, more flexible demonstrations of learning might be taught.

Relation to Background Literature

It is useful to examine how specific findings from this study relate to transfer of learning theory and the operations training literature reviewed earlier. The data obtained from the operations training phases of this study parallel Gagné's (1965) basic description of lateral transfer. The clients did perform some behaviors, in the context of the complex skills, which were not directly taught, but were at approximately the same level of difficulty as those taught (i.e. opening, closing, grasping, etc.). The type of generalization demonstrated would probably be categorized as either near, specific and/or

literal transfer since direct similarities apparently existed between the original (operations training) and transfer (performance in a complex skill) tasks.

One could say that the clients had now developed "schema" for the various generalized responses, accounting for the performance of these responses in the complex skills. However, this "explanation" does not seem to provide any additional information as to how the generalization actually occurred. Skinner's (1953) notion that similar elements of responses were strengthened still seems to adequately describe the situation that occurred as efficiently as the inferred "schema." That similar elements of an "opening" response, for example, were reinforced in the presence of various discriminative stimuli would seem a more parsimonious account. In the context of the complex skill, similar discriminative stimuli also occasioned the opening response.

During operations training of collage-making for client #1, the dramatic jump in independent acquisition of the skill occurred simultaneously with the training of only one generalized response to an independent level. In a sense, this is an example of "non specific" transfer in which the amount of generalization cannot be accounted for by specific similarities (Royer, 1979), and seems to conform to the "learning to learn" phenomenon (Harlow, 1949) described earlier. One explanation might be the possibility of functionally related responses which cannot be accounted for by a topographical approach (Johnston & Pennypacker, 1980). Perhaps, the degree of generalization is accountable by the data, and therefore not so "non-specific." All the generalized responses had been trained, by session 14, although not to

independence. Various aspects in terms of both stimuli and responses had been reinforced in training, thus promoting the greater likelihood of generalization (Skinner, 1953).

Skinner's description of induction is somewhat difficult to extend to the specific outcomes of this project. Independent performance of the complex skills did indeed increase as a function of operations training; however, there was not necessarily a one-to-one correspondence between responses trained during operations phases and sub-components subsequently performed in the complex skills (see Appendex A).

For example, when client #1 was working on "opening," "closing," "picking up" and "putting down," two of the components in toothbrushing performed independently during probe sessions at that point were "rinsing toothbrush" and "brushing teeth." Similarly, client #2 began independently to demonstrate "turning off water" during training of the same four operations. Perhaps these components contained elements of "picking up" and "putting down," but why these particular components were demonstrated independently is not easily explained.

In retrospect, one difficulty with this type of research is the manner in which task analyses are divided into sub-components (i.e., the specification of response classes). In this project, some components could have been further divided so that each element could be traces as it carried over from operations training to probe sessions. In future research, it would be useful if sub-components were defined to correspond directly with specific responses taught during operations training.

As for the general operations training literature, the results of this study support the feasibility of training a group of responses and promoting generalization to previously untrained skills (Horner & Bellamy, 1979). This study more directly promoted acquisition across complex tasks as a result of training generalized responses. What is most important in educational and other settings is the numbers and types of complex skills a client can perform, not simply the performance of specific responses. In other words, "Johnny can brush his teeth" rather than "Johnny can replace the cap back on the toothpaste tube" has important implications for teaching and staffing patterns. Thus, there is a greater likelihood that the types of results generated by this project would obtain more support within the educational community.

Conclusion

When this project was undertaken, little or no systematic programming existed for the clients. It seemed that despite any learning achieved, it would be unlikely that the procedures would be maintained by the institution. However, recently a day activity program has been planned in the near future for the clients' ward. This development is especially significant as it seemed as if any training the investigator undertook would not have any lasting effects on the clients' future. Although the day activity program happened independently of the implementation of this study, it's gratifying to know that a demonstration that these clients can indeed learn has been made available to the unit staff.

This study was not intended to simply demonstrate how, if one trained opening responses with fifteen different bottles, a client would open a sixteenth bottle with which she was not previously trained. The most dramatic and potentially useful result was the carry over to a very different context--both within and across domains. Two complex skills representing two different domains of instructions are clearly seen to be related. The possibilities of determining components common across hosts of complex skills may be an exciting and important direction for curricula development.

It may seem surprising that the generalization across skills was considerable. What would be surprising is if these results <u>didn't</u> occur. It is remarkable that the wealth of literature dating back several decades has had very little bearing, until recently, on our educational strategies. Educators tend to follow rigid task analyses which necessitate the use of additional maintenance and generalization procedures due to the restricted type of learning generated. This outcome should serve as a clue to the limitations of our present approach to teaching the developmentally disabled.

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Appendix A

Collage-Making	Baseline			Operations			Training				Follow-up	
	1	2-6	7-8	14	20,24	25	26-27	28	29-30	31-33		
1. Pick up paste	O	X	X	X	X	X	X	X	X	X	X	X
2. Unscrew lid	O	O	O	X	X	X	X	X	X	X	X	X
3. Brush paste on paper	X	X	O	X	X	X	X	X	X	X	X	X
4. Place stick in jar	O	O	O	O	O	X	X	X	X	X	X	X
5. Pick up cut-up paper	O	O	O	O	X	O	X	X	X	X	X	X
6. Place on pasted area	O	O	O	X	X	X	X	X	X	X	X	X
7. Press down firmly	O	O	O	O	O	O	O	X	O	X	X	X
8. Close lid on jar	O	O	O	O	O	O	O	O	O	O	O	O

Client #1

(X = independent; O = prompts needed)

Toothbrushing	Baseline								Operations				Baseline									Training							Follow-up	
	1	2	3	4	5	6	7	8	14	20	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41		
1. Take toothbrush from holder	0	X	X	X	0	0	0	0	0	0	X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2. Pick up toothpaste	X	0	0	0	X	X	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3. Unscrew top	0	0	0	0	0	0	0	0	0	X	X	X	X	0	X	X	X	X	X	X	0	X	X	X	X	X	X	X	X	X
4. Place top on counter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Put paste on brush	0	0	0	X	0	X	X	0	0	0	0	0	0	X	0	0	0	0	0	0	0	X	0	0	X	0	X	0	X	0
6. Brush teeth	X	X	X	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7. Turn on cold water	0	0	0	0	0	0	0	0	0	0	0	X	X	0	X	0	0	X	0	X	0	X	X	0	X	X	X	0	X	0
8. Rinse tooth-brush	0	0	0	0	0	0	0	0	X	0	X	X	0	X	0	0	X	0	0	0	0	0	0	X	0	X	0	X	0	X
9. Fill cup with water	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	0	0	0	X	X	X	X
10. Turn off water	0	0	0	0	0	0	0	0	0	0	0	X	X	0	0	0	0	0	0	0	X	0	X	0	X	X	X	0	X	0
11. Wipe face with towel	X	0	0	X	0	0	X	0	X	0	0	0	0	0	0	X	X	X	X	X	0	0	X	0	X	0	0	X	0	X
12. Replace cap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Replace tube in holder	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	X	0	X	X	X	X	X

· Client #1

(X = independent; 0 = prompts needed)

Pot Holder-Making	Baseline					Operations				Training				Follow-up
	1-25	28	31,34	38	42	43	45	47	48	49	50	51	52-54	
1. Pick up loop	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2. Place one end on loom	0	X	0	X	0	X	X	X	X	X	X	X	X	X
3. Hold end in place	0	0	0	0	0	0	0	0	0	X	0	0	0	0
4. Stretch & pull	0	0	0	0	0	0	X	X	X	X	X	X	X	X
5. Attach other side	0	0	0	0	0	0	0	X	0	0	0	X	X	X
6. Release hands	0	0	0	0	0	0	0	0	X	X	X	X	X	X
7. Turn loom 1/4 turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8. Weave thru	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Client #1

(X = independent; 0 = prompts needed)

Shoe-Tying	Baseline									Operations		Baseline	Training		Follow-up
	1,2	3	4	5-15	16-17	18	19-20	24,25,28	34,38,42	43	45-48	49-55	56-57	58-61	
1. Grasp Laces	0	X	0	0	X	0	X	X	0	X	X	X	X	X	X
2. Pull tight	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X
3. Cross laces over	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X
4. Hold intersection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Pull left lace thru	0	0	0	0	0	0	0	0	0	0	0	0	X	X	0
6. Pull laces tight	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X
7. Form left loop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8. Wrap right lace	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9. Push right lace thru	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10. Grasp & pull thru	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11. Pull loops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Client #1

(X = independent; 0 = prompts needed)

Collage-Making	Baseline									Operations			Training				Follow-up
	1	2-8	9	10-12	13-14	15-19	20	27	30	31	38	40,41	42	43-44	45	45	
1. Pick up paste	O	X	X	X	X	X	X	X	O	O	X	X	X	X	X	X	X
2. Unscrew lid	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
3. Brush paste on paper	O	O	O	O	X	O	X	O	O	O	X	X	X	X	X	X	X
4. Place stick in jar	O	O	O	O	O	O	O	O	O	O	X	X	X	X	X	X	X
5. Pick up cut-up paper	O	O	X	O	O	O	O	O	O	O	O	X	X	O	X	X	O
6. Place on pasted area	O	O	O	O	O	O	O	O	O	O	O	O	X	X	X	X	X
7. Press down firmly	O	O	O	O	O	O	O	O	O	O	O	O	O	X	X	O	O
8. Close lid on jar	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Client #2

(X = independent; O = prompts needed)

	Baseline															Operations			Baseline						Training		Follow-up
	1	2	3	4	5-8	9	10-12	13	14-15	16	17	18	19	20	27,30	31	38,40	41	42	43	44	45	46	47	48-50	51-53	
1. Take toothbrush from holder	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	0	0	0	0	0	X	X
2. Pick up toothpaste	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X
3. Unscrew top	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Place top on counter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Put paste on brush	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Brush teeth	0	0	0	0	0	0	0	0	X	0	0	0	X	0	0	0	X	X	X	X	X	X	X	X	X	X	X
7. Turn on cold water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	0
8. Rinse toothbrush	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0
9. Fill cup with water	0	0	0	0	0	0	0	0	0	X	0	0	0	X	0	X	X	X	X	X	X	X	X	X	X	X	X
10. Turn off water	0	X	X	0	0	X	0	X	X	0	X	X	0	X	X	0	X	X	X	X	X	X	X	X	X	X	X
11. Wipe face with towel	X	0	X	0	0	0	0	0	0	0	0	X	X	0	0	0	0	0	0	0	X	X	0	0	X	X	X
12. Replace cap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Replace tube in holder	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Client #2

(X = independent; 0 = prompts needed)