*TEACHING SEVERELY MULTIHANDICAPPED STUDENTS
TO PUT ON THEIR OWN HEARING AIDS*

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Two experiments were conducted with six severely multihandicapped students with hearing impairments to: (a) train the six students to put on their own hearing aids independently, and (b) provide an empirical evaluation of a comprehensive instructional program for putting on a hearing aid by assessing acquisition, maintenance, and generalization of that skill across environments. All six students acquired the skill rapidly, with two students requiring remedial training on one step of the program. Because for two of the original three students the newly learned skill failed initially to generalize to other environments, a second experiment was initiated to assess generalization across environments as well as to replicate the efficiency of the acquisition program. When a variation of the multiple-probe baseline technique was used, the behavior of three additional students generalized to other settings without direct training in those settings.

DESCRIPTORS: multiple-probe technique, hearing aid skill, generalization, multihandicapped students

The incidence rate of hearing impairment in normal children is quite low (Berg & Fletcher, 1970), with only .05% of the children in the United States having a hearing impairment of 71 dB or greater (Eagles, Wishik, Doerfler, Melnik, & Levine, 1963). However, the percentage of retarded children with this same degree of hearing impairment ranges from 10% to 20%, with the severely and profoundly retarded having the highest incidence rate among the various categories of retarded children (Fulton & Lloyd, 1969). Information on the inci-

dence rates for the severely multihandicapped is incomplete because of the difficulties in the evaluation of these individuals. Mitra (1970) reported that mental retardation appears in combination with hearing impairment more frequently than with any other single handicap.

The importance of sound amplification systems for the severely hearing impaired is generally undisputed (e.g., Cox & Lloyd, 1976; Ross, 1976; Clark, Note 1). Furthermore, various writers have emphasized that a hearing-impaired individual should be capable of wearing a hearing aid for extended periods of time across different listening situations and different living environments (e.g., Kopchick & Lloyd, 1976; Clark, Note 1).

Teaching hearing-impaired children of normal intelligence to put on their own aid independently has been reported as a problem easily overcome with the proper orientation to the hearing aid (e.g., Cox & Lloyd, 1976). However, little attention has been devoted to teaching the hearing-impaired retarded, especially multihandicapped individuals, to put on their own hearing aids independently. Most clinicians have devoted their efforts to training parents, direct-

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care staff, or teachers to put the hearing aids on their children or students (e.g., Cox & Lloyd, 1976; McCoy & Lloyd, 1967; Moore, Miltenberger, & Barber, 1969; Saunders, 1975; Clark, Note 1; Downs, Note 2).

Cox and Lloyd (1976) have described "hearing aid orientation" as the "direct counseling with the child and parents about the use of the hearing aid" (p. 177), which includes four general topics: (a) description of the child's hearing impairment to the child, parent, and other habilitation team members, (b) description, demonstration, and supervised use of the hearing aid, (c) care of the hearing aid, and (d) use of the hearing aid in various listening situations. Although all four aspects of hearing aid orientation are important to all individuals involved with a hearing-impaired child, the orientation procedure as described is not directly applicable for those concerned with teaching severely multihandicapped individuals with hearing impairments. According to Cox and Lloyd (1976), the "mature" child must be allowed time to practice using the various hearing aid controls and inserting and removing the earmold under supervision. Typically, severely multihandicapped individuals require more precise, systematic training in order to acquire complex skills (e.g., Fredericks, Baldwin, Grove, Riggs, Furey, Moore, Jordan, Gage, Levak, Alrik, & Wadlow, 1975; Horner & Keilitz, 1975). For example, it was necessary for Baer, Peterson, and Sherman (1967), as well as Striefel (1974), to use intensive shaping and fading procedures to teach severely and profoundly retarded children to imitate a series of motor behaviors. Furthermore, for severely multihandicapped students who exhibit imitative behaviors, systematic imitation procedures have been included in several communication training programs (e.g., Guess, Sailor, & Baer, 1978; Waryas & Stremel-Campbell, 1978). However, the efficacy of the systematic use of imitation procedures in conjunction with other types of verbal and gestural prompts (e.g., Horner & Keilitz, 1975) has not been well established.

The present study was designed to: (a) teach six severely multihandicapped students with hearing impairments to put on their own hearing aids independently, and (b) provide an empirical evaluation of a comprehensive instructional program for putting on a hearing aid by assessing acquisition, maintenance, and generalization of that skill across environments. The present study was not concerned with learning the use of the aid, wearing the aid for extended periods, or care of the aid.

METHOD

Students

Five male and one female severely multihandicapped residents of the Kansas Neurological Institute (KNI), a residential institution for the mentally and physically handicapped, were selected to serve as students for the experimental field test of the hearing aid program. The students ranged in ages from 15 yr 6 mo to 22 yr 3 mo. All six students were evaluated in the KNI Hearing Clinic and assessed to have a hearing loss of sufficient magnitude to warrant sound amplification. The chronological age, level of retardation, type of hearing loss, type of hearing aid recommended, and type of hearing aid support accessory used is presented for each student in Table 1.

Setting

Three settings were used in both experiments. The training setting consisted of a small (1.83 m $\times$ 2.44 m) room with a one-way window (for reliability observations), a table, and one chair each for the student and trainer. The room was virtually void of any distractions. This room was used for both the training and maintenance conditions (to be described).

Generalization across environments and adults was assessed in two separate settings: an educational classroom and a residential living unit. Different students were assessed in different classrooms; however, each individual student was always assessed in the same room. Each classroom

Table 1
Student Characteristics

<i>Student</i>	<i>CA (yr-mo)</i>	<i>Retardation level (AAMD)</i>	<i>Hearing loss</i>	<i>Hearing aid</i>	<i>Accessory</i>
Susan	19-9	Severe	Moderate Bilateral Sensorineural	Moderate-gain Body-type Air	Commercial Harness
Tom	22-3	Severe	Moderate Bilateral Sensorineural	Moderate-gain Body-type Air	Modified Harness
Matthew	20-2	Severe	Moderate Bilateral Conductive	Moderate-gain Body-type Bone	Commercial Harness
Billy	15-6	Profound	Moderate Bilateral Mixed	Moderate-gain Body-type Air	Modified Harness
Randy	17-2	Severe	Moderate Bilateral Mixed	Moderate-gain Body-type Bone	T-shirt
Steve	20-8	Moderate	Profound Bilateral Sensorineural	High-gain Body-type Air	Modified Harness

provided daily educational programming for several students simultaneously with one to three teachers present. Generalization was also assessed in each student's living quarters. Several peers usually were present, as well as one to three ward attendants.

Trainers and Observers

Within the training setting, three trainers (the authors and an assistant to the audiologist) conducted acquisition training with the six students. Each trainer-student dyad remained constant during acquisition training only. All the trainers were skilled in the use of behavioral teaching techniques prior to the study, but only one was experienced in the use of the specific procedures used. However, the teaching procedures reported in the present study have been demonstrated to be effective when used by relatively untrained individuals (Horner & Keilitz, 1975), and have been included in an educational curriculum for paraprofessionals (Tucker & Horner, 1977).

Generalization probing and training were conducted by the teachers in the classrooms and by ward attendants in the residential units.

The three individuals conducting acquisition training also served as reliability observers for students for whom they were not the trainer.

Task Analysis

The program for teaching severely multihandicapped students to put on a hearing aid¹ consisted of 10 components, three of which were universal components, i.e., segments of the chain for any student regardless of the nature of the hearing impairment. Inclusion of the other seven allowed a selection of the most appropriate components, depending on the type of hearing aid selected and the fine motor skills demonstrated by the students. The first component was a universal component, consisting of obtaining the hearing aid from its container. The second and third components were designed to teach the student to put on a harness that securely fastened the hearing aid to the body. Either a commercially available hearing aid harness (second component) or a "homemade" hearing aid harness (third component) can be

¹A detailed description of the specific behavioral components of each step in the hearing aid program is available from either author.

used within this set of steps. The fourth component consisted of putting on a T-shirt with a specially constructed pocket for the hearing aid attached to the front. A vest with an attached hearing aid pocket comprised the fifth component. The sixth was a universal component instructing the student to fasten the hearing aid into the harness pocket. The seventh component was designed to teach the student to put on an air-conduction hearing aid, whereas the eighth component was designed for a bone-conduction hearing aid. The ninth component was for ear-level (wireless) hearing aids that fit behind the ear, and the tenth was the final universal component, turning the aid on and adjusting the gain (loudness).

The components of the hearing aid program were initially developed from observations and pilot tests on three students who had differences in either: (a) type of hearing impairment (i.e., sensorineural or conductive loss), (b) motor development (i.e., normal motor performance, orthopedic impairment), (c) language development (i.e., deficiency in expressive and/or receptive language skills), (d) other physical impairments (i.e., visual impairment), or (e) behavioral problems (e.g., tantrums, resistance to instruction and physical guidance). Table 2 illustrates the sequence of steps across program components for each of the six experimental students. The format of the program allows for the integration of new branches (components) for any student demonstrating new behavioral differences, such as component 9, use of an ear-level hearing aid. None of the students in the present study was a likely candidate for this type of hearing aid, thus, no data are reported for component 9. Likewise, no data are reported for component 5, use of vest; however, one student was successfully trained in this component during the developmental phase (pilot test) of the program.

Procedures

The same procedures were used for all students in both experiments. All "verbal" instruc-

tions or prompts were given either vocally, vocally with manual sign, or with manual sign alone, depending on which method had been found previously to be most effective with each individual student.

Baseline. The baseline procedure for all six students consisted of the trainer placing in front of the student the box containing the hearing aid equipment and providing the following instruction: "(Student's name), please put on your hearing aid." The student was then provided the opportunity to perform any of the steps correctly without assistance or extrinsic consequences from the trainer. Steps performed according to the behavioral definitions were scored as correct regardless of the sequence in which they were performed. The dependent measure for each session was the percentage of hearing aid attachment steps completed correctly without trainer assistance.

Training. The training procedure was similar to that used by Horner and Keilitz (1975) and Bieberly, Lent, and Keilitz (1974) in which a graded sequence of assistance by the trainer was given as needed: (a) "No Help," (b) "Verbal Instruction," (c) "Demonstration and Verbal Instruction," and (d) "Physical Guidance and Instruction." This sequence of assistance was used for each step in the hearing aid chain. All steps were taught in sequence during each daily session; correct responses were followed by praise.

Each training session was initiated with the same instruction: "(Student's name), please put on your hearing aid." The student was then allowed approximately 5 sec to perform the first step correctly without trainer assistance ("No Help"). If the response was correct, the trainer scored a "+" and provided praise, and approximately 5 sec was allowed to perform the second step with "No Help." If a student failed to respond within 5 sec, the trainer scored a "-" and provided a nonspecific verbal (vocal or manual sign) prompt (e.g., "Go ahead" or "What's next?"). If the student responded incorrectly, the trainer immediately provided "Verbal Instruction" in the form of a short explicit

Table 2
Hearing Aid Program Task Analysis

<i>Component</i>	<i>Step</i>	<i>Susan</i>	<i>Tom</i>	<i>Matthew</i>	<i>Billy</i>	<i>Randy</i>	<i>Steve</i>
Universal	1. Open container	1	1	1	1	1	1
	2. Remove harness (or other)	2	2	2	2	2	2
Commercial Harness	3. Harness over head	3		3			
	4. Fasten side strap 1	4		4			
	5. Fasten side strap 2	5		5			
Modified Harness	6. Arm 1 through strap 1		3		3		3
	7. Arm 2 through strap 2		4		*		4
	8. Harness over head		5		4		5
	9. Fasten harness		6		5		6
T-shirt	10. Pull T-shirt over head					3	
	11. Arm 1 through sleeve 1					4	
	12. Arm 2 through sleeve 2					5	
	13. Pull hem down to waist					6	
Vest	14. Wrist 1 through hole 1						
	15. Vest to shoulder						
	16. Wrist 2 through hole 2						
	17. Vest to shoulder						
	18. Fasten vest						
Universal	19. Unsnap pocket	6	7	6	6	7	7
	20. Remove aid from container	7	8	7	7	8	8
	21. Insert aid into pocket	8	9	8	8	9	9
	22. Snap pocket	9	10	9	9	10	10
Body-type Air Aid	23. Pick up earmold	10	11		10		11
	24. Insert earmold into ear	11	12		11		12
Body-type Bone Aid	25. Pick up headband			10		11	
	26. Place headband on head			11		12	
Ear Level Aid	27. Pick up aid & earmold						
	28. Place aid behind & over ear						
	29. Insert earmold into ear						
Universal	30. Turn on aid	12	13	12	12	13	13
	31. Set gain control	13	14	13	13	14	14

*Billy's harness contained only 1 strap to accommodate an orthopedically impaired arm.

prompt (e.g., "Open the hearing aid box."). Once again, a correct response was praised and the student was allowed approximately 5 sec to perform the next step without trainer assistance. If the student again failed to respond within 5 sec or responded incorrectly following the verbal cue, the trainer modeled the desired response, accompanied by the prompt (i.e., "Demonstration and Verbal Instruction"). Again, a correct response was praised and the student was provided the opportunity to perform the next step without trainer assistance. If the student did not imitate correctly within 5 sec of

the model, the trainer physically "put the student through" (e.g., Striefel, 1974) or physically guided the desired response in conjunction with the prompt ("Physical Guidance and Instruction"). If the student resisted the physical guidance or still failed to respond correctly with physical guidance, the trainer did not praise the student and proceeded to the next step with "No Help." Criterion for completing acquisition training consisted of at least two consecutive sessions of 100% correct performance without trainer assistance on all steps. (Eight additional steps involving cosmetic functions,

such as straightening folds, were initially included in the sequence. However, these steps proved to be irrelevant to putting on a hearing aid competently and were not included in criterion performance or the data analysis.)

Remedial training. In the first experiment, two students, Susan and Tom, initially failed to reach criterion as a result of having difficulty learning one of the steps (Insert Earmold into Ear) with the standard procedures. The training procedure was temporarily modified for these two students by removing the problem step from the rest of the chain and providing intensive training on that step. The training consisted of 10 trials per session of inserting the earmold into the ear accompanied by "No Help," "Verbal Instruction," "Demonstration and Verbal Instruction," and "Physical Guidance and Verbal Instruction," until a criterion of five consecutive correct trials was met. Praise for correct responses was continued. After criterion performance was achieved on this step, it was inserted once again into the entire chain and the students were asked to perform the step in its proper sequence.

Maintenance probes. In the first experiment, follow-up probes were instituted after the training condition to assess the maintenance of the hearing aid skill in the training setting. The probe procedures were the same as the baseline procedures in that no prompts or consequences were provided. Each probe session was conducted once a week for three consecutive weeks. Maintenance probes were not included in the second experiment.

Generalization probes. In the first experiment, following the maintenance condition for Susan, Tommy, and Matthew, probes were conducted to assess the degree of generalization of putting on a hearing aid across different environmental settings with new trainers. Prior to these probes, although the students were acquainted with the environments and trainers, there had been no previous opportunity to perform the hearing aid task in the new environments or with the new trainers. The probe procedures were identical to

the baseline procedures in that no prompts or reinforcement were delivered initially. As reported in the Results, two of the three students (Susan and Tommy) failed to generalize under these conditions and were subsequently retrained by the new trainer. The procedures for retraining Susan and Tom were identical to the training procedures except that a new trainer provided the prompts and reinforcement.

During the second experiment, intermittent generalization probe sessions were conducted concurrently with baseline and training conditions. The purpose of the concurrent probes was to assess the degree of generalization to untrained environments during the same temporal period as the baseline and training conditions in the training environment. Although the "true baseline" (see experimental design) and training sessions were conducted once a day on consecutive days (except for weekends, holidays, and illnesses), these probe sessions were conducted in close temporal proximity. Oftentimes a probe session was conducted on the same day as a baseline or training session (as exemplified by Billy's baseline sessions in Figure 2), while at other times conducted on different days (as exemplified by Steve's baseline in Figure 2). These probe procedures were identical to those of the first experiment except that no training was ever conducted in these probe environments. The trainers provided only the opportunity to engage in the task and never delivered prompts or reinforcement.

Observer reliability. Interobserver reliability was assessed by a second observer who simultaneously but independently observed and recorded the responses of the students on each step. The reliability observer was one of the other two acquisition trainers in the training setting as well as all probe settings. In the training setting, the reliability observer viewed the student's performance through a one-way observation window. Although the trainer was generally aware of the observer's presence, the student was kept naive to the presence of others. However, in the probe settings, the primary

observer and the reliability observer were visible to each other as well as the student and trainer, although separated from each other and the trainer by an adequate distance to avoid knowledge of the recordings.

Reliability observations were conducted on all six students frequently throughout most conditions. A cell-by-cell (step-by-step) comparison was made for calculating percentage agreement between observers. Agreements and disagreements on each step were compared; then percentage agreement was calculated by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100.

Experimental Design

Experiment 1. A multiple-baseline design across students (Baer, Wolf, & Risley, 1968) was used to assess the efficiency of the training procedure in teaching Susan, Tom, and Matthew to put on a hearing aid.

In addition to the multiple baseline across students, conditions were reversed to baseline at 1-wk intervals for 3 consecutive wk, in order to assess the maintenance of the acquired skill when experimentally induced contingencies were not in effect. This reversal was extended to assess the generalization of putting on a hearing aid across environmental settings while under the supervision of adults who were different from the trainer.

Experiment 2. A modified multiple-baseline design across students with multiple probe sessions during baseline conditions comprised the experimental design used to teach Billy, Randy, and Steve to put on a hearing aid. This design is similar to that reported as a multiple-probe technique by Horner and Baer (1978). The multiple-probe technique is similar to the multiple-baseline design in that independent baselines are obtained simultaneously, for differing lengths of time. Whereas the multiple-baseline design uses frequent, clustered measures, the multiple-probe technique uses intermittent probes separated by a longer time span, culmi-

nating in a few continuous "true baseline" sessions (Horner & Baer, 1978). "True baseline" sessions are defined as consecutive sessions (illustrated as connected points in Figure 2), while multiple-probe baseline sessions are characterized by temporal gaps between the sessions (illustrated as unconnected points in Figure 2). The primary advantage of adapting such a design for teaching a complex chain of relatively independent behaviors like the hearing aid program is to reduce the length of time spent in the baseline condition, thereby reducing the probability of extinction and punishment effects in addition to competing behaviors (cf. Horner & Keilitz, 1975).

In addition to the multiple-probe technique, the design included intermittent generalization probes across two different environments simultaneous with the baseline and training conditions in the training environment.

RESULTS

Experiment 1

Interobserver reliability was assessed during baseline, training, and generalization conditions for all three students and assessed in one maintenance session for Susan. Percentage agreement for each reliability session is plotted on Figure 1 for Susan, Tom, and Matthew. Near-continuous reliability checks during baseline yielded 100% agreement in all instances. During the training condition, 11 reliability observations for Susan produced a range of 92% to 100% agreement (mean = 98%). Agreement on Tom's training performance was 100% for each of the four observations. The two reliability observations of Matthew's training performance resulted in 92% agreement for each of the sessions. Only one reliability observation was conducted during the maintenance conditions; this yielded 100% agreement on Susan's performance. Five observations across the three students during generalization probes resulted in 100% agreement for each of two sessions for Susan, two sessions for Tom, and one session for Matthew.

Fig. 1. Percentage of hearing aid steps completed correctly without trainer assistance for Susan, Tom, and Matthew. The shaded area for Susan and Tom represents the period of time required for remedial training on the program step in which their behavior was deficient. Connected dots represent performance in the training setting. Vertical bars represent maintenance and generalization probe behavior. The R represents the level of reliability agreement for a given session.

Figure 1 also illustrates the session-by-session performances of Susan, Tom, and Matthew in putting on a hearing aid during conditions of baseline, training, maintenance, and generalization. Each of the three students demonstrated rapid acquisition during training after stable baseline performances. Susan and Tom, however, failed to reach criterion initially due to continued problems with one step, Insert Ear-mold into Ear. After the remedial training procedure of repeated trials on that step, both Susan's and Tom's behavior reached criterion. Susan required 90 remedial training trials and Tom, 95, before their behavior met criterion with the entire chain. All three students maintained near-perfect performance in the training

setting when measured 3 wk following their training.

After the maintenance condition, the students' ability to perform the hearing aid skill in environments outside of the training setting was assessed. In three consecutive sessions, Matthew demonstrated 93%, 100%, and 100% performance in his residential living quarters. Susan's and Tom's behavior, on the other hand, each fell to 13% correct performance in the first probe session. The ward staff then conducted training sessions in the residential setting. Tom's behavior immediately returned to 100% correct performance, while Susan required three additional training sessions before returning to 100% correct performance.

EXPERIMENT 2

Fig. 2. Percentage of hearing aid steps completed correctly without trainer assistance for Billy, Randy, and Steve. The crosshatched bars represent probe performance in the education classroom; the solid bars represent probe performance in the residential areas. The connected dots represent continuous consecutive sessions of either baseline or training in the training area; unconnected dots represent periodic consecutive baseline sessions. Probe data are temporally superimposed over the training area data. The *R* represents the level of reliability agreement for a given session.

Experiment 2

Interobserver reliability was assessed for all three students in some sessions of baseline, training, and generalization. Percentage agreement for each reliability observation session is plotted on Figure 2. For Billy, 8 out of 25 sessions in the training setting were observed for reliability purposes. Percentage agreement ranged from 83% to 100% with a mean of 94%. Billy's performance was monitored by a reliability observer in 10 of the 11 sessions in the generalization settings resulting in 92% or better agreement (mean = 97%) in all sessions checked.

Reliability observations were conducted for Randy and Steve across the three environmental

settings: the training room, the educational classroom, and the residential living quarters. In 16 reliability observations of Randy's performance across environments, percentage agreement ranged from 92% to 100% (mean = 98%). For Steve, 19 total sessions monitored by a reliability observer resulted in a range of agreement from 85% to 100% (mean = 98%).

Randy and Steve maintained relatively stable, but low, correct performances during the intermittent baseline probes and continuous baseline sessions. Billy's continuous baseline performance was, on the other hand, rather variable at higher levels of proficiency. Steve demonstrated rapid acquisition to criterion; Billy and Randy demonstrated rapid acquisition to just below crite-

tion level, then slow acceleration to criterion performance. None of these three students required remedial training during acquisition.

Baseline probes for generalization of performance across two additional settings showed that the performance of the skill in the untrained settings corresponded to the level of performance in the trained setting. It was not necessary to retrain any of the final three students in the generalization settings.

DISCUSSION

Six severely multihandicapped students with hearing impairments successfully acquired the skill of putting on their own hearing aids after being trained with a graded sequence of assistance similar to the procedures used by Horner and Keilitz (1975). Five of the six students showed rapid acquisition following relatively low stable correct baseline performances, demonstrating the facilitative effects of the training procedure. However, because one student's (Billy's) performance was somewhat variable at a high level of accuracy during baseline, interpretation of the effects of the training procedure on his performance is questionable. Anecdotally, Billy engaged in several disruptive and resistive behaviors, and that may possibly account for the variability in his performance. Nevertheless, the effects of the training are unclear with regard to Billy's performance, although he did achieve criterion levels.

Although a demonstration in only two students is not conclusive evidence, the possible facilitative effect of the remedial training procedure for Susan and Tom is interesting. It took 90 and 95 trials, respectively, in addition to the 21 and 19 previous training sessions, for these two students to learn to insert the earmold into the ear. A session consisting of the entire chain would constitute one trial per session of that particular step, so it would have taken an additional 90 and 95 sessions (at the same rate) for Susan and Tom to meet the criterion performance for the chain. The procedure of removing

the step from the chain apparently saved approximately 81 training days for each student. (The remedial training consisted of 10 repeated trials per training day.) Thus, this procedure represents a relatively economical strategy when teaching complex chains of behaviors to slow learners.

Although the present study did not provide a functional analysis of generalization, it is encouraging that four of the six students spontaneously generalized correct performance of the hearing aid skill to untrained environments. The failure of Susan and Tom to generalize their performance to another environment illustrates a common (e.g., Guess, Keogh, & Sailor, 1978; Stokes & Baer, 1977), but perplexing problem. Further analysis of techniques for facilitating generalization is still needed (Stokes & Baer, 1977), especially with complex chains of behavior (Siegel & Spradlin, 1978).

Perhaps a more important issue than generalization across environments for the severely retarded hearing impaired at this time is whether the hearing aid improves their auditory discrimination abilities. The importance of putting on a hearing aid is certainly questionable if the aid does not increase the auditory reception for these individuals. Despite the absence of a measure of auditory reception, the present study did demonstrate the relative power of a multiple-prompt procedure for teaching severely multihandicapped individuals a complex chain of functional behaviors.

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