ACQUISITION AND CROSS-SETTING GENERALIZATION OF MANUAL SIGNS WITH SEVERELY RETARDED INDIVIDUALS

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In this study, we assessed the effect of a transfer of stimulus control procedure on the acquisition and cross-setting generalization of manual signs with four profoundly retarded individuals. Two individuals were trained to produce appropriate signs to verbal instructions, whereas the other two were trained until manual signs were controlled by visual stimuli (objects). Data obtained from three probe situations (two for one individual) constituted the dependent variables of the investigation. The results, gathered within a multiple-baseline design across signs showed that (a) individuals acquired the trained signs and (b) maintenance and generalization across settings (classroom, ward) and persons (teachers, ward staff) occurred, but was highly variable between and within individuals.

DESCRIPTORS: manual sign language, retarded individuals, acquisition, cross-setting generalization

The interest in designing and implementing nonverbal language systems for mentally retarded and autistic individuals has been founded by professionals working with deaf persons and by investigators teaching communicative behaviors to chimpanzees (e.g., Fouts, 1972; Gardner & Gardner, 1969). Different systems for the improvement of communication deficits are available. Deich and Hodges (1982) developed a system based on Premack's earlier work (1972) with plastic symbols, whereas Rumbaugh has focused on computer-assisted communication systems (Rumbaugh & Savage-Rumbaugh, 1978). A major effort in this area lies in teaching manual signs or gestures.

Many articles have described manual signs taught to mentally retarded and autistic individuals. Despite the numerous studies dealing with training

manual signs and gestures, only a few have provided procedures based on a valid methodology and reliable recording. Carr, Binkoff, Kologinsky, and Eddy (1978), for instance, validated the effect of simultaneous communication training on the acquisition and cross-therapist generalization of manual signs with four autistic children. Further analysis of the effects of the procedure, in which the word and the visual referents of the sign were presented, revealed that manual sign responses were mainly controlled by the visual referent of the sign, instead of by the verbal instructions. Although this can be effective in some cases, it also limits stimulus control to a small class of stimuli.

Duker and Michielsen (1983) developed a training procedure through which subjects' manual signs could be controlled by the auditory stimulus (verbal instruction) as well. The procedure was based on the concept of transfer of stimulus control and has been validated with three severely mentally retarded children. As a further step toward a more effective technology for teaching manual signs to retarded individuals, verbal instructions pertaining to signs not yet trained were subjected to S^A training. This implied that (a) signs were trained

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in a serial order and (b) verbal instructions of manual signs yet to be trained were presented concurrently with the target stimulus, whereas the subject refrained from any responding to the nontarget stimulus.

One can argue that the aforementioned procedure of S^A training might be incompatible with the rationale of the multiple-baseline design. From a procedural point of view, our previous study was unclear as to whether the acquisition and generalization of manual signs to verbal instructions depended on the transfer of stimulus control procedure, on the S^A training, or on the combined effect of the two. In this investigation the procedure of transfer of stimulus control was tested, whereas the S^A training was omitted.

Two experiments were conducted. In the first experiment two retarded individuals were required to produce manual signs to verbal instructions. Probes (a) immediately after training sessions in the therapy room, (b) in the classroom, and (c) in the ward were conducted to assess whether signs were acquired and generalized across settings and persons. The second experiment was conducted with two other individuals, with whom previous attempts (not through sign teaching) to establish verbal control of their gross motor responses had failed. The purpose with these individuals was to have visual stimuli (objects) control the production of manual signs. As in Experiment 1, probes were also taken in situations other than the therapy room to assess generalization effects. In both experiments one follow-up recording was undertaken.

EXPERIMENT 1

METHOD

Participants and Setting

Two mentally retarded women were selected for this investigation. Criteria for selection included the ability to imitate gross motor responses, to establish eye contact, and to follow verbal instructions. Participants were living at the Winckelsteegh, an institution for the retarded, affiliated with the University of Nijmegen. Both women

were enrolled in a special classroom several hours each day.

José was 23 years of age. The cause of her retardation was unknown. Her reported mental age from the Leiter test of intelligence was less than 2 years and her social age on the Vineland Social Maturity Scale was 4.1 year, with a corresponding SQ of 17.2. She had been institutionalized since she was 4 years of age. She had no expressive language skills. Prior to the investigation she had acquired the signs for sleeping, drinking, combing hair, and cleaning as responses to verbal instructions.

Erna was a 22-year-old woman. The cause of her retardation was unknown. The aforementioned testing devices yielded a mental age and social age of 1.6 year and 4.9 year, respectively (SQ = 24). She had no verbal expressive repertoire. Informal observations showed that she tended to communicate by pointing. She had acquired manual signs for drinking and combing hair prior to the investigation.

Neither of the women were receiving any medication or had any sensory disorders. Neither had ever participated in research.

Training and probes were conducted in a 5 × 3 m therapy room equipped with a soundproof one-way vision screen. Data were also collected in a classroom, which was attended by five other residents, and in a ward, which was the same for José and Erna. The living group on the ward consisted of nine severely and profoundly retarded residents.

Materials

The signs constructed for both experiments were iconic, that is, they resembled the objects and actions for which they stood. Symmetry of sign movements, touch (Kohl, 1981), and phonological dissimilarity between the verbal referents of the signs were considered in constructing the signs. Furthermore, assignment of specific signs to the women was based on informal observations of their interest for certain objects or activities, such as playing with certain toys, riding on a tricycle, or cleaning furniture. The signs used for each woman are reported in the Results section.

Recording

The dependent variables of the study consisted of the participants' responses to probes which were taken (a) immediately after each training session in the therapy room (probe 1), (b) in the classroom by the teacher presenting the verbal instructions (probe 2), and (c) in the ward (probe 3). In the ward, verbal instructions of the sign were presented by an available ward staff member. Probes occurred 5 days a week in the therapy room, twice a week in the classroom, and once a week in the ward.

The probe session involved the presentation of all four instructions twice in random order. During probes the participant was required to produce the signs appropriate to the instructions in the absence of other cues. Signs and motor imitation responses acquired by the participant before the investigation (competency items) were interspersed with the trained instructions with a ratio of 1:2 for competency trials and probe trials, respectively. Correct responding was defined as the response being (a) emitted first within 10 s after presentation of the instruction and (b) congruent with that instruction. Incorrect responding consisted of no responding, correct responding beyond the 10-s interval, emitting responses extraneous to the instructions in training or responses related to an instruction other than that presented, and correct responding preceded by any other response. During probes, correct responding to competency items was consequated by a response-appropriate reinforcement or a sip of a soft drink, whereas responding to training instructions was never consequated, neither by reinforcement of correct responding nor by disapproval in case of incorrect responding.

Design

The sequence of training manual signs conformed to the multiple-baseline design across instructions for each woman to demonstrate change in stimulus control of sign before and after starting training.

After a baseline of five and seven therapy room probe sessions for José and Erna, respectively,

training was started for one sign, whereas baseline recording continued for the untrained signs. Training for each sign continued until probe 1 had given three consecutive sessions of 100% correct responding. After that the participant was taught the next sign, unless this was already shown correctly. One follow-up recording was carried out 3 months after training had been ended.

During the initial baseline period, i.e., before the first sign was trained, the women were provided with a type of placebo training, consisting of imitating stimuli which were not related to the signs to be trained. This was an attempt to control for increased social attention which might be a rival explanation for the effect of the procedure.

Reliability

Reliability of sign recording was assessed in the following manner:

Probe 1. Each reliability check consisted of the trainer probing as usual and the assessor (senior author) recording simultaneously. Reliability data were collected during 33 and 36 of the therapy room probe-sessions for José and Erna, respectively. Recording occurred through a one-way screen. Through a half-closed curtain only the participant (not the trainer) was observable. So, the assessor could neither hear, nor see the instructions presented to the participant.

Probe 2. Reliability of sign recording was assessed in almost every classroom probe by the trainer (who observed through a one-way screen) and the teacher (Table 1). As in probe 1, the (trainer)-observer remained naive as to the particular sequence of the instructions being presented by the teacher. Whereas the teacher was seated with her back to the one-way screen to prevent the assessor from being biased by lip-reading or other visual cues, she indicated to the assessor which of the women would receive the next instruction.

Probe 3. Reliability of sign recording was assessed in almost every ward probe by the trainer and a staff member (Table 1). Because no one-way vision facilities were present on the ward, the observer could not remain naive.

None of the classroom teachers, the ward staff

members, or the assessor was provided with feedback concerning the accuracy of their recording. On each trial both observers (including teachers, ward staff member, trainer, and assessor) scored whether the sign was made correctly, incorrectly, or was omitted. Agreement was assessed on a trial-by-trial basis. A percentage of agreement for each session was computed by dividing the number of agreements on occurrences and nonoccurrences of signs by the total number of trials and multiplying by 100.

Procedure

Training was conducted 5 days per week and sessions lasted about 20 minutes. During each session the participant and trainer sat facing each other. Before an instruction was presented, eye contact was established and the participant was asked to place her hands on her lap or on the trainer's knees. A transfer of stimulus control procedure was used to establish the signs. A flow chart of the procedure is presented in Figure 1. During the trials the trainer pointed to the object while demonstrating the appropriate sign and saying the name of the object. If the participant failed to make the manual sign within 5 s after the presentation of the instruction, the trainer would fade in physical guidance ($\frac{1}{3}$ = touching and moving the arm(s); $\frac{2}{3}$ = guiding the arm(s) into the appropriate position; $\frac{3}{3}$ = complete guidance of the movement until a correct response was made and possibly to the point that the correct sign had to be molded by the trainer, while saying the name of the object. During subsequent trials the trainer would fade out the physical guidance step-by-step (see Fig. 1). While saying "no," incorrect responses were physically interrupted as early as possible (Duker, 1981) and followed by physical guidance of the correct response. After that, the trainer would repeat the trial and fade in physical guidance. After three consecutive correct responses, each reinforced with the opportunity to manipulate the object for about 10 s or to have a sip of a soft drink, the trainer started to omit the demonstration of the sign, i.e., presenting the object, and only said the name of it. If the participant failed to make the correct manual sign, the trainer

resorted to fading in the demonstration of the manual sign ($\frac{1}{3}$ = trainer merely moved his hand; $\frac{2}{3}$ = trainer brought his hand in the appropriate position; $\frac{3}{3}$ = performing the movement for the sign) analogous to the procedure of fading in of physical guidance. During subsequent trials the trainer faded out the demonstration of the manual sign step-by-step. If the participant still failed to make the correct sign, the trainer added physical guidance. While saying "no," the trainer physically interrupted incorrect responses as early as possible, followed by demonstration of the correct sign. After that the trainer repeated the trial and faded in the appropriate model for the manual sign. After three consecutive correct responses, which were consequated as described previously, the trainer presented only the verbal instruction as the stimulus to control the appropriate manual sign. Failure to respond resulted in fading in the object—pointing to ($\frac{1}{3}$), touching ($\frac{2}{3}$), holding the object in the hand ($\frac{3}{3}$). If the participant still failed to make the correct sign, the trainer modeled or physically guided. Again, incorrect responses were physically interrupted as early as possible, while saying "no." Interruption was followed by showing the object. After that, the trainer would repeat the trial and fade in the appropriate cues.

Three consecutive sessions of 100% correct responding to the verbal instruction resulted in progression to the next sign. Once criterion had been met with one sign, trials involving the previously mastered sign(s), as well as motor imitations (not related to signs), were interspersed with trials involving the new sign in a ratio of approximately 1:1. Sign training continued until the participant had mastered four signs. ♦

RESULTS

Table 1 presents the frequency of reliability assessments as well as means and ranges of the interobserver reliability percentages for the participants at the three probe settings.

Figures 2 and 3 display the percentages of correct sign responses to verbal instructions across the three probe settings for the two women. Because there were two trials per session for each instruc-

Figure 1. Flowchart of stimulus control procedure for the signs to be trained.

tion, scores could be 0%, 50%, or 100%. During baseline, there were no correct responses to the instructions presented; acquisition of manual signs occurred only after the administration of the transfer of stimulus control procedure. It took 16 and 19 sessions to attain criterion level (in probe 1) for the first sign for José and Erna, respectively. The second sign took 15 and 12 sessions. A more rapid attainment of criterion level was achieved beyond training of the second sign for both individuals. Erna's response pattern of previously acquired signs became somewhat erratic after starting the training of a new sign. With the exception of the sign "give me" for José, increased generalization of responding to the settings of classroom and ward was also demonstrated. It can be observed, however, that some signs differentially generalized across the settings of classroom and ward. "Closing/opening" for José was more frequently emitted in the classroom than on the ward, whereas Erna demonstrated a varied pattern of responding for that sign

across settings. At follow-up, José maintained two of the four signs, whereas Erna maintained all four signs.

EXPERIMENT 2

The second experiment was conducted to demonstrate the effectiveness of the training procedure used in Experiment 1—to have visual stimuli control the production of signs with two individuals with whom previous attempts to have spoken words control motor responses had failed.

Participants and Setting

Marius was 13 years 3 months old at the start of the investigation. He had been institutionalized since 6 years of age. His diagnosis reported mental retardation and autistic behaviors. Like Erna, Marius communicated by pointing or tugging at ward personnel and teachers. His social age was 3.1 (SQ = 23), as assessed by the Vineland Social Ma-

Table 1
Reliability Scores for Participants' Sign Responses Across Experimental Settings

Partici- pant	Therapy room			Classroom			Ward		
	Freq.* (%)	Mean (%)	Range (%)	Freq.* (%)	Mean (%)	Range (%)	Freq.* (%)	Mean (%)	Range (%)
José	33	99	88-100	100	99	88-100	100	100	—
Erna	36	98	75-100	96	98	88-100	93	100	—
Marius	20	98	75-100	100	100	—	100	100	—
Ronnie	40	98	88-100	—	—	—	100	100	—

* Proportion of sessions during which reliability assessment was undertaken.

Figure 2. Percentage of correct signs during probes made by José to verbal instructions before, during, and after training (F.U. = Follow-up).

Figure 3. Percentage of correct signs during probes made by Erna to verbal instructions before, during, and after training (F.U. = Follow-up).

turity Scale. Although he had received verbal training, he did not have any expressive verbal behaviors. Previous to formal training, Marius had acquired signs for "closing/opening" as well as for "eating" and "drinking."

Ronnie had a diagnosis of Down's syndrome. He was 8 years of age and had been institutionalized for 15 months. He did not vocalize and he did not respond to any spoken instructions. Ronnie's social age was 2.9 (SQ = 34.4) on the Vine-

land Social Maturity Scale; his mental age on the Leiter was less than 2 years. Ronnie had acquired manual signs as responses to some objects—food, drinks, and some toys. Neither of the individuals had participated in previous investigations. Medical examination did not reveal any sensory deficits with the two individuals. Criteria for selection were similar to those used in Experiment 1, with the exception of verbal control of gross motor responses.

Training sessions were conducted in the same therapy room used for Experiment 1. The wards were different for Marius and Ronnie and also different from José's and Erna's ward in the first experiment. The living groups of the wards of Marius and Ronnie consisted of nine and eight severely retarded persons, respectively. Most of them were enrolled in special classroom activities, such as sorting and matching tasks.

Recording

During probes, the boys' manual signs to visual stimuli (objects) were recorded. Classroom probes were omitted for Ronnie because he did not attend a classroom. Data were also collected in the ward for both individuals. Probes for Marius' responses were identical to probes for José and Erna, although, due to practical reasons, the number of probes in the generalization settings (classroom and ward) was reduced during the final part of the study. As with Experiment 1, one follow-up recording was undertaken 3 months after training ended.

Design and Reliability

The experimental design was identical to Experiment 1, except that, due to practical reasons, Marius was taught three instead of four manual signs. The procedure for assessing reliability of sign recording was also the same as that used in Experiment 1. The assessor could not see which particular object was presented because the objects were never handed to the participants during probe sessions.

Procedure

Training was aimed at establishing manual sign responses to visual instead of verbal stimuli. Training involved the transfer of stimulus control procedure described previously, with the following differences: (a) the verbal instruction was omitted, and (b) criterion was attained if the appropriate manual sign was produced on the presentation of the visual stimulus (i.e., object).

RESULTS

Table 1 shows the frequency of reliability assessments as well as means and ranges of reliability percentages for the participants at the probe settings. Figures 4 and 5 show the percentages of correct responding across the stimuli and probe settings for both individuals. During baseline, neither of the boys emitted correct responses to the instructional stimuli. The successive acquisition of manual signs as a function of the independent variable supports the validity of the training procedure. Data from these two individuals show a high degree of between-subject variance; Ronnie almost immediately attained criterion level, whereas Marius' acquisition rate was extremely slow and erratic. Marius took 23 training sessions before reaching criterion level for the first sign. Figure 4 shows that the second sign was acquired within 17 sessions. Criterion performance on the third sign was preceded by 15 training sessions. Generalization (to ward) and maintenance data were far better for Ronnie than for Marius. Ronnie and Marius, like José and Erna, differed in their responses to the instructions presented during follow-up.

GENERAL DISCUSSION

Data from the two experiments indicate that the transfer of stimulus control procedure resulted in the acquisition of manual signs to verbal stimuli (instructions) and visual stimuli (objects). For these four profoundly retarded individuals this procedure constituted a necessary and sufficient training condition. The procedure can be considered an extension of that used by Carr et al. (1978); in fact, this procedure led to controlling manual signs through verbal instructions. This achievement is a step toward the spontaneous use of acquired signs.

For the sake of procedural and methodological rigor, S^Δ training was not a component of the training package. Although no assessment of the differential effect of S^Δ training on the acquisition of manual sign responses was undertaken, informal observations revealed that during probes for signs related to instructions not yet trained, participants

Figure 4. Percentage of correct signs during probes made by Marius to objects before, during, and after training (F.U. = Follow-up).

emitted either several kinds of idiosyncratic responses (e.g., waving, pointing) or the manual signs previously acquired.

Summarizing the results of both experiments, it was shown that stimulus generalization was better than expected on the basis of other investigations (e.g., Koegel & Rincover, 1977). This, however, might be an artifact of the design used because 100% correct responding levels were required during three consecutive sessions, while the previous sign(s) continued to be presented during training and probes. This might have produced overlearn-

ing. Some evidence for the effect of overlearning on stimulus generalization in the area of language training exists (DeHaven & Garcia, 1974).

The individual data show a high degree of between-subject variability. Although this is considered to be a general feature of performance by the mentally retarded population (see e.g., Baumeister & Kellas, 1968), the chosen manual signs and the relation between them might also account for a great deal of variability. Research on the effects of dimensional properties of manual signs on their acquisition has been reported. Kohl (1981), for

Figure 5. Percentage of correct signs during probes made by Ronnie to objects before, during, and after training (F.U. = Follow-up).

instance, found that signs involving symmetrical hand movements were acquired significantly faster than asymmetrical signs. However, the functional significance of a sign for the individual will probably most affect its acquisition rate. Marius, for instance, acquired and generalized prior to formal training the sign for "open/close" within a few training sessions. For this boy, the sign was extremely functional because it was known that he enjoyed opening doors to get to outdoor activities.

Another aspect of the investigation that deserves mention is the problem of procedural contrast between training and probes (Cuvo, 1979). As probe trials are administered without any consequence, the design (i.e., training and probes) actually implies alternating conditions of reinforcement and extinction for the training and probe sessions, respectively. Buchwald (1960) showed that such a procedural contrast may negatively affect performance during probes. During pilot sessions pre-

ceding this investigation, we found that if individuals discriminated between training and probe sessions, their performance deteriorated during the latter ones. The procedural contrast was minimized by interspersing "competency items," responses to instructions already present in the individual's repertoire, among the probe items.

In this study, we demonstrated that profoundly retarded individuals can acquire and generalize manual signs to instructional stimuli of a verbal and visual nature. Future research should deal with the differential effect of S^A training on the acquisition, generalization, and maintenance of manual signs, as well as with the effect of various stimuli (i.e., verbal, model, object) controlling manual signs on the aforementioned variables. Other research should focus on elaborating training procedures for direct care personnel in eliciting (Faw, Reid, Schepis, Fitzgerald, & Welty, 1981) and using manual signs in natural environments.

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