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Communication Intervention for Children with Autism: A Review of Treatment Efficacy

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Empirical studies evaluating speech and language intervention procedures applied to children with autism are reviewed, and the documented benefits are summarized. In particular, interventions incorporating sign language, discrete-trial training, and milieu teaching procedures have been used successfully to expand the communication repertoires of children with autism. Other important developments in the field stem from interventions designed to replace challenging behaviors and to promote social and scripted interactions. The few studies of the parent and classroom training studies that included language measures also are analyzed. This article seeks to outline the extent to which previous research has helped identify a compendium of effective instructional practices that can guide clinical practice. It also seeks to highlight needs for further research to refine and extend current treatment approaches and to investigate more comprehensive treatment packages.

KEY WORDS: Autism; communication intervention; language development; social interaction.

This review focuses on experimental research on treatment effectiveness applied to speech and language skills of individuals with autism. Studies reviewed sought to evaluate whether changes in communication skills were associated with treatment protocols rather than uncontrolled factors, such as maturation or everyday learning opportunities. The positive effects of treatment may cover a wide range of communication skills including comprehension, production, and social use of language form (phonology, syntax, morphology), content (semantics), and use (pragmatics).

Appropriate communication depends on the use of a vast array of linguistic skills, made all the more complicated when they must be applied collectively and adapted to interactions with others. Particular interventions may target one of these domains, but their intent is usually to influence children's ability to use communication to control, understand, and participate in their social world. It is important to keep in mind that most children with autism have deficiencies across a variety of linguistic domains, and the selection of intervention targets is largely a matter of establishing priorities. The target behaviors under investigation ranged from single words or phrases in isolated contexts to conversational interactions in varying contexts.

This review focuses on peer-reviewed research articles published in the past 20 years that evaluated communication treatments with children with autism. The following minimal selection criteria were used to justify reviewing an article:

1. Program descriptions or case studies with no experimental design were excluded.
2. Only empirical studies that reported results with measures of some aspect of language form, content, or use in individuals with autism were included.
3. Only studies reporting reliability estimates for the dependent variables under investigation or studies using standardized instruments were included.

Tables I to VI summarize approximately 60 studies that evaluated the effectiveness of child language treatment approaches. The columns provide (a) ratings of internal validity, external validity, and generalization

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Table I. Communication Interventions Incorporating Sign Language

References	Participants (n)	Experimental design	Independent variables	Dependent variables	Generalization measures	Results	Duration
Brady & Smouse, 1978 I, IV, II	6 yr old (1)	Simultaneous treatment design	Sign only, speech only, & TC	Rec (speech, sign, and TC) Rs (three actions × three colors × 3 objects)	× experimenters	TC significantly better than speech alone	21 sessions
Carr & Dores, 1981 II, III, IV	mute; 6–11 yrs (6)	MBL × Ss & training sets	Rec (TC) labeling with good (4) versus poor (2) imitators	Comprehension of speech versus signs	Not assessed	2 chn acq rec signs and 4 chn acquired rec signs and speech, predicted by verbal imitation scores	Median trials to criterion = 97–286; 6 sets of 4 objects
Carr, Pridal, & Dores, 1984 II, III, IV	6–16 yr (10)	Comparison of 4 good versus 6 poor imitators	Rec (sign and speech) labeling in two groups	Rec (sign and speech) labeling	Not assessed	No difference in sign discrimination, but big difference in speech discrim (not correlated with MA or language age	Signs→ ~20–300 trials to criterion; in 1000 trials most speech discrims not learned; 3 pairs of objects
Wherry & Edwards, 1983 I, IV, IV	5 yr (1)	Simultaneous treatment, counter balanced txs and teachers	Prompting and differential reinforcement	Rec Rs to speech, signs, & TC) (9 verbs × 9 colors × 9 nouns); also initiations and eye contact	Not assessed	Poor acquisition data and no differences × conditions	3 daily sessions 18 days intervention
Barrera, Lobato-Barrera, Sulzer-Azaroff, 1980 I, IV, II	mute; 4 yr old (1)	Alternating treatments design	Sign only, speech only, and TC (total communication)	Expressive labeling and level of prompting	× persons & stimuli	TC→ superior learning replicated × groups of words	26–104 trials to criterion for 10 TC words, 21 words learned in 12 sessions
Barrera & Sulzer-Azaroff, 1983 I, II, IV	echolalic; 6–9 yr (3)	Alternating treatments design	Speech only versus TC	Expressive labeling and level of prompting	Not assessed	TC→ faster and more complete learning replicated × groups of words & children	52–88 trials to criterion in TC condition and 65–82 in speech condition; 6–10 words learned in 16–25 sessions
Layton 1988 I, I, II	6–9 yr, mod-sev autism (60)	Random assignment to four matched groups (good and poor imitators)	Speech alone versus sign alone versus alternating versus simultaneous txs	Exp and rec (signs/words) functional vocabulary	× settings & persons; 3 mos maintenance	All txs effective for good imitators, speech alone, less effective for poor imitators	90 40-min. daily sessions; Rec M = 11–31 words/signs; Exp M = 3–30 words/signs

Yoder & Layton, 1988 I, I, III	Min verbal; 3–7 yr olds (60)	Multigroup random assign; aptitude × tx interaction analysis	Speech alone versus sign alone versus alternating versus simultaneous txs	Total number of child-initiated spoken words	× settings	Sign alone → less child-initiated speech; verbal ability predicted post-tx vocabulary	90 40-min. daily sessions
Casey, 1978 II, III, II	6 and 7 yr, (4)	MBL × Ss	Parents taught to use signs	% intervals of communication attempts and inappropriate behavior	× settings	Clear increases in communication & decreases in inappropriate behavior for 2 of 4 children	20 sessions

Note: Roman numerals in the first column denote ratings of internal validity, external validity, and generalization, respectively, based on the following criteria:
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External validity: I, Random assignment of well-defined cohorts and adequate sample size; II, nonrandom assignment, but well-defined cohorts and adequate sample size or replication across 3 or more subjects in a single-subject design; III, well-defined population of three or more subjects in single-subject designs or sample of adequate size in group designs; IV, small sample in group design or one or two subjects in single-subject design.
Generalization: I, Consistent generalization to functional setting beyond treatment setting without further intervention or robust social validation results; II, long-term maintenance or generalization to one setting beyond treatment setting; III, intervention occurred in natural setting or outcome measure with document relation to functional outcomes; IV, not addressed or other.
MBL = Multiple Baseline Design; TC = Total Communication; Rec = Receptive; Exp = Expressive; R = Response; chn = children; Tx = treatment.

Table II. Discrete Trial Training

References	Participants (n)	Experimental design	Independent variables	Dependent variables	Generalization measures	Results	Duration
Koegel, O'Dell, & Dunlap, 1988 II, II, II	severe communication delay; 3–11 yr (4)	Reversal design	Reinforce verbal attempts versus shaping motor speech production	Affect ratings and changes in phonemic production scores	4 year follow-up for 3 chn	Slightly better affect ratings in verbal attempt condition; effects on speech production difficult to interpret	14–24 sessions
McIlvane *et al.*, 1984 II, IV, IV	18 yr (1)	Multiple probe design × Rs	Exclusion procedure to teach food names	Exp speech and sign vocabulary	× novel words	2–10 rec matching trials before began naming foods	10 food names
Handleman, 1979 II, II, I	6–7 yr (4)	MBL × Q sets, BCBCBC-restricted versus multiple natural settings	Differential reinforcement and correction procedure	1 word Rs to *wh*-Qs	× settings and adults (i.e., home)	Training in multiple settings → greater generalization to home for 3 of 4 chn and equally high gen for 4th child	3 sessions per day, 20 training trials→ 100–1740 trials to criterion per set of 5 Rs
Handleman, 1981 II, II, III	5–12 yr (6)	MBL × Q sets, BCBCBC-restricted versus multiple natural settings	Differential reinforcement and correction procedure	1 word Rs to *wh*-Qs	× settings (i.e., corner of classroom)	No consistent difference in learning and generally associated with 2 training conditions	3 sessions per day, 20 training trials→ 40–1560 trials to criterion per set of 5 Rs
Secan, Egel, & Tilley, 1989 II, II, I	5–9 yr (4)	MBL × Q forms and subforms (e.g., how Qs relating to action, means, affect) and Ss	Picture training using differential reinforcement and modeling correction procedure	Rs to what, how, and why-Qs to pictures	× storybook and natural contexts and to Q-asking	Rapid learning with pix referents, no gen × Q subforms and forms; fair to good gen × contexts, 2–5 sessions interspersed training stimuli remediated poor gen; and no Q asking	3–9 training sessions per Q form
Egel, Shafer, & Neef, 1984 II, II, II	6–8 yr (4)	ATD (object versus self positioning) and MBL × Ss	Discrete-trial training with differential reinforcement prompting, and modeling	Comprehension of prepositions—behind, in front of, next to,	× novel stimuli and R topographies	Positioning objects did not gen to positioning self and vice versa without multiple exemplar or interspersal training	3–12 training sessions per S for 2 prepositions
Buffington, Krantz, McClannahan, & Poulson, 1998 II, II, I	4–6 yr (4)	MBL × Rs	Modeling, prompting, token reinforcement, and praise	Gestural and verbal Rs (attention, affect, and reference)	× probe stimulus and to classroom and social validity ratings of videos	Zero baseline → robust effects replicated across R categories and chn, gen probe data paralleled training data. Classroom data not presented. Good social validity results.	57–69 sessions

Koegel, Camarata, Valdez-Menchaca, & Koegel, 1998 II, II, I	3–5 yr (3)	MBL × Ss	Modeling, prompting imi tation, reinforced with desired items in a bag	Number of “what’s that” Qs asked, new nouns produced	× stimuli, settings, and people	Qs learned, used with less preferred items and generalized. Average 6 new exp noun labels learned/wk	16–34 sessions
Krantz, Zalenski, Hall, Fenske, & McClannahan, 1981—Exp 1 II, II, I	7–13 yr (4)	MBL × language categories	Token reinforcement and modeling in discrete-trial format	Descriptions of objects and pictures Verb + Color + Shape/size + Label	× persons, settings, novel materials, and modality (writing)	Chn quickly learned and gen when taught increasingly longer utterances	Total ~100 days
Krantz *et al.*, 1981—Exp 2 II, II, I	5–10 yr (3)	MBL × *wh*-concepts	Verbal prompting/fading and differential reinforcement	Rs to *wh*-Qs (4–5 concepts each for what, how, and why Qs	× untrained stimuli	Children quickly learned and generalized	2–3 mo, 36–54 sessions
Krantz *et al.*, 1981—Exp 3 II, IV, II	5 yr (2)	MBL × settings (home and school) + tasks (sentences and paragraphs)	Modeling, rehearsal, prompting, and fading	Rs to *wh*-Qs about past events	× settings	Zero baseline→ robust effects for sentences and clear effects for paragraphs	5–8 mo
Goldstein & Brown, 1989 II, IV, I	2–3 yr (2)	MBL × Rs (submatrices) and modalities	Modeling of items selected from obj-prep-location submatrices	Rec Rs to and production of obj-prep-location utterences	× untrained stimulus combinations and settings	64 rec and 64 exp 3-word Rs learned through peer modeling of 3 rec + 5 exp Rs for one child and 4 rec + 2 exp Rs for second child and gen to home	13 sessions

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Table III. Milieu Teaching

References	Participants (n)	Experimental design	Independent variables	Dependent variables	Generalization measures	Results	Duration
Charlop, Schreibman, & Thibodeau, 1985 II, II, II	5–11 yr (7)	MBL × Ss	Time-delay procedure	Object RQs (four per child); all but one child could label objects	× settings, unfamiliar persons, untrained stimuli	Children (who could label) quickly learned and generalized RQing once time delay implemented	3–6 blocks of 10 training trials
Charlop & Walsh, 1986 II, II, II	6–8 (4)	MBL × Ss and settings	Time delay procedure and peer modeling in 2nd setting	Spontaneous exp of "I like/love you"; eye contact, smiling, approach/touch	× settings and response gen	Time delay and not peer modeling effective, variable gen × settings (until time delay implemented) and little gen to ancillary behaviors	~45–60 days
Charlop & Trasowech, 1991 II, II, I	Echolalic; 7–8 yr (3)	MBL × Ss and settings	Parents taught time-delay procedure	Social phrases to adults	× locations and persons	Time delay → spon phrase use in 4 of 6, 4 of 7, and 2 of 6 contexts, respectively; gen or loss of control for other contexts; good maint.	25–34 mo of observation and 1–4 mos of training
Ingenmey & Van Houten, 1991 II, IV, II	10 yr (1)	MBL × behaviors	Time-delay procedure (model descriptions of car play and drawing)	% of trials with spontaneous descriptions of play	× settings, 5 wk and 4 mo follow up	Time delay → immediate increase in spontaneous speech, gen to untrained actions w/in 5 sessions	22 sessions
Matson, Sevin, Box, Francis, & Sevin, 1993 II, II, II	4–5 yr, echolalic and limited Rs (3)	MBL × behaviors	Two Rs each taught using time delay versus modeling and visual cue fading procedures	Social phrases—*hello, play with me, excuse me, thank you, help me*	× people and settings	Both treatments effective for increasing self-initiated Rs to nonverbal cues (e.g., therapist entering room, presentation of a game)	33–47 sessions, 2–16 sessions to learn each response
McGee, Almeida, Sulzer-Azaroff, & Feldman, 1992 II, II, II	3–5 yr (3)	MBL × Ss	Peer incidental teaching (wait for RQ initiation, RQ imit, provide reinforcer and praise)	% intervals of positive reciprocal interactions, % intervals of initiations	× settings; teacher ratings of social competence; peer sociometric ratings	Increase in reciprocal interactions and less teacher involvement; specific effects on spon verbal RQs not clear	17–38 sessions
Neef, Walters, & Egel, 1984 II, II, II	4–6 yr (4)	MBL × Ss	Discrete-trial tutoring sessions ("is this a ___?") versus across-the-day child RQ-initiated embedded tx ("do you want ___?")	% correct yes/no Rs	× new stimulus items and Q types (actions, possessions and spatial relations)	Embedded instruction associated with rapid improvement in Ring; gen to "is this a ___?" Qs only after introduced in embedded instruction, good gen × Q types	38–62 sessions, tx effect established in 1–7 days
McGee, Krantz, & McClannahan, 1985 II, II, II	6, 8, 11 yr (3)	MBL × pairs of preps with ATD and MBL × Ss	Tradition training (Where is the ___?, prompt, arbitrary reinforcer) versus Incidental training (Where is ___?, Tell me where, prompt elaboration, access to RQed item	Prep production to describe location of edibles and toys	× teachers settings, and stimulus arrangements	Both txs equally effective for acq and retention, incidental teaching → better, but incomplete gen × settings (less gen × arrangements) and more spontaneous productions	90 sessions, ~30 sessions of training to approximate mastery

Koegel, O'Dell, & Koegel, 1987 III, IV, III	4 and 5 yr (2)	MBL × Ss	Child-selected stimuli, modeling (w/o imitation RQ), communicative attempts reinforced, with access to toys and socially	Imitative, deferred imitative, and spontaneous word production	× settings	Following 2 and 19 mo of analog teaching, Natural Lang Paradigm implemented → increase in immed imitation and eventually spontaneous utterances (but after 4 or 5 mo)	2 h/2 × week/over 30 mo
Hwang & Hughes, 2000 II, II, I	Preverbal 32–43 mo (3)	MBL × Ss	Social interactive training with adult partner (contingent imitation, environment arrangement, expectant look, natural reinforcers)	Freq of child eye contact, joint attention, and motor imitation	× setting (novel classroom with teacher) and social validity ratings of videotapes	Increases in three target behaviors replicated as training was initiated across Ss. Good generalization, especially for eye contact, but minimal for joint attention. Robust effects on social validity msres	58 observation sessions
Koegel, Camarata, Koegel, Ben-Tall, & Smith, 1998 I, II, I	3–7 yr (5)	Reversal design ABACAB with counterbalanced order	Analog (discrete-trial) versus naturalistic teaching procedures	Accuracy of target phoneme production and intelligibility ratings by naïve judges	× settings (home with parents, school with peers)	Correct production in conversation language samples much greater for phonemes in naturalistic tx condition replicated within and across children plus gen × settings	54–94 sessions
Laski, Charlop, & Schreibman, 1988 II, II, I	4 mute and 4 echolalic 5–9 yr (8)	MBL × Ss	Parents taught Natural Language Paradigm (reinforce attempts, turn taking, vary task, share control)	Frequency of parent and child verbalizations	× 3 settings	Clear experimental effects for 7 of 8 families	13–20 sessions; 5–9 parent training sessions

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MBL = Multiple Baseline Design; ATD = Alternating Treatments Design; RQ = Request; Q = Question; R = Response; Tx = treatment; gen = generalization; Rec = Receptive; Exp = Expressive; chn = children.

Table IV. Communication Interventions to Replace Challenging Behavior

References	Participants (*n*)	Experimental design	Independent variables	Dependent variables	Generalization measures	Results	Duration
Carr & Durand, 1985—Experiment 1 II, II, IV	7–14 yr (4)	ABACACABA	Easy tasks with 100% attention; Easy with 33% attention; Difficult tasks with 100% attention	% intervals of problem behavior (aggression, tantrums, self-injury)		Little adult attention and high task difficulty → increased problem behaviors for different *S*s	31 sessions
Carr & Durand, 1985—Experiment 2 II, II, IV	7–14 yr (4)	ABACACABAC	Relevant and irrelevant Rs (*I don't understand* and *Am I doing good work?*)	% intervals of problem behavior and relevant and irrelevant Rs		Communicative replacement behaviors for same function only (soliciting attention or help) → less problem behavior	20–40 sessions
Durand & Carr, 1987—Experiment 1 II, II, IV	7–13 yr (4)	ABACACABA	Social attention and task demands	% intervals of stereotypic behaviors		Difficult task → increased stereotypy	28 sessions
Durand & Carr, 1987—Experiment 2 II, II, IV	7–13 yr (4)	ABABABABA	Time-out (removing task demands) contingent on stereotypy	% intervals of stereotypic behaviors (hand flapping, body rocking)		Contingent removal of task demands → increased stereotypy	23–36 sessions
Durand & Carr, 1987—Experiment 3 II, II, IV	7–13 yr (4)	MBL × Ss	Imitation, time delay, correction procedure to teach "help me"	% intervals of "Help me" RQs and stereotypic behaviors		Teaching children to RQ assistance → reduced stereotypy	25 sessions
Durand & Carr, 1992—Experiment 1 II, II, IV	3–5 yr (12)	ABACACABA (baseline attention and demand conditions)	B-Attention reduced from 100% to 33% of matching trials; C-increase difficulty of tasks to 33% correct level & CRF	% intervals of challenging behaviors, correct matching Rs, Trainer behaviors		Reduced adult attention was associated with increased problem behavior in all 12 children	27 sessions
Durand & Carr, 1992—Experiment 2 & 3 II, II, II	3–5 yr (12)	ABABAC; 2 matched groups (Functional Communication Training versus time-out)	FCT-imitation, time delay training of "Am I doing good work?" (in M = 18 min) TO-similar training of "My name is ___" (18 min)	% intervals of challenging behavior and unprompted attention RQs (Am I doing good work?)	× trainers (ABAB in Experiment 3)	Both treatments successful, but only group that received FCT across settings maintained low rates of problem behaviors w naïve teachers	Experiment 2—27 sessions Experiment 3—18 sessions

Horner & Budd, 1985 II, IV, II	11 yr (1)	MBL × behaviors	Prompts, reinforcement, correction used to teach sign RQs in simulation setting and then natural setting	% correct sign production Grabbing, yelling, and sign RQs during school day	× settings	Although signs learned in simulation setting, sign use and reduction in maladaptive behaviors occurred only after training in natural setting	35 school days
Bird, Dores, Moniz, & Robinson, 1989 II, IV, I	27 and 36 yr (2)	~MBL × Ss and MBL × Trainers for *S*2	FCT (token exchange for *S*1 and signs for *S*2) after series of DRO and DRI conditions	Mean self-injury Rs/RQ and Freq self-injury + aggression	× trainers, settings, and task demands	*S*1—immediate reduction in self-injury and spontaneous RQs → ~0 after 12 wk of FCT *S*2—robust effects on problem behavior (~0 after 8 wk) and increases in spontaneous communication	S1 ~120 weeks; S2 ~200 weeks
Wacker, Steege, Northup, Sasso, Berg, Reimers, Cooper, Cigrand, & Donn, 1990 II, II, III	7 (w aut.), 9, 30 yr (3)	ATD and Reversal designs	RQs (e.g., Please) taught with least-most prompting; TO or graduated guidance consequences for problem behaviors	% of intervals with problem behavior; independent signing or switch presses (*S*2), prompts	× therapists	*S*1—component analysis showed that FCT and TO (and not DRO) → increase signing and decreased problem behavior; FCT and graduated guidance most effective for *S*3; FCT alone effective for *S*2	29, 14, and 42 sessions
Haring & Kennedy, 1990 II, IV, III	15 yr-autism; 19 yr Down syndrome (2)	ABCBCB	DRO and time-out in task and leisure contexts	3 stereotypic behaviors per participant (% intervals)	× behaviors (rate of correct Rs in task context)	DRO and not TO reduced problem behavior (and increased correct Rs) in task context and only TO reduced problem behavior in leisure context	27 and 30 sessions
Schreibman & Carr, 1978 II, IV, II	7 and 15 MR (2)	MBL × Ss	Taught "I don't know" in R to previously echoed Qs, prompt-fading	# of "I don't know," appropriate, & echolalic Rs	× untrained Qs, wh-Q types, and persons	Generalized reduction in echolalic responding after taught "I don't know" R, maintained at 1 mo follow-up	37 sessions
McMorrow & Foxx, 1986—Experiment 1 II, IV, II	21 yr (1)	MBL × Q types (identification, interaction, facts/figures)	Present answer card, silence cue, ask Q, point to card, repeat Q without card	Correct Rs to Qs in 3 content areas & echolalia	× persons	70–100% echoes in baseline replaced with correct responses when pause-point prompts provided, pointing faded	daily 30–40 min, 95 sessions
McMorrow & Foxx,							

continued

1986—Experiments 2 and 3 II, IV, II	21 yr (1)	MBL × Q sets	Immediate (Experiment 2) and delayed (Experiment 3) modeling of answers by another adult	Correct Rs to Qs in 2 content areas & echolalia	× novel stimuli in Experiment 3	Modeling → immediate increases in correct Rs to Qs and good maintenance	51 sessions and 48 sessions
Foxx, Faw, McMorrow, Kyle, & Bittle, 1988 II, II, II	13, 36, 40 yr (3)	MBL × Ss	Present answer card, silence cue, ask Q, point to card, repeat Q without card	Correct verbal labels in R to Qs, echolalic Rs	× untrained Qs and settings	Cues-pause-point training → correct labeling Rs and decreased echolalia, generalized × settings	~ 87 trials
Davis, Brady, Williams, & Hamilton, 1992 II, IV, II	7 with Down syndrome and 5 yr (2)	MBL × trainers	Series of high-probability RQ administered prior to each low-probability RQ	% correct Rs to RQs	× adults	Immediate increase in Rs to low-probability RQs when tx administered; gen after implemented by 2–3 adults	~25 days, max of 40 trials/day
Koegel, Koegel, & Surratt. 1992 I, II, II	3–4 yr old (3)	Reversal design (BCBC) with counterbalancing	Analog (discrete-trial) versus NLP teaching procedures	Disruptive behavior and language target behaviors	exp effects for language targets not presented graphically, but small-moderate effects implied by condition averages	Consistently less than 20% disruptions in NLP conditions and 20–90% in analog conditions;	11–16 sessions

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Table V. Interventions to Promote Social and Scripted Interactions

References	Participants (n)	Experimental design	Independent variables	Dependent variables	Generalization measures	Results	Duration
McGee, Krantz, McClannahan, 1984 II, II, II	13–15 yr (3)	MBL × assertive R classes	Modeling, rehearsal, and token reinforcement	% intervals with positive and negative assertions to peers during card game and ball game	Gen to untrained positive assertions and 4.5 mo follow-up	Tx → clear increases replicated across four R classes & Ss, stronger effects for positive assertions	18 sessions and 4.5 mo follow-up
Shafer, Egel, & Neef, 1984 II, II, II	5–6 yr (4)	MBL × Ss	Peers taught to share and give play directions using models, prompts, practice, and feedback	Motor-gestural and vocal-verbal initiations and responses	× settings	Rapid improvement in social behaviors (mainly Rs) during peer training; followed by gen to trnd peer only in play group; training needed for gen × settings	3–6 peer training sessions
Goldstein, Kaczmarek, Pennington, & Shafer, 1992 II, II, III	3–6 (5)	ABCB reversal	Triads with two typical peers prompted to attend to, comment, and respond to Ss during play	Verbal and nonverbal communication acts and adult monitoring behaviors	No	Peer strategy use associated with increased social behavior, but mainly nonverbal for all but 1 child	39–51 sessions
Charlop & Milstein, 1989 II, II, I	6–7 yr (3)	MBL × Ss and multiple probe × conversations	Peer video modeling of scripted conversations and time delay	Rs variations, Q asking, scripted conversations	× untrained topics, persons, settings, and stimuli, social validation	Increasing quick and robust gen production of 3-behavior conversations after max of 3 of 5 or 6 conversations modeled	3–20 video viewings to reach criterion
Goldstein & Cisar, 1992 II, II, II	Preschool (3) in triads with two typical peers	MBL × scripts	Three sociodramatic play scripts with 10 behaviors for each of three roles taught	Trained and untrained theme-related and unrelated social behaviors	× peer groupings	Each script learned increasingly quickly and → theme-related interaction, plus maintenance and gen to untrained, related utterances	6–15 sessions/scripts and 30–39 play sessions

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Table VI. Parent and Classroom Training

References	Participants (n)	Experimental design	Independent variables	Dependent variables	Results	Duration
Harris, Wolchilk, & Weltz, 1981 III, IV, IV	30–74 mo (11)	Two groups trnd (home versus lab treatment?), repeated measures design	10 weekly parent training group meetings and 6 consultative home visits	Number correct and highest step on hierarchy of 21 communication skills	Large effects for 2 of 5 verbal children, mod effects for 2 nonverbal children, other effects minimal. Significant verbal versus nonverbal × time interaction. No changes at 1 yr follow-up.	10 wk
Howlin & Rutter, 1989 II, II, III	3–11 yr (30)	Matched group comparison	Parents taught behavioral techniques (questions, repetition, expansion, correction, prompts, and reinforcement)	Frequency of communicative speech, echolalia and noncommunicative utterances, increase complexity	Clear experimental effects for mothers and Chn; Significant increase in children's social utterances, morphemes, and reduction in incomprehensible and nonverbal behavior for experimental group. High correlation between mothers' and children's language changes	18 mo intervention, comparison after 6 mo reported
Harris, Handleman, Kristoff, Bass, & Gordon, 1990 III, IV, IV	4–5 yr (10)	Group assignment, matched but not randomly assigned	Integrated versus segregated classes	Preschool Language Scale	No pretest-posttest group differences	5–11 mos
Ozonoff & Cathcart, 1998 II, II, IV	2–5 yr (22)	Treatment versus no-treatment comparison, matched groups	TEACCH-based home program, but no treatment fidelity measures	Psychoeducational Profile-Revised—7 developmental domains	Significant grp × time effects on imitation, fine and gross motor, and nonverbal cognitive domains	8–12 training sessions, 10 wk of treatment, 4 mo between pre- and post-tests
Jocelyn, Casiro, Beattie, Bow, & Kneisz, 1998 I, II, IV	2–6 yr and parents (35)	Randomized controlled trial, 16 in experimental group and 19 in day care only group	12 wk of lectures, consultations at day-care centers for staff and parents, and family support	Autism Knowledge Quiz, Rating Autism Symptoms, EI and Preschool Development Profiles, Family assessment and stress measures, satisfaction measure	Significant grp × time interaction for one of six developmental domains (i.e., language); also grp × time difference in Autism Quiz for mothers and child care workers	12 wk

Note: Roman numerals in the first column denote ratings of internal validity, external validity, and generalization, respectively, based on the following criteria:
Internal validity: I, Prospective group or single-subject design experiment comparing alternative treatments; II, pre-post group design or single-subject design with reliable, objective outcomes measures; III, pre-post, ex post facto, or single-subject designs with questionable internal validity or measurement.
External validity: I, Random assignment of well-defined cohorts and adequate sample size; II, nonrandom assignment, but well-defined cohorts and adequate sample size or replication across 3 or more subjects in a single-subject design; III, well-defined population of three or more subjects in single-subject designs or sample of adequate size in group designs; IV, small sample in group design or 1–2 subjects in single-subject design.
Generalization: I, Consistent generalization to functional setting beyond treatment setting without further intervention or robust social validation results; II, long-term maintenance or generalization to one setting beyond treatment setting; III, intervention occurred in natural setting or outcome measure with document relation to functional outcomes; IV, not addressed or other.

results of each study; (b) summaries of the ages and number of subjects included in individual studies; (c) the experimental designs; (d) the independent variables under investigation or an outline of the treatment components; (e) the measures used to evaluate primary effects and generalized effects; (f) a summary of results, and (g) an estimate of the duration of training or the study length. The studies were categorized to reflect six primary approaches to the development of communication interventions that are commonly applied to children with autism. Table I summarizes studies that incorporated sign language into training. Table II summarizes studies using a variety of largely operant approaches to language intervention that appear to be presented in discrete trial training formats. Table III includes studies that sought to teach language using various milieu language teaching paradigms. Table IV summarizes studies that investigated the relationship between problem behaviors and communication skills. Table V includes studies that sought to promote social and scripted interactions that focused on language skills. Table VI includes more general parent and classroom training approaches that included measures of language.

COMMUNICATION INTERVENTIONS INCORPORATING SIGN LANGUAGE

Much research has explored the effects of introducing gestural and visual modes of communication through augmentative and alternative communication systems. Clearly, the use of augmentative and alternative communication systems has spurred the development of language skills with a great number of children who had extremely limited communication abilities. Presenting language stimulation using the visual modality seems to capitalize on an area of relative strength for many children with autism. Table I includes nine experiments that investigated the benefits of introducing signs with children with autism. Experiments using communication systems using pictures, symbols, print, vocal output devices, and such are reviewed in the Mirenda chapter (this volume). Of course, great interest in the latter area was generated given the miraculous claims offered by proponents of "facilitated communication." When those claims have been subjected to rigorous experimental scrutiny, however, evidence of meaningful communication under the control of individuals with autism was found lacking (see Green, 1994; Jacobson & Mulick, 1995).

Dating back to the late 1970s some investigators focused on the use of sign language systems. A number of studies compared the effects of teaching expressive vocabulary using speech, sign, or total communication (speech + sign) input (Barrera Lobatos-Barrera, & Sulzer-Azaroff 1980, 1983; Layton, 1988; McIlvane, Bass, O'Brien, Gerovac, & Stoddard, 1984; Yoder & Layton, 1988). Other studies taught receptive vocabulary (Brady & Smouse, 1978; Carr & Dores, 1981; Carr, Pridal, & Dores, 1984; Wherry & Edwards, 1983) or both expressive and receptive vocabulary (Layton, 1988). The results of these studies are rather consistent. Sign or total communication training resulted in quicker and more complete learning of vocabulary than speech training for many participants. The participants who benefit most seem to be those with more limited communication repertoires, whereas more sophisticated participants, and especially those with better verbal imitation skills, are more likely to learn from systematic discrimination training regardless of the mode of communication. Participants with good verbal imitation skills are more likely to demonstrate speech production in addition to or in lieu of sign production than participants with poor verbal imitation skills (Carr & Dores, 1981; Carr, Pridal, & Dores, 1984; Yoder & Layton, 1988). The one study (Yoder & Layton, 1988) that sought to explore whether other factors might predict spoken vocabulary performance found verbal imitation to account for a majority of the variance ($R^2 = .63$), and that 78% of the variance could be accounted for by adding age and IQ to the regression model. In some studies the extent of the repertoire taught was quite limited; for example, Hinerman, Jensen, Walker, and Peterson (1982) taught a participant to request "milk" and "cookies." Very few studies progressed beyond single words; Keogh, Whitman, Beeman, Halligan, and Starzynski (1987), in a study with older students, taught brief dialogues. Most of the studies employed single-subject experimental designs with 1 to 10 participants. Two studies enrolled 60 participants each and randomly assigned participants to four treatment conditions (Layton, 1988; Yoder & Layton, 1988).

Although interest in this area has waned, the general findings are fairly clear. Total communication appears to be a viable treatment strategy for teaching receptive and expressive vocabulary (i.e., language content) to individuals with autism. The presentation of speech alone is less effective for individuals who have poor verbal imitation skills in particular. Although few studies explored the use of sign alone, it is contraindicated because the likelihood of children producing speech is diminished. In contrast, total communication often results in comprehension and production of both signs and speech. Because the focus of these studies has been on teaching vocabulary for the most part, one can assume that investigators have not pursued this approach to the point of teaching sign language as an alternative communication system to children with autism. Thus it would appear that presenting signs as well as speech is mainly an effective adjunct strategy for jump-starting early vocabulary learning. Signs represent another symbolic system for representing objects and actions in the world that children with autism hopefully will be motivated to request, label, and comment upon. Signs are less transient than words, and gestures and signs are easier to prompt than verbal productions. Whether these or other reasons underlie their benefits is largely a matter of speculation at this point.

INTERVENTIONS INCORPORATING DISCRETE TRIAL TRAINING FORMATS

Table II summarizes 12 experiments that investigated methods of teaching comprehension and/or production of various language content (e.g., vocabulary and phrases) and forms (e.g., verb + adjectives + noun utterances). One study focused on speech production (i.e., phonology) (Koegel, O'Dell, & Dunlap, 1988), and one study focused on gestural communication (Buffington, Krantz, McClannahan, & Poulson, 1998). The majority of the experiments taught children to produce single-word responses or single phrases (e.g., "What's that?"). However, children's responses required discrimination of language forms (e.g., different types of *wh*-questions). The last four experiments in Table II taught sentences.

These studies investigated teaching procedures that were employed in a variety of discrete-trial training formats. Thus various differential reinforcement and correction procedures with modeling of responses and prompting-fading procedures are commonalities. Not surprisingly, these procedures are largely effective in teaching the behaviors of interest. Perhaps the most impressive of these studies are those experiments in which the training was organized to teach increasingly complex productions. Krantz, Zalewski, Hall, Fenski, & McClannahan (1981) taught children to describe objects and pictures using four-term sentences (verbs + colors + shape/size + labels) and to answer a variety of *what*, *how*, and *why* questions about immediate and then past events with single or multiple sentences.

One should note that the questions addressed by these studies typically went beyond straightforward effects of instruction to explore procedures that might produce more efficient learning or generalized treatment effects. For example, McIlvane *et al.* (1984) demonstrated that exclusion procedures in which unknown food names are presented in the context of known foods resulted in accurate receptive responding and that expressive naming emerged without specific training after relatively few trials. Although the exclusion procedure (akin to process of elimination) is effective for teaching basic concepts or novel words in a manner that permits generative language learning, its use with children with autism is not evident in the literature. This work has been replicated and extended with other individuals with severe developmental disabilities, however.

Buffington *et al.* (1998) demonstrated that children with autism could be taught to include gestures to accompany simple verbal responses to improve their communication. It is not clear in the article whether the traditional training provided affected gestural and verbal communication skills equally, but social validity measures indicated that their communicative attempts were virtually indistinguishable from age-matched typical peers. Although the children generalized to probes using novel materials, data on carryover to natural environments were not included.

Research on autism also has contributed greatly to the literature on generalization-promoting strategies. A well-established technology for producing generalization is still under development, based largely on the conceptualization of several strategies forwarded by Stokes and Baer (1977) in their landmark article. For example, when a multiple exemplar approach did not produce consistent results (Egel, Shafer, & Neef, 1984; Handleman, 1979, 1981), investigators developed additional strategies to overcome deficiencies in generalization exhibited by children with autism. Investigators found that minimal additional training was required. Also, embedding instruction across the day or interspersing different types of trials proved rather effective (Egel, *et al.* 1984; McMorrow & Foxx, 1986; Neef, Walters, & Egel, 1984; Secan, Egel, & Tilley, 1989). These findings seem to indicate that generalized effects are not likely when generalization probes are easily discriminated from the training situation. However, if training exemplars are selected carefully, are sampled broadly from natural contexts relevant to the child, and are embedded within those contexts, then widespread generalization across settings is likely to result.

Perhaps the experiment in which generalization was most clearly elucidated was an application of matrix-training procedures to object-preposition-location utterances (e.g., *penny under couch*) with two preschoolers with autism (Goldstein & Brown, 1989). In that study, recombinative generalization to new utterances occurred predictably as new preposition and location words were learned via peer modeling in the context of 6 to 8 utterances systematically selected from 64 possible combinations of 4 known objects, 4 unknown prepositions, and 4 unknown locations. Generalization accounted for 95% of the 128 responses generated. Generalization from production to comprehension did not occur until modeling in that modality was demonstrated, however. The conditions that produce cross-modal transfer remain elusive.

In summary, experiments involving discrete-trial training formats have provided a foundation for the development of procedures needed to teach discriminative performances that children with autism had not learned on their own. In contrast to the investigations in the late 60s and the 70s, there has been increasing attention on teaching somewhat more sophisticated language and on improving the generalized use of new language skills. These advances have been in response to the often-disappointing effects of discrete-trial teaching on the everyday functioning of children with autism. The need to assess and program generalization from training situations into everyday living contexts has inspired application of many of the same instructional strategies within the natural milieu of home, school, and community contexts.

INTERVENTIONS DESIGNED FOR IMPLEMENTATION IN THE NATURAL MILIEU

Table III presents summaries of 12 studies that investigated time delay, milieu language teaching, or natural language paradigm interventions. Time delay is a prompting procedure in which a delay is imposed between a stimulus and a prompt or a hierarchy of prompts. The delay can be held constant (e.g., 5 seconds) or can be lengthened progressively until the child anticipates the prompt and produces the desired verbal or motor response. Time delay procedures have established rapid and often generalized language productions, especially requesting, when the communications skills are in children's repertoire but rarely used (e.g., Charlop, Schreibman, & Thibodeau, 1985). In many studies it is not clear whether children are acquiring new skills, however. Correction procedures usually appear to accompany the use of time-delay procedures; so modeling with or without prompts to imitate tends to be an additional intervention component (Charlop & Trasowech, 1991; Charlop & Walsh, 1986). Charlop and Walsh (1986) found that implementing a time delay procedure was associated with spontaneous productions of "I like/love you," whereas peer modeling of this utterance was not effective. Matson, Sevin, Box, Francis, and Sevin (1993) found modeling and the fading of visual cues as effective as the time delay procedure in teaching social phrases. McGee, Krantz, and McClannahan (1985) found traditional training with arbitrary reinforcers as effective as incidental teaching with requested items serving as reinforcers when teaching children to produce prepositions; but better generalization across settings and more spontaneous productions resulted from incidental teaching. Likewise, Neef *et al.* (1984) found greater generalization of yes/no responses to various question types when teaching trials were embedded across the day in comparison to tutoring sessions.

Milieu language teaching is a family of procedures that are designed to capitalize on children's desires and interests in their natural environments to embed teaching opportunities. Incidental teaching (cf. Hart & Risley, 1975), perhaps the hallmark of milieu language teaching, requires that the child initiate an attempt to communicate, usually to make a request. Mand-model procedures were developed to teach fundamental communication skills that could be used to make requests to children who are not initiating. Then time-delay procedures could be used to teach independent use of those skills. Other procedures that are designed for use in natural environments with a focus on following the child's lead might be considered forms of milieu language teaching (e.g., the Natural Language Paradigm).

Milieu language teaching is usually used to teach requesting, because high motivation is inherent when individuals are requesting desired items that presumably function as reinforcers. However, an examination of Table III reveals that a variety of communicative functions are being taught to children with autism using milieu teaching procedures: preverbal communication (eye contact, joint attention, and motor imitation, Hwang & Hughes, 2000); spontaneous productions of "I like/love you" (Charlop & Walsh, 1986); descriptions of drawings and car play (Ingenmey & Van Houten, 1991); social amenities such as "please, thank you, excuse me, you're welcome, hello" (Matson *et al.*, 1993); positive interactions with peers (McGee, Almeida, Sulzer-Azaroff, & Feldman, 1992), answers to "Where is ___?" questions (McGee *et al.* 1985); phoneme production (Koegel, Camarata, Koegel, Ben-Tall, & Smith, 1998); and simply increased talking

(Laski, Charlop, & Schreibman, 1988). It is notable that parents have been taught to implement time delay procedures (Charlop & Trasowech, 1991) and the Natural Language Paradigm (Laski *et al.*, 1988). The Natural Language Paradigm (NLP) is a multiple component intervention that continues to evolve because it has not always been operationalized the same way (e.g., Koegel, O'Dell, & Koegel, 1987; Laski *et al.*, 1988). Characteristics of this approach have begun to be clarified, especially when contrasted with discrete-trial training. For example, Koegel *et al.* (1998) clearly contrasted the procedural differences in analog (discrete-trial) versus naturalistic (NLP) intervention approaches based on selection of stimulus items, steps in training, interaction patterns, response-reinforcer contingencies, and the types of consequences provided.

Research on milieu language teaching procedures has been extensive and seems to be applicable to teaching early language skills to a broad population of children (see Kaiser, Yoder, & Keetz, 1992). Most of the applications to children with autism have focused on Mand-model and time-delay procedures to accommodate their deficiencies in communicative initiations. Investigators have had success when applying fairly well-established procedures that have been used with other populations.

At this point, there is no compelling evidence that milieu teaching procedures are clearly more effective than the procedures that have developed out of discrete-trial procedures. Indeed, one might argue that there is a great deal of commonality in the procedures employed. An analysis of naturalistic language intervention procedures offered by Hepting and Goldstein (1996) includes many of the instructional techniques found in the discrete-trial teaching literature. One can argue that milieu language teaching procedures can be more easily incorporated into everyday activities and reduce the need to program for generalization. Such comparisons of treatment approaches are not necessarily straightforward. An examination of Table II indicates that many interventions using discrete trial training have produced impressive generalization results. Also, a comparison of Tables II and III shows little overlap in the target behaviors that were taught using discrete-trial and milieu teaching procedures.

Comparison studies have yielded mixed results. In one such comparison study, Elliott, Hall, and Soper (1991) taught receptive and expressive vocabulary to 23 adults with autism and severe to profound mental retardation using discrete-trial and natural language teaching techniques using a crossover design with matched groups; they found no significant differences in acquisition or generalization. Koegel *et al.* (1998) contrasted traditional (analog) articulation training with a naturalistic approach (Natural Language Paradigm) in a single-subject experiment (counterbalanced reversal design) and found much greater generalization to conversational language samples for phonemes taught using the naturalistic procedures.

Yoder *et al.* (1995) argue that teaching approaches may differ depending on the language skills being taught or the linguistic sophistication of the children. Only in the case of sign language interventions (Yoder & Layton, 1988) have these correlational analyses been done with children with autism. Nevertheless, a careful inspection of the correlational findings used to detect aptitude-by-treatment interactions indicates that few children consistently fall into the regions of significance that are differentially predictive of outcomes (e.g., Cole, Mills, Dale, & Jenkins, 1996; Yoder *et al.*, 1995; Yoder & Warren, 1999). Defining profiles that are predictive of differential treatment effects is thus likely to be difficult. Experimental investigations of aptitude-by-treatment interaction hypotheses have yet to be done with any children with developmental disabilities, let alone children with autism.

COMMUNICATION INTERVENTIONS TO REPLACE CHALLENGING BEHAVIOR

Table IV presents a summary of 17 experiments in which communication skills have been taught as alternative to a variety of maladaptive or challenging behaviors (e.g., stereotypy, aggression, tantrums, property destruction, self-injury, echolalia). This aspect of communication intervention emphasizes a view of language as a means of control over one's environment. Interventions represented in this segment of the literature have been applied to especially challenging cases, most often children and adults with severe developmental disabilities and severe behavior problems, many of whom have been diagnosed with autism. Investigators have developed procedures for identifying antecedent and consequent variables that appear to motivate challenging behavior in individuals with severe disabilities. Carr and Durand (1985) hypothesized that challenging behaviors could serve a communicative function. This observation has inspired numerous investigations in which individuals with autism and other disabilities are taught specific language skills to serve the same communicative function as their challenging behavior. Because of the potential to prevent the development of challenging behavior by focusing on communication training early, Table IV and this section of the review includes data on older individuals with autism, many of whom we can assume were not treated successfully when they were younger.

When individuals with autism are taught communication skills that serve efficiently and effectively as alternative behaviors, reductions in challenging behaviors result (Bird, Dores, Moniz, & Robinson, 1989; Carr & Durand, 1985; Durand & Carr, 1987, 1992; Horner & Budd, 1985). Determining the motivation of challenging behavior is important, because a typical response of allowing individuals to escape demands when this is the motivation for stereotypic behavior, for example, may serve to reinforce the undesired behavior (Durand & Carr, 1987). Although manipulation of consequences or teaching communication in other contexts may be associated with initial reductions in challenging behaviors, functional communication training conducted in a variety of natural contexts is associated with broader generalization and greater maintenance of effects (Bird *et al.,* 1989; Durand & Carr, 1992; Horner & Budd, 1985). Identifying the function of challenging behaviors and developing effective interventions is often complicated. Wacker *et al.* (1990) demonstrated that multiple-component interventions are sometimes more effective than functional communication training alone. Haring and Kennedy (1990) showed that the motivation of challenging behavior could vary based on context (task versus leisure contexts) as well.

Schreibman and Carr (1978) found that they could replace echoing of questions with a general verbal response (“I don’t know”). McMorrow and Foxx (1986) demonstrated that inhibiting the echoing of questions accompanied with teaching of correct responses (either through written cues or peer modeling) resulted in appropriate responding. They suggest the benefits of teaching individuals to pause before responding. In subsequent extensions to this work (McMorrow, Foxx, Faw, & Bittle 1987; Foxx, Faw, McMorrow, Kyle, & Bittle 1988), they found that subsequent to cues-pause-point training, participants were able to apply their labeling repertoire to untrained questions in a variety of generalization settings. Davis, Brady, Williams, and Hamilton (1992) demonstrated that embedding requests that are unlikely to obtain a response (low-probability requests) within a series of requests that are responded to readily (high-probability requests) can improve instruction following. Koegel, Koegel, and Surratt (1992) found that teaching language targets to 3- to 4 year-olds using NLP procedures resulted in less disruptive behavior than when using analog procedures in a discrete-trial format. However, data were not displayed adequately to determine whether consistent changes in language responding were under such clear experimental control. In general, these studies demonstrate several effective strategies for remediating echolalia, noncompliance, and disruptive behavior in children with autism.

This is an especially important area because of the intense interest in managing challenging behavior of children with autism in school, as well as in home and community settings. The replacement of challenging behaviors with appropriate and increasingly sophisticated communication skills has the potential to have far-reaching implications for academic achievement, social relationship development, and vocational outcomes.

INTERVENTIONS TO PROMOTE SOCIAL AND SCRIPTED INTERACTIONS

Table V summarizes studies from a larger body of literature on facilitating social skill development (see McConnell article, this volume). These five studies were selected because of their inclusion of communication measures. Two studies taught facilitative strategies to peers. When peers were taught to share and give play directions (Shafer, Egel, & Neef, 1984) or to attend to, comment, and respond to peers with autism (Goldstein, Kaczmarek, Pennington, & Shafer, 1992), children with autism demonstrated increased social-communicative interaction (mainly responding) during play. Maintenance and generalization across settings is largely dependent upon prompting peers to continue using the facilitative strategies.

A common concern found in the literature is the difficulty in getting children with autism to initiate interactions. A number of modeling and prompting approaches have been used successfully to increase initiations, however. McGee *et al.* (1984) used modeling, rehearsal, and token reinforcement to teach older children with autism assertive statements to use with peers during a card game and a ball game.

Investigators have taught scripted interactions of varying length and complexity. Charlop and Milstein (1989) showed videotapes of peers engaging in three-turn conversations. Goldstein and Cisar (1992) developed sociodramatic play scripts involving three roles that were taught to triads with two typical peers and a child with autism; 10 behaviors per role were delineated with nonverbal, single word, or sentence-long variations of each of the 30 steps in the sequence. In each of these studies children with autism demonstrated improved peer interaction and the children produced untrained as well as trained variations or elaborations on the scripts.

Given that a problem relating to others is a core social deficit associated with autism, the effectiveness of these interventions in increasing social interaction with peers in particular is quite striking. Increased social interactions can set the stage for other developments as well, e.g., generalized use of newly acquired language skills, modeling of new language skills, inclusion in more normalized educational settings, and, hopefully, the development of positive, long-lasting relationships with peers and others. This aspect of the literature helps provide insights into methods for incorporating communicative interventions into natural environments of children with autism.

CLASSROOM AND PARENT INTERVENTIONS APPLIED TO GROUPS

Table VI includes five group design studies that seemed to focus on teaching communication skills or focused their evaluations on language measures. See Rogers (1998) for a review of evaluations of comprehensive treatment programs, most of which were applied for 2 or more years. Harris, Wolchik, and Weltz (1981) taught parents facilitative interaction skills and examined effects on a hierarchy of communication skills. Results were difficult to interpret (e.g., the nature of the groups); nevertheless, after 10 weeks, analyses revealed a significant verbal ability by time interaction, because the children with better imitation skills were the children who benefited most from treatment. No further improvements were evidenced after parent training was terminated based on a 1-year follow-up. Howlin and Rutter (1989) conducted a matched group comparison in which parents were taught behavioral techniques thought to facilitate language development. After 6 months of intervention, parents in the experimental group talked more to their children and used more language facilitative forms. In turn, their children showed a significantly superior increase in social utterances and morphemes, as well as a reduction in their incomprehensible or nonverbal behaviors. Harris, Handleman, Kristoff, Bass, and Gordon (1990) administered the *Preschool Language Scale* after 5 to 11 months of intervention to 10 "matched" children with autism who were enrolled in integrated or segregated preschool classes and found no differences. Ozonoff and Cathcart (1998) compared 22 "matched" children who enrolled in the TEACCH program or a wait-list control. After 10 weeks of treatment, results revealed significant group by time interactions on three of seven domains on the PEP-R, but not on the language domain.

The single randomized, controlled trial ($n = 16 + 19$) compared typical day care with a day care that included 12 weeks of lectures and consultations for staff and families (Jocelyn, Casiro, Beattie, Bow, & Kneisz, 1998). A significant group by time interaction effect was shown for one of six developmental domains assessed using the Early Intervention or Preschool Developmental Profiles—the language domain.

Our confidence in the results of these studies should be tempered for a number of reasons. They suffer from a lack of true experimental designs (except for the Jocelyn *et al.*, 1998 study), small samples, short intervention periods, the absence of treatment fidelity measures, and sketchy descriptions of the interventions. In general, these group design studies reviewed reveal little about what specific treatments or components of intervention programs result in clinically significant improvements in communication development. The lack of randomized controlled clinical trials in the autism literature may seem disappointing. It can be argued that sufficient knowledge has been accumulated in the literature reviewed in previous sections to put together treatment packages that are likely to be highly successful in improving educational outcomes and daily functioning of children with autism. However, the difficulty in doing this should not be underestimated.

DISCUSSION OF THE STATE OF THE LITERATURE

Participant Selection and Description

One will notice the lack of specificity in the column used to summarize the participants in Table I to VI. It is difficult to provide brief summaries of developmental levels and severity of impairments of participants with any confidence based on information presented in most journal articles. The level of detail and the nature of participant descriptions vary. Some investigators give priority to narrative descriptions, and others rely largely on standardized assessments. Clearly, the field would benefit from a set of conventions that would help standardize the sharing of descriptive information about participants.

One of the limitations of this review is that it ignores a broader treatment literature that is pertinent to children with autism. Developmental disabilities researchers do not always report or highlight diagnoses of autism for a number of possible reasons: they may think that the diagnosis is not relevant given their interest in developing instructional procedures with broad applicability; they may not have access to diagnostic records or may choose not to pursue diagnostic workups. Nevertheless, many investigations describe children with severe developmental disabilities who exhibit autistic characteristics. For example, Stoddard, McIlvane, and their colleagues (e.g., McIlvane, Dube, Green, & Serna, 1993; McIlvane *et al.*, 1984) at the Shriver Center have conducted extensive research with exceedingly difficult-to-teach individuals with developmental disabilities. Their research is largely absent from this review. Yet, they have developed effective procedures for individuals who have had difficulty in learning simple discriminations and have used those behaviors as the basis for establishing conditional discriminations. Most of their participants have progressed to the point of learning equivalent relationships among concepts and various symbolic representations (e.g., spoken words, pictures, written words, signs, graphic symbols, and verbal productions). Their advances in instructional technology and errorless learning procedures, as well as the work of others, may have great relevance to children with autism. A focus solely on studies that enrolled children with autism may avert our attention from other important findings in the educational treatment literature. An alternative approach might be to develop a database around target behaviors to a greater extent than was accomplished in this paper.

Treatment Components

The descriptions of the actual training procedures used by investigators are often quite sketchy. A review of “naturalistic” language intervention studies by Hepting and Goldstein (1996a) cautions us from assuming that treatment procedures are equivalent even when interventions are called the same thing (e.g., “incidental teaching” or “interactive”). Further specification is needed to delineate what treatment components are planned as part of a treatment program, to determine the extent to which the treatment components are in fact implemented as part of a treatment program (treatment fidelity), and to begin to determine what components are more and less responsible for treatment effects (component analyses). Perhaps the taxonomy used by Hepting and Goldstein (1996a) provides a starting point for specifying treatment components. They were able to classify 34 language-treatment studies based on the inclusion of eight procedures that manipulated antecedents (prompting imitation, manding verbalization, requesting elaboration or clarification, waiting for initiations or responses, arranging the environment, modeling, repeating/expanding/recasting, and descriptive talking) and three procedures that manipulated consequences (delivering desired consequences, praising, minimal encouragers). The under-specification of what instructional procedures are active in interventions represents a large obstacle to those interested in conducting treatment comparisons.

Treatment Intensity

No literature was found that directly sought to evaluate the effects of delivering treatments with varying frequency or intensity. Some relevant information could potentially be extracted from the literature, however. Most single-subject experiments present data that allow one to assess the rapidity of learning. It is difficult to evaluate treatment intensity data in a straightforward manner. For example, some investigators may seek to increase the frequency of communication skills already in the repertoire of participants. One might expect quicker effects in those cases than when teaching totally unfamiliar behaviors. Other investigators individualize their selection of target behaviors by identifying new skills that are developmentally appropriate and functional for their participants, but some investigators are better at this than others. The greater the discrepancy between targeted behaviors and the present repertoire of participants, the longer one might expect the acquisition process. On the other hand, errorless training procedures may be especially effective with children with autism, but they do not necessarily maximize the efficiency of learning. This can be remedied with probes of more sophisticated performances, but one necessarily expects errors to occur when task demands exceed present capabilities.

Placebo Effects in Single-Subject Experiments

One of the concerns that should be considered in quasi-experimental research is the possibility of placebo effects. In particular, one would want to be confident that treatment effects are not attributable to the effects of the added attention given to participants enrolled in a treatment study, to the effects of repeated testing or measurement, or other threats to internal validity. Repeated measurements over time have the potential to minimize concerns about placebo effects if treatment effects are clearly and consistently associated with implementation of treatment conditions and if two other conditions are met. First, investigators need to have reliable and valid measures. Second, data collection within conditions, and in baseline or control conditions in particular, must be sufficient to establish stability in performance. Interpretation of results is severely compromised when investigators are lax about the latter requirement (cf. Johnston & Pennypacker, 1993; Sidman, 1960).

These requirements do not discount the possibility that peers and teachers in educational settings, for example, are not displaying behaviors other than those under examination that have an influence on children with autism. Consequently, it is advantageous to keep individuals and data collectors blind to the schedule of treatment implementation. For example, children who are taught communication skills through video modeling might view brief videos that are unrelated to the skills being taught until they are scheduled to begin the language intervention condition. In that way the classroom observers, teachers, and others are unaware of when the treatment is initiated (e.g., Hepting & Goldstein, 1996b).

Also, social validity assessments are gaining wider acceptance in the literature, whereby naïve raters make judgments about the behavior of participants usually based on pre- and post-treatment videotapes presented in a random order. These social validity assessments allow one to judge whether the treatment effects are readily discernable. They also can help to validate the measures taken by observers and researchers and alleviate some of the concerns that changes are attributable to biased recording on their part.

CONCLUSIONS

This body of research has emanated from a number of disciplines, primarily psychology and special education, as well as communication sciences and disorders. It is notable that children with autism are overrepresented in the language intervention literature generally; approximately 26% of language intervention studies include this comparatively small population in terms of prevalence (Goldstein & Hockenberger, 1991). The bulk of the child language intervention research has sought to develop effective treatments for our most challenging cases and thus have targeted more rudimentary language skills. Two reasons for this emphasis come to mind. First, teaching language to children with severe communication deficits has profound impacts on the lives of both the children and the people who interact with them everyday. Rudimentary language skills can make a tremendous difference in the ability of children to control their environment. In addition, language has been found to be an adaptive alternative to highly disruptive forms of communication (such as tantrums, aggression toward others, or self-injurious behavior). Second, more information is available on early language development than later language development. Having a more complete knowledge of developmental milestones and their sequencing makes it easier to identify treatment goals that are developmentally appropriate. As the complexity of the language system grows, one begins to address the subtleties and nuances of effective communication that are harder to define. The full complement of language skills that come into play as the demands of development and new situations expand has yet to be defined adequately, let alone addressed in treatment studies. Indeed, knowledge of the effects of language treatment has developed incrementally. Experimental studies have focused (largely to their credit) on restricted treatment goals and relatively short-term outcomes.

The accumulated knowledge of the effects of specific treatments on particular target behaviors has resulted in a compendium of fairly sophisticated instructional procedures, but the development of an effective technology is in its infancy. Because most experiments are designed to assess the effects of a restricted set of treatment components on certain aspects of language development, it is conceivable that treatment programs that draw upon a number of empirically supported approaches and are individualized to meet the specific needs of children with autism have the potential to have robust clinical effects. The process of compiling this technology into long-term, comprehensive treatment programs remains an ambitious, complex challenge. Speech-language pathologists and service delivery teams are aware of the multifaceted nature of communication and realize that the complexities of the developing language system that children must acquire to be fully competent communicators is not well understood. Nevertheless, they need to draw upon the existing knowledge base to develop treatment programs to address the multiple needs of individual children and their families. What behaviors should be included? How should skills from different communication domains be sequenced? How should the program be adapted based on the child's age, educational environment, families' wishes, cultural milieu, etc.? Few individuals, be they researchers, teachers, speech-language pathologists, or parents, would be satisfied with the scope and sequence reflected in available training programs, many of which were developed decades ago.

Investigators interested in evaluating larger treatment packages face an even stiffer challenge. First, they need to identify appropriate outcome measures. There is considerable danger in depending upon global measures of change in language development that may not be sensitive to changes associated with their intervention efforts. Because of the relationship between language skills and other academic and social domains, one can argue that comprehensive language treatment programs are likely to have significant impacts on long-term outcomes, such as academic achievement, the extent of special education services required, school dropout rates, and vocational placements. How different aspects of language relate to these important outcomes has yet to be delineated. To help us understand these relations and other moderating influences, it is important to measure primary and short-term outcomes. Also, it is essential that direct intervention effects are documented to help us interpret results, especially when long-term outcomes are modest or absent.

Second, researchers must specify, measure, and control the active variables in their interventions. As mentioned earlier, it is difficult to extract information on treatment procedures in the literature. This problem tends to be compounded in the case of comprehensive treatment programs. Furthermore, one must specify the extent to which interventionists should be expected or allowed to individualize treatments to meet the needs of children with a broad range of developmental levels. It is critical that when comprehensive interventions are evaluated that treatment components are specified in an operational manner. Measures need to be developed to judge the fidelity of the treatment that is administered over time.

We need to encourage behavioral scientists to continue pursuing the promising results that have been summarized in this review. When we have evidence of treatments that are effective at teaching functional communication skills, this is a beginning point and not an end point. We have not discovered a silver bullet and we are unlikely to do so. Teaching children with autism tends to be a difficult, painstaking endeavor. We have made much progress, but we must recognize that progress will continue to be slow if the scientific community continues to publish only about three experimental studies per year that address such a complex problem: teaching communication to children with autism. More investigators should be encouraged to pursue these promising findings. A single study may help to identify a promising treatment approach, but a number of systematic replications are needed to begin to:

- refine treatments by adding useful components or by eliminating superfluous ones.
- maximize the breadth of generalization and the durability of treatment effects.
- delimit the contextual conditions under which the treatment protocol is effective.
- delineate with whom the treatment is more and less effective.
- identify other behaviors to which the treatment can be applied effectively.
- elucidate psychological mechanisms or learning processes that help us understand why the treatment is effective.

Based on this review, one can conclude that substantial evidence exists to claim that effective interventions exist to teach communication skills to children with autism. Even though the vast majority of the studies reviewed were conducted with few subjects, with few exceptions investigators were able to demonstrate clearly and repeatedly that the initiation of their treatment was associated with improved communicative performance. In many cases, the effects are dramatic because control conditions show conventional communication to be so minimal for many children with autism. For children with at least rudimentary speech and language skills, who are verbally imitative, for example, there are an array of approaches that may yield fairly rapid learning. For children who are nonverbal, more precise programming and slower progress is likely. Are there interventions that have been shown to be efficacious in teaching relatively complete communication systems to the most challenging children with autism? I do not think so. But a knowledge base is available to help guide efforts to expand the communication repertoires of those challenging cases.

The literature provides little direction in terms of service delivery models or the intensity of services that are more likely to maximize communication intervention efforts. Logical arguments can be made related to opportunities to learn. It is hard to imagine a variable that is more predictive of learning than opportunities to respond (Greenwood, 1991). But that begs the question of the quality of instruction. The literature reviewed is firmly grounded in principles of learning derived from operant and social learning perspectives and their descendants. Effective communication interventions will depend on good decision making on a variety of fronts. For example, careful programming is needed: to select useful objectives, to provide environments that set the occasion for meaningful communication, to provide functional reinforcers that eventually are available with regularity in the natural environment, and to provide scaffolds (models, prompts, corrections, and encouragement) that are faded to promote independent and spontaneous communication. Developing comprehensive communication intervention programs for children with autism represents a major challenge, perhaps involving a healthy dose of art. Yet, the available literature provides a scientific foundation that should allow us to discriminate interventions that are purely art and imagination from those that are built upon treatment procedures with empirical support.

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