The generative language matrix: A comprehensive clinical analysis of generative language classes, conditional discriminations, ecobehavioral functions, abstract comprehension, and natural language development

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The treatment of autism

Natural language and social behavior may be analyzed in many ways. When the purpose of the analysis is to develop natural social and language skills, then it is helpful to integrate the analysis into a comprehensive organizational framework. In intensive early intervention with young children with autism, the great variety of natural language skills can be developed within such a coherent conceptual framework. As a result, the framework will enable productive treatment planning and program evaluation, as well as efficient language programming. Intensive therapy will be most cost-effective when both language and social skills are developed through an organized, as opposed to disordered, curriculum. The mark of an integrated curriculum is that it has content and coherent validity. Given that natural social behavior is highly inter-dependent with language skill, the valid curriculum should integrate both areas of skill development.

In the assessment of the needs of a child who has been diagnosed with autism, three areas of development typically appear to deviate from the normal range. The child will have a distinctly atypical developmental repertoire of both language and social behavior. The child will also show some form of stereotyped behavior. Each child will show a highly individualized pattern of these developmental deviations (Committee on Children With Disabilities, 2001). Therefore the curriculum should integrate a therapeutic approach to addressing all three areas, but in a framework that allows for significant individualization, as opposed to a simple progressive cookbook.

In order to attain the best possible outcomes for the child, behavior therapy should result in natural patterns of behavior in all of the typical environments of childhood. If these outcomes are thought of in terms of the natural repertoire of a typical six-year-old child, the goals of such treatment can be described generally as follows. The child will empathize and share affection with his family. The child will independently make and keep mutual friendships. The child will succeed independently in school. The child's social interaction will both be responsive and dynamic. The child will be effective in social situations. Finally, the child will meet the natural expectations for social behavior and self-control of their behavior in the environment. The child will possess all of these typical behavior patterns in the appropriate environments without requiring specialized supports. Instead, these typical behavior patterns will independently arise in the context of the natural ecology of the environment.

To more operationally define these general aspects of typical development, the treatment goals are for the child to show developmentally typical patterns of the following behaviors.

- Generalized imitation
- Generalized compliance
- Distal compliance
- Response to novel adults
- Compliance with group instructions
- Attending in small and large groups
- Intelligible speech
- Generalized speech
- Colloquial speech
- Creative story telling
- Social comprehension
- Cooperative play with adults
- Cooperative play with peers
- Congruent social play

- Maintenance of mutual friendships
- Participation in group conversations
- Thorough social responsiveness
- Self control of stereotypy
- Self control of excessive activity levels

When a child has mastered these goals, by spontaneously using these skills as appropriate in the natural environment, he is likely to have reached a point at which he is independent in the typical environments of childhood. He can enter and graduate from first grade without requiring special supports. He attains all of the typical developmental milestones. He can attain normal scores of cognitive functioning in standardized testing environments. He does not qualify for any diagnosable mental disorder. He responds equally appropriately in all environments, and with his parents, peers, siblings, and all natural care-providers, as well as with trained therapists. He does not require ongoing specialized therapy to develop further. These results have been found when behavior therapy is delivered as intensive early intervention. These outcomes might be the best possible, and in published research, children who attain these goals have a high likelihood of maintaining independence throughout childhood (McEachin, Smith, & Lovaas, 1993).

In order to accomplish these ambitious aims, a large body of research in Applied Behavior Analysis has been pursued over the past 40 years. The implication of this research is that behavior constantly responds to its environment. This interaction of behavior and environment results in all of the learned behavior patterns exhibited in a child's life. Whether interactions with parents and staff are planned or unplanned in their intent, these responses still interact with the child's behavior patterns to result in development. The developing behavior can follow a path that results in autistic behavior. In the development of autistic behavior, stereotyped tendencies generally become stronger as a result of the interaction of autistic behavior patterns with the environment throughout the 24-hour day. Inconsistent treatment approaches do not readily alter this dysfunctional pattern nor do they result in progress toward normalcy. However, consistent treatment is regularly shown to result in appropriate development. Therefore, to alter the developmental course of autism, treatment must transform the child's home and community into a 24-hour therapeutic ecology. The most well-proven therapeutic ecology is based upon the results of Applied Behavior Analysis.

More specifically, to transform the autistic behavior patterns into typical social behavior patterns, effective treatments must establish natural behavior interactions in their typical environments. Behavior therapy is most effective when the clinical focus is upon treating dysfunctional behavior problems, such as stereotyped tendencies, which are functioning to prevent typical development. To eliminate these behavior problems is then to result in accelerated progress toward typical development. In addition to the remediation of these dysfunctional patterns, behavior therapy will also entail a direct teaching approach which establishes the prerequisite skills necessary for natural behavior patterns to emerge. Therefore, effective behavior therapy is a two-fold process. Not only must typical skills be established through direct teaching, but also, for these skills to develop naturally and be used effectively in the natural environment, the child's clinical behavior problems must be remediated. As such, there are both structural and functional goals in behavior therapy.

Regarding the clinical focus, a large number of the dysfunctional behavior problems have been identified in clinical practice. These behavior problems include:

- Rigidity
- Preference for routine and sameness

- Perseveration
- Frustration avoidance
- Retreat from overwhelming complex environments
- Social disengagement
- Failure to learn from the environment
- Ecological effectiveness of autistic behaviors
- Self-motivation as opposed to social orientation
- Stereotyped reinforcement
- Oppositional behavior
- Generalization decrements

Each of these clinical behavior problems may be addressed through a task analysis of the individual child's specific needs in the area. Then the task analysis is followed as a series of individualized interventions. The interventions are modified in response to a prescriptive analysis of their effectiveness. The clinical interventions are interdependent upon the direct teaching of skills that are also needed to help the child function in the natural environment.

An example of a sequence of intervention that is designed to address one clinical behavior problem, rigidity, involves the following general steps. Before treatment, the child's rigidity is interfering with the normal development of social skills, as the child actively refuses participation in unfamiliar activities. Then, when treatment is begun, a waiting skill is developed through proactive teaching. Then tolerance of events, which currently provoke autistic behaviors, is developed by exposing the child to the provocative stimulus, and then reinforcing calm waiting behavior, through providing the opportunity to escape the stimulus after waiting. A variety of generalized forms of patience, such as waiting for a requested reinforcer, waiting in community activities, and independent work, are then developed through a gradual shaping process. Then flexibility in daily activities is developed through differential reinforcement and observational learning. Finally, the skills involved in empathy with others are developed. The empathy skills are elaborated to the point where the child will act to meet the needs of others as well as themselves. Of course, while the component language and social skills might be taught directly, the clinical need is not met unless the skills are established as typical behaviors in the natural environment. The child is able to use these skills when the rigidity is not preventing their function in the environment. In order for a skill to be considered to be mastered, the skill must occur independently of specialized therapy, and must effectively supplant the clinical behavior problem that had previously prevented natural development.

The development of natural language

The child with autism will typically also have substantial needs in the area of language development. In many children, the tendency toward stereotyped forms of language will be so great as to interfere with normal social communication and development.

The structure of behavior. In daily interaction, the child will show a highly individualized tendency to make certain stereotyped language responses, and these stereotyped language responses will occur at different rates. Generally each of these stereotyped structures will be rooted in rote imitations of language that the child has heard. And, whether produced contextually or not, they will not show evidence of true understanding of the meaning of the words used, because they will often recombine into nonsensical or simple sentence errors. Because of the stereotyped nature of the child's language, the errors will then often become perseverative error patterns. Examples of these stereotyped language structures include the following.

- Word omissions
  - "I a car."
- Filling nonsense sounds or words into a phrase
  - "Look at the uba uba uba truck."
- Incorrect or over-generalized articles
  - "Go to a kids."
- Pronoun errors
  - "You give it to you."
- Plural agreement errors
  - "The colors is red."
- Word salads
  - "Balls red cups heavy."
- Substitutions
  - "The train is train."
- Tense errors
  - "The boy running."
- Conjunction errors
  - "It's a big and red and tent."
- Noncontextual statements
  - "What's your name?" "My address is 2492 Lake St."
- Word order errors
  - "Dogs bone eating."
- Word association errors due to being in the wrong context
  - "Terry is brushing his 'hair' (instead of teeth)."

The function of behavior. But beyond the immediate description of the structure of the behavior, the function of the behavior may also be evaluated. Not only will language be defined by its structure, but it will also be defined by its function. More specifically, different forms of language will be found to be response classes that are controlled by a functional relationship with environmental stimuli. A variety of functions of stereotyped language may be identified. These include:

- Errors are shown to occur in a noncompliant pattern.
- Emotional responses occur when the stereotyped language behavior is interrupted.
- A response does not generalize from one stimulus to another, as if the response had been learned by rote practice.
- Isolated errors occur in a perseverative pattern in an otherwise mastered response class.
- When an unmastered, or difficult task is presented, predictable errors are substituted for correct responses in a perseverative pattern.
- Simple perseverative overuse of a word or phrase.
  - A word has local momentum and continues to be used at a high rate.
- Over-generalized sentence structure in multiple contexts.
  - "'it's a' we go outside now."
- Overuse of a specific word in specifiable sentences or contexts.
- Using an incorrect (but often learned) sentence form in a predictable context.
  - Making a request by asking a question, "do you want to go outside?" (in this example, the sentence form is learned by direct imitation)
- A word association controls subsequent local language behavior.
  - Pivoting on a word: "Let's go outside is Dan's car."
- Not responding to the entire context or message.

    - A response is controlled by a single word in a sentence rather than the entire statement: Instead of "I like your shirt," "Thanks;" the following occurs: "It is a blue shirt," "Thanks."
- Overgeneralization of a response when learning a skill.
    - The last exemplar mastered is over-used as an error during learning of the subsequent exemplar: "What school do you go to?" "I am six years old."
- Generalized noncompliant statements.
- Attention-getting response classes.
- Escape behavior.
- Behavior that is reinforced by coercing tangible reinforcement.

Some functions may be very difficult to discern without repeated assessment. This is especially the case with socially nonresponsive language behavior – behavior that does not directly respond to specifiable social stimuli, while still showing a functional relationship to the stimuli. Observable functions across time include:

- The correct form is not imitated after a model, even though imitation has already formed as a response class.
- The same error is repeated after the child had complied with a correction procedure for the error.
- While engaged in the stereotyped language behavior, there is no response to another social stimulus, such as an appropriate interruption.
- A stereotyped error in response to a specific stimulus is manipulable by differential reinforcement.

Behavior therapy for natural language development. The functions of autistic language, that are described above, may cause clinical programming to be ineffective. As a result, the child may make slow progress with a high error rate; have significant levels of stereotyped language patterns; fail in effective communication in natural interactions; and lack maintenance of skills. Therefore, to avoid these problems, the objectives of behavior therapy should be natural language responses which both have typical functions in the environment and typical structures. To attain these objectives, behavior therapy may follow this sequence. Behavior therapy is initiated by building on strengths – generalizing simple forms of language and expanding the vocabulary within those forms as early in the child's development as possible. (In this initial phase, both expressive and receptive single-term labels and requests are developed into generative response classes). Then the individual language terms are combined into generative conditional discriminations, or sentences. Once conditional discriminations begin to reach the generative stage, more advanced language forms are developed as single terms (possessives, plurals, etc.), and other language forms are developed (reciprocals, social initiations, etc.). Then concrete visual and auditory comprehension skills are developed. After that, abstract auditory comprehension skills are developed, along with abstract production skills. Throughout this process, the language forms that are acquired are generalized to function in natural activities, while simultaneously, the 24-hour ecology of the stereotyped language is altered to weaken the stereotyped language and replace it with typical language forms. Finally these natural language skills are generalized to more challenging activities and settings (distracting settings, complex environments, etc.)

Therefore, as has been discussed, the simple design of the curriculum is not enough to ensure success. In addition, an intensive, systematic clinical program must be provided to address all of the needs for support of language development. In a systematic intervention program, the child is assured of sufficient hours of one-to-one instruction, effective staff training and management, complete (consistent 24-hour follow-through) involvement of the parents and

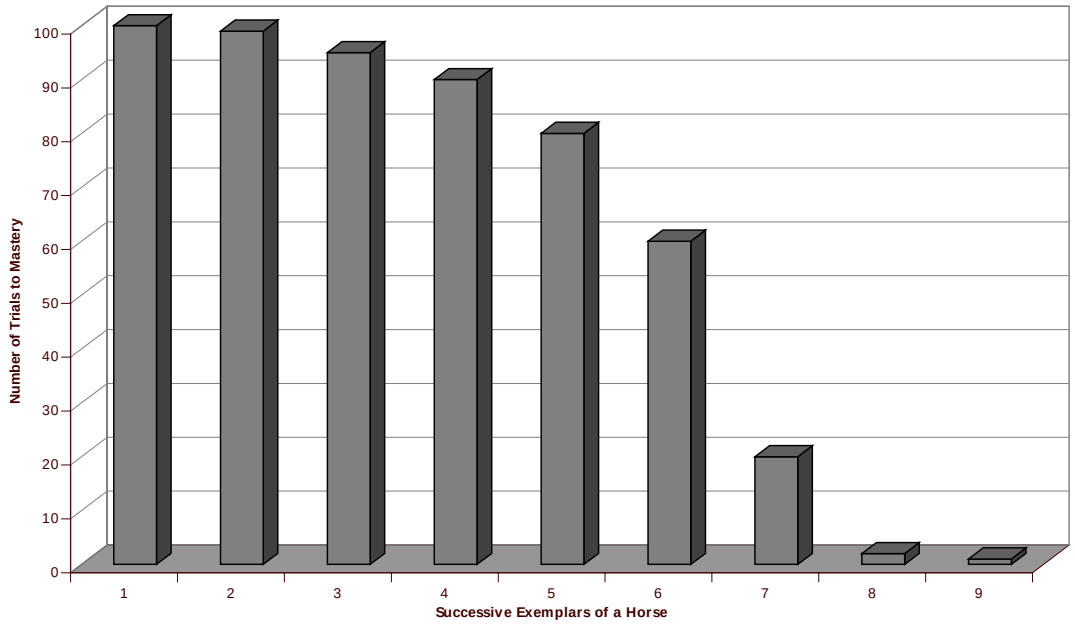
typical care-takers, and regular planning and case-management to ensure an optimum rate of development and individualization to meet the child's special challenges.

Generative response classes. The foundation of language programming is the development of generalized imitation, which has been shown to be a class of behavior (Baer & Sherman, 1964; Baer, Peterson, & Sherman 1967; Garcia, Baer, & Firestone, 1971; Schroeder & Baer, 1972). The concept of generative response classes is integral to the design of the current system. A response class has been defined as a collection of behaviors which, when measured as a group and subjected to environmental controls, vary together and produce "smooth curves" in graphic representation of their variability (Skinner, 1936). When a class is formed, it is said to be generic. In other words, when an environmental manipulation, such as reinforcement, is applied consistently to the members of the class, their rate co-varies with the rate of reinforcement so as to show a consistent effect of the reinforcement across the members of the class (Baer, Peterson, & Sherman, 1967). This effect can also be described as: the behaviors are functionally related as a class.

In the development of language, a subsequent concept, generative responding, may also be used to define membership in a class. Here, various exemplars of a class may be taught singly in the context of discrete trials. When later-introduced members of the class acquire discriminative control more rapidly than did earlier members, intra-class generalization occurs; suggesting a functional relationship between the members and, therefore, membership in a common class. When a later-introduced member of the class is shown to be acquired virtually immediately, the class may be said to be "generative" (Schumaker & Sherman, 1970). Training of some members of the class generates the acquisition of subsequent members (Baer & Guess, 1971; Clark & Sherman, 1975; Goldstein & Mousetis, 1989; Guess & Baer, 1973; Halle, Baer, & Spradlin, 1981; Schumaker & Sherman, 1970; Stokes, Baer, & Jackson, 1974). In many cases, no apparent training whatsoever is required for subsequent members to occur.

The following figure (1) illustrates generative training of a simple label (horse). Here, each column represents the number of trials required to develop discriminative control over a specific exemplar (a given toy horse, picture of a horse, or live horse). A trial is counted each time the child is presented with an S^D of the given horse exemplar, or a distractor exemplar (a toy cow, for example), whether or not the child correctly responds, "horse." Mastery is defined, simply, as when, on the first trial of a new day in which the child is presented with yesterday's exemplar, the child independently makes the correct response, "horse." In this example, the first column shows that the child required 100 such trials before independent responding on the first trial of a new day occurred when the target was a specific three-inch-long, black, plastic, toy horse. The second column shows that the child required 98 trials before the independent response to a ten-inch-long, brown, painted, toy horse was acquired. And so on with different toys or pictures being the focus of each subsequent column. The last column shows that the child required only one trial acquire the correct response, without a prompt, to a live horse which was standing in a field alongside the road as the family drove by. The child's expressive label, "horse," was now generative, as the child no longer needed a prompt in order to spontaneously and correctly label a novel horse.

Figure 1: Generative development of the class: "Horse."



The process of developing generative language classes is a foundation of the process of establishing functional language. Until training in some exemplars of the class can generalize to all related members, training is incomplete. Once training has generalized to all related members, the child shows evidence that "the child has acquired a true understanding of the term or concept." The child is no longer showing a response that was memorized by rote, but instead shows the same language comprehension that any typical child shows. Therefore, "generative responding" describes the child's responses that have not been demonstrated earlier and have not been directly taught (Baer, Peterson, & Sherman, 1968). By training generative responding, the child can exhibit novel responses to novel stimuli. Further, individual language terms (i.e., subject, action, preposition, adjective, object, possessive pronoun, pronoun, singular form, plural form, past tense, present tense, future tense) can be conceptualized as generative response classes. By training varied and numerous exemplars of each specific language term, one can observe the emergence of new and untrained exemplars of that language term in response to novel stimuli. Thus, behavior therapy is developing generative response classes rather than a large set of rote responses.

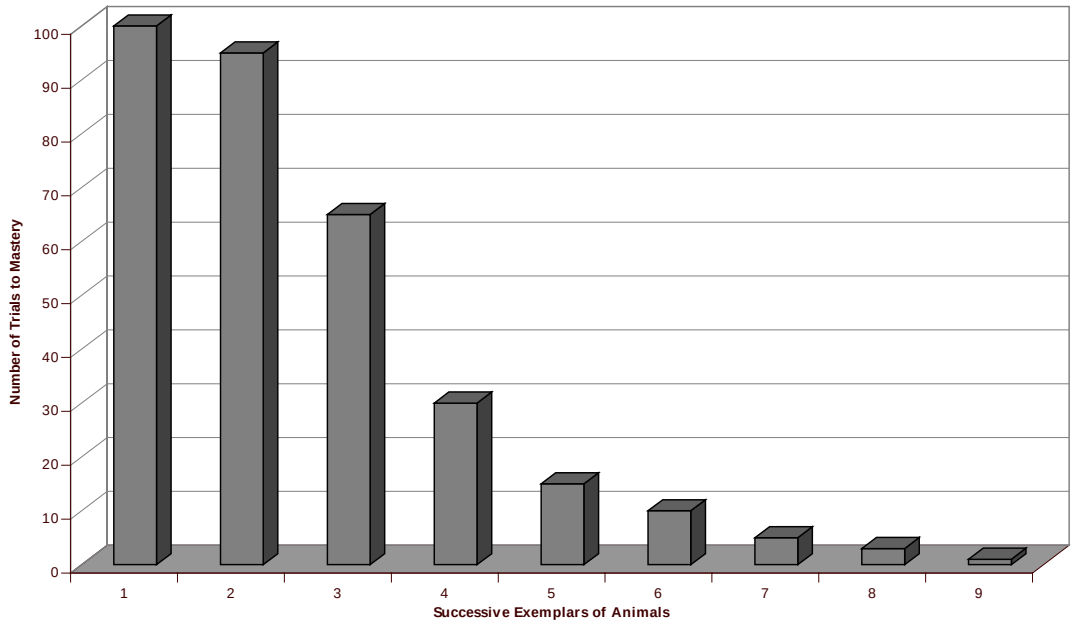
A variety of language terms have been demonstrated to be generative response classes in the experimental analysis of language. These have included the past tense, the present progressive tense (Schumaker & Sherman, 1970), and the /-s/ and /-z/ allormorphs utilized for object pluralization (Sailor, 1969). In a specific example, Guess, Sailor, Rutherford, and Baer (1968), chose the productive use of the plural morpheme as the language term for analysis. Through imitation and differential reinforcement, a child was taught to correctly label singular and plural object labels in response to single objects and pairs of objects. After training across several exemplars of the two forms, the child produced plural object labels that had been taught only in the singular form. This generalization to novel plural forms, showed that the plural morpheme was a generative response class.

In intensive early intervention, a basic programming question often is: "how many exemplars of a label should be taught?" The answer is: the number of exemplars necessary to reach a mastery criterion in which the child can immediately generalize to all members of the class. The development of generative forms of language is incompatible with the development of

stereotyped forms of the same language term. Generative training has also been shown to produce better response maintenance (Whitehurst, 1971; Baer & Guess, 1973). This is very likely the case because, once the class has generalized to novel members which don't require training, the class has become independent of direct training – it should maintain on its own.

Similar to the development of a class of language responses, a concept may be acquired through successive discrimination training across multiple exemplars (Stokes & Baer, 1977). In this case, successive training of different exemplars of the concept results in generalization to novel members. Again, once this occurs, the concept is said to be generative. The following figure (2) illustrates generative training of a concept, Animals, in much the same way as the training of the concept, Horse, proceeded.

Figure 2: Generative development of the concept: "Animals."



In the curriculum for language development, then, the foundation for moving on from the development of single words to that of multiple-term sentences is the generative label. A child should first fully acquire the generative labels and concepts that will then be combined into sentences. Not only may single terms (horse) be found to be generative when generalization to novel exemplars of the term occurs; but also concepts and even forms of speech may be found to be generative. A concept (animal) is generative when generalization to novel exemplars of animal occur. Even a form of speech (adjective) can be shown to be generative, when subsequent exemplars of the form of speech (big, long, red, hairy) are acquired with minimal or no training (Schumaker & Sherman, 1970).

The matrix of natural language responses. In clinical practice, various stimulus modes are often found to be more rapidly acquired by individual children than are others. Several modes are commonly employed – three dimensional materials (the child labels toys), two dimensional materials (the child labels pictures), the first person (the child labels their own behavior), or the second person (the child labels the behavior of the therapist). The third person is also used, in which the child labels the behavior of someone other than the therapist, as are written communication modes. In addition, there are often strong individual differences in the rate of acquisition of receptive (responding to the language behavior of others) versus expressive

(using language as a stimulus for the behavior of others) modes. Beyond these common modes, written stimuli and responses are frequently found to be an essential mode of language instruction in autism. In clinical practice, with the matrix curriculum, the child will acquire generative language most efficiently if the therapy begins with the most effective mode. Further, the process of reducing errors also often addresses the clinical needs of the child (preventing the development of perseverative errors, or minimizing frustration). Once generative language is acquired in one mode, the successful mode may be used to more rapidly teach responding in the less effective modes, through using the successful mode either as a prompt or for behavioral momentum. These multiple modes can be arrayed as a two-dimensional matrix of stimulus and response modes (See Table 1).

Table 1: Matrix of stimulus and response modes.

		Stimulus Mode				
		Two Dimensional	Three Dimensional	First Person	Second Person	Written
Response Mode	Matching					
	Imitation					
	Requesting					
	Receptive Labeling					
	Expressive Labeling					

Therapy typically begins with teaching generative expressive and receptive repertoires at the 1-term discrimination level for each of the individual exemplars (i.e., specific subjects, actions, prepositions, etc.). Of course, as a prerequisite, the children must be able to accurately imitate the phonemes and number of syllables found for each particular response. In addition, the class may be developed through matching, until generative exemplars are acquired, prior to introducing the receptive or expressive S^Ds. Individual children present different strengths in either receptive or expressive labeling skill, and this may be related to the types of differences between these modes themselves. For example, the receptive task requires a response to an auditory S^D, while the expressive task requires a response to a visual S^D. Further, the visual stimulus component of the receptive compound discriminations are typically simultaneous discriminations, whereas the visual component of the expressive compound discriminations are typically successive. However, the auditory component of the receptive discrimination is necessarily successive. These differences may play to specific functional strengths of the individual child, and the analysis of these differences offers strategies for training one mode by generalizing from a previously mastered mode through graded steps of successively more similar approximations of the target mode.

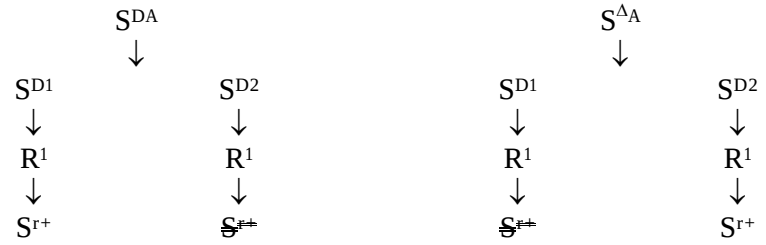
Typically, the most readily acquired language classes are concrete terms, as opposed to relative terms. The ability to label or request objects, actions, and subjects is usually acquired first. Although here, with individual children, actions may prove to be sufficiently relative (the same boy may be running or sitting, whereas he is always the same boy) to require additional effort to train. Also, subjects (specifically, the proper names of people) may be (at first glance) surprisingly difficult to teach. Although within the context of autism (a child is more focused on the child's behavior than that of others), it may not be surprising that the child does not attend to the identity of others in their environment. Adjectives and prepositions are commonly more difficult to teach, as each are clearly relative to the concrete objects in the child's environment. These terms, when proven generative, fall along a third dimension of the language matrix (See Table 2).

Table 2: Terms.

	Generative Terms				
	Objects	Subjects	Actions	Adjectives	Prepositions
Individual Response Classes	Horse	Mommy	Run	Long	On
	Car	Frank	Slide	Round	Under
	Table	Barbie	Grab	Scary	Next to
	Rocket	Auntie Jane	Crush	Enormous	Between
	Doll	Donald Duck	Slurp	Smooth	By

Conditional discriminations. Once two separately developed terms become generative, the curriculum may then progress to sentences, or the combination of multiple terms (Karlan, Brenn-White, Lentz, Hodur, Egger, & Frankoff, 1982; Lutzker & Sherman, 1974; Mineo & Goldstein, 1990; Striefel, Wetherby, & Karlan, 1976). The use of a sentence may be best considered as a conditional discrimination. As a simple illustration of a conditional discrimination, in Figure 3, a successive conditional discrimination is diagrammed where a response to S^{D1} is reinforced only in the presence of S^{DA} and a response to S^{D2} is reinforced only in the presence of $S^{\Delta A}$. Therefore, reinforcement of the response to S^{D1} is conditional upon the presence of S^{DA}. In the case of a sentence, when there are at least two terms in the sentence, each of which require a discrimination, then the correct response to the entire sentence would similarly require a conditional response – a correct response to one of the terms is not reinforced unless it is in the presence of a correct response being made to the second term also.

Figure 3: Successive conditional discrimination.



As a specific example of the process of moving from the single-term discrimination to the conditional discrimination, single-term labels (receptive adjectives) are first taught as simple discriminations: fat versus skinny; round versus square, cold versus warm, etc. until the receptive adjective is generative (hard versus soft is mastered in one prompt or less). Now, new members of the class are acquired almost automatically. Similarly, receptive objects are also taught to a generative level: car, truck, ball, jet, pirate, knight, etc., until the receptive object is generative (a subsequent object, spaceman, is acquired with one prompt or less). Then, a two-term phrase is taught as a conditional discrimination: fat pirate vs. skinny pirate *versus* fat knight vs. skinny knight. Here, the discrimination task includes each possible combination of the two terms. When the discrimination task therefore involves distracters for both terms (adjective and object), a conditional discrimination is present. A response to "knight" is only reinforced in the presence of "fat" if "fat knight" was the S^D. Put more technically, a correct response to "knight" is only reinforced in the presence of a correct response to "fat." Therefore, if the child is to use a sentence that contains more than one term, the child is making a conditional discrimination. A correct conditional discrimination is only made when both terms are simultaneously discriminated to produce the one correct response (out of four possible in this case).

Figure 4: Two-term conditional discrimination.

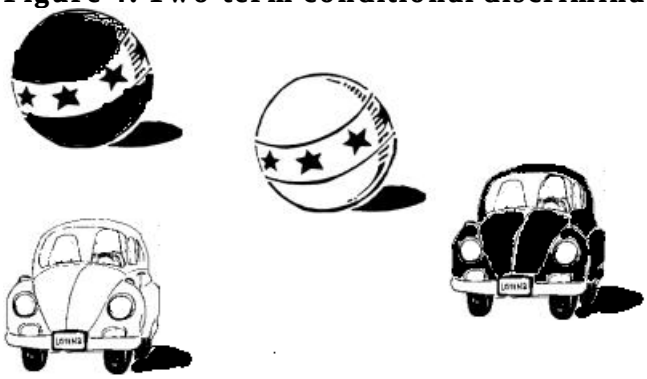


Figure 4 shows a second example of a two-term conditional discrimination. This is another adjective-object discrimination, where the S^D is, "white ball." On the floor is a black ball, a white ball, a black car and a white car. A simple discrimination would be “ball” and a response to either ball would be correct. The response becomes conditional when the adjective determines which ball is correct (i.e., white ball). In effect, the adjective “white” is the conditional stimulus (similar to touching the center key in an experimental conditional discrimination procedure). Again, in this case, a conditional discrimination is not present unless there is an alternative S^Δ, or distracter, for each term in the conditional discrimination (black vs. white and car vs. ball). If there were only a black and white car on the floor, then the discrimination of car vs. ball would not be necessary, and the discrimination of white vs. black would be a single-term discrimination.

If both terms did not have a distracter present, the child may not fully attend to both terms and possibly either learn to use the nondiscriminated term as a stereotyped phrase within sentences; or the child may acquire latent inhibition over the nondiscriminated term (Lubow & Moore, 1959; Lubow, 1989). In latent inhibition, the child is in effect receiving extinction training for the nondiscriminated term (its correct use is not functional in determining reinforcement). As a result the child may not respond to the extinguished term in future training when it is used functionally to control access to reinforcement. Because of the potential for latent inhibition, single-term discriminations are often developed without the use of extraneous words that are not functional terms. For example, the use of the S^D “show me running,” would be shortened to “run,” to avoid extinguishing discriminative responses to “show me.” Therefore the first condition to be fulfilled in acquiring sentence skill is to acquire a valid conditional discrimination of at least two individual terms.

Conditional discrimination training has been shown to result in generalized responding (Saunders and Spradlin, 1990). The incorporation of conditional discrimination training into language programming has also been shown to be effective in remediating overselective responding to multiple cues (Riedesel & Larsson, 2002). Overselective responding, in which separate cues are not equally functional in controlling responding, is often cited as a response characteristic of children with autism (Lovaas, Koegel, & Schreibman, 1979). However, several studies have demonstrated that children with autism could learn to respond to multiple cues if the environment is arranged properly through the use of conditional discrimination training (Schreibman, Koegel, & Craig, 1977; Koegel & Schreibman, 1977). Furthermore, after presenting a series of conditional discriminations, children with autism have responded to novel conditional discriminations without demonstrating overselective responding (Riedesel & Larsson, 2002).

Recombinative generalization. By teaching a conditional discrimination, a new process for the formation of a generative response class, as a conditional discrimination, becomes possible: recombinative generalization (Goldstein, 1983). Here a generative two-term response is acquired when the individual terms spontaneously recombine into previously untrained combinations. For example, responses to "pushing barrel," "filling barrel," and "filling cup," are prompted, but "pushing cup" is acquired as a novel recombination – one which had never before been prompted or reinforced. True mastery of a two-term conditional discrimination would be when a novel combination of two terms, which had never before been prompted in a conditional discrimination, "throwing car," occurs. As a result, the child is again "showing true comprehension" of the sentence by being able to respond correctly to untrained sentences. Therefore, the second condition for acquisition of a sentence is a conditional discrimination that has reached the level of recombinative generalization.

Therefore, there are two uses of the term "matrix" in this curriculum. The first, as has been used in this paper to this point, is the use of the term to describe the overall interaction of language programs throughout the language curriculum. The second (as shown in Figure 5) is to refer to the smaller scale programming of a matrix of tasks to most effectively result in a recombinative multiple-term conditional discrimination within a single skill development program (Wetherby & Striefel, 1978). For example, a two-dimensional matrix, might, along one axis, include adjective labels (i.e., blue, green and red) and along the second axis include object labels (i.e., cup, bowl and plate). By identifying the cross sections between axes, one could develop and train a variety of language term combinations (i.e., blue cup, blue bowl, red bowl, etc.). With a goal of recombinative generalization, the process of training specific combinations of language terms, (i.e., blue cup and red cup) derived from the matrix, continues until it results in the comprehension and production of previously untrained combinations (i.e., blue bowl and green cup).

Figure 5: Two-dimensional programming matrix within a single skill program.

		Adjectives (Color)		
		Blue	**Green**	**Red**
Objects	**Cup**	**Blue Cup**	**Green Cup**	**Red Cup**
	Bowl	**Blue Bowl**	**Green Bowl**	**Red Bowl**
	Plate	**Blue Plate**	**Green Plate**	**Red Plate**

Mastery of every multiple-term conditional discrimination is only achieved when novel combinations are reliably produced (recombined) with no specific training.

This process of developing recombinative conditional discriminations is a markedly different language acquisition process from that of acquiring scripted sentences through repetitive practice. In the review of common stereotyped language structures presented above, many of the errors described are errors of recombination. In practice, effective conditional discriminations may commonly be trained to the eight-term level. These multiple-term conditional discriminations add a fourth dimension to the matrix (See Table 3).

Table 3: Common Multiple-Term Conditional Discriminations

2-Term Conditional Discrimination	
	Subject-Action Action-Object Adjective-Object Subject-Adjective Preposition-Object Subject-Preposition Action-Preposition Preposition-Adjective Adjective-Adjective
3-Term Conditional Discrimination	
	Subject-Action-Object Action-Adjective-Object Subject-Action-Adjective Action-Preposition-Object Subject-Action-Preposition Preposition-Adjective-Object Action-Action-Object
4-Term Conditional Discrimination	
	Subject-Action-Adjective-Object Subject-Action-Preposition-Object Action-Preposition-Adjective-Object Action-Adjective-Adjective-Object Subject-Action-Preposition-Adjective
Multiple-Term Conditional Discrimination	
Alternate Term Order/Conjunction	

Responses are controlled by the complete compound discriminative stimulus (i.e., all of the terms and their combination within the sentence) rather than a component of the discriminative stimuli (i.e., one term of the sentence). As the language term combinations increase in number and complexity, so too does the stimulus array.

In conditional discrimination training, the number of terms which are considered to be part of the conditional discrimination are only counted by the number of terms for which there are functional distracters present in the task, rather than by the number of structural terms present in the sentence. For example, if a sentence such as “Don pulled the red car” is given as part of a conditional discrimination trial, there are four structural terms presented – a subject: Don; a verb: pulled; an adjective: red; and an object: car. However, there must be a functional distracter present for each term – another subject: Joe; another verb: pushed; another adjective:

blue; and another object: ball – to count it as a four-term conditional discrimination. Examples of these conditional discriminations in different modes are given in Table 4.

Table 4: Four-term conditional discrimination: subject/preposition/adjective/object ("The horse is on the tall fence.")

Distracters in the Field	Sample S^D	Sample Response
Receptive three-dimensional Six toys	S^D: "Put the chicken on the hard box."	R: The child chooses the correct one of two subjects that is in a location relative to one of four objects possessing one of two adjective properties.
Receptive First Person Four toys and at least two persons in area	S^D: "Sam is on the little chair."	R: The child places himself in the correct location relative to one of four objects possessing one of two adjective properties.
Receptive Third Person Four toys and at least two persons in area	S^D: "Is Bill under the long table?"	R: The child answers yes or no according to the accuracy of the question posed by the therapist.
Receptive two-dimensional Books/Pictures	S^D: "Baby Bop is on the pink bike."	R: The child points to the correct picture containing the subject/ preposition/adjective/object.

Distracters in the Field	Sample S^D	Sample Response
Expressive three-dimensional Six toys	S^D: Demonstrate placing one of two subjects in a location relative to one of four objects possessing one of two adjective properties.	R: "The chicken is on the hard box."
Expressive First Person Four toys and at least two persons in area	S^D: Model placing yourself in a location relative to one of four objects possessing one of two adjective properties and then the child labels after they imitate.	R: "Bobby is on the little chair."
Expressive Third Person Four toys and at least two persons in area	S^D: Demonstrate placing yourself in a location relative to one of four objects possessing one of two adjective properties and then the child labels what you did.	R: "Kara is under the long table."
Expressive two-dimensional Books/Pictures	S^D: Present a picture containing the subject/preposition/adjective/ object.	R: "Baby Bop is on the pink bike."

Table 4 illustrates the concept that the structural words in a sentence are only counted as terms when there is a distracter for them.

In Table 4, receptive labeling instructions ("Put," "Point to," "Go,"), and the expressive labeling questions ("Where," "What," "Is,") could have been used, but would not be counted as a distinct term, because there are no distracters for these words. These natural sounding instructions and

questions may be used in the interest of natural generalization, but they risk becoming irrelevant through the process of latent inhibition (the child ignores them in the S^D and later does not respond differentially when they are true discriminators of correct performance), as described above. Indeed, in clinical practice, the "Wh" question words are often found to be poor discriminations, and it is likely that latent inhibition is the culprit. Therefore, with a child who requires careful introduction of terms, these words are best not even used in early programming. The receptive labeling instructions are taught correctly as a conditional discrimination later as a separate program, and then they are used correctly in these programs with distracters. The question words are also taught later as a separate program with correct distracters. Once these skills have been mastered, then the examples shown in Table 4 are valid natural goals of careful programming. In general, the decision to use extraneous words in S^Ds is a significant one, and commonly, the best practice is to limit S^Ds to only the least necessary words. A child should clearly demonstrate an ability to respond correctly to the additional nondiscriminated words before they are used in regular practice.

This brings up the issue of the use of colloquial sentence structures versus the use of telegraphic speech. The early goal in therapy is to maximally expand the functional vocabulary (as defined by the total number of generative discriminations) rather than to produce typical sounding sentences with relatively few discriminations, when there is a conflict between these two practical goals. This is because the breadth of vocabulary (or number of functional language discriminations) developed early in age is the best predictor of later intellectual capacity. Therefore with some children, the use of articles (the, is) may be avoided in order to increase the speed of language acquisition. As a result, the children sound as if they are speaking telegraphically (on a temporary basis). Then the use of articles themselves is introduced as a term in subsequent responding.

Similarly, when keeping the number of terms at the most effective level, but still providing typical sounding sentences in a matrix of distracters, nonfunctional filler words may be used. For example, in a two-term conditional discrimination (verb-adjective), the discriminative stimulus need not be of an abstract form (push red). Instead, a perfectly acceptable (and typical sounding) two-term sentence might be "push the red one," with no distracter present for "one."

Of course the preference would be to use natural sounding language at the point at which the rate of acquisition is similar, with or without the use of nonfunctional terms. This point leads to the next topic of this discussion, individualization.

Individualization and the sequence of language therapy. To this point, the discussion has focused on the development of concrete requests and labels of the visual environment, whether receptive or expressive. In the present framework, a given program to develop a specific multiple-term skill would contain the following significant procedures. First, each component term of the conditional discrimination has been taught until generative. Then the multiple-term skill is first taught as a matching or imitation task. This ensures the successful discrimination of the complex stimulus array, before adding on the additional task of attaching a verbal label to the array. The match or imitation itself would be developed until recombinative generalization occurs. In order to ensure that the conditional discrimination is valid, a sufficient matrix of distracters for each term in the conditional discrimination is included. This will ensure that the conditional discrimination is truly a conditional discrimination, rather than allowing a single term to inadvertently be a relevant S^D for the conditional discrimination. Table 4 provided examples of the range of modes and necessary distracters required to master each multiple-term skill.

The next mastery step is to develop the conditional discrimination until generalization occurs to the first presentation of a novel combination of exemplars, embedded in a field of novel distracters (to avoid the process of elimination serving as an inadvertent prompt). This feature ensures that the presence of either known or unknown items will not inadvertently serve as a relevant S^D or S^Δ for responding. It is essential to program discriminations between stimulus continuums that are relevant and those that should be irrelevant to the conditional discrimination. A large variety of potential discriminations may be addressed, given the target skill and the tendencies of the specific child. As early as possible in each skill program, and regularly in virtually every session, the other modes are then randomized with the target mode to ensure that the child is not falling into a pattern of responding. For example, alternate multiple-term sentences are discriminated from the target sentence; alternate instructional arrangements may be employed; or alternate subclasses of the general case of a given term may be included. These discriminations, which are not of the type of direct discriminations that have been identified in the matrix, are important to ensure that the child is responding to the relevant language, rather than to the inadvertent prompt which is offered by the format of the task being presented. For example, the child sits down on the floor and sees a typical receptive 3D adjective labeling task arranged, but is given the S^D "where is the lamp?"

Then the skill, which heretofore had often been taught through repetition, is generalized to the natural environment by gradually expanding the time and variety of intervening activities between target trials, as well as varying the S^D and the location of trials, until spontaneous generalization and maintenance in natural activities can be anticipated. Another feature is to begin programming (earlier or later, depending upon the child's current optimal learning style) multi-modal activities in which unrelated stimulus and response modes are mixed into the same activity. This is followed by generalization of the therapy activities into forms of naturally occurring activities. In fact, one of the best conventions used for the promotion of thorough generalization and maintenance, is to purposely design skill-training programs within the context of natural play language activities (playing with emergency vehicles, doll houses, etc).

For maximum efficiency in therapy, the existence of the matrix is not used to dictate a standard, lock-step progression through programs. Instead a premium is placed upon the clinical judgment of the practitioner to advance the progress of programs in the optimum manner. Moving too slowly through the curriculum has been found to result in an increase in the rate of stereotyped language. Instead, progress through the curriculum is best based upon dynamic behavior principles. For example, one skill is moved to the next as soon as generative responding is acquired. When the rate of learning is not accelerating, the practitioner begins a prescriptive functional assessment to determine more effective procedures (direct prompting versus behavioral momentum, for example), or a change in therapeutic focus across modes in order to maintain optimum progress toward generative responding. In clinical practice, a child who shows a strong individualized tendency to learn more readily in one mode as opposed to another, will typically move through several levels of multiple-term conditional discriminations in a single mode, before the other modes are even addressed. This allows the child to learn the most individual terms and combinations as early in their development as possible, rather than slowly acquiring a broad vocabulary. Normative cognitive research suggests that the earlier the child acquires a broad vocabulary, the higher he will score in later measures of cognitive functioning (Ramey, Campbell, & Finkelstein, 1984; Hart & Risley, 1995). Further, by acquiring fluent skill in language through a single mode, the child may more readily acquire basic functioning in the more difficult modes.

Dynamic decision making. There are several important aims in teaching each skill, and as many as possible should be accomplished at once for optimum progress. When they can't be,

follow this general hierarchy in determining how much to try to accomplish per day. For example, the initial goal is to accelerate the acquisition of novel discriminations. If the child is initially capable of learning new words with accurate articulation in a single day, then target both. But if he will learn many more discriminated exemplars with poor (but understandable) articulation, then focus on the number of exemplars as the priority, and introduce a second short-term objective for quality, which is implemented in parallel. The child will then continue to accelerate their acquisition of new words, while also improving quality afterward. In time these two objectives should be able to be worked on in the same objective.

A. Master the response to the prompt before using it to teach a higher skill
B. Increase the rate of discriminated exemplars mastered
C. Increase the spontaneity of each exemplar
D. Generalize the exemplar to all natural contexts (or teach in the natural context)
E. Increase the quality of each exemplar until it looks and sounds natural (articulation, intonation, eye contact)
F. Teach with a minimum of specialized therapy techniques (teaching in a free-play setting; or fade out massing, antecedents, prompting, and reinforcement)

In deciding what is the daily target for decision making, there is a hierarchy of levels of skill, and the highest point on the hierarchy at which the child's acquisition of targets is the highest, is the most desirable. The supervisor needs to be probing weekly to see if the skill can be taught at a higher level than was achieved last week, in order to maximize progress.

Here is an example of breaking down a short-term objective into a hierarchy of potential daily targets. The actual sequence would also be individualized per child based upon his strengths (one child is stronger in 2D Expressive while another child is stronger in 3D Receptive). At each level, the criterion to move to the next level is generalization to a novel, unprompted exemplar on a new day. None of these steps would be a requirement; instead, the supervisor would probe ahead to see if the child could skip steps and still learn at the same rate or higher. Simultaneously, as this sequence emphasizes the expressive 3D mode, the child may also be in a sequence which emphasizes receptive 2D. Other more challenging modes for that child, such as receptive third-person, would not be addressed until both of the prior sequences are mastered.

1) One-term matching of generalized objects.
2) One-term expressive of a single exemplar of an object taught in 3D, following a behavioral momentum trial of matching that object.
3) One-term expressive of a single exemplar of an object taught in 3D, without behavioral momentum trial.
4) One-term expressive of a multiple exemplars of a single object taught in 3D.
5) One-term expressive of generalized objects taught in 3D.
6) One-term expressive of multiple-object exemplars of a single adjective ("red") taught in 3D.
7) One-term expressive of a two randomly interspersed adjectives ("green" and "white") taught in 3D.
8) One-term expressive of generalized adjectives taught in 3D.
9) Two-term expressive of generalized adjective with a rote object, taught in 3D.
10) Two-term expressive of generalized adjective-object, taught in 3D.
11) Two-term expressive of one combination, taught in one mode.
12) Two-term expressive of one component of the three-term combination, randomly alternated with the other component of the target three-term, taught in one mode. (The

three-term is subject-action-object, the two two-terms are subject-action and action-object).
13) Three-term expressive of one combination, taught in one mode.
14) Three-term expressive of two randomly interspersed combinations, taught in one mode.
15) Three-term expressive of all possible combinations, taught in one mode.
16) Three-term receptive of all possible combinations, taught in one mode.
17) Three-term expressive of all possible combinations, with one combination of a receptive randomly interspersed, all taught in one mode.
18) Three-term receptive/expressive of all possible combinations, taught in one mode.
19) Three-term receptive/expressive of all possible combinations, taught in one mode.
20) Three-term receptive/expressive of all possible combinations, using one mode as a prompt to teach a second mode.
21) Three-term receptive/expressive of all possible combinations, taught in a mix of first person and 3D.
22) Three-term receptive/expressive of all possible combinations, taught in mixed modes in a structured setting.
23) Three-term receptive/expressive of all possible combinations, taught in mixed modes in a structured setting.
24) Three-term receptive/expressive of all possible combinations, taught in mixed modes in a natural setting.

In the language matrix, different modes are typically associated with different discrimination training procedures. A receptive two-dimensional task is typically a simultaneous discrimination, but a receptive first-person task is typically a successive discrimination. An expressive task is typically a successive discrimination, while a receptive task may be either. This important difference in procedure may be another source of individual children's differential difficulty with one mode as opposed to another. In addition other differences in procedure may result in significant effects upon skill acquisition. These procedural differences include auditory versus visual stimulus modes, speed of presentation, types of distracters available, or vocal versus physical response mode – each of which may interact with individual error history, motor ability, tendency to impulsively respond, or attractiveness of stimuli. Regarding the matrix of multiple-term sentences, the conditional nature of an expressive task is very different from the same number of terms in a receptive task. The effective use of matching or imitation as a prompt also varies depending upon the mode used.

The choice of vocabulary should be designed to promote natural language development. As follows from the use of novel language learning as the criterion for mastery, the continuing elaboration of this criterion suggests that the best ongoing procedure is to automatically include novel vocabulary in all multiple-term programs so that the child is maintaining the skill of learning new words in a single trial, as a typical child does. Some children require an ongoing vocabulary program in which each trial is composed of a different mode (of which currently there are 23 identified modes), to ensure that the vocabulary learning is sufficiently generative (in the first trial, the term is introduced as a definition; in the second as a yes-no answer; in the third as a two-dimensional expressive, etc.). A related concept here is to integrate natural social and play vocabulary in all programs, as opposed to over-reliance upon academic concepts. The essential aim of behavior therapy for autism is to teach social language, so two goals can be accomplished simultaneously if the exemplars have to do with common social and play concepts (Disney villains, Hot Wheels cars, action heroes, etc. rather than community helpers and days of the week). We are teaching children to have attractive play skills rather than be academics (the latter often being an easy goal). The focus on social and play language also determines the best modes of instruction. Two-dimensional tasks may be readily available, but are the least similar

to actual play activities. Therefore labeling of three-dimensional toys and the actions of others are much more readily generalized skills.

As noted above, most children acquire language skills more readily in one mode than in others, and this fact offers a significant strategic means of individualizing therapy. The language skills may be best introduced in the primary, most successful mode, and then generalized to the more difficult modes. Once sufficient skill is developed with the primary mode of instruction, related modes, which may be more challenging to teach, can be either: generalized to; programmed through behavioral momentum from the primary mode; or taught by using the primary mode as a prompt. For the purpose of generalization, materials that readily generalize from one mode to another may be very strategic. Then the transfer from one mode to the other can be pursued in a series of graded steps. For example, when a child's strongest mode is two-dimensional, Colorforms (two-dimensional vinyl pictures) or realistic stickers may be used to create the exact two-dimensional stimulus that will also be set up as a three-dimensional stimulus with the three-dimensional toys that are pictured in the Colorforms or stickers. The Colorforms provide for response and stimulus generalization, in that the child can be manipulating the placement of the two-dimensional picture of the toy in a similar manner to their manipulation of the toy. This ready generalization can then be faded into less similar stimuli. In another example, for a child who attends well to television, labeling a video on a screen, or a frame from a CD-ROM book, can be generalized to the same arrangement of three-dimensional figures, using the same toys. For a child for whom active gross motor play is highly preferred, the use of requesting in the context of playground play may be the most effective initial mode, followed by generalization to the same play actions with, for example, a Playmobil playground set. Similarly to generalize from the three-dimensional mode to the first-person mode, the child may initially be moving toys around a table-top arrangement of toy furniture. Then the child moves the same toys around similar actual furniture in the room. Actions are initially targeted with toys for which a non-object movement is also possible (banging with a hammer can generalize to banging a fist). Then the toys are removed and the child moves their own body around the room. To generalize from the first-person mode to the two-dimensional, the child may "match" two-dimensional photographs of their body in certain positions to their mirror image as they act out the same body positions. To generalize from two-dimensional to third-person responding, the child may match photographs of other persons who are engaged in a behavior to the actual body of the other person as they act out the same behavior.

Applications to specific structural problems. Table 5 is an illustration of a sequence of programming for pronouns, which takes advantage of both the concept of generative distractors as well as careful analysis of the structure of the sentence to make the pronoun acquisition more errorless.

Table 5: Instructional sequence for pronouns

I.	One term Subject labels using proper names
II.	One expressive or receptive pronoun interspersed with subject labels (he, she, they, them, her, him, it) Then Randomize
III.	Me, you, I, we (initially either only as receptive or only as expressive, due to the reversal confusion between expressive and receptive) (consider matching picture or word to subject as prompt) Then Randomize
IV.	One term adjectives (other than pronouns)
V.	One term possessive adjectives using proper names
VI.	One expressive or receptive possessive pronoun interspersed with possessive

	adjective (his, her, hers, their, its) Then Randomize
VII.	My Your Then Randomize
VIII.	Expressive and receptive in parallel separate activities
IX.	Mixed Expressive and receptive
X.	Multiple term sentences with pronouns Keep pronoun in same term in the sentence with no other pronouns or subject labels in sentence A. Pronoun in subject position You push the ball Bill push the ball I push the ball (instead of mixed with: I push Bill) B. Pronoun in object position Push Bill Push Me Push her C. Pronoun in adjective position (This is possessive).
XI.	Then mix sentences with pronouns in different positions
XII.	Then mix sentences with two or more pronouns I have your hat Bill has my hat I gave my hat to Bill I gave my hat to you

Sample results of expressive and receptive matrix programming

Children. For illustrative purposes, clinical data on three children's performances with language matrix programs are presented here. Each child had been diagnosed with autism or PDD/NOS and was participating in an in-home early intervention behavior therapy program. The level of direct therapy hours was approximately 40 hours per week of home- and school-based intervention. The average age at intake was 3 years old (range: 2 years 11 months to 3 years 2 months). At the onset of intervention, the children's verbal abilities varied from five-to-six one-term receptive and expressive labels to 50 receptive and expressive object labels. Each child demonstrated limited verbal ability. Once the children acquired generalized matching skills and an assessment of each child's receptive language skills was conducted, the receptive language matrix programming was implemented into each child's therapy programming. Expressive language matrix programs were implemented once the child was able to accurately imitate phonemes and the required number of syllables for each expressive response.

Clinical data. Preliminary clinical data were collected for each child on each dimension of the language matrix (i.e. response mode, stimulus mode, and the components of the conditional discrimination). In order for each child to meet the generative mastery criteria, the child needed to generalize responding to novel or untrained conditional discriminations in each response and stimulus mode on the first trial of a new day independently (without prompting).

Child 1. Data for Child 1 are presented as number of days to mastery of each skill, organized by type of program, rather than consecutively (see Figure 2). Child 1 met the generative mastery criteria for receptive 1-term discriminations after an average of 19 consecutive days of training