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A REVIEW OF RECOMMENDATIONS FOR SEQUENCING RECEPTIVE AND EXPRESSIVE LANGUAGE INSTRUCTION

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We review recommendations for sequencing instruction in receptive and expressive language objectives in early and intensive behavioral intervention (EIBI) programs. Several books recommend completing receptive protocols before introducing corresponding expressive protocols. However, this recommendation has little empirical support, and some evidence exists that the reverse sequence may be more efficient. Alternative recommendations include teaching receptive and expressive skills simultaneously (M. L. Sundberg & Partington, 1998) and building learning histories that lead to acquisition of receptive and expressive skills without direct instruction (Greer & Ross, 2008). Empirical support for these recommendations also is limited. Future research should assess the relative efficiency of receptive-before-expressive, expressive-before-receptive, and simultaneous training with children who have diagnoses of autism spectrum disorders. In addition, further evaluation is needed of the potential benefits of multiple-exemplar training and other variables that may influence the efficiency of receptive and expressive instruction.

Key words: autism treatment, expressive language, language intervention, listener behavior, receptive language, tacts, verbal behavior

Early and intensive behavioral intervention (EIBI) for children diagnosed with autism spectrum disorders enjoys substantial empirical support (for meta-analyses and reviews, see Eldevik et al., 2009; Virués-Ortega, 2010). In the last 15 years, a number of books and intervention manuals have been published that describe behaviorally based procedures, and in some cases curricula, for teaching various skills in the context of EIBI (Barbera, 2007; Greer & Ross, 2008; Leaf & McEachin, 1999; Lovaas, 2003; Maurice, Green, & Luce, 1996; Schramm, 2006; M. L. Sundberg & Partington, 1998). Each of these books is to a greater or lesser extent influenced by a curriculum that was originally developed by O. Ivar Lovaas and his colleagues at the University of California at Los Angeles (UCLA) and described in detail in early publications (Lovaas, 1977, 1981). Many similarities exist across books. For example, all recommend breaking down complex language skills into basic components, teaching these skills in a structured format, and using positive reinforcement, discrimination training, and transfer-of-stimulus-control procedures. However, it may be useful to distinguish between two general categories of published work of this nature based on subsequent influences: work that follows the UCLA model, and work that follows the verbal behavior model. UCLA-model publications include the curriculum chapter in Maurice et al. (Taylor & McDonough, 1996), the curriculum manual by Leaf and McEachin, and the book by Lovaas (2003), all of which address a wide range of language,

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social, self-help, and preacademic skills. Despite updates and influences by more recent behavior-analytic work, the content remains fairly close to Lovaas's (1977, 1981) original curriculum. Publications that follow the verbal behavior model (Barbera, 2007; Greer & Ross, 2008; Schramm, 2006; M. L. Sundberg & Partington, 1998), by contrast, focus primarily on language and communication, and use Skinner's (1957) analysis of verbal behavior as a starting point for program design. In addition, the Greer and Ross (2008) book is influenced by current theory and research on derived stimulus relations. These influences are reflected in the terminology used in those books, as well as in certain recommendations that concern teaching strategies and curriculum objectives.

A recent survey of EIBI providers (Love, Carr, Almason, & Petursdottir, 2009) suggests that publications that describe both UCLA-model and verbal behavior curricula are widely used in EIBI programs. This is not surprising, given that books published in both traditions contain a wealth of helpful information, recommendations, and suggestions that are based on extensive clinical experience and empirical data. As a whole, the UCLA model has a great deal of empirical support, in that it has been used in a number of outcome studies on the effects of EIBI on intellectual functioning and other measures (e.g., Lovaas, 1987; Sallows & Graupner, 2005; Smith, Groen, & Wynn, 2000). By contrast, no large-scale outcome studies have used curricula derived from the verbal behavior model. This model, however, has indirect support from research on certain curriculum objectives that depart from the UCLA model (see J. E. Carr & Firth, 2005). Both categories of work also draw on decades of behavior-analytic research on acquisition procedures.

Although the content of EIBI publications is thus firmly grounded in empirical research, practitioners should not assume that every recommendation contained therein is evidence based. As Lovaas (2003) pointed out, a number of specific recommendations made in UCLA-model books remain to be investigated, and the same may be true of various recommendations that have been introduced by verbal behavior model books. In some cases, different publications make conflicting recommendations, and in these cases, it is important to examine the empirical evidence behind each recommendation.

In this article, we review recommendations regarding the sequencing of language instruction protocols that are termed *expressive* and *receptive* in the UCLA-model publications. Expressive protocols are generally those that aim to establish spoken responses by the child (however, they can be adapted for use with alternative communication systems), whereas in receptive protocols, a child responds nonvocally to a teacher's spoken instructions. In the verbal behavior model publications, the term *expressive* is replaced with Skinner's (1957) verbal operant taxonomy of speaker behavior. Instructional targets are described as *mands*, *tacts*, or *intraverbals*. Greer and Ross (2008) also favor the term *listener behavior* or *listener training* over receptive language or receptive instruction.

A common recommendation in UCLA-model books (Leaf & McEachin, 1999; Lovaas, 2003; Taylor & McDonough, 1996) is to complete receptive language protocols before introducing expressive protocols that address the same instructional targets. For example, before a child is taught to say color names in the presence of color stimuli, it is recommended that the child be taught to point to the appropriate color stimuli when presented with spoken color names. The verbal behavior model books, by contrast, typically do not advocate this sequence. To the extent that these books make sequence recommendations, they vary depending on the child's level of verbal functioning and the verbal operant that is

targeted in expressive training. The programs that these recommendations encompass comprise a large proportion of a child's language curriculum (e.g., Taylor & McDonough, 1996). As a result, a practitioner's decision as to which sequence to follow may affect a substantial portion of a child's instructional programming.

In the sections that follow, we first review empirical evidence of relevance to the receptive-before-expressive recommendation. We then review alternative recommendations that have been made in a subset of the verbal behavior model books (Greer & Ross, 2008; M. L. Sundberg & Partington, 1998) and, finally, discuss directions for future research.

THE RECEPTIVE-BEFORE-EXPRESSIVE SEQUENCE

According to Lovaas (1977), the receptive-before-expressive recommendation was originally adopted because it reflected the sequence in which typically developing children had been observed to acquire receptive and expressive repertoires. However, Lovaas (1977, 2003) also cautioned that a typical developmental sequence may not necessarily be the ideal teaching sequence, and the sequencing of programs ultimately should be based on empirical data on teaching efficiency. In addition, Lovaas (2003) suggested that the reverse sequence may be more beneficial for some children (p. 107), and Leaf and McEachin (1999) stated that "it is not always necessary to wait for the mastery of receptive labeling before starting expressive" (p. 209). In spite of these caveats, all three UCLA-model publications consistently list completion of receptive programs as suggested prerequisites for expressive programs.

In the earliest stages of language intervention, the receptive-before-expressive sequence may be a practical necessity for several reasons. First, it is difficult to complete programs that require vocal responses before a child has acquired a vocal imitation repertoire, whereas a variety of receptive programs can be completed concurrently with early vocal imitation training. Second, receptive training may be easier to complete with a child who demonstrates noncompliance, due to the ease of physical prompting. Third, receptive training may be more amenable to the use of errorless training procedures (e.g., stimulus fading) that enhance an early learner's success. It is important to note, however, that UCLA-model publications continue to recommend the receptive-before-expressive sequence for advanced programs that typically are implemented when the child has acquired a basic verbal repertoire, instructional control has been established, and it can be assumed that the child has become a fairly efficient learner. For example, the recommendation is made for teaching prepositions, categories, emotions, letters, and numbers (Leaf & McEachin, 1999; Taylor & McDonough, 1996). The extent to which this sequence enhances acquisition, compared to the reverse sequence or other alternatives, needs to be examined.

Empirical Findings

Although a large body of research exists on teaching receptive and expressive language skills to individuals who have been diagnosed with autism or other developmental disabilities, few studies have attempted to compare directly the receptive-before-expressive sequence with other alternatives. We identified nine published studies (Table 1) with clinically relevant participants that were designed for the purpose of either comparing (a) a receptive-before-expressive sequence to expressive-before-receptive or expressive-only training or (b) the efficiency of receptive and expressive training as an initial training condition. The nine studies are methodologically heterogeneous, and a thorough description of the specific procedures and experimental designs employed in each one is beyond the scope of this article. In this section, we therefore provide only a brief overview of methodological similarities and differences, followed by a summary of results. In the section that

Table 1
Empirical Evaluations of the Receptive-Before-Expressive Recommendation

Study	*N*	Age in years	Participant description	Summary of results
Cuvo and Riva (1980)	20	(a) *M* = 16 years 2 months (b) *M* = 4 years 4 months	(a) Mean IQ = 44; mean MA = 5 years, 2 months[a] (b) mean IQ = 108; mean MA = 5 years 1 month[a]	Expressive training took fewer trials than receptive training. Prior receptive training facilitated subsequent expressive training, but prior expressive training rendered subsequent receptive training unnecessary. The receptive-before-expressive sequence took more time and trials than when expressive training came first. Similar maintenance in both conditions.
Hupp et al. (1986)	12	5 to 19	Severe mental retardation; Stage 6 object permanence; matched 2-D to 3-D stimuli; no vocal or signed language; no augmentative system	Acquisition similar in receptive and expressive conditions, but training did not continue to mastery in either condition. Generalization to receptive responding with novel stimuli greater after receptive than expressive training.
Keller and Bucher (1979)	6	Children	Developmentally disabled; severe language deficits	Greater accuracy on receptive tests following expressive training than on expressive tests following receptive training.
Keller and Bucher (1980)	5	5 to 10	Borderline to moderate mental retardation; rudimentary receptive and expressive skills	Prior receptive training did not facilitate subsequent expressive training. The receptive-before-expressive sequence took more time and trials than when expressive training came first.
Miller et al. (1977)	14	*M* = 12.67	Mean IQ = 43.86; mean MA = 4.83 years[b]; kindergarten arithmetic grade level	Prior receptive training did not facilitate subsequent expressive training. The receptive-before-expressive sequence took more time and trials than when expressive training came first.
Smeets (1978)	1	14	IQ 44[c], deaf, mild cerebral palsy, blindness in one eye; >100 receptive and expressive labels	Expressive training completed in fewer trials than receptive training, but only with the first few stimulus sets.
Smeets and Striefel (1976)	1[d]	14	IQ 44 [c], deaf, mild cerebral palsy, blindness in one eye; some receptive signing; expressive signing rarely observed	Expressive training had a greater effect on receptive responding than receptive training on expressive responding. Greater accuracy on receptive tests following expressive training than on expressive tests after receptive training.
Watters et al. (1981)	4	10 to 16	Autism; IQ < 45 to 80[e]; one participant untestable; existing receptive and expressive vocabulary 32 to192 words	Prior receptive training did not facilitate subsequent expressive training. The receptive-before-expressive sequence took more time and trials than when expressive training came first. Greater accuracy on receptive tests following expressive training than on expressive tests following receptive training.
Wynn and Smith (2003)	6	4 years 3 months to 6 years 4 months	Autism; comprehension age 13 to 42 months[f]; expressive language age 16 to 42 months [f]; vocal-verbal skills ranged from one-word requests to four-word phrases	Variable results within and across participants, but overall greater accuracy on receptive tests following expressive training than on expressive tests following receptive training

[a] MA = mental age; IQ and MA obtained from Peabody Picture Vocabulary Test.
[b] Psychological Scales of Infant Development.
[c] Leiter.
[d] The same participant as in Smeets (1978).
[e] WISC/R Performance Scale.
[f] Reynell Developmental Language Scales.

follows, we discuss our conclusions, along with collective limitations of the nine studies. We refer the interested reader to the original sources for more detailed information, and encourage readers to evaluate the results of each study in light of their respective methodological strengths and weaknesses. It should be noted that two of the studies (Keller & Bucher, 1979; Miller, Cuvo, & Borakove, 1977) were published only as abstracts; thus, minimal procedural information is available.

Overview of methods. The participants in two studies (Watters, Wheeler, & Watters, 1981; Wynn & Smith, 2003) were described as children with autism, whereas the remaining studies were conducted with children and young adults with intellectual disabilities, and no autism diagnoses were specified. As shown in Table 1, participants were described as functioning in the moderate to mild range of intellectual disability. Most studies provided minimal information on existing verbal repertoires. However, participants generally appear to have entered the studies with existing, although in some cases small (e.g., Watters et al., 1981; Wynn & Smith, 2003), receptive and expressive repertoires. An exception was the study by Hupp, Mervis, Able, and Conroy-Gunter (1986), in which participants functioned in the severe range of intellectual disability and were described as having very limited or no communication skills. Dependent variables included acquisition of the target receptive and expressive repertoires in terms of trials to mastery, emergence of one repertoire following instruction in the other (i.e., effects of receptive training on untrained expressive skills and vice versa), stimulus generalization, and maintenance. Experimental designs and other methodological features varied across studies. At one extreme, two studies (Smeets, 1978; Smeets & Striefel, 1976) were conducted with a single participant, who was the same in both studies. At the other extreme, Cuvo and Riva's (1980) study included a comparison group of typically developing children and employed a 2 (instructional sequence) × 2 (disability) factorial design in addition to a multiple baseline design. Miller et al. (1977) and Hupp et al. also employed between-subjects designs to compare instructional conditions. The remaining studies employed within-subject or single-case design strategies, in which receptive and expressive training to mastery were alternated across stimuli or stimulus sets, and each condition was followed by assessment and sometimes training of the alternate repertoire. At least one of these studies (Wynn & Smith, 2003) may have employed too few instances of training in each condition to yield a convincing within-subject comparison. The results of this study should therefore be interpreted with caution.

Participants in three studies (Smeets, 1978; Smeets & Striefel, 1976; Watters et al., 1981) received instruction in manual signing, whereas participants in the remaining studies were taught vocal communication. A common feature of all nine studies was that the receptive training condition involved establishing control by experimenter-produced signs or vocalizations over stimulus-selection responses. That is, given a sign or a spoken word, the child selected a visual stimulus from an array of two or more available stimuli. The expressive training condition typically involved teaching the child to emit signs or vocalizations in the presence of visual stimuli. The visual stimuli were in all cases three-dimensional objects or two-dimensional pictures of objects, and the resulting repertoires appear to meet Skinner's (1957) definition of the tact as a verbal response controlled by a nonverbal stimulus. An exception is the study by Watters et al. (1981) in which the participant was presented with a picture and a spoken word simultaneously in expressive training. As a result, the signed response could have been under the control of either stimulus or both of them. In receptive training, the participant similarly was presented with both a sign and a spoken word in each trial, but stimulus control analyses revealed that the resulting selection responses

were primarily under the control of the sign rather than the spoken word.

The objective of training in most cases was to teach object names; however, in two cases the objective was to teach coin names or coin values (Cuvo & Riva, 1980; Miller et al.,1977). In Wynn and Smith's (2003) study, four of six participants were taught object attributes (i.e., abstract stimulus properties shared by a number of training exemplars, such as *long* and *short*). In the study by Smeets (1978), the objective of instruction was the plural suffix, because object names had been evaluated with the same participant in a prior study (Smeets & Striefel, 1976).

Trials to mastery. Four studies included data on trials to mastery in receptive training when there was no prior expressive training with the same stimuli, and expressive training when there was no prior receptive training with the same stimuli. These data provide information on the ease of implementing receptive and expressive training as an initial training condition. Cuvo and Riva (1980) reported a substantially greater mean number of training trials in the initial receptive than in the initial expressive training condition for participants with and without intellectual disabilities. The participant in Smeets (1978) also required more receptive than expressive trials to reach criterion with the first few stimulus sets trained in each condition, but not with subsequent sets. By contrast, two of the four participants in Watters et al. (1981) and three of the four in Keller and Bucher (1980) required substantially more expressive than receptive trials to reach the mastery criterion, whereas the remaining participants required either a similar number of trials in both conditions or a greater number of trials in the receptive condition. Overall, the results did not suggest that one training condition was consistently more difficult to complete as an initial training condition than the other.

Of perhaps greater importance are analyses of the facilitative effects of prior receptive training on subsequent expressive training, and vice versa, and the number of trials required to establish both expressive and receptive repertoires in each condition. Four studies included such analyses. First, Cuvo and Riva (1980) found that both groups of participants required significantly fewer trials to complete expressive training if they had previously received receptive training than if they had not. Although this finding suggested a facilitative effect of receptive training on expressive training, the facilitative effects of expressive training on receptive training were even greater, because participants who received expressive training first performed with high accuracy on subsequent receptive tests, rendering receptive training unnecessary. As a result, the total number of trials required to establish both expressive and receptive repertoires was greater for participants who received receptive training first than for those who received expressive training without prior receptive training. In addition, the receptive-before-expressive sequence took twice as many hours to complete as did expressive-only training. In contrast to Cuvo and Riva, Keller and Bucher (1980), Miller et al. (1977), and Watters et al. (1981) found that prior receptive training yielded no savings of expressive training trials. In fact, some participants in Watters et al. and one of Keller and Bucher's participants required more expressive training trials when they had previously completed receptive training than when they had not. All three studies were in agreement with Cuvo and Riva that (a) trials to mastery for receptive and expressive training combined were overall greater when participants received receptive training first than when they received expressive training first, and (b) conducting expressive training first rendered receptive training unnecessary.

No other studies reported analyses of trials to mastery. Sessions to mastery can be derived from the figures in Wynn and Smith (2003), but the number of trials was variable across sessions. The only other measure of acquisition during training was provided by Hupp et al. (1986). In this study, receptive and expressive training were not conducted to mastery;

instead, performance was assessed after a fixed number of training sessions in each condition. At that time, accuracy was low in both conditions, and the difference between the two was not statistically significant; however, statistical power may have been questionable due to the small number of subjects.

Emergence of the alternate repertoire. Instead of or in addition to reporting trials to mastery, several studies evaluated the efficiency of receptive and expressive training as an initial training condition by comparing correct expressive responses after receptive training to correct receptive responses after expressive training. Although not as informative as trials to criterion, this measure provides an indirect estimate of the need for training in the untrained condition.

As previously noted, Cuvo and Riva (1980), Keller and Bucher (1980), Miller et al. (1977), and Watters et al. (1981) found that expressive training rendered subsequent receptive training unnecessary, because the receptive repertoire usually emerged to criterion following expressive training. After receptive training, by contrast, expressive training was still necessary in all four studies. Of the five remaining studies listed in Table 1, all except one (Hupp et al., 1986) also evaluated the effects of expressive training on receptive responding, and vice versa. The results of three studies consistently showed that expressive training was more likely to generate receptive identification to criterion than receptive training was to generate expressive responding. Keller and Bucher (1979) reported criterion performance on receptive tests following expressive training for five of six participants, but reported criterion performance on expressive tests following receptive training for only one participant. In Wynn and Smith's (2003) study, there was substantial variation within and across participants, but 8 of 10 instances of expressive training and 4 of 10 instances of receptive training resulted in criterion performance on tests of the alternate repertoire. Smeets and Striefel's (1976) participant consistently responded with high accuracy on receptive probes following expressive training across a large number of stimuli, whereas receptive training rarely produced correct expressive responses. In the study by Smeets (1978), by contrast, the two training conditions had no differential effects for the same participant, in that both receptive and expressive training yielded highly accurate performance on tests of the untrained repertoire.

Generalization and maintenance. Few studies included measures of generalization or maintenance of the trained or emergent receptive and expressive repertoires. Smeets (1978) assessed generalization of the emergent repertoire to novel exemplars after each instance of receptive or expressive training. Generalization increased across successively trained stimulus sets in both conditions. In the Hupp et al. (1986) study, receptive generalization was the primary dependent variable. Thus, generalization of the trained repertoire to novel stimuli was assessed following receptive training, whereas emergence of the alternate repertoire was tested with novel exemplars following expressive training. These researchers found significantly greater receptive generalization after receptive than expressive training. However, performance was poor in both conditions, which is not surprising given that training did not continue to mastery. Only Cuvo and Riva (1980) provided maintenance data. Both expressive and receptive repertoires were maintained at 1- and 4-week follow-ups, regardless of the training condition.

Conclusion

None of the nine studies listed in Table 1 provide support for the receptive-before-expressive recommendation. If anything, these studies collectively suggest that, when possible, the reverse sequence may be more efficient. Specifically, it appears that expressive training may reduce or eliminate need for receptive training with the same targets (Cuvo & Riva, 1980; Keller & Bucher, 1979, 1980; Miller et al., 1977; Smeets & Striefel, 1976; Watters et al.,

1981) and conducting receptive training first may simply increase the overall number of trials required to establish both repertoires (Cuvo & Riva, 1980; Keller & Bucher, 1980; Miller et al., 1977; Watters et al., 1981). In light of these conclusions, it may be surprising that the receptive-before-expressive recommendation has survived. However, several limitations of the small existing literature must be highlighted. First, with the exception of Wynn and Smith (2003), all of the studies in Table 1 were published 20 to 35 years ago. It is possible that advances in stimulus control technology and reinforcer identification might result in different outcomes if these studies were replicated today. Second, we were able to locate only two studies (Watters et al., 1981; Wynn & Smith, 2003) in which the participants were described as children with autism. This is a potential limitation, given that the receptive-before-expressive recommendation has been made in publications that primarily focus on EIBI for this population. In addition, the participants in many studies were substantially older than children typically enrolled in EIBI programs. Third, few studies provided detailed information on the participants' verbal repertoires (e.g,. existing receptive and expressive skills) at entry into the study. As a result, it is not possible to make any statements, for example, about characteristics of children for whom expressive training may render receptive training unnecessary. Fourth, all nine studies, with the possible exception of Watters et al. (1981), addressed tacts of visual stimuli in Skinner's (1957) terminology. However, many programs labeled *expressive* in EIBI curricula address other types of relations, such as tacts of stimuli presented in other sense modalities, mands for reinforcers, and intraverbal responses to spoken words. A fifth limitation is present in studies that compared effects of receptive and expressive training on the emergence of the alternative repertoire. This limitation consists of difficulty comparing performance on receptive and expressive tests, because chance responding may inflate correct responses on the former, particularly if a very small stimulus array (e.g., two or three stimuli) is provided from which to select in the receptive test condition. As a result, comparisons might be biased toward showing a greater effect of expressive training on receptive responding than vice versa. In addition, a high probability of correct responding by chance during receptive training could increase the probability of false mastery in this condition, creating a further bias against expressive test performance. However, results of studies that employed five or more comparison stimuli in the receptive condition (Cuvo & Riva, 1980; Smeets & Striefel, 1976; Watters et al., 1981) are consistent with results of studies that employed smaller arrays, suggesting that small arrays did not necessarily skew the results.

In addition to the studies listed in Table 1, a few studies (Connell & McReynolds, 1981; Holdgrafer & McReynolds, 1975; Petursdottir, Carr, Lechago, & Almason, 2008; Petursdottir & Haflidadottir, 2009; Williams & McReynolds, 1975) have evaluated the effects of expressive and receptive training on acquisition of the alternate repertoire in young, typically developing children. Holdgrafer and McReynolds (1975) found inconsistent effects, and Petursdottir et al. (2008) found minimal effects of either training condition on the alternate repertoire. Results of the remaining studies, however, were in agreement that receptive repertoires were more likely to emerge after expressive training than expressive repertoires after receptive training. In addition, Connell and McReynolds (1981) found that expressive training was more likely than receptive training to yield derived expressive and receptive relations. Thus, studies conducted with typically developing participants have yielded results that are consistent with results from studies in which the participants had developmental disabilities. This research, however, suffers from the same limitations as studies conducted with clinically relevant participants, including small stimulus arrays in the

receptive condition and an emphasis on tacts of visual stimuli, with the exception of two studies that targeted intraverbals in addition to or instead of tacts (Petursdottir et al., 2008; Petursdottir & Haflidadottir, 2009).

ALTERNATIVE SEQUENCE RECOMMENDATIONS

The recommendation to teach receptive-before-expressive targets does not appear to be supported by the available evidence. Thus, alternative recommendations that have appeared in EIBI publications warrant consideration. We are not aware of any publications that recommend a consistent expressive-before-receptive sequence for learners who are capable of benefiting from expressive instruction, even though this sequence may have greater empirical support than the receptive-before-expressive sequence. However, verbal behavior model publications sometimes offer alternative recommendations that are based on their conceptual foundations as well as practical considerations. In this section, we review the empirical support behind recommendations made in two such books: M. L. Sundberg and Partington (1998) and Greer and Ross (2008). The book by M. L. Sundberg and Partington has enjoyed substantial popularity by EIBI providers (Love et al., 2009), and its sequence recommendations regarding receptive and expressive language objectives are more explicit than those made in other verbal behavior model textbooks. Greer and Ross, by contrast, do not make specific recommendations regarding the sequence in which to introduce early receptive and expressive targets. However, their recommendations for establishing advanced receptive and expressive language skills are unique in the EIBI literature and of potential relevance to the present discussion.

M. L. Sundberg and Partington (1998)

Following Skinner (1957), M. L. Sundberg and Partington (1998) assume that the behavior of the speaker and the behavior of the listener are functionally independent of one another. As a result, they state that "there is no guarantee that by teaching a tact response that a receptive response will emerge, or vice versa" (p. 158) and emphasize that each must be established directly. M. L. Sundberg and Partington make a clear distinction between expressive programs that aim to establish three different verbal operants; mands, tacts, and intraverbals. Thus, the question of when to teach expressive skills, relative to corresponding receptive targets, is considered separately for each of these three verbal operants in the sections that follow.

Mands. At the very beginning of a child's intervention program, M. L. Sundberg and Partington (1998) place a strong emphasis on the establishment of a rudimentary vocal or signed mand repertoire. If their recommendations are followed, a child may acquire mands for several items before he or she receives any receptive training with the same or other items, or any other expressive training. Empirically, it is unknown how this recommendation affects future acquisition or the overall outcome of the intervention program. However, the recommendation to teach mands first may be justifiable on practical grounds alone, because a mand repertoire provides the child with appropriate means of initiating communication to access a variety of reinforcers. In addition, the acquisition of effective mands for specific reinforcers can result in a decrease in inappropriate behavior that has been maintained by the same reinforcers (e.g., E. G. Carr & Durand, 1985).

Tacts. When teaching tacts and related receptive behavior, M. L. Sundberg and Partington (1998) recommend interspersing tact and receptive training trials for the same items within the same teaching sessions. These sessions also include instructional and maintenance trials for various other instructional targets. No specific rationale is offered for this strategy, except for the assumption that tact and receptive repertoires are functionally independent

of one another and, as a result, each must be established through direct contingencies of reinforcement. Although some research supports the notion that tact and receptive repertoires can be acquired independently (e.g., Guess & Baer, 1973; Lee, 1981; Wynn & Smith, 2003), the studies listed in Table 1 indicate that many children may acquire a receptive repertoire without explicit training if they receive tact training with the relevant items. At present, little is known about characteristics or prior histories that may differentiate these children from children who require explicit training of both repertoires. It is possible that even for children who can acquire both repertoires as a result of tact training, simultaneous training, as recommended by M. L. Sundberg and Partington, is a more efficient strategy for achieving the same outcome. However, we are not aware of any studies that have compared the efficiency of interspersed tact and receptive trials with tact-only, receptive-only, or sequential training.

A few studies have evaluated a similar interspersal strategy for teaching tacts and mands. Two studies (Arntzen & Almas, 2002; Carroll & Hesse, 1987) reported enhanced tact acquisition when tact trials were interspersed with mand trials for the same items, compared to tact training alone, whereas Sidener et al. (2010) failed to find the same effect. Similar strategies might be used to evaluate the interspersal of verbal operant trials with receptive trials. The appropriate ratio of tact to receptive trials in interspersed training also might be investigated. Guess and Baer (1973) found that three of the four participants who received expressive training with one set of instructional targets and receptive training with another set failed to acquire the untrained repertoire with one or both sets. In a second experiment, expressive and receptive training were interspersed with only a few reinforced trials that targeted the alternate repertoire. This modification was sufficient to produce acquisition of both repertoires, suggesting that an equal number of receptive and expressive trials may not be necessary.

Intraverbals. Some of the early intraverbal targets described by M. L. Sundberg and Partington (1998), such as filling in blanks in songs, rhymes, and phrases, do not have any obvious corresponding receptive instructional targets. As a result, sequencing recommendations are irrelevant for those targets. However, many of the more advanced intraverbals described in the book are related to a receptive target. For example, a child might be taught to respond to phrases such as "You drive a —" receptively, by pointing to a car, or intraverbally, by saying "car." By the time these programs are introduced, according to M. L. Sundberg and Partington's recommendations, the child has already acquired tacts of the target items (e.g., car). The receptive relations, in which a child selects an item when presented with spoken instructions that exclude the name of the item, are termed receptive by function, feature, and class (RFFC) by M. L. Sundberg and Partington. As with tacts and receptive discriminations, M. L. Sundberg and Partington emphasize a need for directly training both RFFC and the corresponding intraverbals. Although they do not necessarily recommend a specific sequence, they suggest that it often may be useful to complete RFFC first (similar to the typical recommendation in UCLA-model publications). The rationale for this suggestion is that children may often start tacting the stimuli that they select during RFFC trials; for example, a child might respond to "You drive a —" by pointing to a picture of a car and also saying "car." Thus, establishing the intraverbal relation would only require fading the visual stimulus.

We are not aware of any studies that have demonstrated benefits of a receptive-before-intraverbal sequence over the opposite sequence or other possibilities, such as simultaneous instruction. Again, a receptive-before-expressive sequence may be a practical necessity for children whose vocal repertoires are nonexistent

or limited. However, this may not be true of children who have acquired the prerequisites for RFFC that M. L. Sundberg and Partington (1998) recommend, which include "50 words, signs, or pictures as mands, tacts, or receptive discriminations" (p. 174) that occur under a variety of different conditions with short response latencies. If intraverbals are considered to be an instance of expressive language, then the studies listed in Table 1 might provide tentative support for the opposite expressive-before-receptive sequence, but it is important to keep in mind that none of these studies actually targeted intraverbals. We are aware of only two published studies that have evaluated or compared the efficiency of both receptive and intraverbal training (Petursdottir et al., 2008; Petursdottir & Haflidadottir, 2009). Both studies were conducted with typically developing children, and as previously noted, they produced mixed results. Petursdottir et al. (2008) simulated RFFC and intraverbal training with nonsense syllables and arbitrary stimuli. RFFC generated no increase in intraverbal responding, and intraverbal training with different participants had minimal effects on RFFC performance. The other study (Petursdottir & Haflidadottir, 2009) was conducted with two slightly older children and a simplified task. Intraverbal training, as well as tact training, generated receptive responding to criterion for both participants, whereas receptive training usually failed to generate intraverbals and tacts to criterion.

In a study with adolescents with intellectual disabilities (M. C. Luciano, 1986), a subset of participants received intraverbal training without previously acquiring related receptive discriminations. These receptive discriminations were found to be highly accurate after intraverbal training. Similar findings were reported by both C. T. Sundberg and Sundberg (1990) and Remington and Clarke (1993). However, none of these studies evaluated the effects of receptive training on intraverbals. Thus, additional research is needed with clinical populations. Although the aforementioned studies suggest that intraverbal training often may generate receptive repertoires, it is possible that conducting receptive training first might save instructional effort by reducing the number of subsequent intraverbal training trials. Alternatively, the type of interspersed training that M. L. Sundberg and Partington (1998) recommend for receptive and tact trials might facilitate acquisition of RFFC and intraverbals. These possibilities have not been evaluated, and as a result, the advantages of having prior receptive training serve as "a bridge to the development of some types of intraverbal responding" (M. L. Sundberg & Partington, p. 206) remain to be demonstrated empirically.

Greer and Ross (2008)

The Greer and Ross (2008) book is unique in that it emphasizes the establishment of learning histories that may permit a child to acquire new skills without direct reinforcement. Other publications also emphasize the ultimate goal that the child will be able to learn from common classroom contingencies rather than one-on-one instruction (e.g., Taylor & McDonough, 1996). Greer and Ross, however, propose specific learning histories, the provision of which is hypothesized to accomplish this goal. Greer and Ross share M. L. Sundberg and Partington's (1998) assumption that the behavior of speaker and listener are functionally independent in early language acquisition. However, they emphasize the notion that these repertoires may be integrated through appropriate histories of reinforcement (a conceptual rationale has been described by Greer & Longano, 2010; Greer & Speckman, 2009). After the child has acquired basic tact and listener (receptive) repertoires, as well as other prerequisite skills, Greer and Ross introduce a protocol that is intended to establish *naming*, which is defined as "the capacity to acquire a tact … by simply hearing another person tact a stimulus" (p. 149). Accordingly, the goal of this protocol is for the child to be able

to acquire new tacts and listener behavior without direct instruction, and ultimately by merely observing another person's tacts. The primary mechanism proposed to accomplish this goal is instruction with multiple exemplars.

Greer and Ross's (2008) multiple-exemplar instruction (MEI) recommendations may be summarized as follows. First, the child receives identity match-to-sample training with five visual stimuli (hereafter termed Set 1) for which he or she has not acquired tacts or listener behavior. During match-to-sample training, the instructor vocalizes the name of the target stimulus in each trial; however, correct responses do not require control by this vocally presented stimulus. After the child has acquired the identity-matching task, the instructor probes listener behavior by asking the child to point to each stimulus given its spoken name. In addition, tacts are probed under two conditions, with and without an instruction to tact (e.g., "What color is this?"). If listener behavior and tacts are not found to emerge to criterion level, MEI commences. MEI initially is conducted with a set of five new stimuli. Four types of trials (identity match-to-sample trials, listener trials, and tact trials with and without an instruction) are conducted with each stimulus, and different trial types with different stimuli are interspersed with one another. After the child has met the acquisition criterion for all four trial types, listener behavior and tacts are probed again with Set 1. If they have not emerged, MEI is repeated with additional sets, until it is demonstrated that the child can acquire new listener responses and tacts through the identity match-to-sample procedure alone. The protocol also may be completed initially without any tact trials if a child has already acquired a listener, but not a tact, repertoire. The initial goal is then for the child to acquire listener responses through the identity match-to-sample procedure, and the protocol later is repeated with tacts included. After the full protocol has been completed, the child receives no further tact or listener training. Instead, new tacts and listener responses are established indirectly by having the child observe another person's tacts. Thus, if the protocol is successful, it may save future instructional effort and prepare the child to learn new tacts and listener relations through typical classroom instruction. Greer and Ross describe similar procedures to accomplish a variety of other objectives, such as establishing reading and writing skills and enabling a child to acquire mands through tact training.

The reader may recognize that Greer and Ross's (2008) protocol shares some similarities with M. L. Sundberg and Partington's (1998) simultaneous tact and receptive training recommendation, in that both involve interspersing tact and receptive trials for the same items within the same teaching sessions. However, they are not the same recommendation. First, a teaching session as described by M. L. Sundberg and Partington includes a greater variety of different instructional targets than an MEI session as described by Greer and Ross. Second, Greer and Ross provide specific guidance on the arrangement of trials within MEI sessions; for example, they specify that two instructional trials that involve the same stimuli but different target responses (e.g., a tact trial in which the target response is "boat" and a listener trial in which the target response is pointing to a boat) should never be temporally contiguous. By contrast, M. L. Sundberg and Partington provide no specific suggestions for the order of trials within a session, and their general approach implies that temporally contiguous tact and receptive trials might be desirable at the beginning of instruction with a new target, because such contiguity might assist with transfer of stimulus control between visual and vocally presented stimuli. Third, Greer and Ross's MEI protocol is a temporary intervention conducted with a few target items, whereas M. L. Sundberg and Partington describe a strategy for teaching a wide variety of tacts and receptive skills during the course of a child's intervention program. Accordingly, Greer and Ross's protocol,

but not that of M. L. Sundberg and Partington, includes systematic assessment of the emergence of tacts and listener behavior without direct training, and the protocol is discontinued when this outcome is achieved.

Training with multiple exemplars has long been known to enhance stimulus generalization (e.g., Stokes, Baer, & Jackson, 1974). In recent years, a number of studies also have produced evidence that histories of multiple-exemplar training may lead future instruction to produce various forms of untrained responses (e.g., Y. Barnes-Holmes, Barnes-Holmes, Roche, & Smeets, 2001a, 2001b; Y. Barnes-Holmes, Barnes-Holmes, Smeets, Strand, & Friman, 2004; Berens & Hayes, 2007; Gomez, Lopez, Martin, Barnes-Holmes, & Barnes-Holmes, 2007; C. Luciano, Becerra, & Valverde, 2004; Murphy & Barnes-Holmes, 2010). Although most of these studies have not included an assessment of untrained vocal responses, a few studies (Fiorile & Greer, 2007; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Greer, Stolfi, & Pistoljevic, 2007; Speckman-Collins, Park, & Greer, 2007) specifically have evaluated the multiple-exemplar procedures for tacts and listener behavior described in Greer and Ross (2008) with participants with autism spectrum disorders. These studies have demonstrated incidental acquisition of tacts and listener responses after, but not before, MEI. A potential limitation is that some of the studies did not clearly isolate the effects of MEI from the effects of repeated testing, or the effects of simply providing additional receptive or expressive instruction. However, one study (Greer et al., 2007) included a control group that received receptive and expressive instructional trials separately, and suggested that the MEI format produced superior results. In addition, the results are consistent with other research on multiple-exemplar training that has controlled for additional testing and instruction (Y. Barnes-Holmes et al., 2001a, 2001b; Gomez et al., 2007).

Conclusion

The verbal behavior model publications generally do not recommend the receptive-before-expressive sequence, although M. L. Sundberg and Partington (1998) suggest that it may be advantageous in certain cases. However, to the extent that these books make specific sequence recommendations, their benefits remain to be investigated empirically. Greer and Ross (2008) emphasize the use of multiple-exemplar training to overcome functional independence of speaker and listener, or receptive and expressive, repertoires. Although the empirical literature to date (Fiorile & Greer, 2007; Greer et al., 2005, 2007; Speckman-Collins et al., 2007) is promising, a number of questions remain unanswered. First, it is likely that children who progress to advanced stages of language acquisition in programs that do not employ multiple-exemplar training systematically will eventually become capable of acquiring new receptive and expressive skills without explicit instruction. Indeed, expressive training often generated receptive skills for the participants in the studies listed in Table 1, and receptive training sometimes generated expressive skills. The extent to which multiple-exemplar training results in more rapid achievement of this outcome may need to be investigated. In other words, additional research is needed on the extent to which the specific format of instruction described by Greer and Ross is necessary to achieve the desired outcome. Although the Greer et al. (2007) study suggested that repeated iterations of sequential receptive and expressive training might not produce the same effect as MEI, other possibilities, such as the form of interspersed receptive and expressive training described by M. L. Sundberg and Partington, remain to be evaluated. Second, Greer and Ross suggested that "before the child has naming … multiple listener and tact responses must be taught directly" and "many children will need extensive tact instruction before they are ready to learn the naming capability" (p. 158). The

specific prerequisites for beginning multiple-exemplar training may need to be investigated further. Third, as with research on the receptive-before-expressive recommendation, the existing empirical literature has mostly focused on tacts of visual stimuli as an instance of expressive training (but see Greer, Yuan, & Gautreaux, 2005).

DIRECTIONS FOR FUTURE RESEARCH

The authors of some of the early studies listed in Table 1 concluded that "it may be unnecessary to take the time to teach comprehension first on the assumption that it will facilitate acquisition of production" (Cuvo & Riva, 1980; p. 330), and "[the results] call into question the value of prior receptive training in language skills for which productive performance is desired" (Keller & Bucher, 1980, p. 102). It appears that these conclusions may still apply. If a clinical recommendation is to be made based on the available data, practitioners might consider ignoring suggestions to complete new receptive programs before introducing expressive programs for the same instructional targets to learners who have existing receptive and expressive repertoires, at least in the case of expressive protocols that target the tact. Instead, they might consider teaching the tact first, then probing the relevant receptive response, and teaching it only if necessary.

The existing literature, however, is small and dated and has a number of limitations, including the absence of known autism diagnoses for most of the participants. In addition, the relative efficiency of the alternative simultaneous training arrangement described by M. L. Sundberg and Partington (1998) needs to be evaluated. Given the ubiquity of receptive and expressive language objectives in a typical EIBI curriculum, additional research is warranted to identify the most efficient arrangement of receptive and expressive instruction. Future research should compare the efficiency of receptive-before-expressive training, expressive-before-receptive training, and simultaneous receptive and expressive training with children who have autism spectrum disorders. In these studies, it will be necessary to describe participant characteristics and existing verbal repertoires thoroughly in terms of standardized language assessment scores and in terms of prior acquisition of instructional objectives. A crucial dependent variable to assess is the total amount of instruction required to establish both receptive and expressive repertoires in each condition. A few of the studies listed in Table 1 attempted to evaluate the receptive-before-expressive recommendation primarily by comparing the effects of receptive training on expressive repertoires to the effects of expressive training on receptive repertoires (Keller & Bucher, 1979; Wynn & Smith, 2003). However, this measure potentially could provide misleading data if not presented in the context of the total amount of instruction required to establish both repertoires. If the emergence of the alternate repertoire is employed as a second dependent measure, the receptive training and testing conditions might use large stimulus arrays in order to prevent a bias against the receptive condition.

As previously noted, the expressive repertoires that were targeted in most of the studies listed in Table 1 were tacts of visual stimuli according to Skinner's (1957) verbal operant terminology. This is understandable, given that tacts of visual stimuli feature prominently in early expressive language objectives (e.g., Leaf & McEachin, 1999; M. L. Sundberg & Partington, 1998; Taylor & McDonough, 1996). Due to limitations present in the existing literature, future research on instructional arrangements should continue to focus on the tact. However, this research also should be extended to other verbal operants, such as the intraverbal, which is a common component of instructional programs for which the receptive-before-expressive sequence has been recommended (Leaf & McEachin, 1999; Lovaas, 2003; Taylor & McDonough, 1996).

Future research may reveal individual differences with respect to the most efficient arrangement of receptive and expressive trials. In Wynn and Smith's (2003) study, although expressive training overall generated a receptive repertoire more often than receptive training generated an expressive repertoire, the reverse sequence appeared to be more efficient for one participant. One of Keller and Bucher's (1980) participants similarly appeared to benefit more from receptive than expressive training. As a result, it may be advisable to develop assessment procedures to determine the most efficient instructional arrangement for individual learners. In addition, researchers might attempt to identify variables that influence the efficiency of particular arrangements and contribute to individual differences. The identification of such variables might help to determine when to introduce changes into a child's instructional program. For example, when is it necessary to train both receptive and expressive responses related to the same target, and when is a child ready to benefit from expressive training alone? In addition to the participants' existing verbal repertoires, relevant variables might include, for example, the amount of history with receptive and expressive training and prior experience with the specific response topographies required in receptive and expressive trials (Lee, 1981).

For children who have progressed beyond the earliest stages of language acquisition, the potential benefits of multiple-exemplar training should be evaluated further. Prerequisites for beginning multiple-exemplar training should be examined, and alternative means of achieving the outcome of integrated speaker and listener repertoires might be explored. At a more basic level of research, researchers should continue to search for variables that influence the emergence of verbal operants after receptive training and receptive repertoires after verbal operant training. Training with multiple exemplars is one such variable that has been proposed (e.g., D. Barnes-Holmes, Barnes-Holmes, & Cullinan, 2000), and, as previously noted, it has some empirical support. However, other variables also have been proposed to influence this outcome. For example, Horne and Lowe's (1996) naming hypothesis suggests that, during training, the occurrence of certain collateral responses may result in the emergence of new verbal operants or listener behavior. Horne, Lowe, and Randle (2004) reported the results of an unpublished study by Bell (1999) in which a requirement to emit collateral echoic responses during listener training resulted in increased tact emergence, but we are unaware of any published experimental demonstrations of this effect. Lowenkron (1998) similarly has suggested a role of self-echoic responses during testing in the emergence of novel listener behavior, and some evidence exists that self-echoic training may enhance such outcomes among children diagnosed with autism (Tu, 2006). Future research might explore these variables further. In addition, several studies have identified variables that affect transfer between verbal operants, such as the establishment of autoclitic frames (Hernandez, Hanley, Ingvarsson, & Tiger, 2007) and training responses to elements of instructions presented on test trials (Pérez-González, Herszlikowicz, & Williams, 2008). Future research might examine whether these variables also affect transfer between speaker and listener repertoires.

Finally, it may be worthwhile to evaluate other suggestions regarding sequences of instructional programs that have been recommended in EIBI publications. For example, Leaf and McEachin (1999) and Taylor and McDonough (1996) suggest completion of visual–visual match-to-sample protocols prior to the introduction of receptive or expressive programs that target categorization, and Greer and Ross (2008) suggest prerequisites for many of the instructional programs presented in their book. Although EIBI already has sufficient empirical support to be considered the treatment of choice for children diagnosed with autism spectrum disorders (Eldevik et al., 2009), continued research on specific components of

programming can only serve to enhance its efficiency.

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