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Publisher's Statement

The Journal of Speech-Language Pathology and Applied Behavior Analysis (JSLP-ABA) is published by Dr. Joseph Cautilli. It is a peer-reviewed, electronic journal intended for general circulation in the scientific community.

The mission of this journal is to provide a forum for SLP and ABA professionals to exchange information on topics of mutual interest. These topics may include, but are not necessarily limited to support for disorders of prelinguistic communication, speech perception/production, oral language and literacy, speech fluency, and voice. They may also address issues pertaining to accent reduction, culturally-based language variations, and augmentative-alternative communication. JSLP-ABA welcomes articles describing assessment and treatment efficacy research based on detailed case studies, single-subject designs, and group designs. Also encouraged are literature reviews that synthesize a body of information, highlight areas in need of further research, or reconsider previous information in a new light. Additionally, this journal welcomes papers describing theoretical frameworks and papers that address issues pertaining to SLP-ABA collaboration.

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JSLP-ABA is viewed as a primary source of information for speech-language pathology (SLP) professionals and professionals in applied behavior analysis (ABA) who support individuals of all ages with communicative disorders. The contents of this journal are intended to meet the interest of these professionals for information to support evidence-based practice. JSLP-ABA is also intended to serve as a vehicle to encourage collaboration between these SLP and ABA professionals.

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Editorial

Joe Cautilli and Mareile Koenig

We are pleased to present Volume 1, No 3 of the Journal of *Speech-Language Pathology and Applied Behavior Analysis*. Included in this issue are five excellent papers and one book review. Three of the papers and the book review have direct application to the support of children with severe speech-language problems including autism spectrum disorders (ASD). Two of the papers have implications for supporting children with language learning impairments associated with other etiologies.

In the first paper, Carbone et al offer single-case evidence for the relatively greater effect of total communication (TC) (sign plus vocal) versus vocal-only communication training in the development of verbal behavior functions. Although the efficacy of a TC approach has been studied previously, few (if any) previous studies have addressed this procedure from the perspective of its impact on specific verbal behavior functions. Carbone et al's study fills this gap.

Johnston's paper addresses the unique challenges of alternative augmentative communication (AAC) systems for individuals who do not use speech as their primary mode of communication. Based on a matching model of reinforcement and behavior selection, this paper provides a succinct analysis of the impact of response efficiency in the design and use of AAC systems. A protocol is provided for analyzing potential AAC systems in consideration of response efficiency and contextual fit.

A third paper by Schoneberger analyzes the validity of evidence resulting from research into behavioral interventions for children with ASD. This paper highlights the importance of three guidelines for the design of treatment efficacy research and describes two studies, which illustrate the ways in which the internal validity of the resulting data is influenced by the degree to which these guidelines are followed.

In the fourth paper, Rondal and Docquier consider the nature of language addressed to children with language impairments and other developmental disabilities, particularly Down Syndrome. They review previous and current studies showing that language input is normally shaped by a child's language development level. However, they note that the actual analysis of this input is ultimately up to the child. Then, the authors compare the implications of this literature from the perspective of nativistic and behavioral frameworks. Taken as a whole, this information fills an important a gap within the field of behavior analysis. Specifically, while the efficacy of behavior analytic interventions has been demonstrated for a variety of target behaviors (e.g., verbal responsiveness, intelligibility, imitation, language, basic self-help skills, and social skills) since the 1970s (e.g., Farb & Thorne, 1978; MacCubrey, 1971; Nelson, Peoples, Hay, Johnson, & Hay, 1976; Clunies-Ross, 1979; Bidder, Bryant, & Gray, 1975), relatively few studies have examined features of the natural environment that support individuals with developmental disabilities. Rondal's extensive body of work has contributed substantially to an understanding of the natural processes of language development and to the development of strategies for supporting the language development of children with developmental delays (e.g., Gutmann & Rodel, 1979)

In the fifth paper,Van Kleek et al describe intervention research targeting skills reflecting phonological awareness (PA) and phonological working memory (WM). These skills play a crucial role in supporting young children's literacy development; and they art particularly challenging for preschoolers with language learning impairments. Interestingly, the results of Van Kleek et al's intervention research suggest that training in PA will generalize to improvements in phonological WM for this population.

In the last paper, Balazs reviews Schramm's (2006) new book called *Educate Toward Recovery: Turning the Tables on Autism*. His review suggests that this is a well-written, and substantively valuable resource for individuals new to applied behavior analysis (e.g., families of children with autism, new therapists) who wish to learn concepts and skills that are essential for teaching verbal behavior functions and other adaptive skills within an ABA framework to children with autism.

We thank all of our authors for sharing their work with us, and we hope our readers will enjoy this excellent edition of JSLP-ABA.

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A Comparison of Two Approaches for Teaching VB Functions: Total Communication vs. Vocal-Alone

Vincent J. Carbone, Lisa Lewis, Emily J. Sweeney-Kerwin,
Julie Dixon, Rose Louden and Susan Quinn

Abstract

Total communication (TC) involves the use of manual signs with their corresponding spoken words simultaneously; and research indicates that TC facilitates vocal responding by children with autism. However, most of this previous research was conducted 20 years ago and did not consider vocal responding in relation to verbal behavior functions (Skinner, 1957). The present study used an alternating treatment design to compare the effects of TC vs. vocal-alone (VA) training on the vocal tact responses of a child with autism. Results indicated that the child produced nearly four times as many vocal tact responses during TC training than during VA training in less than half the number of teaching trials. The use of manual sign training is considered in relation to its advantages for supporting the production of vocal responses.
Keywords: verbal behavior, sign language, tact, autism, total communication.

Introduction

The use of manual sign language as an alternative form of verbal behavior for persons with various language impairments has its roots in the experimental animal research of Gardner and Gardner (1969). They were the first researchers to use sign language to teach effective communication skills to an infant chimpanzee. The success of sign language training with primates prompted researchers in the applied fields to investigate the effects of sign language training on persons with various language impairments (Sundberg, 1996). Specifically, the profound language deficits presented by many children with autism and other developmental disabilities led early researchers to investigate the viability of sign language as an alternative mode of communication for this population and to examine the benefits that this form of verbal behavior could offer (Carr, Binkoff, Kologinsky, & Eddy, 1978). Subsequent research confirmed that children with developmental disabilities could not only be taught to use manual sign language, but that the manual sign acquisition could support the development of various verbal and nonverbal operants including, receptive discrimination, mands, and tacts (Miller & Miller, 1973; Bonvillian & Nelson, 1976; Carr et al., 1978; Carr, 1979; Carr & Kologinsky, 1983).

Total communication (TC), the most commonly used training procedure to teach sign language to children with autism and other developmental disabilities, involves the simultaneous presentation of both a manual sign and an associated spoken word (Carr, 1979). Research has demonstrated that this form of language training may result in superior acquisition of verbal and nonverbal operants for children with autism and other developmental disabilities as compared with vocal-alone or sign-alone training (Brady & Smouse, 1978; Barrera et al., 1980; Barrera & Sulzer-Azaroff, 1983; Konstantareas, 1984; Sisson and Barrett, 1984). For example, Brady and Smouse (1978) compared the effectiveness of three language training methods (vocal-alone, sign-alone, and TC) on the acquisition of correct behavioral responses to an experimenter's vocal request. Compared to baseline levels of responding, the TC training condition produced significant gains in behavioral responses. Vocal-alone training actually produced a significant decrease in behavioral responses, and sign-alone training condition produced no significant difference in responses.

Research has also suggests that a the use of TC for teaching sign language to non-vocal children may not only enhance communicative effectiveness but also facilitate the development of vocal responses (Fulwiler & Fouts, 1976; Schaeffer, Kollinzas, Musil, & MacDowell, 1977; Brady & Smouse, 1978; Casey, 1978; Carr, 1979; Konstantareas, Webster, & Oxman 1979; Barrera et al., 1980; Layton & Baker, 1981; Barrera & Sulzer-Azaroff, 1983; Konstantareas, 1984; Sisson and Barrett, 1984, Clarke, Remington, & Light, 1988; Goodwyn, Acredolo, & Brown, 2000; Tincani, 2004). For example, when Fulwiler and Fouts (1976) used TC for teaching American Sign Language (ASL) to a non-vocal five-year-old boy with autism, they found not only an increase in the child's use of manual signs but also a concomitant increase in the child's vocal responses following the training. These results were considered to illustrate the benefits of using manual sign language to develop an effective communication repertoire in children with autism.

The effect of TC training on the development of vocal responses has also been investigated in studies of typically developing children. This research has demonstrated that the addition of gestural signs to traditional vocal training accelerated the development of vocal responses in infants between the ages of 11 and 36 months (Goodwyn et al., 2000). Goodwyn et al. found a significant advantage in the acquisition of receptive and expressive language by children who were taught to use gestural sign language paired with spoken words as compared to vocal-alone or no-training conditions. The researchers argued that the use of gestural signs and spoken words facilitated rather than hindered language acquisition. They also proposed that the use of TC led to additional advantages such as reducing problem behaviors and clarifying children's needs and wants.

Further research investigating the facilitative effects of TC training on vocal responses has identified a sub-set of non-vocal children most likely to benefit from this approach. For example, several studies have suggested that TC training may be most effective for developing and increasing vocal responses by children who already demonstrate some degree of vocal imitation or echolalia (Schaeffer, et al., 1977; Carr, 1979). Casey (1978) used TC training to teach sign language to four children with autism whose vocal repertoires consisted primarily of echoic responses. He examined the effects of TC on communicative and inappropriate behaviors. Target behaviors included solicited and spontaneous vocal responses. It was found that these behaviors increased for all participants following TC training. In the case of one participant, vocal speech improved to such a degree that manual signs were eventually faded and vocal speech became the primary response form. In a similar study, Konstantareas et al. (1979) investigated the effects of TC training on various language repertoires in four children with autism. They measured reproductive communication (i.e., imitation of modeled signs), receptive communication (i.e., pointing to a named item in a field of distracters), elicited communication (i.e., labeling objects or providing a sign when given an object's name) and spontaneous communication (i.e., requesting access to objects or activities). Two of the four participants had limited vocal imitation repertoires and produced some spontaneous vocalizations prior to TC training. The other two participants did not produce any imitative or spontaneous vocalizations. Following TC training, elicited and spontaneous vocalizations increased for both participants with prior vocal imitation skills, but no gains were found in either type of vocalization by the two participants who lacked prior vocal imitation skills. In another study, Layton and Baker (1981) conducted a year and a half longitudinal study tracking the acquisition of both manual signs and vocal responses in one child with autism. Prior to TC training, the participant occasionally used single vocal words to express his needs and wants and he vocalized upon command. However, his lack of spontaneous language resulted in his being labeled mute. During initial language sampling, he primarily used signs alone to communicate, and he only occasionally used signs and vocal responses simultaneously. A TC approach was then used to teach 50 signs across various grammatical categories. Following TC training, this participant demonstrated a decrease in the use of signs alone and an increase in the use of TC. Additionally, the participant began occasionally to use vocal responses alone.

Some studies have found increases in vocal responses for children with limited echoic repertoires following TC training to teach labels of pictured items (Clarke, et al., 1988) and mands for preferred items (Tincani, 2004). In one study involving two participants, Tincani (2004) compared the acquisition of vocal manding following two types of TC training. One type involved the use of manual signs together with speech as the response form, and the other type involved the use of Picture Exchange Communication System (PECS) together with speech. The data indicated the acquisition of vocal mands by both participants was greater following TC training with manual signs. In sum, this line of research suggest that for children with autism who have some echoic repertoire, TC training with sign language may produce superior acquisition of various vocal responses than traditional vocal-alone training programs or sign-alone training.

Based on these encouraging findings, researchers have attempted to use manual sign language as a communicative prosthesis (Konstantareas, 1984) to support the development of vocal verbal behavior by persons with autism and developmental disabilities or language impairments for whom traditional vocal-alone training has not been successful. Barrera, et al. (1980) compared the effectiveness of TC, vocal-alone, and sign-alone instruction on expressive word acquisition. One child with autism was taught to name six different objects in each of the three training conditions. The researchers found that TC training produced greater gains in the acquisition of expressive language than the other two treatment conditions. They concluded that TC training may be a more effective for children with autism then either verbal-alone or sign-alone approaches.

Sisson and Barrett (1984) compared the effectiveness of TC to vocal-alone training for increasing the imitative length of utterance in three children with developmental disabilities. Groups of four-word sentences were taught in one of two conditions, TC or vocal-alone. The TC condition included the use of both manual signs and vocal prompts whereas only vocal prompts were used in the vocal-alone condition. For all participants, TC was associated with more rapid acquisition of sentences than vocal-alone training. Therefore, TC training was identified as the most effective intervention for each of the three participants. In a similar study, TC training was found to be effective for supporting the production of complex speech in children with developmental disabilities. Konstantareas (1984) found that TC training resulted in superior acquisition of vocal prepositions and pronouns as compared to vocal-alone training in children with various language impairments. Based on these results, it was suggested that use of sign language may facilitate the development of complex speech by children with language impairments and that TC may be more effective than vocal-alone training.

In another demonstration of the superior effects of TC training, Barrera and Sulzer-Azaroff (1983) compared the effectiveness of TC training to vocal-alone training for teaching vocal labeling to three children with autism. Results showed that the TC condition produced greater gains in vocal labeling responses and required fewer teaching trials than the vocal-alone condition. Vocal-alone training only produced the acquisition of one labeling response for one participant and had no effect on the acquisition of labeling responses by the other two participants. Conversely, following TC training, two of the participants acquired all of the vocal labels targeted, and one participant acquired all but one label before training was discontinued.

Despite the encouraging findings of research published nearly 25 years ago regarding the use of TC with manual sign to facilitate vocal responding in children with autism, no further research has been conducted on this topic. Therefore, the purpose of the present study was to (1) replicate previous research on the benefits of TC (sign plus vocal) compared with vocal alone training, and to (2) determine whether previous findings regarding the effects of TC with sign language could be extended to children who have developed a vocal response repertoire in one operant class (mand relation) but who have failed to acquire vocal responses in another operant class (tact responses). Replication of previous findings would lend additional support to the value of TC with manual for teaching communication skills to children with autism. Moreover, an analysis of TC training relative to verbal behavior functions may enable the results to be interpreted in a more systematic manner. Considerable advances have been made in the past 25 years in the conceptual and empirical analysis of the application of B.F. Skinner's taxonomy of verbal behavior. These advances can support a conceptually systematic analysis of mechanisms that account for the benefits of TC training, and they could support more effective practices by parents and other persons teaching verbal behavior to children with autism.

Methods

Participant and Setting

One individual (Sarah) served as the participant in this study. At the time of data collection, Sarah was a seven-year-old female with autism in the moderate range of disability. She received about 40 hours per week of home-based one-on-one intensive teaching in the form of discrete trial training interspersed with teaching in the natural environment facilitated through play based activities. Sarah demonstrated an echoic repertoire and had acquired a variety of vocal mands that were multiply controlled by both the presence of a desired item and the motivating operation. In addition, she occasionally produced vocal mands for items solely under the control of the motivating operation. Sarah's tact repertoire was limited and prior to the implementation of the independent variables in this study, she had acquired only 57 vocal tacts over an eight month period. Moreover, attempts to increase Sarah's intraverbal repertoire had only resulted in a few responses to specific verbal stimuli. Acquisition data revealed that the rate of acquisition of both tacts and intraverbals had slowed considerably prior to the beginning of this investigation. In the six weeks prior to this study, no tact or intraverbal responses had been acquired despite the presentation of many learning trials.

All observations were conducted in Sarah's home. Three in-home teachers delivered the interventions and recorded the data. During all teaching sessions, Sarah sat at the same instructional table in the same room. A teacher sat across from Sarah. Stimuli and materials were placed in front of the teacher.

Measurement of Dependent Variables

The dependent variable measured in this study was the acquisition of tacts for pictured objects. Prior to implementation of the experimental conditions pictures of objects were displayed to Sarah by holding them at eye level and asking "what is it? If she failed to respond within 10 seconds or responded incorrectly, the picture was chosen for tact training. Twenty pictures of objects from this group were selected and 10 targets were randomly placed in either a vocal alone (VA) or TC experimental condition. As tacts were acquired in either of the conditions, new pictures were added. This resulted in the maintenance of 10 non-acquired targets in each experimental condition. The added targets were selected using the same procedure as described above for the original 20 pictured objects. All targets in each experimental condition were randomly presented during the teaching sessions, and each session lasted about 20 minutes. More than one session per day was sometimes conducted. Examples of the pictured objects in the TC condition included broom, fork, and shovel. Examples of pictured objects in the VA condition included soup, belt and bucket.

Definition of Correct Response: During both experimental conditions, a correct response was defined as Sarah's production of a vocal tact corresponding to a pictured item within three seconds of the picture's display when paired with the question "What is it?" during probe trials interspersed throughout teaching sessions.

Definition of Incorrect Response: An incorrect response was defined as any vocal response that did not correspond to the target picture or a failure to respond within three seconds when a target picture was presentation and paired with the question, “What is it?” during probe trials interspersed throughout the teaching sessions.

Correct and incorrect responding was assessed through the teaching sessions, but only on probe trials that did not include any type of prompt. In other words, probe trials were implemented during each session to measure mastery of the tact response. Prompts were provided throughout the sessions during the teaching of the tacts in both experimental conditions. The prompting and stimulus control transfer teaching procedures are described below. However, the criterion for mastery in both experimental conditions was 100% correct responses for all presentations of the item across two consecutive sessions and two different instructors. This meant that no teaching trials that included prompting of the response could be presented during the entire session and correct responding had to occur on each presentation to meet mastery criterion.

Vocal-Alone (VA) Training

During the VA training condition, vocal tacts were taught using only a vocal prompt to evoke responses during teaching trials. On average about 267 trials were presented during at each session. An errorless teaching procedure utilizing a zero second time delay and then a constant time delay of three seconds stimulus control transfer procedure was employed. In other words, during each teaching trial, the teacher modeled the correct response immediately following the initial display of the picture paired with the question “what is it?” Immediately following this modeled response, the teacher displayed the picture again and said “what is it?” and paused three seconds in anticipation of the Sarah’s response. When Sarah responded correctly, the instructor presented two or three mastered instructional demands and then re-presented the picture and question to support stimulus control transfer of the tact response. This trial was referred to as the test trial. For each correct response in this sequence Sarah received verbal praise. Errors at any point in the teaching trial sequence were corrected by re-presenting the stimulus immediately and returning to the zero second time delay prompt followed by the stimulus control transfer procedures described above. Incorrect responses that required correction did not receive praise from the experimenter. Each target received about 25 trials per session.

The prompting and stimulus control transfer procedures were adjusted by the teacher throughout the session based upon Sarah’s responses. In other words, frequent correct responses during the test trials in any session led to more frequent probe trials. This meant that some targets during some sessions did not receive any prompts and instead were just probed since Sarah had displayed a high rate of correct responses during probe trials in the previous session. In fact, the requirement to reach mastery on any target item required 100 percent correct responding on probe trials during two consecutive sessions across two different in home teachers.

Total Communication (TC) Training

During the TC condition, vocal tacts were taught using a vocal prompt plus display of the manual sign by the teacher to evoke correct responses. On average 234 trials were presented per session during this condition. The manual signs were either the precise ASL sign or a simplified modification thereof. Initial trials began with the display of a pictured object plus the question, “What is it?” This was followed immediately by the teacher’s production of simultaneous models of the TC forms (sign and vocal) corresponding to the pictured object. An errorless teaching procedure utilizing a zero second time delay and then a constant time delay stimulus control transfer procedure of three seconds was employed. In other words, the teacher modeled the TC forms (sign, vocal) immediately following the display of the picture paired with the question (“what is it?”). Immediately following her modeled response the teacher displayed the pictured object again and said “what is it?” and paused three seconds to anticipate a correct vocal and sign response from Sarah. If Sarah produced an incorrect sign but the correct vocal response during this trial, her response was treated as an error, and the error correction procedure described below was implemented. Sarah was required to perform the correct sign and vocalization during this phase of stimulus control transfer to receive social reinforcement in the form of praise. When she responded correctly the instructor presented two or three mastered instructional demands and then re-presented only the picture and question to support stimulus control transfer of the tact response. On this test trial, a correct response only required a correct vocal response to receive reinforcement. For each correct response in this sequence Sarah received verbal praise. Errors during any of the teaching trials were corrected by re-presenting the stimuli immediately and returning to the zero second time delay prompt followed by the prompt fade and test for stimulus control transfer as described above. The teacher treated failure to perform the sign during any of the teaching trials except the test trial as an error and therefore immediately presented the error correction procedure. Incorrect responses did not receive praise from the teacher. Instead, they resulted in the error correction procedure. Each target received approximately 23 trials during each session.

Consistent with the vocal alone condition, probe trials were interspersed throughout the sessions. Once again, the criterion for mastery for any target was 100 percent correct on probe trials over two consecutive sessions across two teachers.

Inter-observer Agreement

Data were recorded throughout the experiment by a primary observer whose only responsibility during the sessions was to record the occurrences of correct and incorrect responses during probe trials. A correct response was recorded when Sarah emitted the vocal tact response corresponding to the pictured object. An incorrect response was recorded when no vocal tact response occurred within three seconds of the presentation of the stimulus or when an incorrect vocal response occurred. A second observer's independent ratings were used to calculate inter-observer agreement (IOA) scores during one third of the sessions. During IOA sessions, the teacher and the second observer recorded their ratings for all responses simultaneously but independently throughout the sessions. For purposes of calculating IOA the ratings of the teacher were compared to those of the second observer. An agreement occurred when both observers gave the observed response exactly the same rating (correct or incorrect). A disagreement occurred when the observers rated the same response differently. The IOA was calculated by dividing agreements by agreements plus disagreements and then multiplying by 100. The actual IOA scores ranged from 93% to 100% with an average of 98%.

Design

An alternating treatment design was used to evaluate the relative effectiveness of TC training vs. VA training for teaching tact responses. Both experimental conditions were conducted during each session. The sequence of the two treatment conditions were alternated randomly across the sessions, and the same condition was never presented more than two times consecutively, according to the requirements of an alternating treatment design (Barlow, Hayes, 1979).

Results

The cumulative number of tacts mastered in both the TC and VA training conditions are presented in Figure 1. Sarah received a total of about 7,500 trials in the VA condition and about 6,500 trials in the TC condition. The first tact in the TC condition was mastered by the fifth treatment session and after 89 teaching trials. By the end of 28 treatment sessions, Sarah had mastered 30 tacts in the TC condition. The first tact in the VA condition was not mastered until the seventh treatment sessions and after 148 teaching trials. Moreover, only eight tacts were mastered by the end of 28 treatment sessions.

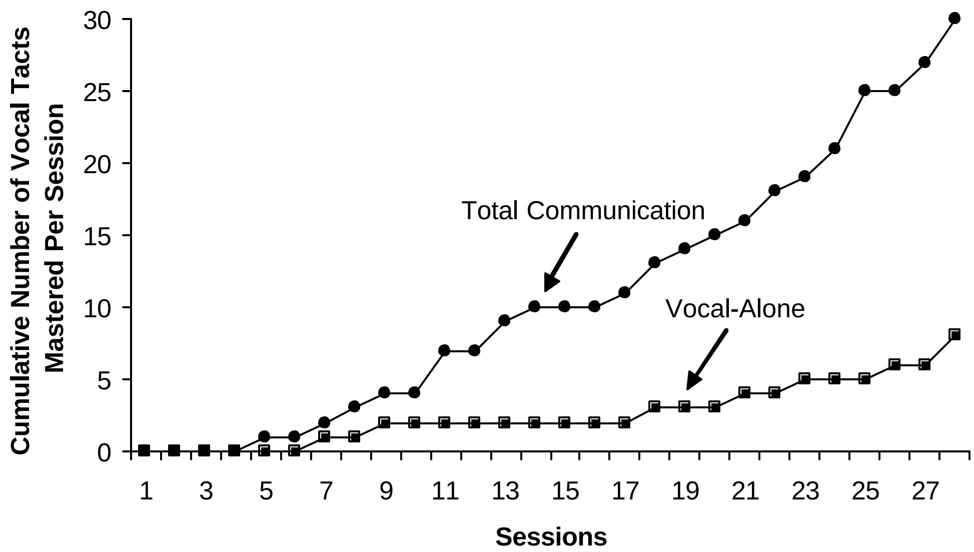

Figure 1. **Cumulative number of vocal tacts mastered in the total communication condition and vocal-alone condition per session.**

Figure 2 presents the mean trials to criterion for tact acquisition in the TC and VA conditions. In the TC condition tact responses were mastered in an average of 155 trials (compared with 357 trials in the VA condition). Overall, the TC treatment produced almost four times as many mastered tacts as the VA condition, and it accomplished this in less than one-half the average number of trials.

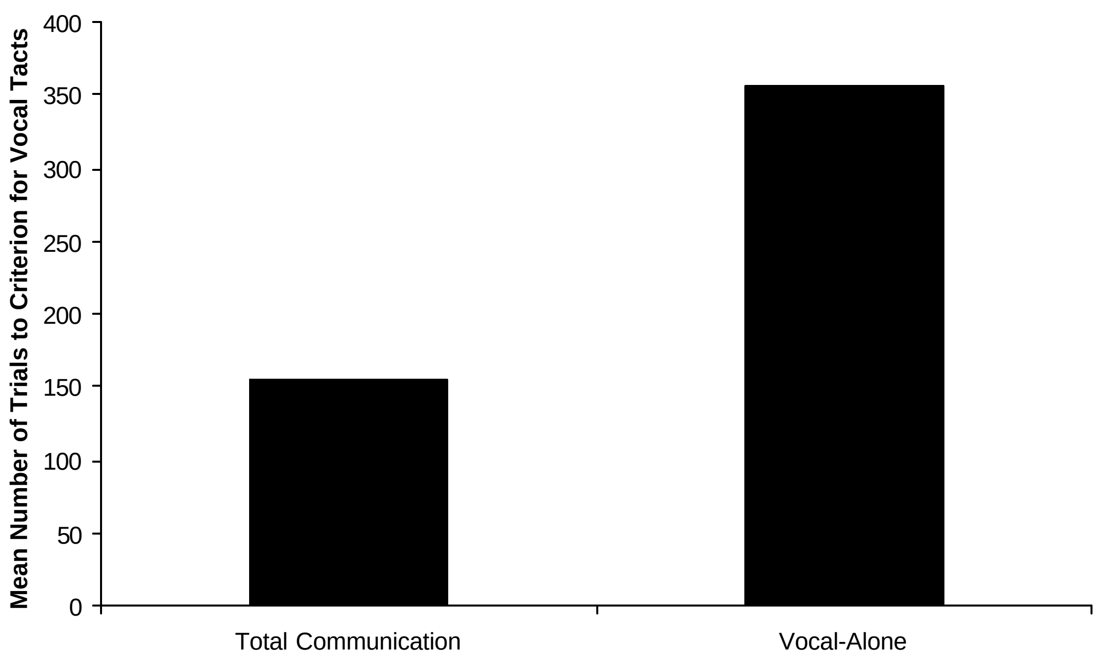

Figure 2. **The mean number of trials to criterion for vocal tacts in the total communication condition and vocal-alone condition.**

Discussion

The results indicate that, for the child with autism in this study, the TC procedure was superior to VA procedure to support the acquisition of tact responses. The participant acquired almost four times the number of responses following TC training as she did following VA training, and mastery was achieved in the TC condition following significantly fewer teaching trials. These results support previous research which has suggested that the addition of manual sign language to vocal training programs (TC) may increase vocal responding in learners for whom vocal-alone training has not produced satisfactory outcomes (Barrera et al., 1980; Barrera & Sulzer-Azaroff, 1983; Konstantareas, 1984; Sisson and Barrett, 1984).

A number of possible explanations for the facilitative effect of manual sign language on the vocal verbal behavior of children with autism have been offered. Barrera and Sulzer-Azaroff (1983) attributed the superior results of TC training to the increase in available sensory cues provided by the simultaneous presentation of manual signs. They asserted that these cues provide additional input to the sensory systems of children with autism, thereby facilitating the development of the vocal repertoire. Konstantareas (1984) suggested that the iconicity of the manual signs may be a contributing factor in the success of TC training or that the use of the signs may result in the storage of a visual image that later aids recall of the vocal responses.

A more thorough behavioral analysis of the findings of this and previous studies reporting similar outcomes may now be possible because of research in recent years stimulated by B.F. Skinner's (1957) theoretical analysis of verbal behavior. Two studies have recently demonstrated the benefit of TC training for increasing the mand repertoires of children with autism who have limited vocal skills (Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Tincani, 2004). Charlop-Christy et al studied three individuals who were learning mand responses in the form of picture exchange (PECS). Vocal responding increased in all three of the participants when their PECS responses were paired with the teacher's production of the word for requested item. The authors concluded that the development of vocalizations may have been due to a combination of factors, including (1) the verbal behavior function being targeted (i.e., mand); (2) the participants tendency to echo the teacher's vocalization; (3) consistent adventitious reinforcement of echoic response; (4) inherent use of a delay procedure, and (5) each participants' pre-treatment repertoire of echoic behavior.

Tincani (2004) measured increases in vocal responding by comparing the effects of PECS training and TC (sign plus vocal) training on the development of vocal manding. He found that both systems produced an increase in vocalizations but TC training led to more vocal responding than did PECS. Both Tincani's study and Cherlap et al's (2002) study used TC training similar to the methods used in the present research to increase vocalizations in their participants. The different forms of total communication used in these studies (PECS-based vs. sign-based) both improved vocal responding. However since TC with manual sign produced superior results, manual sign appear to have a facilitative advantage over PECS in supporting the production of verbal behavior. A plausible explanations for the development of vocalizations offered by Charlop-Christy, et al (2002) could account for the effects of TC training using either picture exchange or manual sign. But what then could explain the superior effects of sign language found by Tincani (2004)? One possibility is to consider these findings according to Skinner's (1957) analysis of language. Specifically, sign language, as with vocal verbal behavior, constitutes topography-based verbal behavior (Michael, 1985). Michael suggests that this kind of verbal behavior is characterized by each operant (sometimes a word) having a different topography (motor movement) for each controlling relation or referent. However, in the case of PECS and other picture/icon selection or exchange systems the motor movement is almost identical for each response and what is different is the picture or icon selected. Michael (1985) referred to this type of responding as selection-based verbal behavior. This difference may be more important than it appears. Sundberg and Partington

(1998) offer an explanation as to how sign language during TC training may gain its superiority over selection-based systems. "Once the motor movements are learned, specific vocalizations can be matched with the signs. This sign-vocalization prompt can help in other ways as well. A child can use signs to prompt his own vocalizations" (p.77). In other words, the unique topographies of individual manual signs (in contrast to the consistent topography of selection systems) may allow allows each sign to act as a "built in prompt". In fact, Tincani (2004) offers this explanation to account for the superiority of sign compared to PECS in the development of vocal responses by children with autism. Similarly, the participant in this study either signed the tact and then emitted the vocal response or she first looked at the sign she produced and then emitted the vocal response. The use of signs as prompts for vocalization seemed to be confirmed by the behavior of the participant in our study based on anecdotal observations.

One of the important findings of this study is the fact that the responses taught were tacts and not mands. Mands are associated with more valuable forms of reinforcement since the form of the response specifies a reinforcer that is presently potent. In the case of tacts, more generalized social reinforcement usually maintains these responses as was the case in this study. In this study however, the participant had a reasonably well developed vocal mand repertoire but failed to develop and maintain a vocal tact repertoire. Despite the seemingly less powerful social reinforcement associated with the tact response the manual signs appeared to act as supplementary stimulation leading to the acquisition of vocal tact responses. This is important since most verbal behavior is maintained by generalized forms of reinforcement, such as the vocal intraverbal response, and therefore most functions of verbal responding may be susceptible to the effects of total communication training with manual sign language.

This study is limited by the fact that findings of only one participant are reported here. Replication of these findings with additional participants with autism who have varying characteristics and levels of disability will be needed in order determine the benefits of total communication training with a wide range of participants. In addition, while no formal maintenance data were collected anecdotal reports indicate the maintenance of the tacts acquired during TC training. In fact, the acquisition data and maintenance reports were so positive that Sarah continues to be taught all verbal behavior with the support of TC using manual sign language. She almost always signs prior to vocalizing and when she fails to emit a vocal response, a request made by her teacher that Sarah sign the response almost always evoked the correct vocalization.

Future researchers may want to determine the effectiveness of TC with simultaneous manual sign and vocal training for learners who emit echoic responses and potentially vocal mands but fail to emit high rate vocal intraverbal responses. In fact, we conducted a second study to address this issue however due to some methodological flaws the results were not included in this report. Nevertheless, the results were promising and suggest that intraverbal vocal responding may be facilitated through TC training using manual sign language.

The pattern of results in this line of research have important implications for practitioners and parents who wish to teach vocal responses to children with autism who exhibit weak vocal responding. It appears that with some of these children vocal-alone training may not be sufficient to produce vocal tact responding and therefore the addition of manual sign language may provide a necessary method in the development of this repertoire. Persons responsible for the design and implementation of language training programs for children with autism who have not yet developed satisfactory vocal responses should consider the evocative effects of TC with manual sign language as an addition to their language training programs.

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Considering Response Efficiency in the Selection and Use of AAC Systems

Susan S. Johnston

Abstract

Individuals with severe disabilities whose speech is either ineffective or inefficient for meeting their communicative needs have benefited from augmentative and alternative modes of communication (AAC). However, despite the evidence supporting the use of AAC with individuals with severe disabilities, practitioners may still encounter challenges in implementing AAC interventions. These challenges may be due, in part, to problems related to contextual fit. This paper (a) examines the importance of contextual fit in the design and implementation of AAC interventions, (b) explores the potential role of response efficiency for enhancing contextual fit, (c) presents a framework for examining the response efficiency of AAC interventions, and (d) provides a discussion of needed research.
Keywords: Augmentative and Alternative Communication, AAC, Contextual Fit, Response Efficiency.

Introduction

Augmentative and Alternative Communication (AAC) refers to the use of devices or techniques that supplement or replace an individual's spoken communication skills (Mustonen, Locke, Reichle, Solbrach, & Lindgren, 1991). AAC includes unaided modes of communication (e.g., gestures, sign languages/systems, and facial expressions) as well as aided modes of communication (e.g., line drawings on a communication board, written words on a pad of paper, laptop computers with synthesized speech output, dedicated AAC devices with digitized speech output).

Individuals with severe disabilities whose speech is either ineffective or inefficient for meeting their communicative needs have benefited from augmentative and alternative modes of communication (e.g., Cafiero, 1998; Johnston, McDonnell, Nelson, & Magnavito, 2003; Johnston, Nelson, Evans, Palazolo, 2003; Marcus, Garfinkle, & Wolery, 2001; Mirenda & Ericson, 2000; Quill, 1997; Rowland & Schweigart, 2000; Schopler, Mesibov, Shigley, & Hearsey, 1995). However, as promising as the evidence supporting the use of AAC with individuals with severe disabilities has been, practitioners still encounter challenges in implementing AAC interventions. These challenges may be due, in part, to problems related to contextual fit. This paper (a) examines the importance of contextual fit in the design and implementation of AAC interventions, (b) explores the potential role of response efficiency for enhancing contextual fit, (c) presents a framework for examining the response efficiency of AAC interventions, and (d) provides a discussion of needed research.

Importance of Contextual Fit in the Design and Implementation of AAC Interventions

The term *contextual fit* refers to the compatibility between an intervention and a variety of variables, including characteristics of the person for whom the intervention was developed, characteristics of the individuals who will implement the plan, and features of the environment within which the intervention will be implemented (Albin, Lucyshyn, Horner, & Flannery, 1996). Albin et al (1996) posit that an intervention "may be theoretically well designed and solidly grounded in both behavior theory and documented practice, and yet still not be a good fit for the people and the environments involved" (p.83). An intervention may lack strong contextual fit for a variety of reasons. For the AAC user, the AAC intervention may require too much effort and/or may not consistently result in interactions that fulfill their communication wants/needs. For communication partners, the AAC intervention may be cumbersome or time consuming to design and implement, may conflict with existing priorities, or may fail to meet their own communicative needs.

Personal experience suggests that many AAC users and their communication partners have participated in interventions that lack a good contextual fit. For example, consider Jane, a preschool aged child who was taught to use sign language to communicate her wants and needs. Jane quickly acquired a large repertoire of signs. However, with the exception of her preschool teacher who possessed some basic knowledge of sign language, none of the peers in Jane's classroom understood or used sign language. Thus, although the use of sign language was an effective AAC strategy for Jane, the overall contextual fit of the intervention was decreased as a result of the skills/abilities of Jane's communication partners. When practitioners are faced with a situation where a beginning communicator with severe disabilities has an AAC system but uses it infrequently, or communication partners engage in infrequent interactions with the AAC user, it may be important to examine the contextual fit of the AAC intervention. One factor that may influence contextual fit relates to the efficiency of the AAC intervention compared with the efficiency of other competing behaviors.

Considering Efficiency as means of Increasing Contextual Fit

Herrnstein (1961) demonstrated that the distribution of behavior among concurrently available functionally equivalent alternatives depends on the history of reinforcement for each of the available behaviors. This led to the hypothesis that when individuals have two or more responses in a functionally equivalent class, they will select the response option that is perceived as most efficient in procuring or maintaining reinforcement (Mace & Roberts, 1993). For example, a student with severe disabilities may have learned that either biting a peer or touching a switch that produces the spoken message "I need a break" will result in release from an activity. In this example, the behavior that is most efficient (i.e., results in the greatest reinforcement for the least effort) is apt to be the more frequently used communicative act. Response efficiency is influenced by at least four variables; response effort (Bauman, Shull, & Brownstein, 1975; Beautrais & Davison, 1977; Horner, Sprague, O'Brien, & Heathfield, 1990; Horner & Day, 1991; Mace et al., 1996; Richman, Wacker, & Windborn, 2001; Skinner, Belfoire, Mace, Williams-Wilson, & Johns, 1997), rate of reinforcement (Conger & Killeen, 1974; Horner & Day, 1991; Mace, Neef, Shade & Mauro; 1994; Martens & Houk, 1989; Martens, Lochner, & Kelly; 1992; Neef, Mace, & Shade, 1993), immediacy of reinforcement (Horner & Day; 1991; Logue, 1988; Neef et al, 1993; Rachlin, 1989), and quality of reinforcement (Hollard & Davison, 1971; Mace, Neef, Shade, & Mauro; 1996; Miller, 1976; Neef & Lutz, 2001; Neef et al., 1993). McDowell (1988) hypothesized that these components interact to influence the probability that an individual will engage in one response option over another.

It seems likely that the components of response efficiency may influence a learner's use of AAC. Consider a learner who chooses to refrain from engaging in communicative interactions using his communication board comprised of black and white line drawings. This choice may be a result of the physical effort required to communicate (e.g., if the motor demands associated with retrieving the communication board and then locating symbols on the system are too great, the learner may choose not to use it). Alternatively, the learner may refrain from using the AAC system because the quality of reinforcement provided is not substantial enough to warrant its use (e.g., the learner may typically receive desired outcomes regardless of whether or not they use their system). Finally, the learner may not use their communication board because too much time lapses between the emission of the communicative behavior and the delivery of the reinforcement (e.g., communication partners do not realize the AAC user is attempting to communicate and/or have difficulty understanding the AAC user's message and therefore do not respond in a timely enough fashion to make the use of the system worthwhile).

Horner and Day (1991) implemented a series of experiments examining the role of response efficiency in teaching a communicative alternative to challenging behavior with three individuals who had severe to profound mental retardation (ranging in age from 12 to 27 years). In each experiment, participants were taught communicative alternatives that were functionally equivalent to their challenging behaviors but were not as efficient in terms of either physical effort (i.e., emitting the signs for "I want to go, please" as a replacement for escape motivated aggression), schedule of reinforcement (i.e., emitting the sign "help" three times as a replacement for emitting self-injurious behavior to obtain assistance), or latency of reinforcement (i.e., receiving a break from tasks 20 seconds after handing the interventionist a card with the word "BREAK" on it as a replacement for escape motivated aggressions). Results indicated that the new, functionally equivalent but inefficient, behaviors did not replace the challenging behaviors. However, when the alternative behaviors were made more efficient (e.g., signing "break" rather than the sentence "I want to go, please", signing "help" only one time rather than three times, receiving a break immediately after handing the interventionist a card with the word "BREAK" on it rather than 20 seconds later), there were dramatic reductions in challenging behavior and collateral increases in the use of the new communicative alternatives.

The components of response efficiency may also influence the propensity of communication partners to engage in interactions with AAC users. This is important to consider because an AAC system is unlikely to be effective without the commitment of the AAC user's communication partners (Brinker, Seifer, & Sameroff, 1994; Brotherson & Cook, 1996; Gallimore, Weisner, Bernheimer, Guthrie, & Nihira; 1993; Musselwhite & St.Louis, 1988). For example, consider a peer who chooses to refrain from engaging in communicative interactions with an AAC user in his class. This choice may be a result of the effort required to communicate (e.g., if the effort associated with understanding the AAC user's communicative attempts are too great, the peer may choose to avoid interactions). Alternatively, the peer may choose to avoid interactions with the AAC user because of a low quality of reinforcement (e.g., the conversational topics that are engaged in by the AAC user may not be of interest to the peer). Finally, the peer may not engage in interactions with the AAC user because too much time lapses between the emission of the communicative behavior and the delivery of the reinforcement (e.g., the time that it takes to engage in turn-taking interactions with the AAC user is so great that the peer does not perceive the communicative interaction to be worthwhile).

In summary, it seems important to recognize the potential role of response efficiency in influencing the contextual fit of AAC interventions for AAC users and their communicative partners. The following sections will illustrate the potential role of the four components of response efficiency (response effort, rate of reinforcement, immediacy of reinforcement, and quality of reinforcement) for AAC users as well as for their communication partners. For each variable of response efficiency, the outcomes of published empirical investigations will be reported and discussed in order to demonstrate the potential influence of the components of response efficiency. In most cases, the focus of these investigations was not to directly examine the operation of the response efficiency variable being discussed. Thus, these summaries provide inferred, rather than direct, evidence of the operation of the components of response efficiency.

Response Effort

Potential influence on the AAC user. The effort required to produce a behavior can effect whether or not a learner will select that response (Bauman, Shull, & Brownstein, 1975; Beautrais & Davison, 1977). The potential influence of response effort may be applicable across a range of contexts. Typically, the influence of response effort is considered in the context of the amount of physical effort required to communicate. Horner et al. (1990) conducted an investigation in which the physical effort required for a 14 year-old learner with moderate mental retardation to request assistance using a voice-output communication aide as an alternative to engaging in challenging behavior was manipulated. In one situation, the learner was required to emit a high effort response (typing the phrase "Help Please" on a voice output communication aid). In the second situation, the learner was required to emit a low-effort response (pressing a single key on the communication aid in order to emit the phrase, "Help please"). Outcomes revealed that the low effort response resulted in a sustained decrease in challenging behavior whereas the high effort response did not result in a sustained decrease in challenging behavior. Thus, results of this investigation demonstrate the influence of relative response effort on choice behavior when the learner has two or more behaviors that serve the same function in his repertoire.

In addition to physical effort, cognitive effort may impact the likelihood that a learner will use a particular action (Johnston, Reichle, & Evans, 2004). For example, consider a situation when a learner can either locate and point to a symbol representing "I need help" on a communication board containing 32 symbols or offer a wind-up toy to a nearby adult in order to request assistance in operating the toy. In this situation, the cognitive effort required to locate the "I need help" symbol may be more than the cognitive effort required to give the toy to the adult. As a result, pointing to the symbol may be less likely if the alternative behavior is equally likely to result in the provision of assistance.

Horn and Jones (1996) provided an example of how cognitive effort may influence a learner's behavior. They collected data regarding the number of error responses engaged in by a four-year-old child with cerebral palsy across two selection techniques, circular scanning and direct selection with a head-mounted optical pointer. Pre-assessment data collected by the authors suggested that scanning would be the most effective technique. However, results revealed that direct selection was used more effectively as measured by response accuracy, acquisition rate, and response time to produce correct responses. The authors indicated that the error responses that occurred during the child's use of scanning were not due to a lack of understanding of the scanning process. Rather, errors occurred as a result of off-task behaviors and inattentiveness that resulted from the inherent slowness of the scanning selection technique. These results might suggest that learner performance is influenced by the cognitive effort required to maintain attention while engaged in scanning. In addition to considering the impact of effort for an AAC user, it may be equally important to consider the impact of effort for communication partners.

Potential influence on the communication partner. A number of variables may influence the physical or cognitive effort required by communication partners who interact with AAC users and/or are involved in the design and implementation of AAC interventions. When attempting to increase efficiency from the perspective of communication partners, it is important to minimize the physical or cognitive effort for interpreting the learner's communication via AAC as well as minimize the work involved in developing and teaching the use of the AAC system. Furthermore, if efforts involved in teaching the use of AAC must be sustained over a long period of time or if the work involved in teaching the use of the AAC system differs significantly from typical work efforts, support may be required in order to minimize physical or cognitive effort (Johnston, Reichle, & Evans, 2004).

Doss et al (1991) provided an example of how cognitive effort may influence communication partner behavior. They conducted two related experiments designed to examine the efficiency and effectiveness of a variety of AAC devices for ordering meals in fast food restaurants. Each experiment included the use of an introduction card that was presented to the communication partner at the beginning of the communicative interaction. In the first experiment, the introduction card stated that the user was non-speaking and that an alternative form of communication would be used. Specifically, the card stated:

> "Hi! I don't talk. I will use this device to place my order." (Doss et al., p. 257).

In contrast, the introduction cards in the second experiment were more explicit. In addition to containing a greeting and statement that the AAC user was non-speaking, it also provided the communication partner with information regarding the important features of that particular AAC device. For example, the introduction card for one of the electronic voice output communication aids used in the study stated:

> Hi! My name is Susan. I cannot speak. I talk by using this machine. Please follow these steps in order to understand my message. 1) *Wait* for me to push buttons. 2) *Listen* to my message. Thank you. (Doss et al., p. 261).

Although it was not the sole focus of the study, results suggested that the provision of an explicit introduction card that directed the communication partner to the relevant features of the AAC system decreased the cognitive effort required for communication partners thereby enhancing the effectiveness and the efficiency of the interaction.

Quality of Reinforcement

Potential influence on the AAC user. Mace and Roberts (1993) noted that when one event is preferred over another, the preferred event has a higher quality of reinforcement. Thus, reinforcement delivered contingent on an AAC user's emission of a specific communicative behavior must be preferred over the reinforcement delivered for not using it. For example, consider an AAC user who is learning to point to black and white line drawings in a communication wallet to request food items in the school cafeteria. It seems logical that one might expect highly preferred food items to be requested more frequently.

Brady, McLean, McLean, and Johnston (1995) observed the initiation and repair behaviors engaged in by 28 individuals with severe to profound mental retardation. All participants engaged in intentional, non symbolic communicative behaviors. Opportunities were provided for the participants to request instrumental actions (e.g., request objects) as well as to request attention to objects (e.g., comment). Results revealed that the participants initiated more requests for objects than comments. One possible explanation for this outcome is that access to tangibles may have been more reinforcing than the provision of attention.

Potential influence on the communication partner. In addition to influencing the communicative behavior of AAC users, quality of reinforcement may also influence the behavior of communication partners. For example, it seems plausible that communicative interactions with AAC users that result in meaningful exchanges are likely to provide a higher quality of reinforcement to communication partners than exchanges that lack true meaning.

The influence of quality of reinforcement on communication partner behavior can be inferred from research examining the perceptions and attitudes of listeners. Light, Arnold, & Clark (2003) discuss that although the relationship between attitudes and actual behaviors towards AAC users is not well understood and is probably not one-dimensional (e.g., other factors such as peer expectations and social norms seem likely to have an influence), it seems plausible that communication partner attitudes might predispose certain behaviors. For example, an investigation by Gorenflo & Gorenflo (1991) revealed that observers had more positive attitudes towards AAC users of the same gender who were perceived to have similarities in terms of values and activities of daily living than towards AAC users of the same gender who were not perceived to have similarities in terms of values and activities of daily living. If communication partner attitudes do influence behavior, these results might suggest that communication partners will feel that communicative interactions with "like-minded" AAC users result in a higher quality of reinforcement than interactions with AAC users who do not have perceived similarities. These results might influence the design of AAC systems by ensuring that AAC users have vocabulary on their systems that will allow them to comment on the similarities between themselves and their communication partners.

Immediacy of Reinforcement

Potential influence on the AAC user. The time that lapses between producing a communicative act and the receipt of a reinforcer may also influence a learner's use of AAC. The outcomes of a study by Soto, Belfiore, Schlosser, and Haynes (1993) provide an example of the potential influence of immediacy of reinforcement. In this investigation, the researchers taught an individual with severe to profound mental retardation to use two AAC systems, a picture board (with no speech output) and a voice output communication aid. Following instruction on the use of both aids, the participant received opportunities to choose which aid to use in communicative exchanges. Results of this preference assessment revealed that the participant chose the VOCA in 100% of the opportunities. A plausible explanation of this outcome might be that the VOCA offered more immediate reinforcement (e.g., as a result of the voice output) than use of the picture board.

An investigation by Reichle and Johnston (1999) provide an additional example of the influence of immediacy of reinforcement on the behavior of AAC users. In this study, the investigators taught two beginning AAC users with severe disabilities to conditionally use communicative requests to obtain desired snack items. When items were proximally near, the learners were taught to independently reach for desired items. However, when items were in the possession of another person (e.g., teacher, peer) or proximally distant, they were taught to point to a graphic symbol to request the item. Initial results revealed that the AAC users did not consistently engage in the most efficient strategy. However, efficient and conditional use was acquired after intervention that focused on the immediacy of reinforcement.

Potential influence on the communicative partner. In addition to influencing the communicative behavior of AAC users, immediacy of reinforcement may also influence the behavior of communication partners. Wilkinson & McIlvane (2002) discuss that the amount of time that it takes to compose a message is perhaps the most frustrating aspect of graphic modes of communication. The time it takes to compose messages is likely to impact communication partner behavior especially as it relates to conventionalized exchanges (e.g., "Hi, how are you?") which King, Spoeneman, Stuart, and Buekelman (1995) indicate may comprise one third of conversations. Conventionalized exchanges are frequently brief, fast-paced exchanges. Thus, if it takes an AAC user a long time to comprise and emit this type of message, communication partners may choose not to engage in conventionalized exchanges as a result of the delay of reinforcement.

A variety of strategies for enhancing rate of communication such as the use of prefabricated messages, letter prediction, and word prediction have been reported in the literature (Silverman, 1995). Each of these strategies may serve to increase the immediacy of reinforcement for communication partners. One rate enhancement strategy that may be of particular interest to communication partners involves the provision of clues for making "20 Questions" more efficient (Garrett, Beukelman, & Low-Morrow, 1989). Frequently, when communication partners interact with AAC users who have a limited array of vocabulary on their system and whose expressive ability includes a reliable yes/no response, the partners attempt to guess the communicative intent of the AAC user by asking the AAC user a series of yes/no questions. This type of interaction often results in a significant delay in reinforcement as a result of the number of turn-taking exchanges needed to determine the AAC user's intended message. Furthermore, this strategy requires a significant amount of cognitive effort on the part of the communication partner because they are responsible for asking the probe questions and then trying to guess the intended message based on the AAC user's responses. In order to address this issue, Garrett, Beukelman, & Low-Morrow (1989) included the use of a "Clues" card as part of an AAC user's system. The clue card consisted of phrases that the AAC user pointed to in order to guide the communication partner through a structured form of 20 questions (e.g., the AAC user would point to a phrase to indicate that he/she was referring to a person, place, event, thing, or time) in order to provide more information before the communication partner starts to "guess". It seems plausible that the utilization of rate enhancement strategies may increase the immediacy of reinforcement that the communication partners receive when interacting with AAC users.

Rate of Reinforcement

Potential influence on the AAC user. Herrnstein (1961) hypothesized that when individuals are presented with two or more functionally equivalent response options, their behavior will be directly dependent on the rate of reinforcement history associated with each alternative. The influence of rate of reinforcement may have particular significance for the design and implementation of AAC interventions. Consider an AAC user who is being taught to touch a line drawn symbol represent "help" rather than tantrum in order to obtain assistance. If all other variables were held constant, Herrnstein's hypothesis would suggest that reinforcement must be provided more often for using the graphic symbol than for engaging in a tantrum.

Duker and VanLent (1991) demonstrated how the rate of reinforcement might impact communicative behaviors in an investigation designed to increase the variety of spontaneous signs emitted by 6 participants with severe to profound disabilities. Assessment indicated that each participant used only a limited number of the signs that they had in their repertoire. In an effort to increase the variety of spontaneous signs produced, interventionists refrained from responding to the participant's high-rate signed vocabulary while at the same time delivering reinforcement for low-rate signed vocabulary (previously taught but typically unused). Results revealed that non-responding to "high-rate" spontaneous signs increased the participant's use of "low-rate" spontaneous signs. Thus, manipulating the rate of reinforcement provided in response to the participants' spontaneous communicative behaviors influenced their engagement in those behaviors.

Potential influence on the communication partner. Rate of reinforcement may also influence the behavior of communication partners. For example, consider a parent who is implementing an intervention designed to teach his child to touch a symbol to request more music as a communicative replacement for his current behavior of biting. If the intervention is effective and the frequency of biting decreases as the frequency of symbolic communication increases, the parent is receiving a higher rate of reinforcement for implementing the intervention than for refraining from implementing the intervention. If this is applied to Herrnstein's (1961) hypothesis related to rate of reinforcement (and all other efficiency variables are equal), it seems plausible that the parent will continue to implement the intervention because he is receiving a higher rate of reinforcement for doing so. However, if the intervention is not effective and the frequency of biting does not decrease, it seems plausible that the parent may choose to stop implementing the intervention.

Combined Influence of Reinforcement Variables and Response Effort

Thus far, the four components of response efficiency have been discussed separately. However, McDowell (1988) proposed that rate of reinforcement, quality of reinforcement, response effort, and immediacy of reinforcement interact to affect the probability that an individual will engage in one behavior over another. Thus, an AAC user needs to analyze the interaction between a particular situation and the efficiency variables to determine the most efficient response to select when more than one communicative act is available. For example, in order to request assistance opening a candy bar wrapper in a darkened movie theater, an AAC user may be faced with the decision of using a natural gesture (such as tapping a communication partner's shoulder and pantomiming his inability to open the wrapper) or touching a symbol on his communication board indicating "HELP". In this context, the individual may choose to use the natural gesture even though it requires a greater response effort than using the communication board. Choosing a more effortful communicative act may seem out of concordance with parameters of response efficiency. However, in a dark environment, it may be impossible for the communication partner to see the AAC system. Thus, using the natural gesture may increase the likelihood that the communicative behavior has its intended effect and may result in an increase in rate, quality, and immediacy of reinforcement.

The combined impact of the variables related to efficiency on communication partners can be inferred when examining the outcomes of an investigation by Schepis and Reid (1995) who compared the frequency of staff interactions with a learner who experienced multiple disabilities when the learner had access to a voice output communication aid compared to when she did not have access to the communication aid and relied on vocalizations and gestures. Although the authors did not report data differentiating staff initiations and responses to learner produced communication acts, results revealed that staff interacted with the learner more frequently when she had access to the voice output communication aid. These results suggest that perhaps the learner's use of the voice output communication aid provided more salient cues than the learner's use of vocalizations and gestures. From the perspective of communicative partners, interactions with the AAC user when using the voice output communication aid may have resulted in a higher quality and/or immediacy of reinforcement. Or, perhaps the communication aid with speech output was easier for communication partners to understand thereby decreasing response effort. Although additional research is necessary in order to discern which variable(s) influence the behavior of communication partners (and different variables may influence the choice behavior of communication partners differently), it seems reasonable to hypothesize that communication partners may be more likely to initiate and/or maintain communicative interactions with AAC users if using AAC speeds up exchanges (immediacy of reinforcement), makes communication interactions more explicit or understandable (quality of reinforcement), or decreases the need for the communication partner to guess or infer intent (response effort).

In summary, it is important to recognize the potential role of the four components of response efficiency (response effort, rate of reinforcement, immediacy of reinforcement, and quality of reinforcement) for AAC users as well as for their communication partners. Although most of the empirical investigations that were reported and discussed provide inferred, rather than direct evidence of the operation of the components of response efficiency, there seems to be support for considering variables related to response efficiency when developing interventions involving AAC for beginning communicators with severe disabilities. A framework for considering the variables of response efficiency when designing and implementing interventions for learners with severe disabilities is provided in the following section.

Designing Interventions with Response Efficiency in Mind

Examining the role of response efficiency for AAC users as well as communication partners when designing and implementing interventions may increase contextual fit. Figure 1, below, provides a planning form that considers the four components of response efficiency when designing or troubleshooting AAC interventions. As discussed by Mace and Roberts (1993), the first step in incorporating the variables related to response efficiency into an intervention involves collecting information on the efficiency of the current behavior. After obtaining information regarding the efficiency of the current behavior, interventionists can formulate an intervention procedure that competes with the current behavior across the four variables of response efficiency. As noted by the planning form in Figure 1, interventionists are prompted to compare the efficiency of the current behavior to the efficiency of the desired behavior for AAC users or communication partners in order to ensure that the desired behavior is relatively more efficient. As discussed previously, McDowell (1988) proposed that the four components of efficiency (rate of reinforcement, quality of reinforcement, response effort, and immediacy of reinforcement) interact to affect the probability that an individual will engage in one behavior over another. Thus, when designing interventions with response efficiency in mind, it may not be necessary (or even possible) to ensure that the desired behavior is more efficient that the current behavior across all four variables. Rather, interventionists should strive to develop interventions where, overall, the new behavior is more efficient than the existing behavior.

Planning Form for Evaluating Response Efficiency Variables

Efficiency is being considered for (circle one): AAC User Communication Partner

Name of Individual(s) completing Planning form: ______________________________

Variable	**Current Behavior:** ________________	**Desired Behavior:** ________________	**Circle the Behavior that is More Efficient**
Response Effort	The physical effort required to engage in the current behavior is (circle one): ***High Medium Low*** The cognitive effort required to engage in the current behavior is (circle one): ***High Medium Low***	The physical effort required to engage in the desired behavior is circle one): ***High Medium Low*** The cognitive effort required to engage in the desired behavior is (circle one): ***High Medium Low***	***Current*** ***Desired*** ***No Difference***
Rate of Reinforcement	Observation reveals that the current behavior is reinforced ___% of the time (insert percentage).	Intervention is designed to ensure that the desired behavior is reinforced ___% of the time (insert percentage).	***Current*** ***Desired*** ***No Difference***
Quality of Reinforcement	The quality of reinforcement for engaging in the current behavior is (circle one): ***-highly non-preferred*** ***-non-preferred*** ***-neutral*** ***-preferred*** ***-highly preferred***	Intervention designed to ensure that the quality of reinforcement for engaging in the current behavior is (circle one): ***-highly non-preferred*** ***-non-preferred*** ***-neutral*** ***-preferred*** ***-highly preferred***	***Current*** ***Desired*** ***No Difference***
Immediacy of Reinforcement	The current behavior results in immediate reinforcement: ***YES NO***	Intervention is designed to ensure that the desired behavior results in immediate reinforcement: ***YES NO***	***Current*** ***Desired*** ***No Difference***

Figure 1. Planning form for Designing AAC interventions relative to response efficiency variables

Future Research

Siegal and Cress (2002) emphasize that communicative interactions are experienced mutually by AAC users and their communication partner and that both the AAC user and the communication partner are mutually affected in social interactions. Thus, experimental investigations are needed to explore (a) ways to increase the contextual fit of AAC interventions, (b) the impact of efficiency variables on the behavior of AAC users, and (c) the impact of efficiency variables on the behavior of communication partners.

Enhancing the Contextual Fit of AAC interventions

Albin et al. (1996) suggest that the biggest positive outcome resulting from strong contextual fit is implementation of the intervention plan. Enhancing contextual fit may alleviate many of the problems encountered by practitioners which include, but are not limited to, situations where (a) AAC systems are developed but not used by AAC users or communication partners, (b) the use of AAC systems by AAC users and/or communication partners is not generalized across a wide array of environments, or (c) the use of AAC systems by AAC users and/or communication partners is not maintained across time. Empirical work is needed to determine the most efficient and effective strategies for enhancing contextual fit when designing AAC interventions as well as for monitoring the contextual fit of AAC interventions on an ongoing basis.

Exploring the Impact of Efficiency Variables on the Behavior of AAC Users

To date, much of the research exploring the impact of efficiency variables on the behavior of AAC users has explored strategies for teaching a new behavior as a replacement to an existing, socially inappropriate, behavior. However, to be maximally efficient in acting on one's environment it is important to learn a variety of different social forms that can be used to achieve the same social outcome. Selecting among different social forms is determined, for the most part, by the relative efficiency of each form in a given situation (Reichle & Johnston, 1999). Additional empirical work is needed to explore the impact of efficiency variables on the behavior of AAC users when the AAC user has two or more socially appropriate forms in their repertoire. This is particularly important as interventionists strive to teach AAC users the conditional use of communication that requires an AAC user to engage in the most efficient behavior given the unique features of a specific physical and/or social environment.

Exploring the Impact of Efficiency Variables on the Behavior of Communication Partners

To date, there is only inferred (as opposed to direct) evidence of the operation of the components of response efficiency on the behavior of communication partners. Empirical work is needed in order to discern the extent to which efficiency variables influence the behavior of communication partners. Empirical investigations should also explore the extent to which factors such as age, gender, and familiarity with the AAC user influence the choice behavior of communication partners.

Summary

In sum, this paper (a) examined the importance of contextual fit in the design and implementation of AAC interventions, (b) explored the potential role of response efficiency for enhancing contextual fit, (c) presented a framework for examining the response efficiency of AAC interventions, and (d) provided a discussion of needed research. It seems likely that enhancing the efficiency of AAC for AAC users as well as communication partners will serve to increase contextual fit thereby increasing the overall effectiveness of AAC interventions.

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EIBT Research after Lovaas (1987): A Tale of Two Studies

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Abstract

Since the publication of Lovaas's (1987) seminal paper, serious questions have surfaced regarding design features that compromise the validity of treatment efficacy data resulting from studies of early intensive behavioral treatment (EIBT) for children with autism. Lovaas and his colleagues have acknowledged the legitimacy of some of these questions, and guidelines have emerged to improve the validity of future efficacy studies: (1) use random assignment of participants; (2) use uniform assessment protocols; (3) document enough methodological detail to support replication. Two recent studies are examined in reference to their compliance with these guidelines (Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Sallows and Graupner, 2005). Findings indicate that different levels of compliance result in different degrees of threats to internal validity.
Keywords: autism, autism spectrum disorders, early intensive behavioral treatment, Lovaas, random assignment, uniform assessment, replication.

Introduction

Since the publication of Lovaas's (1987) seminal study, a growing body of research has been conducted to document the treatment efficacy of early intensive behavioral treatment (EIBT) for children with autism spectrum disorders (e.g., Birnbrauer & Leach, 1993; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991; McEachin, Smith, & Lovaas, 1993; Scheinkopf & Siegal, 1998). However, serious questions have been raised about the validity of much of this research. Lovaas's (1987) study in particular, which was designed to examine the efficacy of treatment offered at the UCLA Young Autism Project, has been subjected to considerable criticism (e.g., Gresham & MacMillan, 1997; Schopler, Short, & Mesibov, 1989). While much of this criticism was challenged by Lovaas and his colleagues, some of it was acknowledged by them to be valid. Moreover, these acknowledgements served as the basis for emphasizing three research guidelines (among others) that could improve the validity of follow-up treatment efficacy studies. Unfortunately, the application of these guidelines has not always been consistent.

The current paper summarizes those criticisms of the Lovaas (1987) study that Lovaas and his colleagues have acknowledged as valid, and it summarizes the research guidelines that evolved from these criticisms. Further, two recently published EIBT studies are reviewed and evaluated relative to their compliance with these guidelines. The first study was conducted by Howard, Sparkman, Cohen, Green, and Stanislaw (2005) and the second was conducted by Sallows and Graupner (2005).

Criticisms of the Lovaas (1987) Research

Criticisms of the Lovaas (1987) research have been addressed by Tristram Smith, a colleague of Lovaas's and Research Director of the Multi-Site Young Autism Project. Specifically, Smith (in Smith, Groen, & Wynn, 2000) noted two criticisms with which Lovaas and his associates reportedly concur:

> First, assignment to groups was based on whether or not therapists were available to provide intensive treatment rather than on a more arbitrary procedure, such as the use of a random numbers table. Thus, *assignment could have been biased* [italics added]. Second,

> because children were referred to outside examiners, they received a variety of different tests rather than a uniform assessment protocol. Hence, *assessment results may have been unreliable* [italics added]. (p. 270)

While concurring with these criticisms, this concurrence was nonetheless qualified. For example, Lovaas and his colleagues have reportedly been dubious about the importance of the second criticism. Nevertheless, to address these (and other) criticisms relative to future research, they emphasized "the need for replication to confirm the results" (Smith et al., 2000, p. 270). Also inherent in their responses are three guidelines to be addressed by follow-up treatment efficacy studies: (1) random assignment of participants to treatment conditions; (2) use of uniform assessment protocols across all participants; and (3) documentation of sufficient methodological detail to allow for independent replication. Unfortunately, mixed results are evident in published follow-up studies relative to these recommendations. In the next section, we examine two prominent, recently-published EIBT studies to illustrate this point.

The Treatment Efficacy Study of Howard, Sparkman, Cohen, Green, and Stanislaw (2005)

Howard et al. (2005) studied 61 children diagnosed with either autistic disorder or pervasive developmental disorder-not otherwise specified (PDD-NOS). These participants were referred by nonprofit agencies ("regional centers") whose primary function is to meet the case management needs of people with developmental disabilities. To be eligible for the study, participants had to satisfy the following criteria: (a) receive a diagnosis of Autism or PDD-NOS before the 4th birthday; (b) be exposed to English as the primary language at home; (c) be available to begin treatment before the age of four years; and (d) have not received more than 100 hours of treatment prior to participating in the study.

Treatment Conditions

The children in the Howard et al.'s (2005) study participated in one of three different, multi-component treatment conditions. Each is summarized below:

Group #1: Intensive Behavior Analytic Intervention (IBT). In the IBT group, participants under 3 years of age received 1:1 intervention for 25 to 30 hours per week, while those over 3 years of age received 1:1 intervention for 35 to 40 hours per week. The IBT participants received treatment across multiple settings including school and home. Using discrete trial training, incidental teaching, as well as "other behavior analytic procedures" (Howard et al., p. 7), 50 to 100 trials per hour were presented. Further, parents were provided with training in fundamental behavior analytic strategies, maintenance and generalization data collection techniques, and methods for implementing their children's treatment programs "outside of regularly scheduled intervention hours" (p. 7). Parents were also required to attend meetings with agency staffers one to two times per month.

*Group #2: Autism Educational Programming (AP)***.** The AP participants received 25 to 30 hours per week of 1:1 or 1:2 interventions delivered in public school classrooms designated to serve students with autism. These participants received a range of interventions including activities derived from the TEACCH model, discrete trial training, Picture Exchange Communication System (PECS) training, and sensory integration therapy.

Group #3: Generic Educational Programming (GP). The GP participants received 15 hours per week of 1:6 interventions in special education, preschool classrooms designated to serve either early intervention or communicatively handicapped students. *Developmentally appropriate* instructional activities were employed, emphasizing "exposure to language, play activities, and a variety of sensory experiences" (Howard et al., p. 8). In addition, a certified speech-language pathologist provided most of the participants with language therapy once or twice a week.

Results

Standardized assessments targeting cognitive, nonverbal, receptive and expressive language, and adaptive skills were administered to the participants during intake and at follow-up (after approximately 14 months of treatment). At intake all three groups had "similar" (Howard et al., p. 11) mean scores on all but one measure. The only difference achieving statistical significance was in the domain of nonverbal skills. Moreover, for all three groups, the mean standard scores across most skill domains were considerably below 100. At follow-up, the differences in the mean scores of the participants in the AP and GP groups were *not* statistically significant. On the other hand, "the IBT group had higher mean scores in all domains than the other two groups combined; and those differences were statistically significant" (Howard et al., p. 11).

At follow-up, the IBT group's mean standard scores for the cognitive, nonverbal, communication, and motor skills domains were within normal range; the only domain in which the AP and GP groups scored in the normal range was motor skills. Thirteen IBT group participants exhibited gains in their IQ scores "from one standard deviation or more below average (i.e., IQ of 85 or lower) at intake to within one standard deviation of average or above (i.e., IQ of 86 or higher) at follow-up" (Howard et al., p. 11). Three other IBT participants whose intake IQ scores were in the normal range (i.e., 84, 89, and 97) exhibited follow-up gains (i.e., from 84 to 122, 89 to 114, and 97 to 102). At intake none of the AP participants exhibited IQ scores within the normal range; at follow-up, two exhibited IQs within the normal range. The IQ scores of 3 participants in the GP group changed from one (or more) standard deviations below average (at intake) to within normal range (at follow-up). Finally, two GP participants who exhibited intake IQ scores within the normal range displayed a *decrease* in their IQ scores at follow-up.

Compliance Guideline #1: Random Assignment

The Howard et al. study did not follow the first guideline. Specifically, a quasi-experimental pretest-posttest, nonequivalent groups design was employed. Participants were assigned to the groups by their respective individual education plan (IEP) or individual family service plan (IFSP) teams where "parental preferences weighed heavily" (p. 6). More specifically, each child's team considered "a range of educational options" which included (but was not limited to) placement in one of the three groups.

The Howard et al. study is appropriately characterized as a *nonequivalent* group design because the participants were not randomly assigned to the three conditions. McGuigan (1997) has defined *random assignment* as "a procedure that assures that each member of a population or universe has an equal probability of being selected" (p. 89). According to Durso and Mellgren (1989), random assignment is the "most important" method of controlling extraneous variables, and "the prerequisite for a *true experiment*" (p. 106). Similarly, Graziano and Raulin (2004) have described random assignment as "the most basic and single most important control procedure" (p. 207). Failure to randomly assign is a "basic weakness" (Kerlinger, 1973, p. 321) of nonequivalent group designs. Similarly, Tristram Smith (T. Smith, personal communication, July 25, 2005) has reported that one of the Howard et al. study's "limitations" is its use of nonrandom assignment. Thus, by failing to use random assignment, the design employed by Howard et al. is not considered a true experiment, but rather quasi-experimental (Cozby, 2001).

Howard et al. acknowledge that their use of nonrandom assignment constitutes a limitation of the study. However, they also assert that the three groups were "very similar" on "key" pretreatment, dependent measures, and that this is the "main purpose of random assignment" (p. 15). But *is* this its main purpose? According to Kerlinger (1973), random assignment is used to provide the rationale for assuming that groups are equal "in *all* characteristics" (p. 127; emphasis added), not just equal (or, worse yet, merely "similar") with respect to "key" (Howard et al., p.15) or "pertinent" (Kerlinger, p. 321) dependent variables. When "randomization is not used . . . it is *not possible* [italics added] to assume that the groups are equal" (p. 322). For McGuigan (1997), "the great value of randomization is that it randomly distributes extraneous effects, whatever they may be, over the experimental and control conditions"(p. 90). When "we do *not* randomly assign participants to groups, . . . we can expect confounds" (McGuigan, 1997, p. 90). Thus, lacking the presumption of equivalence, "we must consider the likelihood that alternative hypotheses may account for the results." (McBurney, 1998, p. 249). Two such alternative hypotheses shall now be considered.

Alternative Hypothesis #1: In accounting for the results reported by Howard et al., alternative hypothesis #1 centers on how differentially motivated to help their children the participants' parents were across the three conditions. Remember that, according to Howard et al., the parental preferences regarding educational placement (i.e., regarding assignment to a particular treatment condition) "weighed heavily" (p. 6). Further, recall that in the IBT treatment condition "parents received training in basic behavior analytic strategies, assisted in the collection of maintenance and generalization data, implemented programs with their children outside of regularly scheduled intervention hours, and met with the agency staff 1-2 times a month" (p. 7). In the other two treatment conditions, no such comparable demands on the parents were identified. Thus, one plausible alternative hypothesis is that those parents who were willing to actively participate in their children's treatment were more motivated to help them change, and thus more likely to choose the IBT condition, while those less motivated were more likely to opt for the AP and GP conditions.

Graziano and Raulin (2004) offered a similar alternative hypothesis in their discussion of a hypothetical pretest-posttest nonequivalent group design conducted to determine "whether eliminating food containing the additives thought to increase hyperactivity will help hyperactive children" (pp. 224-225). In this hypothetical quasi-experiment, the researcher formed the groups by asking the parents whether or not they were willing to effectuate for their children a 4 week diet which excluded the food additives:

> The children of those parents who were willing to expend the effort were put in the experimental group, and those who were not were put in the control group. The serious confounding in this procedure is that the experimental and the control groups are different in terms of parents' willingness to try the dietary restrictions. In other words, the dietary restriction treatment is confounded with parents' willingness to cooperate. We might assume that parents who are willing to do everything necessary to change their child's diet in hope of decreasing their child's hyperactivity may be more motivated to help their child to change. Any posttreatment differences between the groups on measures of hyperactivity might be due to either factor: dietary restriction or parental willingness to cooperate. (p. 225)

Similarly, in Howard et al.'s study, type of autism treatment (IBT, AP, GP) is confounded with parent's willingness to actively participate in treatment. Note that it is *not* the differing roles played by parents across the treatment conditions that is considered a confound; rather, it is differences in parental motivation that is the confound. Post-treatment differences between the IBT group and the two other conditions might be due to the IBT parents being more motivated than the parents in the other conditions to assist their children in changing. There are a number of plausible explanations why this increased motivation may serve as a confound. Perhaps the IBT parents, being more motivated, implemented the treatment program at times, and in locales, that exceeded what was required of them. Or perhaps the IBT parents were more motivated because their children had been more responsive to their earlier attempts to teach them (i.e., *prior* to their entry into the study), thus giving the parents some hope of success when eventually exposed to a highly structured training regimen.

Alternative hypothesis #2. This hypothesis concerns bias associated with the influence of the non-parental members of the IEP/IFSP teams, including the special education and case management professionals. As fiduciaries within a federally mandated special education process, these team members had both a legal and ethical responsibility to advocate assigning to the IBT group only those children for whom such a placement would be “appropriate” based on the child's IEP/IFSP. An “appropriate” placement is one which permits the child to “benefit educationally” from the instruction (Bateman & Linden, 1992/1998, pp. 143-144). So, although the parents' choice of treatment conditions may have, according to Howard et al., “weighed heavily,” the other members of the team doubtless used their expertise to influence the eventual decision.

Indeed, during part of the time in which the Howard et al. study was conducted, representatives of Therapeutic Pathways (the service provider under whose auspices the Howard et al study was conducted) were empowered to play a determinative role in the IEP/IFSP process, *regardless of parental preferences*. Specifically, the Howard et al study was conducted “from 1996 through 2003” (Howard et al., p. 6). In their 1999 manual “In-home Programs for Young Children with Autism,” Therapeutic Pathways required the parents to grant Therapeutic Pathways the ultimate decision making power regarding the range and content of the treatment program, as well as eventual school placement[1]. A reasonable assumption is that Therapeutic Pathways staffers used this power to place in the IBT condition those participants who, in their professional judgment, were more likely to benefit from the program, and to refer the other participants to the other conditions. If this is the case, then experimenter-based, biased assignment to groups provides an obvious alternative explanation of the results.

Consider also another example of the decisive role played by Therapeutic Pathways. As a “nonpublic” (i.e., private) agency, the representatives of the service provider were free to refuse to treat any child who, in their judgment, would not benefit from their program. Howard et al. do not inform us whether or not the service provider exercised this option and, if they did, the criteria that were used. Obviously, if they refused to treat some children whom they judged would not benefit from the program, then this, too, suggests bias.

Compliance with Guideline 2: Use of Uniform Assessment Protocol

Although not identified by Smith (T. Smith, personal communication, July 25, 2005) as a limitation of the study, a close reading of the published paper (Howard et al., pp. 8-10) indicates that the researchers failed to use a uniform assessment protocol during intake and follow-up, thus risking unreliable measurement. Consider these assessment issues in detail across these domains: Cognitive skills, nonverbal skills, receptive and expressive language, and adaptive skills.

Assessment of Cognitive skills. The participants' cognitive skills were assessed using a number of different instruments at intake. Specifically, 42 participants were assessed using the *Bayley Scales of Infant Development-Revised*; 10 participants were assessed using the *Wechsler Primary Preschool Scales of Intelligence-Revised*; 3 were assessed using the *Developmental Profile-II*; and 2 were assessed using the Stanford-Binet Intelligence Scale. Three additional instruments were used to assess each of three children, respectively: *Differential Abilities Scale*, *Developmental Assessment of Young Children*, and *Psychoeducational Profile Revised*.

At follow-up, "the test used . . . varied with the chronological ages of the child" (p. 9). A majority of the participants (i.e. 47 children) participated in cognitive assessments using an instrument that was *not* used at intake (i.e., the *Wechsler Primary Preschool Scales of Intelligence-Revised*). However, three instruments used during intake assessment of cognitive skills were also used at follow-up, albeit for a small number of participants. Specifically, 4 participants were assessed at follow-up using the *Bayley Scales of Infant Development*; 3 were assessed using the *Stanford-Binet Intelligence Scale*; and 2 were assessed using the *Differential Abilities Scale*.

Assessment of Nonverbal skills. At intake, the nonverbal skills of 48 participants were assessed using the *Merrill-Palmer Scale of Mental Tests;* and one participant was assessed using the *Stanford-Binet Performance Test*. At follow-up, 54 participants were assessed with the same instrument used during intake (i.e., the *Merrill-Palmer Scale of Mental Tests*). One participant was assessed at follow-up using an the *Leiter International Performance Scale Revised*, which was not used at intake.

Assessment of Receptive and Expressive Language. The *Reynell Developmental Language Scales* were used to assess the receptive and expressive language skills of 46 participants at intake. Other instruments used at intake included the Rossetti Infant-Toddler Language Scale (for 5 participants); the *Receptive-Expressive Emergent Language Scales-Revised* (for 3 participants), and the *Preschool Language Scale* (for 3 participants). One child was assessed with three instruments at intake, including the *Toddler Developmental Assessment*, the *Peabody Picture Vocabulary Test-3rd Edition*, the *Expressive Vocabulary Test*, and the *Developmental Profile-II* language scale. In the case of one client, there was no assessment of receptive and expressive language skills.

At follow-up, 47 participants were assessed using the same instrument that was used during intake (the *Reynell Developmental Language Scales*). Other instruments used at follow-up (only some of which had also been used during intake) included the *Sequenced Inventory of Communication Development-Revised Edition* (for 3 participants); *Peabody Picture Vocabulary Test-3rd edition* along with the *Expressive Vocabulary Test* (for 2 participants); *Preschool Language Scales-3* (for 2 participants); and the *Expressive One-Word Picture Vocabulary Test* along with the *Receptive One-Word Picture Vocabulary Test* (for 1 participant). In the case of 6 participants, the receptive and expressive language skills were not measured at all during follow-up.

Assessment of Adaptive Skills. At intake, 54 participants were assessed using the *Vineland Adaptive Behavior Scales*. Other instruments used were: the personal adjustment or self-help scales of the *Denver Developmental Screening Test II* (3 participants), *Developmental Profile-II* (1 participant), and the *Rockford Infant Development Evaluation Scales* (1 participant). Two participants were not assessed at all during intake. At follow-up, 56 participants were assessed using the *Vineland Adaptive Behavior Scales*, and 6 participants received no assessment.

Compliance with Guideline #3: Replicability

According to Tristram Smith (T. Smith, personal communication, July 25, 2005), another weakness of the Howard et al. study is that it provides "limited information about the interventions". This weakness makes it next to impossible to replicate. Similarly, Smith's third, remaining criticism (i.e., that there were "unclear procedures for rating the presence or absence of symptoms of autism") also implies that it would be difficult to attempt replication without greater clarity in this area (not to mention that this weakness raises the issue of possible biased sampling and biased assignment to groups).

Other Methodological Problems

According to Howard et al., follow-up assessments were conducted by examiners who were *not* blind to treatment condition assignments of the participants. This raises the obvious issue of examiner bias in favor of IBT, which is clearly a threat to internal validity. Howard et al. argue, however, that given the substantial number of different examiners reportedly used, it is "just as likely" (p. 15) that some assessors were biased *against* IBT as *for* IBT. Unfortunately, no evidence is offered to support this assertion.

Indeed, although the examiners are identified as "independent" of both the investigators and the treatment programs, it remains unclear how these follow-up examiners were funded and thus, how independent they actually were. As Howard et al. reported, one of the agencies funding the research was Valley Mountain Regional Center (VMRC). During the time frame in which the Howard et al. study was conducted, VMRC also contracted with independent vendors to do assessments (N. McGonigle, personal communication, June 14, 2006). Were any of these VMRC-funded vendors used to conduct any of the follow-up assessments in the Howard et al. study? If so, then at least some of these follow-up assessments were funded by the *same* agency that provided funding for the research (i.e., VMRC). This raises the issue of conflict of interest, thereby strengthening concerns about potential (presumably unintentional) bias on the part of the examiners.

An additional potential conflict of interest problem concerns Howard et al.'s third author, an individual who served as the Clinical Director of VMRC during the study's time frame. As the supervisor of some VMRC staffers involved in making placement decisions, what role, if any, did he play in influencing their decisions? There is clearly a conflict between (1) his role as a fiduciary with a responsibility to see to it that only those who are likely to benefit from the IBT treatment package are so assigned and (2) his role as researcher with a responsibility to avoid biased assignment to groups. How was this conflict in roles resolved? Howard et al. do not say.

The Treatment Efficacy Study of Sallows and Graupner (2005)

Sallows and Graupner (2005) studied 24 children with a diagnosis of autism. At intake these children met six criteria: (1) they ranged in age between 24 to 42 months; (2) they had a Mental Development Index "ratio estimate" (i.e., MA divided by CA) of 35 or more; (3) they were "neurologically within normal limits." (Note, however, that children with abnormal EEGs or controlled seizures were accepted as determined by a pediatric neurologist, and no child was excluded based on this criterion.); (4) a developmental diagnosis was established by "independent child psychiatrists" (p. 420); and (5) the diagnosis met the DSM-IV and Autism Diagnostic Interview-Revised criteria for autism. (A "trained examiner" administered both instruments.) In addition, (6) "there were no parental criteria for involvement beyond agreeing to the conditions in the informed consent document" (p. 420).

Treatment Conditions

Each participant was assigned to one of two groups. The nature of each group is summarized below:

Group #1: Clinic-Directed. This group received treatment "replicating the parameters of the UCLA intensive behavioral treatment" (Sallows & Graupner, p. 420). Specifically, the group received "the treatment procedure and curriculum . . . initially described by Lovaas (Lovaas et al., 1981) except that no aversives were used." Additional procedures, buttressed by subsequent research (e.g., Koegel & Koegel, 1995) were also employed (Sallows & Graupner, p. 422). During the first two years, participants received an average of 38 hours per week of direct treatment. Thereafter, as the children began school, the weekly direct treatment hours were gradually decreased. This group "received 6 to 10 hours per week of in-home supervision from a senior therapist and weekly consultation by the senior author or clinic supervisor" (p. 421). Further, "parents were instructed to attend weekly team meetings and were encouraged to extend the impact of treatment by practicing the newly learned material with their child throughout the day" (p. 420).

Group #2: Parent-Directed. This group received essentially the same treatment as Group #1, except that it was less intense. Specifically, "parents in the parent-directed group chose the number of weekly treatment hours provided by therapists" (p. 421). Thus, during the first two years, participants averaged 31.5 hours per week of direct treatment "with the exception that one family chose to have 14 hours both years" (p. 421). As with Group #1, direct treatment hours were then slowly decreased as the child entered school. Further, this group "received 6 hours per month of in-home supervision from a senior therapist (typically a 3-hour session every other week) and consultation every 2 months by the senior author or clinic supervisor" (p. 421). As with Group #1, parents were told to attend weekly team meetings and urged to practice their newly acquired skills throughout the day with their children.

Results

Sallows and Graupner (2005, p. 417) reported that the "outcome after 4 years of treatment, including cognitive, language, adaptive, social, and academic measures, was similar for both groups." For example, on average, the full scale IQ for all participants showed a 25 point increase. Specifically, the authors noted that

> Parent-directed children, who received 6 hours per month of supervision . . . did about as well as clinic-directed children, although they received much less supervision. This was unexpected, and it may have been due in part to parent-directed parents taking on the senior therapist role, filling cancelled shifts themselves, actively targeting generalization, and pursuing teachers and neighbors to find peers for daily play dates with their children. Although many parent-directed parents initially made decisions regarding treatment that resulted in their children progressing slowly . . . , many parents then sought input from treatment supervisors and rapidly learned to avoid making the same mistake twice, becoming quite skillful after a few months. (p. 433)

Compliance with *Guideline #1: Random Assignment*

Sallows and Graupner's study is a product of the Wisconsin Young Autism Project. As participants in the Lovaas' Multi-Site Young Autism Project, these researchers "worked in collaboration with and observed the guidelines set by the National Institutes of Mental Health" (p. 419). Thus, in adherence to NIMH-approved research protocol, preschoolers diagnosed with autism were matched "on pretreatment IQ (Bayler MA divided by CA)" and then "randomly assigned by a UCLA statistician" to the clinic-directed group or the parent-directed group. In short, matched *random* assignment was used, thus satisfying the first guideline. Indeed, it is noteworthy that, while parents clearly had the option to drop out of the study if unhappy with their child's group assignment, "none dropped out upon learning of their group assignment, minimizing bias in selection of participants and group composition" (p. 420).

By randomly assigning participants to groups, this study avoided many of the problems associated with nonrandom assignment (see previous discussion). Further, in employing *matched* random assignment, the study achieved additional benefits. Random assignment is employed to make it more likely that "the difference between subjects that might affect the outcome of the experiment will be even, or averaged out" (Durso & Mellgren, 1989, p. 159). However, by chance, subjects with characteristics likely to strengthen post-treatment performance may still be disproportionately assigned to one condition over the other. Matching is recommended as a means of addressing this threat to internal validity under certain conditions. Specifically, whenever possible, the researcher should use matching if "there is a subject characteristic that is *highly correlated with the dependent variable"* (Durso & Mellgren, 1989, p. 162). Citing a number of studies (e.g., Bibby, Eikeseth, S., Martin, N. T., Mudford, O. C., & Reeves, D., 2002; Lovaas, 1987), Sallows and Graupner (2005) identified IQ as one of the "most commonly noted predictors" (p. 419) of post-treatment outcome. So, participants in the Sallows & Graupner study were first matched on pretreatment IQ and then randomly assigned to either the clinic-directed or parent-directed group, thereby bolstering the benefits achieved when only simple random assignment is used.

Compliance with Guideline #2: Uniform Assessment

During intake, pretreatment measures were taken of all participants, using five different instruments: (a) the *Bayley Scales of Infant Development*, Second Edition; (b) the *Merrill-Palmer Scale of Mental Tests*; (c) *Reynell Developmental Language Scales*; (d) *Vineland Adaptive Behavior Scales* and (e) the *Early Learning Measure* (an experimental assessment tool developed by Smith, Buch, & Gamby, 2000). In addition, direct observation, reports of other professionals, and parent interviews were used to determine the developmental history, "supplemental treatments" history, and presence/absence of functional speech. In sum, a uniform assessment protocol appears to have been followed at intake, thus adhering to the second guideline. However, at follow-up, which occurred annually over a four-year period, this guideline was not strictly followed. With the exception of the Early Learning Measure (which was only given a second time, after several months of treatment), all of the pretreatment instruments were administered at follow-up to at least *some* of the participants. Instruments administered *only at* follow-up (i.e., not at intake) included the *Wechsler Preschool and Primary Scale of Intelligence-Revised*; the *Wechsler Intelligence Scale for Children--WISC-III*; the *Leiter R; the Clinical Evaluation of Language Fundamentals*, Third Edition; the *Woodcock Johnson III Tests of Achievemen*; the *Personality Inventory for Children*; and the *Child Behavior Checklist*. Explaining the use of these other instruments, Sallows and Graupner reported that "as children grew older or became too advanced for the norms of pretreatment tests, we used other age-appropriate tests" (p. 421).

Compliance with Guideline #3: Replicability

The guideline calling for sufficient information to allow for replication was largely satisfied. The researchers not only employed a widely available, detailed set of instructional strategies (e.g., Lovaas et. al., 1981), they also provided additional detail within the body of their paper. For example, they reported that no aversives were used, and that in addition to Lovaas et al. (1981), other treatment procedures inspired by more recent research (e.g., Koegel & Koegel, 1995) were also used. Additional treatment strategies used included conducting only two to three training trials at a time, and using continuous, immediate, and powerful reinforcement. "Between these brief (initially 30 seconds long) learning periods, staff members played with the children to keep the process more like play than work, generalize learned material into more natural settings, and continue to build social responsiveness" (see Sallows & Graupner, 2005, p.422-423 for a discussion of treatment strategies used).

Conclusion

Almost two decades have elapsed since the publication of Lovaas's (1987) original treatment efficacy study. During the first decade, many of the criticisms of that study appeared in print, along with subsequent responses to these criticisms by Lovaas and his colleagues. These responses acknowledged the legitimacy of some of the criticisms, thereby suggesting some minimal, necessary guidelines to be followed by follow-up research. In this paper, two recent treatment efficacy studies were described and evaluated in reference to the three guidelines. Results indicated that when these guidelines are followed, the results are better equipped to withstand criticisms; and when they are not followed, the results are more vulnerable to these critiques.

Utilizing a pretest-posttest nonequivalent groups design, the Howard, Sparkman, Cohen, Green, and Stanislaw (2005) study failed to demonstrate the superiority of early intensive behavioral treatment over that provided by special day classes in public schools. This failure was further exacerbated by Howard et al.'s use of a non-uniform assessment protocol (suggesting unreliability of measurement), as well as their failure to provide anything approaching adequate information about the details of each treatment condition, thus making replication impossible. In comparison, the Sallows and Graupner (2005) study utilized matched, random assignment, an assessment protocol more closely approximating uniformity, and sufficient detail to allow for replication, thus advancing our knowledge of the efficacy of parent-directed early intensive behavioral treatment (EIBT) as a less intrusive, less costly alternative to clinic-directed EIBT treatment.

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Notes

1. *While I am not a lawyer, surrendering broad, decision making power to one member of an IEP/IFSP team seems inconsistent with federal law. Specifically, I doubt that parents can voluntarily surrender their rights, or the rights of other IEP/IFSP members, given that all are considered equal partners in the IEP/IFSP process (see Bateman, B. D. & Linden, M. A., 1992/1998).*

Author's Note: *Disclaimer: The views expressed here are not necessarily shared by my employer, the Stanislaus County Office of Education (Modesto, CA), nor by my fellow employees.*

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Maternal Speech to Children with Down Syndrome: An Update

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Abstract

Recent research on maternal speech to children with Down Syndrome (DS) generally corroborates studies conducted in the 1970s and 1980s. Specifically, the characteristics of language used by parents when speaking to children with mental retardation closely matches the characteristics of language addressed to typical children with the same language age. The question remains, however, why the language of children with DS develops more slowly and sometimes never reaches adult levels. This question is examined in reference to nativistic and learning theory frameworks.
Keywords: language development, Down Syndrome, child-addressed speech, maternal speech, language environment, nativism, learning theory.

Early Studies of Child-Addressed Speech

Early studies of child-addressed speech examined the nature of maternal language input to typically developing (TD) language-normal children (Broen, 1972; Snow, 1972). Additionally, researchers analysed the verbal relationships between cognitively-normal adults and institutionalized adults with mental retardation (MR) (Siegel, 1963a,b,c, 1967; Siegel & Harkins, 1963; Spradlin & Rosenberg, 1964). In combination, these studies led researchers to question whether the language input to children with MR could be considered appropriate for their level of language development.

Buium, Rynders, and Turnure (1974) assessed this question by comparing mother-child verbal interactions in a sample of TD children versus children with DS matched to the TD children for chronological age (CA=2 years). Data were collected in the laboratory while individual child-parent dyads engaged in collaborative play and in an instructional task. Results included statistically significant differences between the two samples of mothers regarding numerous aspects of the speech addressed to the children, and all differences suggested that the language addressed to TD children was more sophisticated than the language addressed to children with DS. The mothers of children with DS were observed to direct higher proportions of imperatives to their children than did the mothers of TD children. Buium et al. interpreted these results as demonstrating that the linguistic environment of language-learning children with DS is different from that of TD children and therefore worthy of careful consideration in any attempt to understand the language delays of the former.

Buium et al.'s interpretation was supported by independent research (e.g., Kogan, Wimberger, & Bobbitt, 1969; Marshall, Hegrenes, & Goldstein, 1973) showing that mothers of DS children are more directive and less likely to invite their child to take the lead in dyadic interaction than are the mothers of the CA-matched TD children. There was a shared belief in the specialized literature of the early- and mid-seventies that the differences in the language environment of TD children and children with MR had a negative influence on the language development of children with MR (e.g., Seitz, 1975; Mahoney, 1975; Mahoney & Seely, 1976; Mitchell, 1976; Levi & Zollinger, 1981). Such a belief was sometimes echoed without nuance as, for example, in Dolley (1974) who characterized adult and maternal speech to children with MR with respect to the restricted linguistic codes defined in Bernstein's early work on lower-social classes (Bernstein, 1961, 1964).

The observation that mothers of children with MR tend to be more directive than mothers of CA-matched TD children (particularly in teaching situations) may not at all be due to a teaching style that is specific to mothers of children with MR. Instead, Rondal (1978a) argued that it may reflect the perceived necessity of these mothers to participate more actively in prompting the learning of their children with developmental delays.

A major methodological problem in the early studies relates to the strategy of matching control group children by chronological age (CA). As demonstrated in the studies of the ’70s and ’80s, parental speech to language-learning TD children is closely related to the levels of language comprehension and production of the children (cf. Rondal, 1985, for a full analysis). Therefore it may be not so much the CAs of the children with MR that matter in the regulation of the verbal interactions between parents and children but rather the linguistic levels of the children. This point was demonstrated in several studies that appeared in the late ‘70s (Rondal, 1976, 1978a; Gutmann & Rondal, 1979; Buckhalt, Rutherford, & Goldberg, 1978; Cunningham, Reuler, Blackwell, & Deck, 1981; Petersen & Sherrod, 1982; Maurer & Sherrod, 1987; Mahoney, 1988). In fact, when children with MR are matched with TD for level of language development, maternal language input does not differ substantially across groups.

Rondal (1976, 1978a) analyzed 20 measures of maternal speech output, including numerical, lexical, semantic-structural, semantic-pragmatic, and language-teaching aspects. Included in the latter category were proportions of verbal approval and disapproval of children’s utterances, utterances produced to catch the attention of the child, self-repetitions, frontal auxiliaries, expansions of children’s utterances, explicit corrections of children’s utterances, and repetitions of the child’s utterances. The study covered the interval of development from 3 to 12 years-CA in the DS children. In contrast to the absence of differences in maternal speech to TD children vs. children with DS at corresponding MLUs (mean length of utterances levels), numerous significant differences were recorded in maternal speech depending on the language levels of the children. This confirmed that expressive language level is a far more powerful factor influencing maternal speech than whether the children are TD or have MR.

In a rare study that included both fathers and mothers of DS children, Maurer and Sherrod (1987) observed no marked differences in the verbal behaviors of the fathers of DS children vs. fathers of developmentally matched TD children. These findings replicated the basic similarity between mothers’ and fathers’ speech found in parental speech to TD children (Golinkoff & Ames, 1979; Rondal, 1980; Brédart-Compernol, Rondal, & Perée, 1981).

To the best of our knowledge, the role of language comprehension by children with MR has not been studied systematically to assess its potentially (co-)determining regulatory role regarding maternal speech. Some correlational data gathered with TD children (Cross, 1977, 1980; Furrow, Nelson, & Benedict, 1979) suggest that even if the child’s productive level largely contributes to fixing the average formal complexity of parental speech, his or her receptive ability determines the maximal complexity of the latter at any time. This hypothesis is all the more likely to be correct given that the child’s verbal comprehension is directly related to the efficiency of parental instructions. This pragmatic motivation is obviously central in dealing with children’s behaviors, particularly in the case of the younger ones.

More Recent Contributions

Perhaps not surprisingly (given that the basic problems could be considered as largely solved in the earlier studies), fewer works have been published in more recent years on mothers’ speech to language-learning children with MR. A bibliographic search in the world databases PsycINFO and ERIC, in the first part of 2006, yielded only three independent sources over the last twenty years. We briefly review these contributions in what follows. With one exception, they are in agreement with the preceding stance.

Hooshyar (1987a; also 1986; 1987b) collected data on language patterns in the interactions of mother-child dyads involving 20 TD children and 20 children with DS. The children in each group were matched for MLU, and their ages ranged from 38 to 107 months. Interactions were videotaped for 20 minutes during free play and mealtime. The utterances of the partners were coded according to seven categories: query, declarative, imperative, performative, feedback, imitation, and self-repetition. The children were divided into two groups: those with a lower MLU [below 1.75; following Brown's (1973) criteria] and those with a higher MLU (beyond 1.75). Data from the mothers were analysed according to a four-way coding scheme: (1) utterances not influenced by the child's condition (TD vs. DS); (2) utterances influenced only by the child's MLU; (3) utterances influenced by the child's condition; and (4) utterances influenced by both condition and MLU. Results confirmed the child's linguistic ability as the primary determinant of maternal speech. Mothers' speech directed to children with DS and to MLU-matched TD children were not significantly different. In both conditions, overall more queries and a larger total number of utterances were directed to children with lower MLU, whereas imitation strategy was employed more with children who had a higher MLU.

Harris (1995) explored five aspects of maternal style: joint attention, topic control, responsiveness, object reference, and directives. Her sample included mother-child dyads involving 28 children with DS and 17 TD children. All children were at the holophrastic stage of language development at the beginning of the study. Their language was assessed at the time of recruitment and thirteen months later with the *Reynell Developmental Scales*. Both groups of mothers used similar strategies for labelling objects, responding to the children's vocalizations, and for directives. The mothers of children with DS did not appear to be more directive than the mothers of the TD children. The former mothers spent more time in joint attention and devoted more time to toys than the latter. This may have to do with a greater immaturity among children with DS than among TD children even when matched on early language level. For children in both groups, maternal language inside joint attention was positively associated with language gains whereas maternal language outside of joint attention was negatively associated with language gains. TD children appeared more sensitive to maternal language in the sense that they made more progress on related aspects of their language than did the children with DS during the interval of time covered by the study.

Cardoso-Martins and Mervis (1985; also Martins, 1985) examined the linguistic environment of five prelinguistic children with DS (CAs: 21 to 37 months) matched for level of development, CA, and MA, respectively, to three groups of TD children (in the MA-matched group, TD children had MAs between 13 and 18 months). Mothers and children participated in a 45-minute free-play session at home using a chosen set of toys. The language of the mothers of children with DS differed from that of the mothers of each group of TD children. Mothers of the children with DS used more imperatives and fewer nominal deictics (e.g., This is a ball) and nouns vs. pronouns. Cardoso-Martins and Mervis (1985) claim that mothers of children with DS contribute to the delayed lexical development of their offspring by failing to provide them with a sufficient amount of referent-label pairings. As noted by Rosenberg and Abbeduto (1993), Cardoso-Martins and Mervis' (1985) implication is unwarranted. They have not established a causal relation between maternal labelling behaviors and children's vocabulary development.

In later works, Mervis and Bertrand (1994, 1995) showed that besides MA (Barrett & Diniz, 1989; Rondal, 1985, 2002) particular cognitive strategies (e.g., mutual exclusivity, entire object reference, novel name—nameless category principles) play an important role in receptive lexical development, favoring a first identification of the target referents and their pairing with conventional labels. Once children with DS have begun to use at least some of these strategies, like younger TD children do, they acquire vocabulary items more rapidly. The observation that mothers of prelinguistic infants with DS use fewer nominal deictics and nouns (the two measures being correlated) than mothers of TD prelinguistic infants, even if valid (given that it has not been replicated in other studies) does not demonstrate that maternal speech to prelinguistic infants with DS is detrimental to lexical development.

There has been, to our knowledge, only one other study conducted on mother-child verbal-vocal interactions at the prelinguistic stage. Specifically, Jones (1977) studied the communicative patterns of dyads involving prelinguistic TD children and children with DS for a period of 3 months. She found that the infants with DS were less involved in child-dependent interactions (i.e., interactions in which the mothers followed the child's initiative). In contrast, DS infants were more involved in mother-directed interactions. It is likely that being maturationally delayed, prelinguistic infants with DS (a kind of CA-matching, in fact, even if it may appear to be a match on "linguistic level") are not comparable to TD infants at the very start of lexical development (as in Cardoso-Martins & Mervis' study). It may be all the more difficult for mothers of DS infants at this stage given the often described greater passivity of their offspring to assess developmental level with any degree of precision. Lastly, one will recall for the sake of the present argument, that it is only when the TD child starts his/her "genuine" linguistic development, that is with the first conventional words, that parental adaptations reach maximal sensitivity regarding the children's language level (i.e., the time at which maternal MLUs are lowest in average values) (cf. Rondal, 1985).

Leaving aside the inconclusive indication of Cardoso-Martins and Mervis (1985), it seems that the conclusions reached in the earlier studies on maternal language to language-learning DS children are supported by the more recent studies. The linguistic environment supplied by the mothers of children with DS appears indeed to supply the sort of Vygotskyan zone of proximal development that may be considered essential for first language acquisition.

Clinical Implications

The basic soundness, formally and functionally, of maternal language to language-learning children with DS does not imply that nothing could be done to further adapt this input in order to favor a more rapid language acquisition in these children. Ways to render the input to children with MR more salient regarding particular aspects that the child happens to be dealing with in her/his development at given moments can be implemented. Demonstrating this point is the clinical research published by Cheseldine and McConkey (1979). These researchers succeeded in favoring a more rapid passing than usually observed from the one-word stage of expression to a level including a high frequency of two-word utterances, in children with moderate MR (including children with DS), by having the parents markedly reducing the length and complexity of their speech to their children during experimental sessions conducted at home.

Although it is not by far an easy task to monitor parental input (if only a few hours a week), parents can always be advised regarding the logical implication of the preceding data concerning their verbal interactions. A relevant advise is to maintain the input within close range of the child's developmental level providing her or him with language that is semantically rich and pragmatically appropriate but only slightly more complex formally than their own. This may run contrary to the naïve belief of well-intentioned parents that more complex input in absolute value should always be facilitative [the kind of belief that presided over the first research works on the topic (e.g., Buium et al., 1974)].

Correctly adapted parental responsiveness has become a central feature of particular intervention curricula designed to address the language but also the cognitive and social needs of young children with developmental problems (including children with DS). One will see for a good case in point the work of Mahoney and associates (e.g., Mahoney, in press; Mahoney, Finger, & Powell, 1985). These researchers have demonstrated the effectiveness of adapted parental responsiveness on several developmental pivotal behaviors in large groups of children with developmental problems.

Theoretical Considerations

If the linguistic environment of a child with MR is not problematic, how are we to explain her (his) language difficulties? Recall Harris's (1987) observation that exposed to corresponding language input DS children profit less from the input over the same period of time than their TD counterparts.

Several explanatory perspectives may be considered, acknowledging that the language development of children with MR follows the same steps and sequences of steps and seem to witness the same processes as typical development (of course, with considerable delays and incompleteness; cf. Rondal & Edwards, 1997, for a discussion). A confirmed explanation is not possible yet (logically, if not empirically), as long as the exact determinism of language ontogenesis in TD children is not firmly established.

For lack of experimental evidence, we are still unable to weight the respective influences on language development of possible innate linguistic representations and learning-constructions. Although Chomskyan types of ideas concerning formal and/or functional grammatical categories (Pinker, 1994) are less accepted in the sense that their supposed genetic origins and cerebral underpinnings remain as mysterious as they were when first proposed (Tomasello, 1995; Rondal, 2006a), they can not be completely ruled out on the basis of the available information. Contrastive, modelised and empirically validated, proposals exist under the banner of connexionism (see Rondal, 2006a, for an analysis), suggesting that it is possible to dispense from formal rules and linguistic representations qua representations in language functioning. The relevant paradigm for language learning development in the latter perspective may be implicit learning and memory; a paradigm first explored by Reber (1967) that has been rejuvenated in recent years to accommodate a large number of cognitive and linguistic facts regarding development (cf. Paradis, 2004; Rondal, 2006a).

Within a perspective such as representational nativism (Pinker, 1994), what prevents an individual with MR from developing fully grammatical language in the first place is the lack of preservation or transcription (not clearly established nor perhaps establishable) of the (supposed) genetic blueprint for grammar. In conformity with such a hypothesis, Pinker (1994) proposed that adolescents with Williams Syndrome (a genetically-based disability) may have better morphosyntactic abilities despite their MR because grammatically-relevant genetic information has been preserved. However, Pinker (1994)'s claim that grammar is mostly intact in WS has been falsified in more recent works (cf. Rondal, 2006a).

In an implicit learning perspective applied to mental retardation, the emphasis would be on problems in the learning of language itself. Although current views of implicit learning see it as robust and relatively independent of general cognitive abilities, semantic and overall procedural memorizing, and possibly abstracting from language input towards formal and functional grammatical categories (if these categories are indeed needed to function properly linguistically, which may be questioned; cf. Paradis, 2004; Rondal, 2006a; for discussions regarding this point), may represent particularly difficult tasks for children with MR.

There is also the repeated claim in recent years, that working memory limitations in Baddeley's terms, (1980), particularly regarding the so-called phonological loop (i.e., a subsystem based on verbal items, allowing to refresh the incoming information therefore with a greater chance to have it transferred to longer-term stores) are largely responsible for the difficulties of children with MR in language development (cf. Brock & Jarrod, 2005). As convincing as the data of Jarrod and associates look, it remains that working memory a form of explicit memory, is of limited relevance to implicit learning.

Whichever the final answer to the preceding theoretical interrogations, it is clear that it is the child who is in charge of her or his language development, even if parental input appears facilitative.

Interpretable in this direction, are data regarding the feedback question, i.e., the way parents react to children's utterances. Contrary to some proposals in the Eighties (e.g., Moerk, 1983, 1992), no formal teaching motivation or capacity can be reasonably attributed to parents of TD children (and likely also to parents of children with MR) beyond the supply of an appropriate input for language construction. The analyses of parental reactions to children's utterances (cf. Rondal, 1997) show that these reactions are motivated almost exclusively, particularly with younger children, by the veridicality and semantic aspects of the productions. Parental feedback is almost always a response to the semantic and pragmatic aspects of children's speech, but not or much less to its morphosyntactic aspects (given that semantically appropriate but grammatically incorrect utterances may be approved, whereas grammatically correct but semantically or pragmatically inappropriate ones tend to be discarded).

The child is responsible for analysing the input received and inducing the relevant regulatory patterns. A child with MR is at a major disadvantage in this respect, not because of an input that would be ill-adapted, as seen, but because of limitations in devoted psycholinguistic abilities as a result of neuropsychological limitations which have begun to be documented (cf. Wisniewsky, et al, 2006; Rondal, 2006b).

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Training in Phonological Awareness Generalizes to Phonological Working Memory: A Preliminary Investigation

Anne van Kleeck, Ronald B. Gilla and LaVae M. Hoffman

Abstract

Early reading achievement relies on phonological awareness (PA) and phonological working memory (WM). Children with language impairment (LI) have problems with both. Three studies were conducted to determine whether treating PA would also improve phonological WM in preschoolers with LI. Study 1 confirmed that children with specific LI perform more poorly than age-matched peers on both PA and WM tasks. Study 2 showed that when children with and without LI are matched on a nonword WM task, differences between the groups on PA and on a word WM task are no longer statistically significant. In Study 3, sixteen preschool children with LI received intervention targeting PA skills and improved both their PA and WM abilities. These studies support the use of PA instruction to improve basic phonological mechanisms underlying working memory.
Keywords: literacy, language disorder, intervention, preschool children.

Introduction

Scholars and practitioners alike are by now well aware that children with language impairments are at increased risk for difficulties in learning to read (e.g., Aram, Ekelman, & Nation, 1984; Aram & Nation, 1980; Bishop & Adams, 1990; Gillam & Carlile, 1997; Korngold, Menyuk, Libergott, & Chesnick, 1988; Menyuk & Chesnick, 1997). The relationship between phonological awareness (PA) and early reading achievement has been clearly established for the general population (e.g., see reviews by Adams, 1990; Blachman, 1994; Wagner & Torgesen, 1987)). It is also been well-documented that children with language impairments have delays in phonological awareness abilities (e.g., Bird, Bishop, & Freeman, 1995; Bishop & Adams, 1990; Catts, 1993; Kamhi & Catts, 1986; Kamhi, Lee, & Nelson, 1985; Menyuk & Chesnick, 1997), and intervention studies have shown that we can successfully foster PA skills in preschoolers and kindergartners with both speech and language impairments (e.g., Gillon, 2000, 2002; Laing & Espeland, 2005; Segers & Verhoeven, 2004; van Kleeck, Gillam, & McFadden, 1998).

Phonological awareness, however, is only one of the phonological processing skills known to be important to early decoding. In addition to PA, the contributions of phonological working memory (WM) to early decoding (word attack skill in early reading) have been well established for children who are typically developing, children with reading disorders, and children with language impairments (see Catts & Kamhi, 1999; Goswami & Bryant, 1990; Wagner & Torgesen, 1987 for reviews). Phonological WM has been measured by both word and nonword repetition and span tasks. Of these two kinds of measures, nonword recall tasks are believed to more "purely" reflect phonological working memory, since they must be carried out independent of semantic lexical knowledge (Gathercole, in press; Gathercole & Baddeley, 1990; Henry & Millar, 1991). Studies outside of the area of reading corroborate that children with language impairment perform more poorly than age- and language-matched peers on nonword repetition and nonword span tasks, suggesting that these children have a diminished phonological WM capacity (e.g., Bishop, North, & Donlan, 1996; Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000; Gathercole & Baddeley, 1990; Gillam, Cowan, & Day, 1995; Gray, 2003, 2004; Marton & Schwartz, 2003; Montgomery, 1995, 2000a, 2000b).

As we continue to work to develop interventions that take empirical findings regarding the basic cognitive underpinnings of early decoding into account, these findings might lead us to ask if we should be targeting phonological WM in addition to PA in order to provide the best possible foundation for later early decoding skills in children with language impairments. First, however, we might ask if it is feasible to directly improve phonological WM skills. We know that nonword recall is highly heritable (Bishop et al., 1996) and that it is not readily affected by environmental influences (Alloway, Gathercole, Willis, & Adams, 2004; Campbell, Dollaghan, Needleman, & Janosky, 1997). One possible consequence of these facts is that the phonological memory skills underlying nonword recall may be resistant to treatment (Gathercole, in press).

We are aware of only one study that has trained children in nonword repetition in order to improve phonological WM, and hence early reading ability. The study involved 120 Greek-speaking kindergartners who were assigned randomly to a control or treatment group (Maridaki-Kassotaki, 2002). The treatment lasted for the school year, and the treatment group showed superior performance over the control group on a reading test at the end of first grade. This was only one study, and it was not conducted with children learning the English script. Being left with little empirical guidance on this question, we might ask what guidance theory offers regarding whether or not there is even a need to focus on phonological WM in addition to PA skills.

Two different theoretical positions regarding the relationship between PA and phonological WM appear to offer different answers to this question. Baddeley (2003) refers to these two opposed positions as the general phonological processing hypothesis (Bowey, 2001; Snowling, Chiat, & Hulme, 1991) and the phonological loop hypothesis (Baddeley, Gathercole, & Papagno, 1998; Gathercole, Willis, Emslie, & Baddeley, 1991). The phonological loop hypothesis regarding phonological processing abilities is part of the broader model of working memory, which includes a central executive function and as well as modality-specific functions (of which the phonological loop is one).

The general phonological processing hypothesis purports that both PA and phonological WM rely on a single latent phonological processing ability (see also Gottardo, Stanovich, & Siegel, 1996; Mann & Liberman, 1984; Shankweiler, Crain, Brady, & Macaruso, 1992). Applied to intervention, this would suggest that working on PA should also improve phonological WM. In contrast, the phonological loop hypothesis posits two separable components –a temporary storage system and a subvocal rehearsal system that allows for refreshing verbal material. The temporary storage serves to hold verbal information in memory while other cognitive tasks, such as comprehension or the manipulation of the sound structure required in PA tasks, are carried out. The rehearsal system refreshes the verbal material to keep it from fading.

In support of the idea of separable subcomponents in the phonological loop, Baddeley (2003) discusses how PA and nonword repetition each account for unique variance in predicting reading, citing a study by Gathercole, Willis, and Baddeley (1991). However, in this cited study, Gathercole et al. conclude that in addition to reflecting unique variance, PA (using rhyme awareness) and phonological WM appear to also share a general phonological processing component. Other studies have also concluded that, in addition to unique variance, there is also substantial shared or overlapping variance between PA and phonological WM in predicting early reading abilities (e.g., Hansen & Bowey, 1994). So even the phonological loop hypothesis seems to suggest that working on PA and might improve phonological WM, at least to the extent that these two areas share overlapping variance.

We clearly cannot take the idea of adding yet another goal to preschool language therapy lightly. Focusing intervention on a basic underlying cognitive process such as phonological WM would mean that less time would be devoted to working on other, more functional goals. Time and resources are not unlimited in providing services to preschoolers with language impairments, requiring that we choose goals judiciously. Since PA and phonological WM skills do share variance that theory suggests is not spurious, with both skills relying at least in part on the same underlying phonological processing ability, it might be possible to improve both PA and WM by working on just one skill.

Of the two skills, working on PA makes the most sense. In addition to the substantial shared variance, Hansen and Bowey (1994) found that the unique variance in predicting decoding that is accounted for by PA skills is considerably larger (19%) than that accounted for by phonological WM skills (5%). This finding would suggest that, if one had to choose between working on either of these two areas, working on PA would be preferable given its much larger unique contribution to later decoding. We have also accrued a great deal of evidence showing that we can improve PA skills, and in doing so also improve early decoding abilities (see Bus & van IJzendoorn, 1999; and National Reading Panel, 2000, for two meta-analyses of these intervention studies). As noted earlier, there is only one study of Greek-speaking children that has focused on practice with nonword tasks in order to improve children's phonological WM and subsequent reading ability. Finally, PA skills are also directly applied in the classroom setting where, in combination with letter knowledge, they form the basis of phonics training. There is no functional equivalent for nonword span or repetition that contributes directly to success in early decoding.

The goal of the present study, as such, was to provide intervention focused on PA skills in preschoolers with language impairments to determine if doing so would impact not only PA skills (to corroborate previous findings), but also phonological WM as measured by a nonword and word span tasks. As noted earlier, nonword span or repetition tasks are believed to more purely reflect phonological WM than word span tasks that additionally require lexical access (e.g., Baddeley, 2003; Baddeley et al., 1998). For this reason, we included both nonword and word span tasks as outcome measures for our PA training. If PA training improves phonological WM, it should have a greater impact on nonword than on word tasks, since word tasks are supported by lexical access in addition to phonological WM. And finally, we focused on preschoolers given Bus and van IJzendoorn's (1999) conclusion in their meta-analysis that PA training is more effective with preschoolers and kindergartners than with older children.

To begin to explore the impact of training PA on both PA and phonological WM skills, we conducted three studies. In our first study, we compared children with SLI and their age-matched controls on two PA tasks (phoneme awareness and rhyming) and three phonological WM tasks (single-syllable word span, multi-syllable word span, and nonword span). This study was designed to replicate previous research showing the co-occurrence of deficiencies in PA and phonological WM in children with SLI and, in so doing, to validate our measures.

In our second study, we matched children with SLI to children who were typically developing according to their nonword memory span before administering our PA and word span tasks. The primary research question was, "Will children with and without SLI who were matched on nonword recall show performance differences on measures of PA and on word span tasks?" If PA and phonological WM are closely related, we would expect that the group differences on the measures of PA between the children with SLI and the children with typically developing language we expected to find in Study 1 should disappear in Study 2. Furthermore, the magnitude of group differences found in Study 1 should be more reduced in Study 2 for PA skills than for the word span task, since word span tasks rely on lexical access in addition to phonological WM.

In the third study, we trained PA, using both rhyming and phoneme awareness, in children with SLI. Our research question was, "Will training in PA result in improvements in PA and in phonological WM as measured by nonword and word span tasks?" We also asked, "If there are improvements in phonological WM, will these be greater for nonword tasks that rely more exclusively on phonological WM than they are for the word span tasks that rely on lexical access in addition to phonological WM?"

Study 1

Recall that the first study was designed to replicate previous research showing the co-occurrence of deficiencies in PA and phonological WM in children with SLI and, in so doing, to validate our measures. The primary research question was, "Will children with and without SLI differ on their performance on measures of PA, nonword recall, and word recall?"

Method

Participants: Sixteen children with SLI and 16 typically developing age-matched children participated in the study. The mean age of the children with SLI was 4;6 (years; months) (*SD* = 0;6) and the mean age of the children in the control group was 4;6 (*SD* = 0;9). The effect size of the age differences between the groups (measured by Cohen's *d*) was quite small (.024), indicating 98.5% overlap in the age distributions of the two groups.

The children with SLI had been diagnosed by licensed speech-language pathologists and were enrolled in a private school for children with communication disorders. These students had all been tested within the previous 12 months by licensed speech-language pathologists and/or psychologists, using tests such as *The Test of Early Language Development* (Hresko, Reid, & Hammill, 1991), the *Clinical Evaluation of Language Fundamentals-Preschool* (Wiig, Semel, & Secord, 1992), and the *Preschool Language Scale-3* (Zimmerman, Steiner, & Pond, 1992). All 16 children in the SLI group had been referred for testing due to teacher and/or parent concerns about their communication, performed more than 1 *SD* below the mean on one or more of the global standardized language measures, and had nonverbal IQ scores above 90 as documented in special education records.

The children in the age-matched control group were drawn from local preschool programs. None of the children in this group had a history of speech and language disorders, and all were performing at age-level expectations according to teacher report.

Procedures: Children completed an informal PA assessment battery designed to measure rhyming and phoneme awareness. Four rhyming tasks and four phoneme tasks were administered. Raw scores from the four rhyming tasks and the four phoneme awareness tasks were combined to create composite rhyming and phoneme awareness scores. A description of the 8 tasks follows:

1. *Rhyme identification through oddity*. Following MacLean, Bryant, and Bradley (1987), children were shown a series of three pictures and were instructed to point to the picture that did not rhyme with the other two. Children received one training item and ten additional test items.

2. *Rhyming identification.* Similar to an investigation by Smith and Tager-Flusberg (1982), children were shown a puppet named Jed who liked words that rhymed with his name. After two training items, the children identified whether seven words rhymed with "Jed." Next, children were told that Jed also liked words that rhyme with "kite." The process was repeated with seven more words that either rhymed or did not rhyme with kite ("kite" was repeated as each new word was presented).

3. Rhyme production. Following a procedure by MacLean et al. (1987), children were asked to generate one word that rhymed with single-syllable words spoken by the examiner. A training trial was followed by 10 test items.

4. Rhyme fluency. Children were introduced to a puppet named Matt who also liked words that rhymed with his name. The examiner demonstrated two examples, one real word (cat) and one nonsense word (gat), and then asked children to think of as many words as they could that rhymed with Matt. Children were given a maximum of 30 seconds to complete the task

5. Phoneme judgment and correction. Similar to Chaney (1992), children were introduced to a puppet named Max who sometimes didn't say words right. The examiner showed a series of pictures and said a correct or incorrect version of a single syllable word that was depicted in each picture. The examiner asked children whether Max said the word correctly or not (the judgment task), and then asked the child to show Max how to say the word (correction). Fourteen items were presented after a training item.

6. Initial sound identification. In another task devised by Chaney (1992), children were told that a puppet named Max liked words that started with the same sound as his name. Children heard word pairs ("Max" plus a second word beginning or not beginning with an "m") and were asked to judge whether or not the initial sounds were the same. There was one training item and fourteen test items.

7. Generating initial sounds. Children were introduced to a puppet named Tom who liked words that started with the first sound of his name. The examiner gave children an example of a real word that started with /t/ (tick) and a nonsense word that started with /t/ (toup), then, children had 30 seconds to generate as many words as they could think of that started with the first sound of Tom's name.

8. *Identifying initial and final sounds*. The examiner presented five words and asked the child to identify the first sound (one began with a vowel) and then presented five more words in which the child was asked to identify the last sound (all consonants). There were no training items on this task.

Children also completed three phonological working memory (WM) tasks. Two were word span tasks (one single-syllable and the other multi-syllable words) and one was a nonword span task. Measures of working memory used an immediate recall format that included lists of phonetically dissimilar single-syllable words, phonetically dissimilar single-syllable non-words, and multisyllable words. Note that we use a nonword span task rather than the nonword repetition task that was pioneered by Baddeley and his colleagues (Baddeley, 2000; Baddeley et al., 1998; Baddeley & Hitch, 1974). Research by Hulme and his colleagues (Hulme, Maughan, & Brown, 1991a; Hulme & Roodenrys, 1995; Roodenrys, Hulme, Alban, Ellis, & Brown, 1994) and Gillam and his colleagues (Gillam et al., 1995; Gillam, Hoffman, & van Kleeck, 1998; Gillam & van Kleeck, 1996) indicates that nonword span tasks are also good measures of phonological WM, and that they are sensitive to working memory differences between children with SLI and their peers who are typically developing. Furthermore, the two kinds of tasks are actually quite similar in their demands on children. Nonword repetition tasks typically increase the number of syllables children are requested to repeat, whereas nonword span tasks use single syllable items, but the number of them children are asked to repeat varies from one to six.

In this study, we measured children’s memory spans for single-syllable words (SSW) (bed, cake, doll, gum, feet, nap, pig, soup), single-syllable nonwords (SSNW) (deet, bem, nad, pook, gake, zeeg, kig, fap), and multi-syllable words (MSW) (basket, hammer, scissors, whistle, banana, elephant, kangaroo, policeman) according to working memory procedures established by Cowan (Cowan, 1992; Cowan, Wood, & Borne, 1994) and Hulme (Hulme, Roodenrys, Brown, & Mercer, 1995; Hulme, Snowling, & Quinlin, 1991b; Hulme & Tordoff, 1989). Sequence lengths of two to six items were created in each span condition by sampling at random without replacement. Three lists were created at each list length between 2 and 6 items within each of the span conditions (SSW, SSNW, MSW).

Before span testing began, children listened to and repeated each word or nonword on the test. To eliminate the noise of potential articulatory constraints, the children's production of words or nonwords in isolation was used as the articulatory criterion for the span tasks. On occasion, children produced a word or nonword incorrectly during production testing, then began to produce that item in an adult-like manner as the experiment progressed. When this happened, children were given credit for the correct (adult-like) productions in addition to their more immature productions.

For each span condition, children listened to and repeated three lists of words or nonwords at each list length, beginning with two-item sequences. The list length was increased until children made one or more errors in all three lists at a particular length. Span was calculated as the maximum length at which a participant recalled all three lists correctly, plus 0.33 for each subsequent correct list. This procedure is more sensitive than measuring span as the longest list repeated without error (Cowan, 2001; Hulme et al., 1991a).

Three orders of span conditions (SSW, SSNW, MSW; SSNW, SSW, MSW; and MSW, SSW, SSNW) with separate item orders within the lists were counterbalanced across participants. Within each condition, the lists were spoken in a monotone at a rate of one item per second.

Results and Discussion

A two-way repeated measures ANOVA was computed to evaluate group differences on the PA tasks of rhyming and phoneme awareness. For this and subsequent studies, Eta squared values (indicating the amount of total variance that can be attributed to an effect) are reported for significant main effects and interactions. Cohen's (1988) standardized effect size values (*d* equals the difference between means divided by the root mean square of their respective standard deviations) are reported for post hoc comparisons.

There was a significant main effect for group (F (1, 30) = 17.02, $p < .001$, $\eta^2 = .983$). Neither the Task main effect nor the Group x Task interaction was significant. The children in the SLI group earned significantly lower scores on both the rhyming and phoneme awareness tasks in comparison to their age-matched controls (Table 1), and the group differences were quite large ($d = 1.21$).

A second two-way, repeated measures ANOVA was calculated to evaluate group differences on the three memory measures (single-syllable words, multi-syllable words, and nonwords span). Significant main effects for Group (F (1, 30) = 38.04, $p < .001$, $\eta^2 = .559$] and Task [F (2, 60) = 58.83, $p < .001$, $\eta^2 = .662$) were subsumed by a significant Group x Task interaction (F (2, 60) = 4.37, $p < .05$, $\eta^2 = .127$). Tukey pairwise comparisons revealed that the children in the SLI group had poorer recall than their age-matched peers on tasks that measured memory for single-syllable words ($d = 1.60$) and memory for nonwords ($d = 1.55$). The group differences on tasks that measured memory for multi-syllable words were not significant, and the effect size ($d = .61$) was in the moderate range (Table 1). Scheffé complex comparisons revealed that the groups differed with respect to the relationships between single-syllable and multi-syllable word recall (Scheffé F (2, 60) = 4.44; $p < .05$, $\eta^2 = .129$) (Figure 1). Specifically, children with SLI had larger multi-syllable word spans than single-syllable word spans, but their non-impaired peers had smaller multi-syllable word spans than single-syllable word spans. The groups also differed with respect to relationships between multi-syllable word recall and nonword recall (Scheffé $F(2, 60) = 4.94$; $p < .05$, $\eta^2 = .141$). In comparison to their nonimpaired controls, children with SLI evidenced a larger difference between multi-syllable and nonword spans (a span difference of 1.62 vs. a span difference of .85 respectively).

Table I.
Mean Performance of Children in the SLI and Age-Matched Groups on the Phonological Awareness and Memory Measures Presented in Study 1.

	SLI		CONTROL		
	M	*SD*	*M*	*SD*	*d*
Phonological Awareness					
Rhyming	12.94	5.77	21.69	9.06	.97
Phoneme Awareness	15.19	5.67	22.75	6.30	1.2
Memory Measures					
Single-Syllable Words	2.25	.65	3.31	.66	1.60
Multi-syllable Words	2.35	.66	2.68	.54	.61
Nonwords	.73	.39	1.83	.71	1.55

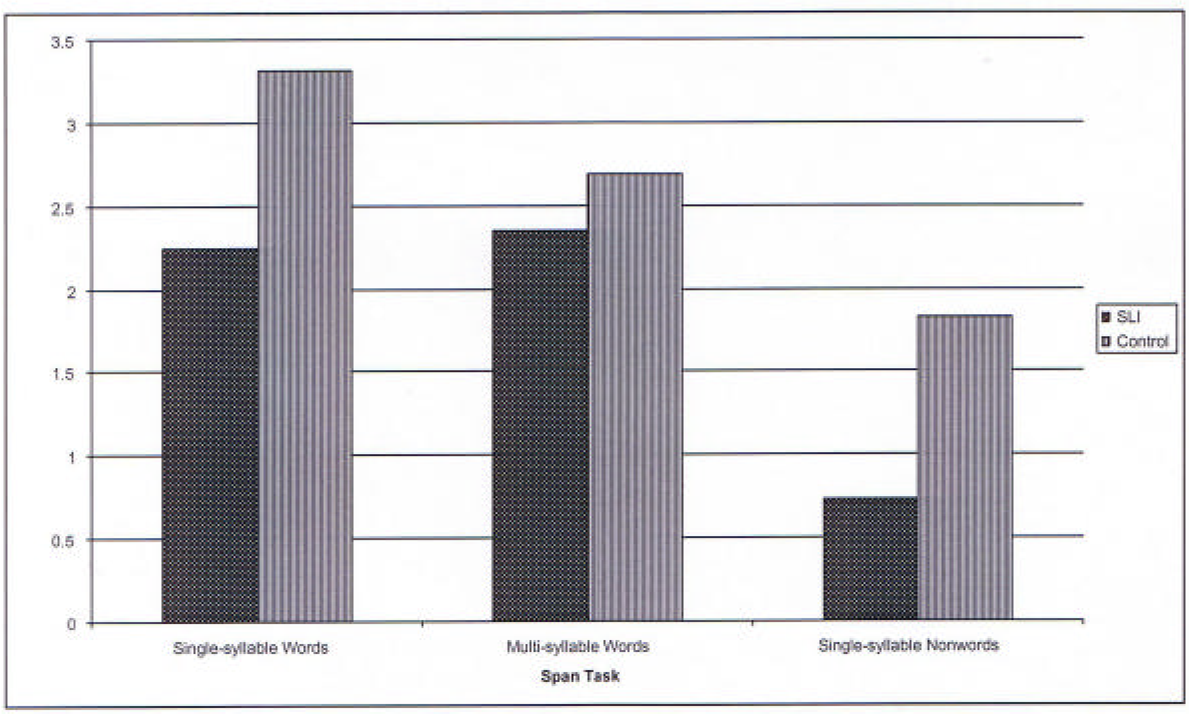

Figure 1: Comparison in Study 1 of children with SLI and age-matched children who were typically developing and served as controls on single-syllable word, multi-syllable word, and single-syllable nonword tasks.

In comparison to their same age, non-impaired peers, children with SLI performed significantly poorer on our measures of rhyming, phoneme awareness, and working memory. In addition, the magnitude of the group differences was rather large. These results replicated the findings of previous studies showing the co-occurrence of deficiencies in PA and phonological WM in children with SLI, and also served to validate the measures used in the current study.

Study 2

As indicated earlier, word and nonword recall tasks differ because nonword memory tasks appear to rely more exclusively on phonological WM, while word memory tasks appear to rely on phonological WM and lexical access. We performed a second experiment in which children with and without SLI were matched for nonword recall ability, and were then assessed on the same PA and word span measures that were used in Study 1. The research question in Study 2 was, "Will children with and without SLI who were matched on nonword recall show performance differences on measures of PA and on word span tasks?" To the extent that PA and phonological WM share overlapping variance, we would expect the differences found in Study 1 on PA tasks to disappear when children were matched for phonological WM ability. We would also expect the group differences on word span from Study 1 to disappear in Study 2, to the extent that word span relies on phonological WM. In addition, the magnitude of group differences found in Study 1 should be more reduced in Study 2 for PA skills than for the word span task, since word span tasks rely on both lexical access and phonological WM.

Methods

Participants: Twenty children participated in Study 2. We matched 10 children with SLI (none of whom participated in Study 1) with ten typically developing children according to their performance on the nonword span task. In order to obtain 10 closely matched pairs of children, we screened 39 typically developing children from four preschool programs using the nonword span task described in Study 1. The mean nonword recall spans for the two groups were identical (SLI M = 1.463, SD = .280; Memory-matched M = 1.463, SD = .475).

As in Study 1, the children with SLI in Study 2 performed one standard deviation or more below the mean for their age on one or more formal language tests and had nonverbal performance IQ's of 90 or above. The ten children with SLI had a mean age of 5;10 (SD = 1;0). The ten typically developing children who were matched for nonword span had a mean age of 4; 8 (SD = 1;0). A preliminary ANOVA revealed that the children in the control group were significantly younger than the children in the SLI group [F (1, 18) = 7.08, $p < .05$; d = 1.209]. As in Study 1, none of the typically developing children had a history of speech and language disorders, and all were performing within age-level expectations according to preschool teacher reports.

Procedures. The same tasks from Study 1 were administered in Study 2.

Results and Discussion

When we matched for nonword span, there were no significant group differences on any of the measures of either PA or word span (Table 2). The effect size for rhyming was small (d = .35), with a 76% overlap between the distributions for the two groups. There was also a small effect size (d = .319) for group differences in phoneme awareness, which corresponds to a 78% overlap in the group distributions. In comparison to Study 1, matching for nonword recall reduced the magnitude of group differences in rhyming and phoneme awareness by 136% and 73%, respectively. The magnitude of group differences in single-syllable and multisyllable word span was reduced by 63% and 52%, respectively. These results appear to support a strong relationship between PA and phonological WM.

Although phonological WM as measured by nonword span plays an important role in working memory for words, it accounts for somewhat less of the variance in word memory tasks than it does for PA. This finding aligns well with the belief that word tasks may rely more on lexical access than on phonological WM.

Table 2
Mean Performance of Children in the SLI and Nonword Memory-Matched Control Groups on the Phonological Awareness and Memory Measures Presented in Study 2

	SLI		CONTROL		
	M	*SD*	*M*	*SD*	*d*
Phonological Awareness					
Rhyming	27.90	7.51	24.30	10.07	-.35
Phoneme Awareness	23.40	10.33	26.30	9.09	.32
Memory Measures					
Single-Syllable Words	2.80	1.00	3.23	.72	.59
Multi-syllable Words	2.43	.70	2.66	.79	.29

Study 3

In the third study we asked, "Will training in PA result in improvements in phonological WM as measured by a nonword span task?" We also asked, “Will the training also impact word tasks that are less reliant on phonological WM?”

Method

Participants. The sixteen children with SLI who participated in Study 1 received PA training consisting of rhyming and phoneme awareness training. The children attended two classrooms in a school for children with communication disorders. At the beginning of the study, the mean age of the children was 4; 6 (SD = 0;6) At the end of the study, the mean age of the children was 5; 2 (SD = 0;6).

Procedures. The children received 15 minutes of small-group lessons twice each week for two semesters. During the fall semester, children attended a rhyming center for 15 minutes twice each week. Children were led through a series of increasingly difficult rhyming activities progressing from recognition, to imitation, to identification, to judgment, and finally to rhyme creation.

During the spring semester, children attended a phoneme awareness center for 15 minutes twice each week. The purpose of the phoneme awareness activities was to help the children acquire an awareness of sounds at the beginning and end of words. The specific intervention procedures that were used are described in greater detail in van Kleeck et al. (1998).

Results and Discussion

Intervention that focused on rhyming for one semester and on phoneme awareness for a second semester resulted in improved phonological awareness abilities. The effectiveness of this training was reported in van Kleeck et al. (1998). In the current study, we were interested in the impact that training in PA had on two phonological WM tasks, nonword and word span tasks.

We conducted a repeated-measures ANOVA to test changes in various memory spans (single-syllable word, multi-syllable word, and nonword) from Time 1 (pretreatment) to Time 2 (postreatment). A significant Type of Memory by Time of Testing interaction [F (2, 30) = 24.49, p < .001] subsumed significant main effects for Type of Memory Span [F (2, 30) = 49.86, p < .001] and Time of Testing [F (1, 15) = 64.69, p < .001). Gains in single syllable word repetition from pretest (M = 2.14, SD = .66) to posttest (M = 2.85, SD = .63) were smaller (d = 1.11) than gains on nonword repetition tasks (d = 3.61) from pretest (M = .67, SD = .39) to posttest (M = 2.19, SD = .46). Notice that multi-syllable memory spans changed very little (d = .21) from pretreatment (M = 2.33, SD = .68) to posttreatment (M = 2.48, SD = .70). These differences imply that PA training impacted nonword span approximately 3 times more than they impacted single-syllable word span. We did not have a control group that did not receive treatment, so it is possible that nonword recall improved more than word recall for reasons that were extraneous to the intervention. However, this possibility is unlikely since our results are consistent with findings reported by Hansen and Bowey (1994) and Metsala (1999). In both of these studies, correlations between nonword repetition tasks and PA tasks were higher than correlations between word recall tasks and PA tasks.

Summary

We reported three studies that were designed to replicate previous findings regarding relationships between phonological awareness (PA) and working memory (WM) in a group of children with known problems in phonological processing skills, and to determine if working on PA skills would simultaneously improve phonological WM skills. Our first study replicated findings from other research demonstrating that children with SLI perform more poorly than their age-matched peers on our PA tasks and on our two working memory tasks (nonword and single-syllable word span). These results validated the measurements that were subsequently used in Studies 2 and 3.

In Study 2, children with SLI were matched to their non-impaired peers on the basis of their nonword memory spans. When we matched children with SLI and non-impaired children for nonword memory span, differences between the groups on PA and word span tasks were not statistically significant. Analyses of the group effect sizes revealed that matching on nonword recall accounted for more variance in PA tasks than in word span tasks, thereby suggesting a closer relationship between PA and nonword tasks, than between PA and word tasks.

In Study 3, we measured changes in nonword and word span following training in PA. Children's performance on a series of PA tasks improved statistically, but so did their performance on two phonological working memory measures. In addition, we found that children presented a larger improvement on our nonword recall task than on our single-syllable word recall task. The findings of Study 3 demonstrate the feasibility of using rhyming and phoneme awareness instruction to improve basic phonological mechanisms underlying working memory.

There are two potential explanations for the generalization of PA training to phonological WM. Bowey (1996) and Metsala (1999) found that PA measures and nonword repetition measures shared variance in relation to vocabulary development. These authors suggest that phonological WM and PA tap into a common phonological processing substrate that they refer to as phonological sensitivity. As vocabulary development increases, children reorganize the way they represent sounds in words. From this perspective, instruction on PA tasks impacted phonological sensitivity, which also plays a critical role in phonological WM. One potential problem with this explanation is that is does not account for our finding of greater generalization to nonword recall than to word recall.

The second potential explanation for our results relates to phonological storage mechanisms. Recall that the phonological loop hypothesis posits that working memory involves a temporary storage system and a subvocal rehearsal system that allows for refreshing verbal material. In the rhyming and phoneme awareness tasks that were taught in study 3, children were required to hold sequences of sounds in temporary storage and then to perform other cognitive operations on them (i.e., comparing the first sequence of sounds to other sequences of sounds, thinking of new onset-rhyme combinations, deciding which sound came first in a sequence, and/or finding pictures of words that begin with the same sound as the target word). While the children were completing the PA tasks, they had to hold the original target words in memory. It is likely that these tasks improved the processes inherent in phonological storage, which is thought to play a greater role in nonword recall than word recall (Gathercole, in press). If phonological storage mechanisms were improved through the PA training the children received, it makes sense that they would improve more on nonword recall tasks than on word recall tasks.

It is clear that children with language impairments often have unusual difficulties on phonological working memory tasks and on phonological awareness tasks, and that both of these tasks tap into skills that support reading development. We conducted this study to determine whether it is feasible to directly improve phonological WM skills by working on PA tasks. The clear answer is yes. Weekly PA instruction with preschool-aged children with language impairments resulted in improved phonological awareness and improved phonological working memory.

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Book Review: Educate Toward Recovery: Turning the Tables on Autism (Schramm, 2006)

Tony Balazs

Robert Schramm's (2006) *Educate Toward Recovery: Turning the Tables on Autism* is a very well written, clear and concise treatment of up-to-date ABA approaches for teaching children with autism. The book describes the most important components of verbal behavior instruction, both theoretically and practically, and it does so in a comprehensible style. I was also particularly pleased with the compassion and humanity that the author of this book displays.

Some of the strengths of this book include its emphasis on teaching (versus treating) children with autism, warnings against captive learning and over-repetitive teaching, the inclusion of a detailed manding schema, a sensible approach to data collection, and the concept of using mini-consequences as a reflexive motivation to reduce non-compliant behavior.

The introduction to the book offers a refreshingly different way of describing autism. However, I personally wonder if the discussion of recovery as the ultimate goal of teaching is not overly optimistic for the majority of children who will benefit from ABA with an emphasis on verbal behavior instruction.

The book is filled with well-written chapters that address the important aspects of developing a quality ABA program. The best of these chapters discuss understanding behavior, earning instructional control, discrete trial teaching, using motivation to teach, Skinner's behavioral classification of language, errorless learning, toilet training, VB teaching procedures and the ethics of ABA.

Three concerns surfaced for me as an ABA professional reading this book. However, each one is a non-issue when one considers the audience for whom this book is intended. For example, BCBA professionals may find the content of this book too simplified and non-technical. I particularly had some difficulty accepting the simplified definitions as listed "in plain English." However, this book is intended for beginning consumers of behavior analysis (e.g., families of individuals with autism, beginning therapists) and not for BCBA professionals. From that perspective, the information is pitched at a very appropriate level, and references are provided for those who wish to learn about ABA in greater depth. A second point to note is that the author invites application of learning goals from several sources, including commercial approaches such as RDI. However, he encourages parents to be appropriately critical of any unsubstantiated claims and to teach to these goals within the context of a good ABA/VB program. Finally, I felt that the inclusion of an additional chapter about teaching to the "control child" was not necessary to the discussion of earning instructional control. However, I can see that this is a useful way of explaining these important concepts to individuals who are new to ABA.

Overall, I enjoyed reading this book very much and think that it will be an extremely useful addition to the canon. In a complex field such as this, there are always differences of emphasis and approach. In Schramm's book I found these differences to be minor relative to mainstream ABA, and I would definitely recommend this book to others, particularly to parents and beginning therapists.

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