CELLreviews

Center for Early Literacy Learning

2011 ■ Volume 4 ■ Number 4

Influences of Sign and Oral Language Interventions on the Speech and Oral Language Production of Young Children with Disabilities

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The influences of sign and oral language interventions on the speech and oral language production of preschool-aged children with different types of disabilities were examined in 33 studies including 216 children. The children's disabilities included autism, Down syndrome, intellectual and developmental disabilities, social-emotional disorders, and physical disabilities. All of the studies used some type of simultaneous communication (oral language together with some type of sign language) to promote the children's increased use of vocal or verbal behavior. Results showed, regardless of type of sign language, that simultaneous communication facilitated the children's production of speech and oral language. The interventions also had positive effects on child speech and oral language production regardless of other variables, including type of child disability and the different conditions of the interventions. Implications for practice are described.

The extent to which adult use of sign and oral language with young children with developmental disabilities facilitates or promotes the speech and oral language production of the children is the focus of this research synthesis. Reviews of research investigating the use of sign language with older children and adults with Down syndrome (Clibbens, 2001; Remington & Clarke, 1996), autism (Goldstein, 2002; Mirenda, 2002; Wendt, 2006), physical disabilities (Pennington, Goldbart, & Marshall, 2005), and other types of developmental disabilities (Bonvillian & Nelson, 1982; Millar, Light, & Schlosser, 2006) found that simultaneous communication has positive effects on speech and oral language acquisition. The focus of this research synthesis was the effects of different types of sign language training on the speech and oral language production of young children with Down syndrome, autism, language impairments, intellectual and developmental disabilities, and other kinds of disabilities who had little or no oral language abilities.

The research synthesis differs from other research reviews and meta-analyses by examining the use of Signed English, American Sign Language, Japanese Sign Language, Ontario Sign Language, and other types of sign language (e.g., Makaton) on child speech and oral language production, and investigating the manner in which signing facilitated speech and oral language production. The studies in the research synthesis were coded and analyzed in order to be able to *unbundle* (Lipsey, 1993) and *unpack* (Dunst & Trivette, 2009) the interventions to (a) isolate which characteristics of the interventions accounted for variations in the study outcomes and (b) identify the conditions under which simultaneous communication was most effective in terms of facilitating speech and oral language production of young children with disabilities.

The main focus of the research synthesis was the relationship between adults' use of signing and oral language and children's speech and oral language production. This type of intervention uses sign language and speech simultaneously where signing is hypothesized to promote or facilitate the production of oral language among children who have little or no speech (Schlosser & Wendt, 2008). We were particularly interested in empirically evaluating the extent to which sign language interventions facilitated or impeded speech and oral language learning in order to resolve the long

CELLreviews are a publication of the Center for Early Literacy Learning (CELL) funded by the U.S. Department of Education, Office of Special Education Programs (Grant #H326B060010). CELL is a collaboration among the Orelena Hawks Puckett Institute, the American Institutes for Research, and the PACER Center. Appreciation is extended to Marcil Boucher for her comments and feedback on an earlier version of this *CELLreview*.

standing debate and controversy whether or not signing is an effective speech and oral language-learning intervention strategy for young children with disabilities (see e.g., Carr, 1979; Zangari, Lloyd, & Vicker, 1994).

SEARCH STRATEGY

Studies were located using "*sign language*" OR "*signing*" OR "*signed*" OR "*finger spell**" OR "*manual communicat**" OR "*manual english*" AND "*infan**" OR "*toddler*" OR "*preschool*" OR "*kindergarten*" OR "*early childhood*" NOT "*deaf*" NOT "*hard of hearing*" NOT "*hear*impair**" as search terms. Both controlled vocabulary and natural language searches were conducted (Lucas & Cutspec, 2007). Psychological Abstracts (PsychInfo), Educational Resource Information Center (ERIC), MEDLINE, Academic Search Premier, Education Research Complete, FirstSearch, Cumulative Index to Nursing and Allied Health Literature, WorldCat, and Dissertation Abstracts were searched. These were supplemented by Cochran Database, Google Scholar, and Ingenta searches, and a search of an extensive EndNote Library maintained by our Institute. Hand searches of the reference sections of all identified journal articles, book chapters, and books were also examined to locate additional studies. Studies were included if the majority of participants were eight years of age or younger, some type of sign language and oral language was used simultaneously to promote the children's speech and oral language production, and a child vocal or verbal outcome measure was used to evaluate the effects of the sign language interventions. Studies that investigated the facilitation of the use of some type of sign language as the primary means of communication were excluded.

SEARCH RESULTS

Thirty-three studies were located that included 36 samples of children. Appendix A shows selected characteristics of the children who were taught using simultaneous communication to facilitate speech and oral language production. The studies included 216 children. The mean chronological ages of the children ranged from 7 to 102 months (Median = 60 months). In those studies including the children's developmental levels of functioning, the mean mental ages of the children ranged between 11 and 65 months (Median = 24 months). The children's disabilities included Down syndrome, autism, intellectual disabilities, language disorders or impairments, cerebral palsy, emotional or behavior disorders, intellectual disabilities, and other types of disabilities. Based on information included in the research reports, 51% of the children had severe or profound developmental delays, 43% of the children had mild or moderate developmental delays, and 6% of the children had less serious developmental delays.

The types of sign language used to promote speech and oral language production and selected characteristics of the interventions are shown in Appendix B. American Sign Language (N = 14 studies), Ontario Sign Language (N = 1), Japanese Sign Language (N = 1), Signed English (N = 11), Makaton (N = 1), or other unspecified types of sign language (N = 13) were used in the studies. The different types of sign language were all used with adult oral language to facilitate the children's signing and/or speech and oral language production.

The interventions varied considerably in terms of the length of time the interventions lasted, and the number, frequency, and length of sessions. The interventions ranged from one to 16 months in length (Mean = 4.93 months, SD = 3.77). The average number of sessions ranged from one to more than 100 (Mean = 57.39, SD = 93.72). The individual sessions lasted between 15 minutes and 4 hours (Mean = 53 minutes, SD = 62.78). The frequency of the sessions ranged from two times a day five days a week to just one session every 2 to 4 weeks.

Most of the studies included other intervention characteristics or conditions together with signing. Most of the studies also included a number of different naturalistic or extrinsic reinforcements that were provided in response to a child's use of signs and vocalizations or verbalizations. Thirteen studies used some type of extrinsic reinforcement, six studies used some type of intrinsic reinforcement, and five studies included both types of reinforcement. Three studies used unspecified types of reinforcement.

The outcome measures in the studies included either child vocalizations or verbalizations. Vocalizations included some type of vocal sounds other than words. Verbalizations included only oral language production. The largest majority of outcome measures were the number or percentage of child vocalizations or verbalizations prompted or spontaneously used by the children, although a few studies included standardized measures of expressive language abilities (Bzoch & League, 1971; Clark, Moores, & Woodcock, 1975; Hedrick, Prather, & Tobin, 1975). One focus of analyses was the spontaneous, nonprompted use of vocalizations or verbalizations to communicate as a result of the simultaneous communication interventions.

Twenty-one of the studies used some type of single participant design and 12 studies used some type of group design. The single participant studies included ABA, multiple baseline, alternating treatment, or pretest-post test designs. The group studies used pretest-post test, comparative conditions, or experimental vs. control group designs. Two types of comparisons were made in both the single participant and group design studies. One included comparisons of either baseline or nonintervention conditions with intervention or post test outcomes. The other included comparisons of either sign *or* oral language interventions with sign *and* oral language interventions.

Cohen's *d* effect sizes for the baseline vs. intervention phases in the single participant design studies, and Cohen's

d effect sizes for the between group or comparative conditions in the group studies were used to evaluate the effects of sign language intervention. The effect sizes were calculated as the mean difference between the intervention conditions and the pretest or baseline conditions divided by the pooled standard deviations for the two conditions (Dunst, Hamby, & Trivette, 2007). In cases where the baseline indices in the single participant design studies were all zero, the effect sizes were estimated using the standard deviations for the both the baseline and intervention phases combined as the denominator (Rosenthal, 1994). The average effect sizes and their 95% confidence intervals were used for substantive interpretation of the finding. A confidence interval not including zero indicates that the average effect size differs from zero at the 0.05 level (Shadish & Haddock, 2009).

SYNTHESIS FINDINGS

Appendix C includes the intervention conditions in each of the studies, the child outcomes that were the focus of investigation, the particular contrasts or comparisons that were the focus of this research synthesis, and the effect sizes for these comparisons or contrasts. Preliminary analyses found that the average effect sizes for the single participant design studies (Mean = 1.41, 95% CI = 1.17 – 1.65) were more than twice as large as those for the group design studies (Mean = 0.63, 95% CI = 0.43 – 0.83). The findings therefore are presented separately for the two types of studies. The extent to which the pattern of results of the two types of studies were similar or different was used for substantive interpretation.

The extent to which different types of signing were associated with increases or differences in the child speech and oral language production outcomes is shown in Table 1. The interventions, regardless of type of sign language, were related to increased child speech and oral language production. In the group design studies, the average effect size ranged between 0.57 (95% CI = 0.21 – 0.93) and 0.80 (95% CI = 0.34 - 1.25). In the single participant design studies, the average effect sizes ranged between 1.04 (95% CI = 0.66 – 1.43) and 1.68 (95% CI = 1.24 – 2.13). The pattern of results for the two types of studies showed that the sign language interventions positively influenced child speech and oral language production.

Table 2 shows the results for the differences between the contrasting or comparative conditions and the study outcomes. In the group design studies comparing either pre-intervention vs. post intervention outcomes, or oral or sign language intervention vs. sign and oral language intervention, the average effect sizes were 0.81 (95% CI = 0.55 – 1.08) and 0.50 (95% CI = 0.20 – 0.70) respectively. In the single participant design studies comparing baseline or non-intervention pretest vs. intervention or post intervention differences, the average effect size was 1.40 (95% CI = 1.15 – 1.66). The average effect size in single participant design studies where the baseline included either oral *or* sign language interventions and the intervention phases included both oral *and* sign language interventions, the average effect size was 1.06 (95% CI = 0.52 – 1.60). Taken together, the results showed that regardless of research design or comparative/contrasting conditions, the interventions were effective in terms of promoting child speech and oral language production.

The effectiveness of the sign language intervention on children with different disabilities and severity of delays is shown in Tables 3 and 4 respectively. The findings showed, regardless of type of disability or severity of delay, that the sign language interventions positively influenced the speech and oral language production of the study participants. In

Table 1
Average Effect Sizes and 95% Confidence Intervals for the Sign Language Interventions on Child Vocal and Verbal Behavior

Type of Sign Language	Number		Average Effect Size	95% Confidence Interval
	Effect Sizes	Sample Sizes		
Group Design Studies				
American Sign Language[a]	11	20	.57	.21-.93
Signed English	9	44	.79	.57-1.01
Unspecified	13	77	.80	.34-1.25
Single Participant Studies				
American Sign Language[b]	22	10	1.23	1.01-1.46
Signed English	32	17	1.68	1.24-2.13
Unspecified	29	18	1.04	.66-1.43

[a] Includes one study that used Ontario sign language and one study that used Makaton.
[b] Includes one study that used Japanese sign language.

Table 2
Average Effect Sizes and 95% Confidence Intervals for the Different Contrasting and Comparative Study Conditions and the Study Outcomes

Comparative Conditions	Number		Average Effect Size	95% Confidence Interval
	Effect Sizes	Sample Sizes		
Group Design Studies				
Pretest vs. Sign + Oral Post Test	23	109	.81	.55-1.08
Oral or Sign vs. Sign + Oral	10	59	.50	.20-.80
Single Participant Design Studies				
Baseline vs. Sign + Oral	68	41	1.40	1.15-1.66
Oral or Sign Baseline vs. Sign + Oral	15	14	1.06	.52-1.60

Table 3
Average Effect Sizes and 95% Confidence Intervals for Different Child Disabilities and the Study Outcomes

Child Disability	Number		Average Effect Size	95% Confidence Interval
	Effect Sizes	Sample Sizes		
Group Design Studies				
Autism	16	58	.69	.47-.91
Down syndrome	11	50	.75	.17-1.33
Developmental/intellectual delays[a]	6	33	.73	.35-1.11
Single Participant Design Studies				
Autism	46	25	1.04	.86-1.23
Down syndrome	19	9	1.64	1.04-2.24
Social-emotional disorders	11	5	1.86	1.03-2.70
Intellectual/developmental delays[a]	4	3	1.51	1.13-1.88

[a] Includes children with different types of delays or disabilities, other than Autism or Down syndrome (see Appendix A).

Table 4
Average Effect Sizes and 95% Confidence Intervals for Severity of Child Disability and Delay and the Study Outcomes

Severity of Child Delay	Number		Average Effect Size	95% Confidence Interval
	Effect Sizes	Sample Sizes		
Group Design Studies				
Mild/Moderate	9	45	.85	.18-1.52
Severe/Profound	15	38	.67	.40-.94
Mixed	9	58	.66	.40-.91
Single Participant Design Studies				
Mild/Moderate	40	19	1.44	1.06-1.81
Severe/Profound	43	26	1.25	.98-1.53

the analyses of the relationship between type of child disability and speech and oral language production in the group design studies, the average effect sizes ranged from 0.69 (95% CI = 0.47 – 0.91) to 0.75 (95% CI = 0.17 – 1.33). In the single participant design studies, the average effect sizes ranged from 1.04 (95% CI = 0.86 – 1.23) to 1.86 (95% CI = 1.03 – 2.70). In the severity of delay analyses, the average effect sizes ranged from 0.66 (95% CI = 0.40 – 0.91) to 0.85 (95% CI = 0.18 – 1.52) in the group design studies. In the single participant design studies, the average effect sizes were 1.44 (95% CI = 1.06 – 1.81) for the children with mild or moderate delays and 1.25 (95% CI = 0.98 – 1.53) for the children with severe or profound delays.

The extent to which the sign language interventions positively affected either or both vocal or verbal child behavior is shown in Table 5. There were only verbalization outcomes in the group design studies, but both vocalization and verbalization outcomes in the single participant design studies. The sign language interventions had positive effects on child speech and oral language production in both types of studies. In the group design studies, the average effect size for child verbalizations was 0.72 (95% CI = .51-.92). In the single participant design studies, the average effect size for child vocalizations was 0.97 (95% CI = .57-1.37) and for child verbalizations the average effect size was 1.48 (95% CI = 1.21-1.75).

Whether or not the sign language interventions influenced spontaneous use of child speech or oral language was determined by coding the vocal and verbal outcomes according to spontaneous language production, prompted responses, or some combination of both. The results are shown in Table 6. For both types of studies, the sign language interventions were associated with increased spontaneous child speech and oral language production. In addition, the sign language interventions were associated increased prompted speech and oral language production in both types of studies.

All but a few studies used either or both naturalistic and extrinsic reinforcers for child speech and oral language production. The naturalistic reinforcers included access to preferred objects, activities, or edibles (food or drink). The extrinsic reinforcers included verbal or physical praise, edibles, or some type of tokens. Table 7 shows the relationships between type of reinforcement and child speech and oral

Table 5
Average Effect Sizes and 95% Confidence Intervals for Type of Child Outcome

Child Outcome	Number		Average Effect Size	95% Confidence Interval
	Effect Sizes	Sample Sizes		
Group Design Studies				
Verbalizations	33	141	.72	.51-.92
Single Participant Design Studies				
Vocalizations	23	9	.97	.57-1.37
Verbalizations	60	36	1.48	1.21-1.75

Table 6
Average Effect Sizes and 95% Confidence Intervals for Spontaneous and Prompted Child Speech and oral language Production

Type of Child Speech	Number		Average Effect Size	95% Confidence Interval
	Effect Sizes	Sample Sizes		
Group Design Studies				
Spontaneous Speech	9	48	.83	.61-1.05
Prompted Speech	18	87	.68	.33-1.03
Combination	4	23	.54	-.21-1.28
Single Participant Design Studies				
Spontaneous Speech	11	7	1.67	.79-2.54
Prompted Speech	51	33	1.44	1.15-1.73
Combination	5	4	1.14	.32-1.97

Table 7
Average Effect Sizes and 95% Confidence Intervals Associated With the Use of Different Types of Reinforcement and the Study Outcomes

Type of Reinforcement	Number		Average Effect Size	95% Confidence Interval
	Effect Sizes	Sample Sizes		
Group Design Studies				
Naturalistic	8	8	.78	.37-1.19
Extrinsic	16	70	.67	.32-1.01
Single Participant Design Studies				
Naturalistic	18	10	.82	.46-1.18
Extrinsic	34	16	1.69	1.35-2.03
Combination	26	16	1.20	.84-1.55

language production. In the group studies, both types of reinforcement were associated with average effect sizes of 0.78 (95% CI = 0.37 – 1.19) and 0.67 (95% CI = 0.32 – 1.01) for naturalistic and extrinsic reinforcers, respectively. In the single participant design studies, the average effect sizes ranged from 0.82 (95% CI = 0.46 – 1.18) for naturalistic reinforcers to 1.69 (95% CI = 1.35 – 2.03) for extrinsic reinforcers.

The final set of analyses examined the relationships between the length of the interventions in months and the number of intervention sessions and child speech and oral language production. The results are shown in Figure 1. In the group design studies, more months of intervention and more intervention sessions were associated with larger effect sizes. In the single participant design studies, fewer months of intervention and fewer intervention sessions were associated with larger effect sizes. The pattern of finding appear to be the result of the fact that the children in the single participant studies tended to receive more frequent and intense interventions compared to the children in the group design studies.

CONCLUSION

Findings showed that regardless of type of sign language, simultaneous communication had positive effects on the speech and oral language production of young children with different kinds of disabilities. The findings also showed that the interventions had positive effects in terms of facilitating the children's spontaneous speech and oral language production. The results, taken together, demonstrate the fact that different types of simultaneous communication facilitated speech and oral language production when used with children with little or no language behavior. The findings indicate, contrary to arguments made by some (see Carr, 1979; Zangari et al., 1994; for a description of the debate), that the interventions did not impede speech or oral language production.

It has been well established that infants' and toddlers' use of nonverbal gestures is associated with language learning and production (e.g., Bates & Dick, 2002; Camaioni, Aureli, Bellagamba, & Fogel, 2003; Capirci, Montanari, & Volterra, 1998; Iverson & Goldin-Meadow, 2005; Kita, 2003; Tomasello, Carpenter, & Liszkowski, 2007). Sign language appears to have the same effect as was found in this *CELLreview*. Bates and Dick (2002) noted, for example, that gestures

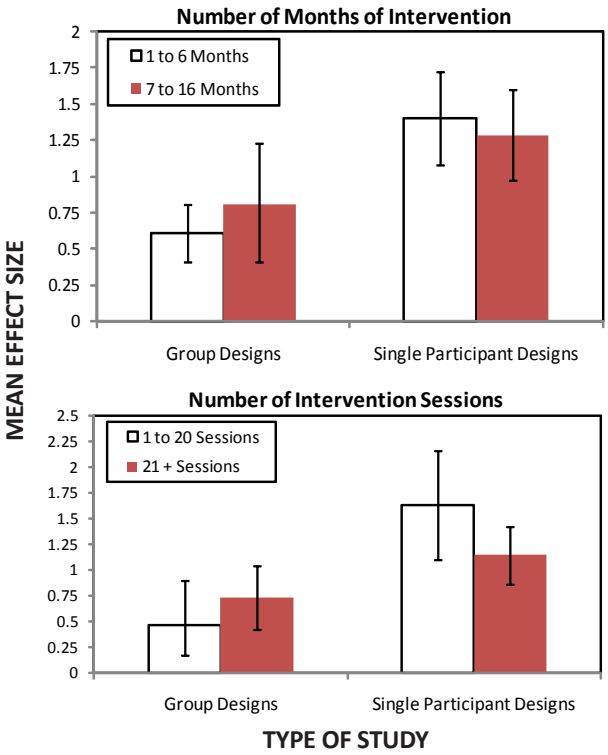

Figure 1. Average effect sizes and 95% confidence intervals for the relationships between number of months of intervention, number of intervention sessions and child speech and oral language production.

pave the way for young children to crack the language code at which time gestures play a less important role in language development, and for some children, drop out altogether.

The fact that natural gestures play less and less of a role in typical oral language learning once the language code is cracked suggests a need to investigate whether the same is the case when formal types of sign language are used to facilitate speech and oral language production. This unfortunately was not directly evaluated in the studies included in this research synthesis. That type of study is indicated and could contribute to a better understanding of the conditions under which simultaneous communication interventions need to "give way" to language-only interventions.

Implications for Practice

The use of signing together with oral language to facilitate a young child's speech and oral language development is indicated in cases where a child has little or no communication skills and other teaching methods have not been found to be successful. Simultaneous communication is likely to affect the child's use of signs where the signs function as a foundation for attempts to produce speech and oral language. The particular words that are selected as behavior targets should be one's associated with highly desired and preferred objects, actions, and people to ensure child interest and engagement to speech and oral language production. The words should also be one's that are easy for the child to produce. As the child becomes proficient in using the targeted words, signing should be faded out (if learning sign language is not the goal) to permit speech and oral language to become the primary form of communication.

CELLpractices for use by both parents and practitioners include activities for incorporating sign language into adult-child activities and interactions to encourage early communication, language, and literacy development (www.earlyliteracylearning.org). The practice guides for infants are specifically designed to engage children in activities to promote acquisition of speech and oral language skills. The *Infant Signing Dictionary* practice guide includes descriptions of 15 signs for actions that most children enjoy and engage in on a day-to-day basis. The interested reader can find descriptions of additional signs by searching the Internet for *Infant Signing Dictionary*. The websites that will be located include video examples of many different signs. The signs can easily be used together with oral language to promote a child's speech and oral language development.

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Appendix A

Characteristics of the Study Participants in the Sign Language Studies

Study	Participant Characteristics						
	Number of Children	Mean Chronological Age (Months)	Chronological Age Range (Months)	Mean Developmental Age (Months)	Developmental Age Range (Months)	Child Condition	Severity of Delay[a]
Acosta (1981)	4	48	36-59	23	15-30	Down syndrome	M/M
Alarcon (1977)	2	78	72-84	NR[b]	NR	Autism Autism	S/P M/M
Barrera & Sulzer-Azaroff (1983)	2	78	72-84	30	24-36	Autism	S/P
Barrett & Sisson (1987)	1	63	–	NR	–	Emotional and/or behavioral disorders	S/P
Benaroya et al. (1977)	6	NR	60-144	NR	NR	Autism	S/P
Bird et al. (2000) (Sample 1)	10	42	25-62	22	18-27	Down syndrome	S/P
Carbone et al. (2006)	1	7	–	NR	–	Autism	M/M
Casey (1977); Casey (1978)	4	78	72-84	NR	NR	Autism	S/P
Cohen (1979)	1	48	–	NR	–	Autism	M/M
Fulwiler & Fouts (1976)	1	61	–	NR	–	Autism	S/P
Gaines et al. (1988)	21	54	36-86	20	10-33	Autism/ Intellectual delay Intellectual delay Autism Autism Aphasia	S/P S/P S/P M/M S/P
Gibbs et al. (1990)	6	14	NR	NR	NR	Down syndrome	M/M
Gibbs & Carswell (1988); Gibbs & Carswell (1991)	1	14	–	NR	–	Down syndrome	M/M
Hurd (1995)	8	NR	42-72	NR	NR	Severe learning difficulties	S/P
Jago et al. (1984) (Sample 1)	11	28	18-36	NR	NR	Down syndrome Developmental delay Not specified	M/M DD M/M
Jago et al. (1984) (Sample 2)	13	28	18-36	NR	NR	Down syndrome Developmental delay Not specified	M/M DD M/M
Kahn (1977)	12	72	53-101	NR	NR	Intellectual delay	S/P

Appendix A, continued

Study	Participant Characteristics						
	Number of Children	Mean Chronological Age (Months)	Chronological Age Range (Months)	Mean Developmental Age (Months)	Developmental Age Range (Months)	Child Condition	Severity of Delay[a]
Konstantareas (1984)	14	95	46-133	65	45-114	Autism Autism Developmental language disorder Head injury Developmental delay Not specified Not specified Not specified	S/P M/M M/M DD DD DD S/P M/M DD
Konstantareas et al. (1979), (1980)	2	102	101-103	NR	NR	Autism/ Intellectual delay	S/P
Kotkin et al. (1978)	2	78	72-84	35	29-41	Down syndrome	S/P M/M
Kouri (1988)	3	33	28-36	22	17-26	Down syndrome Autism Not specified	S/P M/M DD
Kreimeyer (1980)	1	54	–	48	–	Autism	M/M
Kreimeyer (1984)	4	47	40-64	12	10-14	Autism	S/P
Luetke-Stahlman (1985)	1	60	–	25	–	Intellectual delay/ Aphasia	M/M
Oxman et al. (1976)	1	94	–	20	–	Autism/ Intellectual delay	S/P
Shimizu (1988)	1	64	–	24	–	Autism	M/M
Sims-Tucker (1988)	6	43	38-52	11	8-13	Autism Autism/ Intellectual delay Cerebral palsy	S/P S/P S/P
Sisson & Barrett (1984)	3	79	56-97	38	27-52	Intellectual delay/ Behavior disorder	S/P
Tincani (2002); Tincani (2004)	3	78	70-85	NR	NR	Autism/ Intellectual delay Pervasive developmental disorder Autism	S/P M/M M/M
Weber (1995)	2	38	35-41	NR	NR	Cerebral palsy/ Language disorder Down syndrome	M/M M/M
Weller & Mahoney (1983)	15	NR	18-36	16	NR	Down syndrome	M/M
Willems et al. (1982)	1	20	–	NR	NR	Not specified	M/M
Wolf & McAlonie (1977)	8	35	26-37	21	18-33	Down syndrome Down syndrome Down syndrome Not specified	S/P M/M DD M/M

Appendix A, continued

Study	Participant Characteristics						
	Number of Children	Mean Chronological Age (Months)	Chronological Age Range (Months)	Mean Developmental Age (Months)	Developmental Age Range (Months)	Child Condition	Severity of Delay[a]
Yoder & Layton (1988) (Sample 1)	15	64	NR	28	NR	Autism Autism	S/P M/M
Yoder & Layton (1988) (Sample 2)	15	66	NR	27	NR	Autism Autism	S/P M/M
Yoder & Layton (1988) (Sample 4)	15	64	NR	28	NR	Autism Autism	S/P M/M

[a] Estimated based on information included in the research reports (DD = Developmentally delayed, M/M = Mild/moderate delay, S/P= Severe/profound delay).
[b] Not reported.

Appendix B

Types of and Selected Characteristics of the Sign Language Interventions

		Intervention Characteristics					
Study	Type of Sign Language	Approximate Length of Intervention (Months)	Average Number of Sessions	Frequency of Sessions	Approximate Length of Sessions (Minutes)	Preferred Objects/ Words	Reinforcement
Acosta (1981)	Signed English with spoken English	NR[a]	17	1 x day	25	No	Verbal and physical praise, stickers
Alarcon (1977)	Signed Exact English with spoken English	5	80	4 x week	20	No	Verbal and physical praise, access to desired objects, opportunity for play with researcher
Barrera & Sulzer-Azaroff (1983)	American Sign Language with spoken English	2	23	1 x day	38	No	Verbal praise, edibles
Barrett & Sisson (1987)	Unspecified sign language with spoken English	NR	NR	1 x day x 5 x week	20-40	No	Verbal praise, edibles
Benaroya et al. (1977)	Signed English with spoken English	4	NR	NR	NR	No	Access to referent objects
Bird et al. (2000) (Sample 1) (Treatment 1)	American Sign Language	1	3	NR	NR	No	Verbal praise
Bird et al. (2000) (Sample 1) (Treatment 2)	American Sign Language with spoken English	1	3	NR	NR	No	Verbal praise
Carbone et al. (2006)	American Sign Language with spoken English	NR	28	NR	86	No	Verbal praise
Casey (1977); Casey (1978)	Signed English with spoken English	1	NR	NR	NR	NR	Verbal praise, edibles, tokens, peer applause
Cohen (1979)	American Sign Language with spoken English	11	22	3 x week	20	No	Verbal and physical praise, edibles
Fulwiler & Fouts (1976)	American Sign Language and signed English with spoken English	5	40	2 x week	30	No	Access to desired objects
Gaines et al. (1988)	Unspecified sign language with spoken English	1.5	80	2 x day x 5 x week	25	Yes	Edibles
Gibbs et al. (1990)	Unspecified sign language with spoken English	16	25	1 every 2-4 weeks	NR	Yes	NR
Gibbs & Carswell (1988); Gibbs & Carswell (1991)	Signed English with spoken English	14	112	2 x week	30	Yes	NR
Hurd (1995)	Makaton (sign language) with spoken English	–	1	–	NR	No	NR
Jago et al. (1984) (Sample 1)	Intensive unspecified sign language with spoken English	7	56	2 x week	210	No	Verbal praise
Jago et al. (1984) (Sample 2)	Less intense unspecified sign language with spoken English	13	56	1 x week	60-240	No	Verbal praise, edibles
Kahn (1977)	Unspecified sign language with spoken English	9	NR	NR	NR	No	Yes, NR
Konstantareas (1984)	Unspecified sign language with spoken English	1	3	1 x day	NR	No	NR

Appendix B, continued

Study	Type of Sign Language	Intervention Characteristics					
		Approximate Length of Intervention (Months)	Average Number of Sessions	Frequency of Sessions	Approximate Length of Sessions (Minutes)	Preferred Objects/ Words	Reinforcement
Konstantareas et al. (1979), (1980)	Ontario Sign Language with spoken English	9	180	5 x week	240	No	Verbal praise, access to referent objects, activities, and edibles
Kotkin et al. (1978)	Signed English with spoken English	1	9	3 x day	NR	No	Verbal praise, edibles
Kouri (1988)	Modified Signed English with spoken English	8	17	2 x week	40	Yes	Verbal praise, access to referent objects and activities
Kreimeyer (1980)	Unspecified sign language with spoken English	NR	18	NR	NR	Yes	Access to referent objects and activities
Kreimeyer (1984)	Unspecified sign language with spoken English	2	50	1 x day	25	Yes	Access to referent objects, activities, and edibles
Luetke-Stahlman (1985)	American Sign Language with spoken English	9	NR	NR	NR	No	Verbal praise, stickers
Oxman et al. (1976)	Unspecified sign language with spoken English	7	NR	NR	NR	NR	NR
Shimizu (1988)	Japanese Sign Language with spoken Japanese	6	27	1 x week	30	Yes	Verbal praise, access to desired objects
Sims-Tucker (1988)	Unspecified sign language with spoken English	1	5	2 x day x 5 x week	20	No	Verbal praise, access to referent objects or edibles
Sisson & Barrett (1984)	Unspecified sign language with spoken English	3	80	5-6 x week	15-30	No	Verbal praise, edibles
Tincani (2002); Tincani (2004)	American Sign Language with spoken English	2	32	5 x week	30-40	Yes	Verbal praise, access to referent objects and edibles
Weber (1995)	Unspecified sign language with spoken English	3	56	1 x day	15-40	No	Access to referent objects and edibles
Weller & Mahoney (1983)	Signed Exact English with spoken English	5	20	1 x week	20-30	NR	Yes, not specified
Willems et al. (1982)	Seeing Essential English (sign language) with spoken English (Anthony, 1974)	3	10	1 x week	90	Yes	Yes, not specified
Wolf & McAlonie (1977)	American Sign Language and spoken English	5	60	3 x week	15	No	NR
Yoder & Layton (1988) (Sample 1)	Signed English with spoken English	3	90	1 x day	40	No	Verbal praise, access to desired objects
Yoder & Layton (1988) (Sample 2)	Signed English	3	90	1 x day	40	No	Verbal praise, access to desired objects
Yoder & Layton (1988) (Sample 4)	Signed English with spoken English	3	90	1 x day	40	No	Verbal praise, access to desired objects

[a] Not Reported.

Appendix C

Research Designs, Outcome Measures, Comparative Conditions, and Effect Sizes

Study	Research Design	Treatment Conditions	Outcomes: Type	Outcomes: Measure	Comparative Conditions/Contrasts	*Cohen's d* Effect Sizes	
Acosta (1981)	Multiple baseline design	Baseline vs. Alternating Oral vs. Sign + oral (P1 & P4)	Vocalizations	Total number of vocalizations or verbalizations	Baseline vs. Sign + oral	P1 P2 P3 P4	4.33 1.61 1.61 .13
		Baseline vs. Alternating Sign + oral vs. Oral (P2 & P3)			Oral vs. Sign + oral	P1 P2 P3 P4	2.21 -.10 .72 .63
Alarcon (1977)	Single participant design	Sign + oral	Verbalization	Number of correct verbalization probes	Pretest vs. Sign + oral	P2 P3	1.42 .00
Barrera & Sulzer-Azaroff (1983)	Alternating treatments design	Alternating Oral vs. Sign + oral	Verbalization	Total number of words verbalized when prompted	Oral vs. Sign + oral	P1 P2	.73 .83
Barrett & Sisson (1987)	Multiple baseline design	Baseline vs. Alternating Oral vs. Sign + oral (requiring a sign + oral response) vs. Modified Sign + oral (requiring only oral response)	Verbalization	Mean number of verbalized sentence parts learned	Baseline vs. Sign + oral	P1	1.53
					Baseline vs. Modified sign + oral	P1	1.34
					Oral vs. Sign + oral	P1	1.46
					Oral vs. Modified sign + oral	P1	.32
Benaroya et al. (1977)	One group pretest post test design	Sign + oral	Verbalization	Total number of single verbal words acquired	Pretest vs. Sign + oral		1.10
				Total number of multiword verbal phrases acquired	Pretest vs. Sign + oral		.86
Bird et al. (2000) (Sample 1)	Comparative conditions design	Alternating Oral vs. Sign vs. Sign + oral	Verbalization	Mean number of words produced accurately	Oral vs. Sign + oral		.00
					Sign vs. Sign + oral		.44
				Mean number of words produced approximately	Oral vs. Sign + oral		-.13
					Sign vs. Sign + oral		.49
Carbone et al. (2006)	Alternating treatment design	Alternating Sign + oral vs. Oral	Verbalization	Number of verbal tacts acquired for pictured objects	Oral vs. Sign + oral		1.13
Casey (1977); Casey (1978)	Multiple baseline design	Baseline vs. Sign + oral	Verbalization	Mean proportion of elicited verbalizations	Baseline vs. Sign + oral	P1 P2 P3 P4	2.00 1.67 1.40 1.64
				Mean proportion of spontaneous verbalizations	Baseline vs. Sign + oral	P1 P2 P3 P4	.41 2.00 1.63 2.05

Appendix C, continued

Study	Research Design	Treatment Conditions	Outcomes		Comparative Conditions/Contrasts	*Cohen's d* Effect Sizes
			Type	Measure		
Cohen (1979)	Multiple baseline design	Baseline vs. Sign + oral	Verbalization	Percentage of unprompted verbal labeling	Baseline vs. Sign + oral	1.32
				Percentage of unprompted simultaneous verbal with sign labeling	Baseline vs. Sign + oral	1.25
				Percentage of prompted simultaneous verbal with sign labeling	Baseline vs. Sign + oral	1.33
				Percentage of unprompted noun-verb combinations	Baseline vs. Sign + oral	1.47
				Percentage of prompted noun-verb combinations	Baseline vs. Sign + oral	1.77
Fulwiler & Fouts (1976)	Single participant design	Baseline vs. Sign + oral	Verbalization	Total number of acquired verbal words	Baseline vs. Sign +oral	1.14
				Total number of acquired verbal phrases	Baseline vs. Sign +oral	1.50
Gaines et al. (1988)	One group pretest post test design	Pretest vs. post test	Verbalization	Mean number of verbalizations learned	Pretest vs. Sign + oral	.47
				Mean number of verbalizations and signs learned	Pretest vs. Sign + oral	.53
Gibbs et al. (1990)	One group pretest post test design	Pretest vs. post test	Verbalization	Expressive language quotient	Pretest vs. Sign + oral	-.51
Gibbs & Carswell (1988); Gibbs & Carswell (1991)	Single participant design	Baseline vs. Sign + oral	Verbalization	Percentage of correct words acquired	Baseline vs. Sign + oral	1.18
				Percentage of correct words + signs acquired	Baseline vs. Sign + oral	1.13
Hurd (1995)	Comparative group design	Sign + oral vs. Oral	Verbalization	Total number of appropriate verbalizations of the words "big" and "little"	Oral vs. Sign + oral	1.01

Appendix C, continued

Study	Research Design	Treatment Conditions	Outcomes		Comparative Conditions/Contrasts	*Cohen's d* Effect Sizes
			Type	Measure		
Jago et al. (1984) (Sample 1)	Comparative group design	Intensive Sign + oral pretest vs. post test	Verbalization	Mean number of words acquired	Pretest vs. Intensive Sign + oral	1.45
			Verbalization	REEL[a] expressive scores	Pretest vs. Intensive Sign + oral	2.60
			Verbalization	SICD[b] expressive scores	Pretest vs. Intensive Sign + oral	1.07
Jago et al. (1984) (Sample 2)	Comparative group design	Less intense Sign + oral pretest vs. post test	Verbalization	Mean number of words acquired	Pretest vs. Less intense Sign + oral	.39
			Verbalization	REEL expressive scores	Pretest vs. Less intense Sign + oral	.20
			Verbalization	SICD expressive scores	Pretest vs. Less intense Sign + oral	.77
Kahn (1977)	Comparative group design	Sign + oral vs. Oral vs. Control	Verbalization	Total number of verbalizations used without prompting	Oral vs. Sign + oral	.90
					Control vs. Sign + oral	1.11
Konstantareas (1984)	Comparative conditions design	Sign + oral vs. Oral	Verbalization	Mean percentage of independently provided answers	Oral vs. Sign + oral	.24
				Mean percentage of cued answers provided	Oral vs. Sign + oral	1.12
Konstantareas et al. (1979), (1980)	One group pretest post test design	Sign + oral	Verbalization	Total number of spontaneous or prompted verbalizations	Pretest vs. Sign + oral	.00
				Total number of spontaneous or prompted verbalizations + signs	Pretest vs. Sign + oral	1.14
				Total number of elicited referent verbalizations	Pretest vs. Sign + oral	.00
				Total number of elicited referent verbalizations + signs	Pretest vs. Sign + oral	1.11
				Total number of elicited non-referent verbalizations	Pretest vs. Sign + oral	1.00
				Total number of elicited non-referent verbalizations + signs	Pretest vs. Sign + oral	1.06

Appendix C, continued

Study	Research Design	Treatment Conditions	Outcomes: Type	Outcomes: Measure	Comparative Conditions/Contrasts	*Cohen's d* Effect Sizes	
Kotkin et al. (1978)	Multiple baseline design	Baseline vs. Oral vs. Sign + oral	Verbalization	Number of correct verbal responses	Baseline vs. Sign + oral	P1 P2	1.99 4.02
					Oral vs. Sign + oral	P1 P2	1.23 3.62
Kouri (1988)	Single participant design	Baseline vs. Sign + oral	Verbalization	Number of spontaneously spoken words	Baseline vs. Sign + oral	P1 P4 P5	1.96 .00 2.19
				Number of verbal responses to questions	Baseline vs. Sign + oral	P1 P5	1.62 1.86
				Number of spontaneously spoken verbal words + signs	Baseline vs. Sign + oral	P5	1.56
				Number of verbalizations + signs as responses	Baseline vs. Sign + oral	P5	.89
Kreimeyer (1980)	Multiple baseline design	Oral (baseline) vs. Sign + oral	Verbalizations	Investigator-developed communication scale	Oral vs. Sign + oral		-.10
Kreimeyer (1984)	Alternating treatments design	Baseline vs. Alternating Prompted sign + oral vs. Modeled sign + oral	Vocalizations	Investigator-developed communication scale	Baseline vs. Prompted Sign + oral	P1 P2 P3 P4	.43 .94 .60 .21
					Baseline vs. Modeled Sign + oral	P1 P2 P3 P4	.32 .91 .50 .01
Luetke-Stahlman (1985)	Single participant design	Baseline vs. Sign + oral	Verbalization	Number of verbalizations	Baseline vs. Sign + oral		1.82
				Number of verbalizations accompanied by signs	Baseline vs. Sign + oral		1.39
Oxman et al. (1976)	Single participant pretest post test design	Sign + oral	Verbalization	Number of correct verbal responses	Pretest vs. Sign + oral		.44
				Number of approximate verbal responses	Pretest vs. Sign + oral		-.08

Appendix C, continued

Study	Research Design	Treatment Conditions	Outcomes: Type	Outcomes: Measure	Comparative Conditions/Contrasts	*Cohen's d* Effect Sizes
Shimizu (1988)	Single participant design	Baseline vs. Sign + oral	Vocalization	Percentage of spontaneous vocalizations alone	Baseline vs. Sign + oral	1.19
				Percentage of spontaneous vocalizations with signs	Baseline vs. Sign + oral	1.10
				Percentage of spontaneous vocalizations with pointing	Baseline vs. Sign + oral	.63
				Percentage of only vocalized responses to mands	Baseline vs. Sign + oral	1.06
				Percentage of responses to mands vocalized with signs	Baseline vs. Sign + oral	1.00
				Percentage of responses to mands vocalized with pointing	Baseline vs. Sign + oral	.63
				Percentage of vocalized interactions	Baseline vs. Sign + oral	1.66
Sims-Tucker (1988)	Simultaneous treatment single participant design	Baseline vs. Simultaneous Sign + oral	Verbalization	Number of verbal labels produced	Baseline vs. Sign + oral	P1 .80 P2 1.28 P3 1.53 P4 1.26 P5 1.26 P6 .82
Sisson & Barrett (1984)	Multiple baseline across type of training design	Baseline vs. Alternating Oral vs. Sign + oral	Verbalization	Mean number of sentence parts learned	Baseline vs. Sign + oral	P1 3.38 P2 4.29 P3 2.80
					Oral vs. Sign + oral	P1 1.91 P2 1.11 P3 .22
Tincani (2002); Tincani (2004)	Alternating treatment design	Baseline vs. Sign + oral	Verbalization	Percentage of word verbalizations	Baseline vs. Sign + oral	P1 2.04 P2 2.15 P3 .00
Weber (1995)	Multiple baseline design	Baseline vs. Sign + oral	Verbalization	Number of correct verbalized or verbalized + signed responses	Baseline vs. Sign + oral	P1 .48 P2 .32
Weller & Mahoney (1983)	Comparative group design	Sign + oral vs. Oral	Verbalization	REEL expressive scores	Sign + oral Pretest vs. Post test	.58
				Total number of words spoken	Sign + oral Pretest vs. Post test	1.13

Appendix C, continued

Study	Research Design	Treatment Conditions	Outcomes		Comparative Conditions/Contrasts	*Cohen's d* Effect Sizes
			Type	Measure		
Willems et al. (1982)	Case study	Sign + oral	Verbalization	Number of word verbalizations or approximations	Pretest vs. Sign + oral	5.30
Wolf & McAlonie (1977)	One group pretest post test design	Sign + oral	Verbalization	MELDS[c] expressive language scores	Pretest vs. Sign + oral	1.14
Yoder & Layton (1988)	Comparative conditions design	Sign vs. Simultaneous Sign + oral vs. Alternating Sign + oral vs. Oral	Verbalization	Number of spontaneously emitted words	Sign vs. Simultaneous Sign + oral	.59
					Sign vs. Alternating Sign + oral	.33
					Pretest vs. Simultaneous Sign + oral	.94
					Pretest vs. Alternating Sign + oral	.55

[a] Receptive-Expressive Emergent Language Test (Bzoch & League, 1971).
[b] Sequenced Inventory of Communicative Development (Hedrick, Prather, & Tobin, 1975)
[c] Minnesota Early Language Development Sequence (Clark et al., 1975).