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Effects of Different Types of Adaptations on the Behavior of Young Children with Disabilities

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Abstract: The effectiveness of adaptations to the environment, materials, and activities with young children with disabilities was the focus of this research synthesis. The synthesis included 19 studies of 104 children with different types of disabilities (autism, multiple disabilities, developmental delays, Down syndrome, visual impairments, cerebral palsy, and behavioral disorders). Most of the studies used single participant designs; two studies used contrasting conditions designs, two investigations were case studies, and one was a cross-sectional study. Results showed that all three types of adaptations were related to variations or changes in child behavior; the adaptations were most effective when used for 10 or more sessions; and the outcomes most effected by the interventions were communication and cognition, and to a lesser degree, social behavior. Implications for practice are described.

This paper includes a research synthesis of findings from studies of young children with disabilities where different types of adaptations were used to promote child participation in typically occurring activities to affect the behavioral competence of the children. The adaptations included both environmental accommodations and modifications to activities and materials (e.g., Bailey & Wolery, 1992; Campbell, Milbourne, & Wilcox, 2008; Doctoroff, 2001; Mayfield, 1996; McCormick & Feeney, 1995; Sandall, 2003). Environmental adaptations include such things as rearranging play areas in classroom settings and rearranging furniture in a child's home to make it easier for a child to move around. Adaptations to activities include such things as making modifications to curricular activities and simplifying an activity by breaking it down into a smaller number of steps so that a child can more easily complete a task. Adaptations to materials include such things as putting handles on puzzle pieces and having a child use specially designed eating utensils to make it easier for a child to use the materials. It is generally agreed that adaptations make possible child participation in classroom, home, and community settings, and that participation in turn provides the contexts for child learning (e.g., Hamm, Mistrett, & Ruffino, 2006; Mistrett, 2004; Ostensjo, Carlberg, & Vollestad, 2003; Wolery, Schroeder, Martin, Venn, Holcombe, Brookfield, Huffman, & Fleming, 1994). The extent to which the use of adaptations were associated with discernable differences in child behavior and competence was the main focus of this research synthesis.

The research synthesis was guided by a characteristics--consequences framework that focused on how and in what manner different types of adaptations had similar or different effects and consequences (Dunst & Trivette, 2009; Dunst, Trivette, & Cutspec, 2007; Dunst, Trivette, & Watson, 2009). More specifically, we examined the conditions under which different types of adaptations affected young children with disabilities' cognitive, communication, social, and motor behavior. The studies included in the synthesis were ones where the adaptations were the primary or sole intervention and child behavioral competence was an outcome of interest. The investigators of all the studies included in the research synthesis hypothesized or predicted that the adaptations would be associated with discernable behavior consequences.

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Background

Young children with disabilities often require special kinds of interventions in order for them to learn and develop (Guralnick, 2005; Wolery, Strain, & Bailey, 1992). Both researchers and practitioners have described how adaptations to physical settings, activities, materials, instruction, etc. can promote children's participation and engagement in interactions with their social and nonsocial environments (e.g., Day, McDonnell, & Heathfield, 2005; Mayfield, 1996; Sandall, 2003). As noted by Campbell et al. (2008), Wolery (1994), and others (e.g., Doctoroff, 2001), adaptations function as a kind of mediator, facilitating young children with disabilities involvement in different activities and routines that more easily permit child learning. Stated differently, adaptations function as a means to an end where the consequences of their use includes more frequent and better opportunities for child learning and improved behavior functioning.

A number of classification schemes have been developed for categorizing different types of adaptations (e.g., Campbell, Milbourne, & Wilcox, 2008; Mayfield, 1996; McCormick & Feeney, 1995; Sandall, 2003). Most categorizations describe adaptations to the physical environment, activities, materials, curriculum, and instructional practices. One of these is *Creating Adaptations for Routines and Activities* described in *CARA's Kit* (Milbourne & Campbell, 2007).

CARA's Kit

Campbell, Milbourne and their colleagues (Campbell, 2005; Campbell, McGregor, & Nasik, 1994; Campbell, Milbourne, Dugan, & Wilcox, 2006; Campbell, Milbourne, & Wilcox, 2008; Wilcox, Guimond, Campbell, & Moore, 2006) have developed, based on both research and practice, a hierarchy for designing and implementing adaptations for young children with disabilities that varies along a continuum from the least to most intrusive kinds of interventions. The hierarchy includes five types of adaptations:

- *Adaptations to the environment*. This includes rearranging furniture, arranging play areas, the use of mobility devices, and the use of specially designed equipment.
- *Adaptations to activities and routines*. This includes changes in how an activity is done (e.g., adding motor movements to telling a story) and changes in the length of time a child has to complete a task.
- *Adaptations to materials*. This includes modifications to toys and other materials (e.g., writing instruments) and assistive technology devices.
- *Adaptations to instructional practices*. This includes reducing the number of steps a child is expected to perform or adding additional information (e.g., pictures) to show a child what he or she is being asked to do.

Provide assistance. This includes another person helping a child do an activity or doing an activity while a child is watching.

This research synthesis examined the effects of adaptations to the environment, activities, and materials on child behavior. Existing research reviews on adaptations to instructional practices can be found elsewhere (e.g., Okolo, Cavalier, Ferretti, & MacArthur, 2000; Wolery & Sainato, 1996). We did not examine studies that involved assistance since our main interest was adaptations to physical settings and materials or activities.

Search Strategy

Search Terms

A series of different searches were done to identify relevant studies using the search strategy described in Lucas and Cutspec (2007). The terms *adapt** or *modif** or *accom** and *infan** or *toddler** or *child** or *preschool** or *kindergarten** or *daycare* or *childcare* or "*day care*" or "*child care*" or "*nursery school*" and *diab** or *disorder** or *delay** or *impair** or *retard** plus a list of more than 50 other specific types of disabilities (autism, Down syndrome, visual impairment, spina bifida, cerebral palsy, etc.) were used in all the searches. The search for studies of adaptations to the environment also included *classroom* or *environment* or *setting* or "*open space*" or "*learning center*" or "*classroom design*" or "*physical arrangement*" plus more than 25 other terms about specific types of environmental adaptations as search terms (furniture, chair, table, etc.). The search for adaptations to activities and routines also included *activit** or *routin** or *cent** or *area** plus more than 100 specific types of activities as search terms (dressing, eating, bathing, playing, etc.). The search for adaptations to materials also included *toy** or *material** and more than 50 specific types of materials as search terms (spoon, pen, book, crayon, etc.). In those instances where very large numbers of

papers were located (more than 1000 in any one search) the results were delimited by using the search terms *research* or *evaluate* or *study*.

Sources

ERIC (Educational Resources Information Center), Psychological Abstracts (PsychInfo), REHABDATA, Medline, Academic Search Elite, and InfoTRAC Expanded Academic ASAP were searched to identify studies. These were supplemented by searches of Ingenta, Google Scholar, and an EndNote library maintained by the Puckett Institute.

Hand searches of the reference sections all retrieved journal articles, book chapters, and books were examined to identify additional studies. The reference sections of the papers cited in the Background section of this paper as well as other articles, chapters, and books (e.g., Bednarczyk, Alexander-Whiting, & Solit, 1994; Campbell, Milbourne, & Wilcox, 2008; Fabregat, Costa, & Romero, 2004; Mistrett, Hale, Diamond, Ruedel, Gruner, Sunshine, Berman, Saunders, & McInerney, 2001; Sullivan & Lewis, 2000) were also examined to identify relevant studies.

Inclusion Criteria

Studies were included if they were investigations of one of the three types of adaptations constituting the focus of the synthesis, the adaptations were designed to promote child participation in typically occurring activities, the studies included children with disabilities birth to six years of age, and the outcomes in the studies included some type of child behavioral consequence or effect. Studies were limited to those investigations where sufficient information was provided about the adaptations and they were not used in combination with other interventions to be able to eliminate treatment confounds and multiple treatment interference.

Exclusion criteria. Studies of children without identified disabilities (Moody, 2008) and studies of children older than six years of age were excluded. In those studies which had children both under and over six years of age, we included the findings for only the younger children. Studies that evaluated children's abilities to learn to use some type of adaptation (e.g., assistive technology) but did not include a child behavioral outcome measure were also excluded. Studies were excluded if the adaptations were implemented in a noncontextual manner (e.g., Olive, Lang, & Davis, 2008) or the child behavior was not appropriate in terms of the manner in which the adaptation was used (e.g., Frea, Arnold, & Vittimberga, 2001). We also excluded studies that implemented multiple kinds of adaptations simultaneously.

Search Results

Participants

Nineteen studies were located that included 104 participants. The characteristics of the study participants are shown in Appendix A. The children ranged in age from 5 to 80 months with the majority between 36 and 60 months of age. Most of the participants (86%) were boys. The children had a variety of types of disabilities, including autism, cerebral palsy, Down syndrome, visual impairments, and Retts syndrome as well as other disabilities.

Study Characteristics

Appendix B shows the research designs used in the studies and the characteristics of the adaptations that were the focus of investigation. Most of the studies (79%) used single-participant designs (AB, ABA, or multiple baseline). Two investigations were case studies, two studies used a contrasting conditions design, and one was a cross-sectional study.

Half of the studies were conducted in classroom settings. Five studies were conducted in the children's homes, two were conducted in clinics or therapy rooms, and one was conducted on a playground and gym.

Three of the studies investigated adaptations to the environment, 12 studies investigated adaptations to activities, and three studies investigated adaptations to materials. The settings in which the interventions were implemented included free play, meal times, book reading, circle time, and art. Two studies investigated adapta-

tions during transitions between activities in classroom settings. The interventions were implemented from one to more than 30 sessions. Most were implemented between 5 and 20 sessions.

Method of Analysis

The sizes of effects for the relationship between the adaptations and child outcomes were discerned in two ways. First, in all the single participant design studies and the contrasting conditions studies, we calculated the means and standard deviations for the baseline and intervention conditions, and then computed a Cohen's *d* for the mean differences using the formula in Dunst, Hamby and Trivette (2007) for single participant design studies. Second, for all the studies, including the case studies and one cross-sectional study, we assessed the degree to which the observed and reported outcomes were consistent or inconsistent with investigator expectations. This was done using a 5-point scale (-2 = highly inconsistent, -1 = somewhat inconsistent, 0 = neither consistent nor inconsistent, 1 = somewhat consistent, 2 = highly consistent) for determining how well the results matched investigator expectations (Yin, 2002b). Inspection of graphs in the single participant design studies, the magnitude of reported influences in the contrasting conditions and cross-sectional studies, and the narrative descriptions in the case studies, were used to make the ratings. The pattern matching strategy allowed us to code and include studies for which traditional effect sizes could not be computed. Inter-rater agreement for the pattern matching ratings was 90% for the complete set of findings.

Mean Cohen's *d* effect sizes and mean pattern matching scores were calculated for different intervention, moderator, and outcome variables. The intervention variables included type of adaptation (environment, activity, materials), number of intervention sessions (Range = 5 to 37), and the setting in which the interventions were implemented (classroom, home, therapy rooms, etc.). Four moderator variables were evaluated: Child gender, age, and disability, and research design. The different outcomes in the studies were coded according to four domains: Cognitive, communication, social, or gross motor. The behavior coded as cognitive outcomes included sound-guided reaching, engagement with the physical environment, and object permanence. The behaviors coded as communication outcomes included child utterances, speech production, child-initiated nonverbal and verbal behavior, and communicative efficacy. The behavior coded as social outcomes included child positive affect, engagement with adults or peers, behavioral compliance, and social greetings. The behavior coded as gross motor outcomes included child-initiated movement and locomotion.

The average Cohen's *d* and average pattern matching scores for the intervention, moderator, and outcome variables were used as the best estimates of the size of effect between variables. The 90% confidence intervals for the means of both effect sizes were used as a measure of the "range of reaction" of the intervention variables on the study outcomes. The smaller the confidence interval for a mean effect size, the better the mean is an estimate of the real size of effect. Neither type of effect size could be weighted since the procedure for doing so cannot be applied to single participant data (Shadish & Haddock, 1994).

We also ascertained for the different intervention, moderator, and outcome variables, the number and percentage of effect sizes that reached an *a priori* predetermined level. A Cohen's *d* of .50 was used as the criterion for determining if an adaptation had a discernable effect on a study outcome. A pattern matching score of one or two was used as the criterion for determining if an adaptation was associated with the expected pattern of results. Both of these metrics assisted in substantive interpretation of the synthesis findings.

Synthesis Results

The complete set of results are shown in Appendix C. The table shows the outcomes that were the focus of investigation, the child behavior that was measured, the domains to which the

outcomes were assigned, and the Cohen's *d* and pattern matching scores for each outcome measure. The information in this table as well as that in Tables 1 and 2 were used to discern the manner in which the adaptations were related to the study outcomes.

Cohen's d Effect Size Findings

Omnibus findings. The omnibus findings are displayed in Figure 1. What are shown are the results for all types of adaptations combined and all outcome measures combined organized by the percentages of effects having different ranges. Just over half (54%) of the effect sizes were greater than 1.0, and 81% of the effect sizes were .50 or greater. Most studies yielded results showing moderate to large effect sizes for the relationships between the different types of adaptations and the study outcomes.

Table 1 shows the results for the three intervention variables and the outcome measures. The results for type of adaptation, number of sessions, and intervention setting provide a basis for ascertaining the differential effects of the interventions on the study outcomes. The results for the outcomes provide a basis for discerning which types of behavior are influenced by the interventions.

Type of adaptation. All three types of adaptations were related to the study outcomes as evidenced by the average Cohen's *d* effect sizes, their confidence intervals, and the numbers and

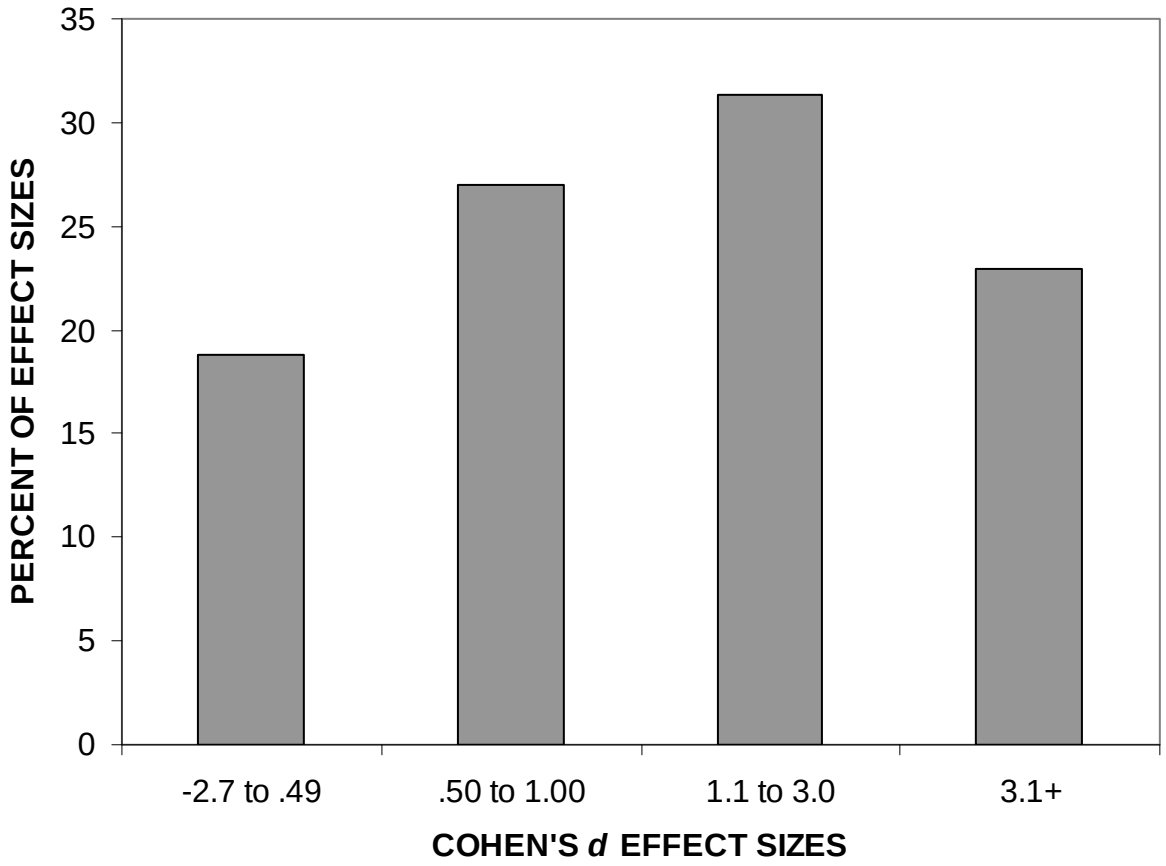

Figure 1. Percentages of Cohen's *d* effect sizes organized according to different ranges of effects for the relationships between the adaptations and the study outcomes

percentages of effect sizes .50 or larger. Adaptations to the environment were associated with the largest average effect sizes whereas adaptations to materials were associated with somewhat smaller (but nonetheless large) average effect sizes. Adaptations to activities were highly effective as evidenced by a large average effect size and a confidence interval showing that the largest majority of adaptations were associated with large effect sizes.

Number of sessions. The more sessions the adaptations were used, the more positive were the study outcomes. This was evidenced by the differences in the average size of effects for the number of sessions the adaptations were used (5 -9 vs 10+) and the numbers and percentages of effect sizes .50 or larger. There were also concomitant increases in the confidence intervals

Table 1
Mean Cohen's d Effect Sizes and 90% Confidence Intervals (CI) for Different Intervention and Outcome Variables

Variable	Number		Mean *d*	90% CI	*d* ≥ .50	
	Children[a]	Effect Sizes			Number	Percent
Type of Adaptation						
Environment	6	10	2.27	.86 – 3.68	9	80
Activity	23	30	1.86	1.38 – 2.34	24	80
Material	6	8	1.39	.41 – 2.36	5	63
Number of Sessions						
5-9	16	25	1.52	.92 – 2.11	17	68
10-15	9	11	2.30	1.30 – 3.29	9	82
16-37	11	12	2.21	1.37 – 3.04	12	100
Setting						
Inclusive Classroom	18	20	2.47	1.85 – 3.10	19	95
Noninclusive Classroom	8	10	2.30	1.58 – 3.01	10	100
Playground/Gym	2	6	1.11	-.82 – 3.05	5	83
Therapy Room/ Clinic	1	3	.95	-2.20 – 4.11	1	33
Home	6	9	.85	-.10 – 1.79	3	33
Outcome Domain						
Cognitive	9	9	3.42	2.53 – 4.31	9	100
Communication	21	28	1.57	1.10 – 2.04	20	71
Gross Motor	2	2	3.52	-.28 – 7.31	2	100
Social	6	9	.88	-.29 – 2.04	7	78

[a] For purposes of the analyses, the results from the Koppenhaver et al. (2001) study were treated as a single participant outcome study.

which indicates that the influences of the adaptations become more pronounced the more they were used.

Intervention setting. The adaptations were differentially effective depending on the settings in which they were implemented. The adaptations were equally effective when implemented in either inclusive or noninclusive classroom settings. This was ascertained by the large average effect sizes and the confidence intervals indicating that the largest majority of sizes of effects were also large. The adaptations were also effective when implemented on a playground or gym as evidenced by the average effect size and the fact that 83% of the effect sizes were .50 or larger. The studies that implemented the adaptations in the children's homes or in a therapy room and clinic produced mixed results. Whereas the average effect sizes for both settings were large, only one third of the individual effect sizes were .50 or larger. In both cases, a few very large effect sizes inflated the average effect size.

Outcome domain. The adaptations were highly effective in influencing cognitive and communication outcomes, and also effective in affecting social and motor outcomes. The sizes of effects for both the cognitive and communication outcomes were large, and the confidence intervals for both sets of measures were also large. The average sizes of effect for the gross motor outcome was also large, where the two effect sizes were 2.91 and 4.12. The largest majority of the effect sizes for the social outcomes were .50 or larger.

Moderator effects. The extent to which the effectiveness of the adaptations were moderated by child and study variables are shown in Table 2. The adaptations were equally effective when used with boys or girls. The adaptations were more effective when used with younger compared to older children as evidenced by decreases in both the average effect sizes and number and percent of effect sizes .50 or larger across age groups. This was probably due to the fact that the older children appeared to be more profoundly impaired based on the information included in the research reports (although few studies reported child functioning levels). The adaptations were most effective for children with autism, multiple disabilities, unspecified developmental delays, and to a lesser extent, cerebral palsy. They were also effective for children with behavioral disorders as determined by the number and percent of effect sizes .50 or larger.

Single participant design studies yielded larger average effect sizes compared to the contrasting group design studies. The fact that the single participant design studies yielded very large effect sizes (relative to other designs) was not unexpected since this has generally been the case where effect sizes are calculated on single participant data (e.g., Raab & Dunst, 2007).

Pattern Matching Findings

Omnibus findings. Figure 2 shows the omnibus findings for the pattern matching analyses. Thirty percent of the study results were rated as highly consistent with investigator predictions, and 38% were rated as somewhat consistent with predictions. Just over two thirds of the outcomes (68%) were rated as matching investigator predictions. Very few results (8%) were rated as inconsistent with investigator predictions. One quarter of the results, however, were rated as neither consistent nor inconsistent with investigator predictions. Nonetheless, the findings, taken together, show that the cross-case synthesis of the results provide more evidence to support rather than to refute the conclusion that the adaptations generally had positive effects (Yin, 2002a).

The pattern matching results for the intervention and outcome variables are shown in Table 3. The findings include the ratings for the outcomes in the single participant design and contrasting conditions studies included in the Cohen's *d* effect size analyses as well as ratings of the results for the two case studies (Aitken & Bower, 1982; Lane & Mistrett, 1996) and the one cross-sectional study (Ostensjo, Carlberg, & Vollestad, 2005). Because of the constrained range of ratings (-2 to +2), effect sizes of .25

to .49 were considered small, .50 to .99 medium, and 1.0 or greater large. All of the average effect sizes for all variables and measure were .26 or larger.

Type of adaptation. All three types of adaptations were associated with positive study outcomes. The average effect size for the material adaptations was large, and those for the activity and environment adaptations were medium. The confidence intervals for the material and activity adaptations indicated that they had medium to large effects, whereas those for the environment adaptations were small to large.

Number of sessions. The findings for the session analyses showed that the more sessions the adaptations were used, the larger the average effect sizes and the larger the number and percent of effect sizes that matched expectations.

Table 2
Mean Cohen's d Effect Sizes and 90% Confidence Interval (CI) for Different Moderator Variables

Variable	Number		Mean *d*	90% CI	*d* ≥ .50	
	Children	Effect Sizes			Number	Percent
Child Gender						
Male	24	32	1.97	1.42 – 2.52	25	78
Female	11	16	1.66	.97 – 2.34	13	81
Child Age (months)						
12-36	5	5	2.50	2.29 – 2.71	5	100
37-48	10	12	2.15	1.26 – 3.03	11	92
49-60	12	19	2.07	1.29 – 2.84	16	84
61-78	7	10	1.01	-.02 – 2.05	4	40
Child Disability						
Autism	17	21	2.36	1.69 – 3.02	17	81
Multiple Disabilities	8	10	2.10	1.07 – 3.12	8	80
Developmental Delay[a]	5	6	1.42	.62 – 2.21	5	83
Cerebral Palsy	4	8	1.17	-.22 – 2.55	6	75
Behavioral Disorder	1	3	.46	-.21 – 1.14	2	66
Research Design						
ABA	12	19	2.02	1.19 – 2.85	17	89
Multiple Baseline	20	24	2.00	1.50 – 2.50	20	83
Contrasting Conditions	3	5	.65	-.67 – 1.98	1	20

[a] Includes children with Down syndrome.

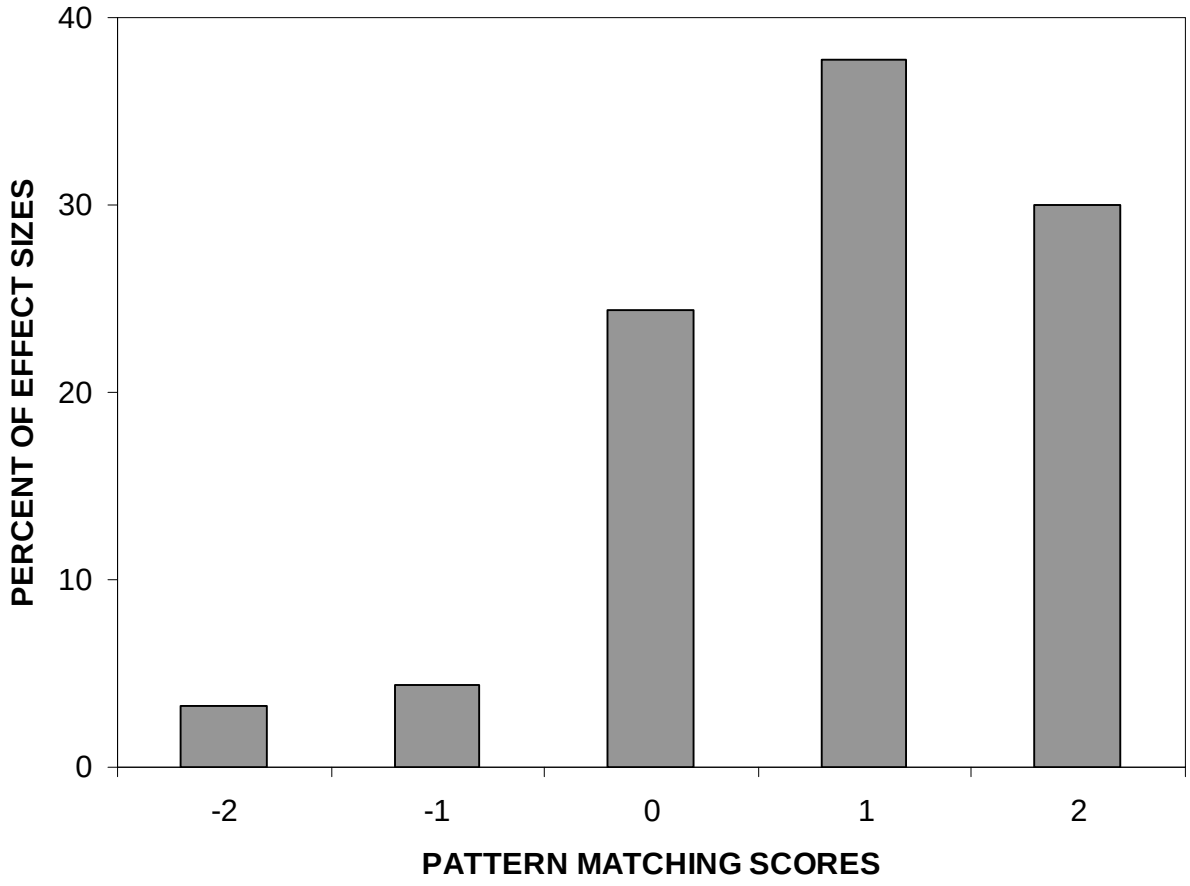

Figure 2. Percentage of pattern matching scores for the relationships between the adaptations and the study outcomes. (NOTE: -2 = Highly inconsistent, -1 = Somewhat consistent, 0 = Neither consistent nor inconsistent, 1 = Somewhat consistent, and 2 = Highly consistent with investigator expectations.)

There were also concomitant changes in the confidence intervals for the average effect sizes, indicating that the effect sizes for the adaptations became larger the more frequently the adaptations were used.

Intervention setting. The adaptations were similarly effective when used in either inclusive or noninclusive classroom settings or home settings. The average effect sizes for the two classroom settings and the homes were all large, and the confidence intervals for all three settings were medium to large. The average effect size for the playground and gym was medium, and that for the therapy room and clinic was small. For both settings, only half the effect sizes matched expectations.

Outcome domain. The outcomes that were most affected by the adaptations were communication and cognitive behaviors. The average effect sizes for the communication and cognitive outcomes were both large and had medium to large confidence interval effect sizes. The average effect size for the social outcomes was medium but the confidence interval effect sizes were only small to medium. The adaptations had mixed results for motor outcomes. Whereas the average effect size was medium, the confidence interval indicated that the effects of the adaptations had both positive and negative effects.

Moderator effects. Table 4 shows the extent to which the relationships between the adaptation interventions and the pattern matching scores were moderated by child and study variables. The average sizes of effects and the confi-

Table 3
Mean Pattern Matching Scores and 90% Confidence Intervals (CI) for Different Intervention and Outcome Variables

Variable	Number		Mean Pattern Matching Scores	90% CI	Matched Expectations	
	Children	Effect Sizes			Number	Percent
Type of Adaptation						
Material	8	10	1.10	.67 – 1.53	8	80
Activity	35	64	.86	.63 – 1.09	43	67
Environment	8	16	.75	.37 – 1.13	10	63
Number of Sessions						
5-9	25	45	.60	.33 – .87	27	60
10-15	10	16	1.00	.64 – 1.36	13	78
16-37	11	12	1.42	1.01 – 1.83	10	83
Setting						
Inclusive Classroom	18	20	1.35	1.12 – 1.58	19	95
Noninclusive Classroom	8	10	1.30	.82 – 1.78	8	80
Home	11	26	1.04	.73 – 1.35	18	69
Playground/Gym	2	6	.50	-.36 – 1.36	3	50
Therapy Room/ Clinic	8	19	.26	-.26 – .79	10	53
Outcome Domain						
Communication	21	28	1.04	.78 – 1.29	26	81
Cognitive	20	30	1.03	.72 – 1.34	20	71
Social	10	20	.55	.18 - .92	9	45
Motor	9	10	.50	-.33 – 1.33	6	60

[a] The findings from the Koppenhaver et al. (2001) and Ostensjo et al. (2005) studies were considered as one participant for purposes of the analyses.

Table 4
Pattern Matching Scores and 90% Confidence Intervals (CI) for Different Moderator Variables

Variable	Number		Mean Pattern Matching Scores	90% CI	Matched Expectations	
	Children	Effect Sizes			Number	Percent
Child Gender						
Male	36	65	.88	.65 – 1.10	46	71
Female	11	16	1.13	.77 – 1.48	12	75
Child Age (months)						
5-36	17	38	.82	.48 – 1.15	27	71
37-48	10	12	1.33	1.00 – 1.67	11	92
49-60	13	28	.79	.52 – 1.05	17	61
61-78	7	10	.60	.11 – 1.09	4	40
Child Disability						
Autism	17	21	1.14	.84 – 1.44	16	76
Multiple Disabilities	8	10	1.00	.61 – 1.39	8	80
Developmental Delay [a]	5	6	1.17	.55 – 1.79	5	83
Visual Impairment	11	31	.68	.28 – 1.07	20	65
Cerebral Palsy	6	19	.63	.30 – .96	10	53
Behavioral Disorder	1	3	1.33	-.61 – 3.28	2	66
Research Design						
ABA	12	19	1.16	.80 – 1.52	15	80
Multiple Baseline	20	24	1.13	.87 – 1.38	19	79
Case Study	12	33	.73	.35 – 1.11	22	67
Contrasting Conditions	3	5	.40	-.12 – .92	2	40
Cross-sectional	1	9	.33	.02 – .64	3	33

[a] Includes children with Down syndrome.

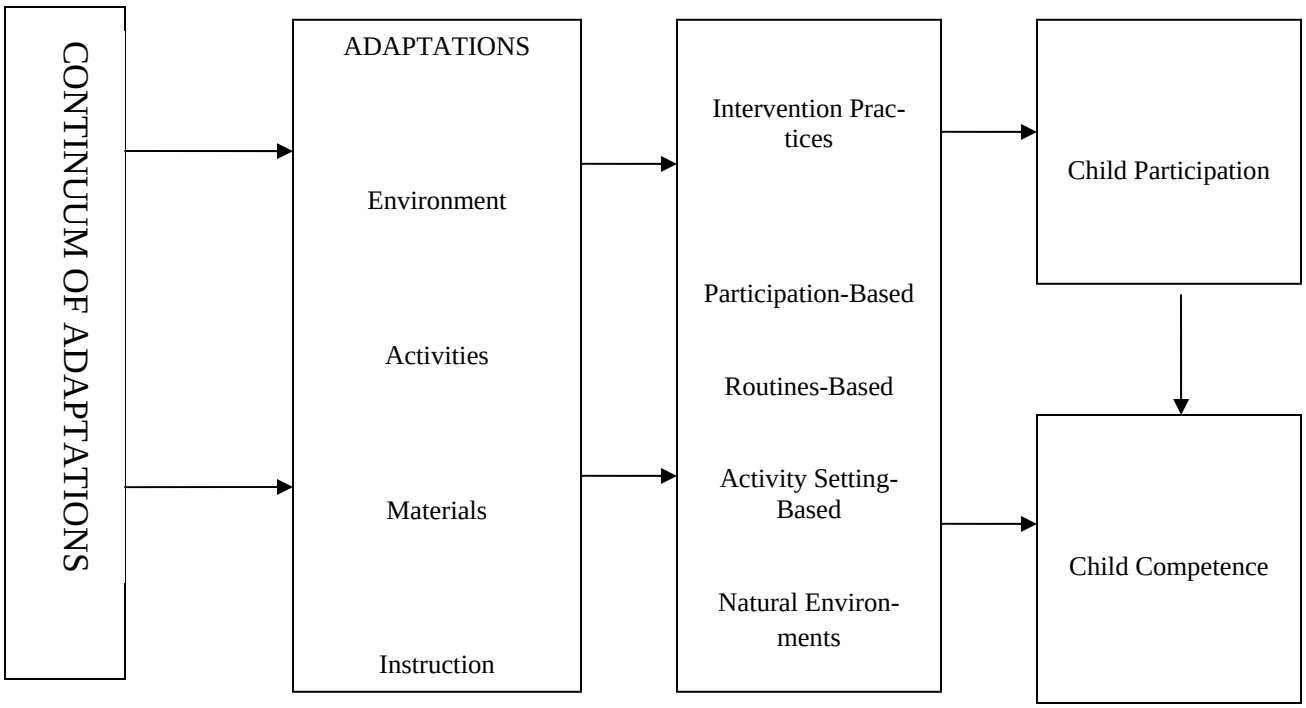

Figure 3. Framework for conceptualizing the functions of adaptations in terms of early interventions practices for promoting child participation in everyday activities and their effects on

dence intervals for child gender showed that the effectiveness of the adaptations differed some but not appreciably by this moderator.

The results from the analyses of child age showed that the effects on the study outcomes were medium to large for children 5 to 60 months of age, but that the influences of the adaptations on the study outcomes were mixed for the 61 to 78 month old children as evidenced by the large confidence interval for the average effect size. The number and percent of effect sizes that matched expectations decreased among the older children indicating that the adaptations were generally more effective when used with younger children.

The adaptations were most effective for children with autism, developmental disabilities, developmental delays, and visual impairments. The effects of the adaptations for children with cerebral palsy and behavioral disorders were mixed as evidenced by the confidence intervals and number and percent of effect sizes that matched expectations.

The single participant design studies produced larger average pattern matching scores compared to the studies using other designs. The one cross-sectional study and the two case studies yielded average pattern matching scores and confidence intervals showing that the adaptations were generally effective. The contrasting conditions studies yielded mixed results.

Conclusions

The preponderance of evidence from both the Cohen's *d* effect size analyses and the pattern matching analyses indicated that the adaptations constituting the focus of this research synthesis were effective in terms of influencing or changing child behavior. There are, however, certain caveats that need to be acknowledged to more fully understand the child and environmental conditions under which the adaptations were most effective:

- The three types of adaptations (environment, activities, materials) had more similar than different consequences in terms of

affecting child behavior (Tables 1 and 3). The sizes of effects for the relationships between the adaptations and the study outcomes were all moderate to large with only a few exceptions.

- The more frequently the adaptations were used with the children, the more effective the adaptations were in terms of influencing child behavior (Tables 1 and 3). Both the Cohen's *d* and pattern matching analyses produced similar results highlighting the importance of frequent use of adaptations with young children with disabilities.
- The settings in which the adaptations were used mattered to a certain degree in terms of the effectiveness of the adaptations (Tables 1 and 3). The adaptations were most effective when used in classroom settings and on a playground or in a gym, and to a lesser extent, in home settings. *The reasons the interventions produced mixed results for the therapy room/clinic setting is not clear but may have to do with both the kinds of adaptations that were used (Appendix B) and the particular outcomes used to measure intervention impact (Appendix C).*
- The adaptations were generally more effective when used with younger compared to older preschool aged children (Tables 2 and 4). On the one hand this indicates that adaptations appear appropriate (even if rather simple) for very young children if designed and implemented carefully. On the other hand, this finding may be confounded by differences in the children varying in age. It appeared (but could not be confirmed) that the older children seemed to have more serious disabilities and impairments.
- The adaptations were most effective for children with autism, multiple disabilities, developmental delays, visual impairments, and to a lesser degree, cerebral palsy. The differential effectiveness, at least in part, is probably due to the fact that different kinds of adaptations (Appendix B) tended to be used with children with different diagnoses (Appendix A).

Taken together, the results as a whole provide support for the contention that adaptations can be effective for making it easier for young children with disabilities to participate in typical classroom, home, and community activities, where participation in turn is more likely to promote learning and have positive behavioral consequences (Campbell, Milbourne, & Wilcox, 2008; Doctoroff, 2001; Mayfield, 1996; Mistrett, 2004; Sandall, 2003). The findings are also consistent with the World Health Organization's (2001) model for conceptualizing the relationship between environmental factors (adaptations), participation, and activity, and how all three contribute to improved functioning. One of the lessons learned from conducting this research synthesis is that there is a need for a better conceptualization and operationalization of different kinds of adaptations, and how adaptations fit into models like the World Health Organization's (2001) framework for explaining and overcoming the consequences of disability (see also National Institute on Disability and Rehabilitation Research, 2006).

Implications for Practice

The findings from this research synthesis as well as key features of a number of studies included in the meta-analysis have a number of implications for practice. One implication has to do with the manner in which adaptations are used with young children with disabilities as part of different kinds of practices that used everyday activities and routines as sources of child learning opportunities (Campbell & Sawyer, 2007; Dunst, Bruder, Trivette, Hamby, Raab, & McLean, 2001; Jung, 2003; Kellegrew, 2000; McWilliam, 2000). Figure 3 shows a simple way of thinking about how adaptations are used to promote both child participation in everyday activities and child competence. Intervention practices used to promote child participation (engagement, involvement, etc.) in activities should provide context for child learning to the extent that the adaptations have anticipated effects. Adaptations in turn should affect child competence to the extent that they support and make it easier for a child to produce behavior. The reader is referred to Campbell (2005) for descriptions of these kinds of practices.

A second implication has to do with the purpose of an adaptation and whether it can rea-

sonably be expected to influence either child participation or competence. In many cases, adaptations are used for purposes other than encouraging child-initiated engagement with people or materials (e.g., installing a ramp to make it easier for a parent to get his or her child in their home). In situations like this, one would not expect that the adaptations would have child-competency enhancing effects (see especially Ostensjo, Carlberg, & Vollestad, 2003, 2005, for examples of these kinds of adaptations). In contrast, adaptations that are specifically designed to affect child-initiated behavior would be expected to have competency-enhancing effects (see e.g., Cosbey & Johnston, 2006, for an example of this kind of practice).

A third implication pertains to the expected relationship between an adaptation and child participation in everyday activities where increased participation is hypothesized to be the consequence of the adaptation. A not so readily apparent finding from this research synthesis is that many of the adaptations were found to be associated with increased child engagement with the social and nonsocial environments which, in principle, would be a condition for better child learning and improved child functioning (e.g., Wimpory, Hobson, & Nash, 2007). The reader is referred to Schilling and Schwartz (2004) for an example of how adaptations had strong positive effects on child engagement.

A fourth implication has to do with the relationship between adaptations and child behavior. Adaptations would be expected to be optimally effective when the adaptations are functionally related to desired or expected child behavior. We were surprised to find studies where the outcome measure constituting the focus of analysis made little or no sense in terms of the adaptations that were being evaluated. Adaptations should be optimally effective in influencing child behavior where the adaptations make possible child production of competence that has discernable environmental consequences (e.g., using an adapted cup in order to more easily drink).

There is at least one implication for research based on the findings from this research synthesis. If the relationships shown in Figure 3 in fact "best explain" how adaptations function as a mediator of both child participation and competence, there are statistical methods that could be used to test whether the model fit the data (e.g., Hoyle, 1995). If the data necessary to conduct meta-analytic structural equation modeling were available, even more sophisticated causal modeling could be performed (e.g., Cheung & Chan, in press). The yield would be a better understanding of how and in what manner adaptations have both direct and indirect effects on child participation and child competence.

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Appendix A

CHARACTERISTICS OF THE STUDY PARTICIPANTS

Study	Sample Size	Age (Months)	Number			Diagnosis/Disability
			Male	Female	Caucasian	
Aitken & Bower (1982)	10	5 to 25	10	0	NR[a]	Congenital blindness
Bellon-Harn & Harn (2008)	1	72	0	1	0	Mental retardation and blindness
Blair et al. (2000)	1	48	1	0	NR	Behavior disorder and language delay
Cosbey & Johnston (2006)	3	43 to 78	0	3	NR	Multiple disabilities
Deitz et al. (2002)	2	60	1	1	NR	Spastic quadriplegia and developmental delay
Dettmer et al. (2000)	1	60	1	0	NR	Autism
DiCarlo & Banajee (2000)	2	24 to 28	2	0	NR	Chromosomal abnormality
Dooley et al. (2001)	1	36	1	0	NR	Autism
Hsieh (2008)	3	42 to 57	2	1	0	Developmental disabilities
Johnston et al. (2003a)	3	39 to 54	1	2	NR	Developmental disabilities
Johnston et al. (2003b)	3	51 to 63	3	0	NR	Autism
Kern et al. (2007)	2	39 and 41	2	0	1	Autism
Koppenhaver et al. (2001)	6	43 to 80	0	6	6	Retts syndrome
Lane & Mistrett (1996)	1	12	1	0	NR	Periventricular Leukomalasia
Ostensjo et al. (2005)	95	58[b]	55	40	NR	Cerebral palsy
Schepis et al. (1998)	4	36 to 60	3	1	NR	Autism
Schilling & Schwartz (2004)	4	47 to 50	4	0	3	Autism
Thunberg et al. (2007)	2	60 and 66	2	0	NR	Autism
Trudeau et al. (2003)	2	65 and 70	1	1	NR	Down syndrome and speech and physical disabilities

a NR = Not reported.
[b] Mean age.

Appendix B

RESEARCH DESIGNS AND CHARACTERISTICS OF INTERVENTION

		Intervention Characteristics				
Study	Study Design	Location	Setting	Type of Adaptation	Description	Number of Sessions
Aitken & Bower (1982)	Case study	Clinic Home	Play	Activity	Sonicguide: (emition of ultrasonic sound)	1-15
Bellon-Harn & Harn (2008)	Contrasting conditions	Therapy session	Book reading	Activity	Use of VOCA	10
Blair et al. (2000)	ABA	Inclusive classroom	Play	Material	Play with many materials and many peers	6
Cosbey & Johnston (2006)	Multiple baseline	Inclusive classroom	Play	Activity	Use of VOCA	12-14
Deitz et al. (2002)	ABA	Playground Gym	Play	Environment	Use of powered mobility riding toy during recess	5
Dettmer et al. (2000)	ABA	Home	Transition	Activity	Visual schedule, visual "finished task" boy and visual timer were used to signal transitions between activities	10
DiCarlo & Banajee (2000)	Multiple baseline	Inclusive classroom	Snack	Activity	Assistive technology used to communicate	9-15
Dooley et al. (2001)	AB	Non-inclusive classroom	Transition	Activity	Use of communication device with pictorial labeling of next activity	17
Hsieh (2008)	Multiple baseline	Classroom	Play	Material	Adaptation of ordinary toys	9-11
Johnston et al. (2003a)	Multiple baseline	Inclusive classroom	Play Snack Group singing	Activity	Use of ACC devices	15-37
Johnston et al. (2003b)	Multiple baseline	Non-inclusive classroom	Play	Activity	Graphic symbol used to represent "Can I play?"	17-22
Kern et al. (2007)	ABA	Inclusive classroom	Morning greeting	Activity	Used songs and lyrics to modify transition into class	9-10
Koppenhaver et al. (2001)	ABA	Home	Book reading	Activity	Various ACC devices	32
Lane & Mistrett (1996)	Case study	Home	Play	Environment	Adapted chair, positioning of furniture, use of pillows for head support	NR
				Material	Adapted race track, use of switches to activate musical toys	
Ostensje et al. (2005)	Cross-sectional	NR	Eating Personal care Communication Play	Material	Use of adapted cups, spoons, etc.	NR
				Environment	Modification to seating, hand rails, etc.	
				Activity	Use of communication systems/devices	
Schepis (1998)	Multiple baseline	Non-inclusive classroom	Snack Free play	Activity	Use of VOCA	4-14
Schilling & Schwartz (2004)	ABA	Inclusive classroom	Art Free play Circle time	Environment	Therapy balls replaced commonly used seating devices	19-28
Thunberg et al. (2007)	ABA	Home	Eating meals Book reading "Talking about school"	Activity	Use of VOCA	3-5
Trudeau et al. (2001)	Contrasting conditions	Home	Reading book	Material	Use of adapted book	6

[a]VOCA – Voice Output Communication System.

Appendix C

OUTCOME MEASURE AND DOMAINS AND THE EFFECT SIZES FOR THE ADAPTATIONS

		Outcomes		Effect Sizes	
Study	Type of Measurement	Child Behavior	Domain	Cohen's *d*	Pattern Matching Score
Aitken & Bower (1982), Child 1	Videoed observation	Reaching for objects	Cognitive	-	1
Aitken & Bower (1982), Child 2	Videoed observation	Response to approaching object	Cognitive	-	2
		Tracking objects	Cognitive	-	2
		Reaching for objects	Cognitive	-	2
		Object permanence	Cognitive	-	2
		Placing to a surface (anticipation of touching)	Cognitive	-	2
		Locomotion	Motor	-	2
Aitken & Bower (1982), Child 3	Videoed observation	Response to approaching object	Cognitive	-	1
		Tracking objects	Cognitive	-	1
		Reaching for objects	Cognitive	-	1
		Social games	Social	-	-1
		Locomotion	Motor	-	2
Aitken & Bower (1982), Child 4	Videoed observation	Response to approaching object	Cognitive	-	1
		Social interaction play	Social	-	2
		Tracking objects	Cognitive	-	2
		Reaching for objects	Cognitive	-	1
Aitken & Bower (1982), Child 5	Videoed observation	Reaching for objects	Cognitive	-	1
		Locomotion	Motor		0
Aitken & Bower (1982), Child 6	Videoed observation	Response to approaching object	Cognitive	-	2
		Reaching for objects	Cognitive	-	1
Aitken & Bower (1982), Child 7	Videoed observation	Reaching for objects	Social	-	-2
		Walking	Motor		-1
Aitken & Bower (1982), Child 8	Videoed observation	Reaching for objects	Cognitive	-	0
		Walking	Motor		-1
Aitken & Bower (1982), Child 9	Videoed observation	Reaching for objects	Social	-	-2
		Locomotion	Motor		-2
Aitken & Bower (1982), Child 10	Videoed observations	Response to approaching object	Cognitive	-	0
		Tracking objects	Cognitive	-	1
		Reaching for objects	Cognitive	-	1
Aitken & Bower (1982), Child 11	Videoed observations	Tracking objects	Cognitive		0
		Placing	Cognitive		0
Bellon-Harn & Harn (2008)	Frequency of behaviors	Number of child utterances	Communication	3.12	1
		Mean length of child utterances	Communication	-.09	0
		Number of child initiations	Communication	-.16	0
Blair et al. (2000)	Observation: frequency of behaviors	Lack of aggressiveness toward peers or teachers	Social	.67	2
		Appropriate engagement in activities	Cognitive	.72	2
		Appropriate interactions with peers	Social	0	0

Appendix C, continued

Study	Type of Measurement	Outcomes: Child Behavior	Outcomes: Domain	Effect Sizes: Cohen's *d*	Effect Sizes: Pattern Matching Score
Cosbey & Johnston (2006), Child 1	Observation: frequency of behaviors	Frequency of independent unprompted VOCA usage	Communication	5.32	2
Cosbey & Johnston (2006), Child 2	Observation: frequency of behaviors	Frequency of independent unprompted VOCA usage	Communication	1.98	2
Cosbey & Johnston (2006), Child 3	Observation: frequency of behaviors	Frequency of independent unprompted VOCA usage	Communication	.84	1
Deitz et al. (2002), Child 1	Frequency of behaviors	Child-initiated movement	Motor	4.12	2
		Child-initiated contact with others	Social	.71	0
		Child positive affect	Social	.88	0
Deitz et al. (2002), Child 2	Frequency of behaviors	Child-initiated movement	Motor	2.91	1
		Child-initiated contact with others	Social	-2.76	-1
		Child positive affect	Social	.82	1
Dettmer et al. (2000)	Latency between activities	Child transition time decrease	Cognitive	4.77	2
DiCarlo & Banagee (2000), Child 1	Frequency of behaviors	Specific initiated communication	Communication	2.70	1
DiCarlo & Banagee (2000), Child 2	Frequency of behaviors	Specific initiated communication	Communication	2.20	1
Dooley et al. (2001)	Frequency of behaviors	Child compliance with new task	Social	2.35	2
Hsieh (2008), Child 1	Frequency of behaviors	Engaged toy play	Cognitive	2.99	1
Hsieh (2008), Child 2	Frequency of behaviors	Engaged toy play	Cognitive	2.78	1
Hsieh (2008), Child 3	Frequency of behaviors	Engaged toy play	Cognitive	3.52	1
Johnston et al. (2003a), Child 1	Frequency of behaviors	Correct use of symbolic communication	Communication	1.52	2
Johnston et al. (2003a), Child 2	Frequency of behaviors	Correct use of symbolic communication	Communication	2.37	2
Johnston et al. (2003a), Child 3	Frequency of behaviors	Correct use of symbolic communication	Communication	.66	1
Johnston et al. (2003b), Child 1	Frequency of behaviors	Correct use of symbolic communication	Communication	.89	0
Johnston et al. (2003b), Child 2	Frequency of behaviors	Correct use of symbolic communication	Communication	.72	2
Johnston et al. (2003b), Child 3	Frequency of behaviors	Correct use of symbolic communication	Communication	.66	0
Kern et al. (2007), Child 1	Frequency of behaviors	Independent responses during morning greeting routine	Social	.89	1
Kern et al.(2007), Child 2	Frequency of behaviors	Independent responses during morning greeting routine	Social	4.32	1

Appendix C, continued

Study	Type of Measurement	Outcomes: Child Behavior	Outcomes: Domain	Effect Sizes: Cohen's *d*	Effect Sizes: Pattern Matching Score
Koppenhaver et al. (2001)	Frequency of behaviors	Successful symbolic communication acts with unfamiliar storybook	Communication	1.40	2
		Successful symbolic communication acts with unfamiliar storybook	Communication	.55	1
Lane & Mistrett (1996)	Investigator descriptions	Participation in social play	Social	-	1
		Smiling	Social	-	2
Ostensje et al. (2005)	Pediatric Evaluation of Disability Inventory (PEDI): Caregiver Assistance subscale	Indoor locomotion	Motor	-	1
		Outdoor locomotion	Motor	-	1
		Self-care - Eating	Social	-	1
		Self-care - Grooming	Social	-	0
		Self-care - Bathing	Social	-	0
		Self-care - Dressing	Social	-	0
		Social functioning – Functional comprehension	Social	-	0
		Social functioning – Functional expression	Social	-	0
		Social functioning - Playing	Social	-	0
Schepis et al. (1998), Child 1	Frequency of behaviors	Communicative interactions during snack time	Communication	2.91	1
		Communicative interactions during play time	Communication	4.40	2
Schepis et al. (1998), Child 2	Frequency of behaviors	Communicative interactions during snack time	Communication	2.28	2
		Communicative interactions during play time	Communication	3.50	1
Schepis et al. (1998), Child 3	Frequency of behaviors	Communicative interactions during snack time	Communication	2.67	2
Schepis et al. (1998), Child 4	Frequency of behaviors	Communicative interactions during snack time	Communication	2.60	1
Schilling & Schwartz (2004), Child 1	Frequency of behaviors	Engaged in art activities	Cognitive	2.13	2
Schilling & Schwartz (2004), Child 2	Frequency of behaviors	Engaged in reciprocal play activities	Cognitive	3.99	2
Schilling & Schwartz (2004), Child 3	Frequency of behaviors	Engaged in small group table activities	Cognitive	4.67	1
Schilling & Schwartz (2004), Child 4	Frequency of behaviors	Engaged in circle time activities	Cognitive	5.24	1
Thunberg et al. (2007), Child 1	Frequency of communication behaviors	Effectiveness of child communication during mealtime	Communication	.05	0
		Effectiveness of child communication in sharing experiences	Communication	.14	0

Appendix C, continued

Study	Type of Measurement	Outcomes		Effect Sizes	
		Child Behavior	Domain	Cohen's *d*	Pattern Matching Score
Thunberg et al. (2007), Child 2	Frequency of communication behaviors	Effectiveness of child communication during story reading	Communication	.11	0
		Effectiveness of child communication in sharing experiences	Communication	.19	1
Trudeau et al. (2003) Child 1	Frequency of communication behaviors	Production of specified intent	Communication	.28	1
Trudeau et al. (2003) Child 2	Frequency of communication behaviors	Production of specified intent	Communication	.13	0