

A Mega-Analysis of Interventions for Autism including Early Intervention, Language, Social
Skills, and Daily Living Skills

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This monograph will discuss the criteria and characteristics of autism spectrum disorder. Then, a discussion of the various types of effect sizes including standardized mean difference effect sizes, correlation/regression-based effect sizes and nonparametric effect sizes will be discussed in preparation to review meta-analyses of interventions for autism spectrum disorder. This monograph will then discuss meta-analyses of early interventions for autism spectrum disorder, language interventions, social skills interventions, and finally, a meta-analysis of daily living skills for adults and adolescents with an autism spectrum disorder.

Autism Spectrum Disorder

According to the Diagnostic and Statistical Manual – Fifth Edition (DSM-5), there are two main diagnostic criteria for autism spectrum disorder: deficits in social communication and social interactions that are persistent and debilitating, and restricted/repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). Autism spectrum disorder is also categorized as a developmental disability that affects brain functioning and brain development. In essence, individuals with autism spectrum disorder tend to interact, behave, and communicate differently than typically developing peers. Symptoms of autism spectrum disorder generally begin to manifest in early childhood and typically last throughout the lifespan.

The deficits in social communication and social interactions seen in individuals with an ASD can be broken down further into deficits regarding social-emotional reciprocity, nonverbal communication behavior, and ability to develop and maintain relationships. An example of how these deficits may manifest themselves in a child with autism would be a difficulty with

understanding, or imitating, the emotions of others. Restricted/repetitive behaviors (RRB) may include the stereotyped or repetitive: use of objects, motor movements, or speech; restricted interests that are abnormal in focus or interest; insistence on sameness, ritualized patterns of verbal or nonverbal behavior; and hyper- or hyporeactivity to sensory input, or abnormal interests in sensory aspects of the impairment. The social and RRB symptoms experienced by the individual must cause significant impairment in important areas of current functioning that may include social, occupational, or school related functioning.

While the occurrence of autism spectrum disorder has increased over the last twenty years (Center for Disease Control and Prevention, 2014) with a 119.4 percent increase from 2000 to 2010 and a change from an occurrence rate of 1 in 150 to an occurrence rate of 1 in 68, it has recently stabilized and the rate of 1 in 68 has been maintained over the last two years (Center for Disease Control and Prevention [CDC], 2016). autism spectrum disorder typically affects 4.5 times as many male children as female children with an occurrence rate of 1 in every 42 males, and an occurrence rate of 1 in every 189 females (CDC, 2016). The CDC survey was conducted in 11 sites across the country with sites in Arizona, Arkansas, Colorado, Georgia, Maryland, Missouri, New Jersey, North Carolina, South Carolina, Utah, and Wisconsin.

Data from the survey for the state of Utah were collected through the University of Utah from three northern counties within the state. 24,945 8-year-old children were included in the survey with 431 children of those surveyed having a diagnosis of an autism spectrum disorder. These results indicate an overall prevalence rate of 17.3 children with an autism spectrum disorder per 1000 children by the age of 8, or approximately 1 in 58 children for the state of Utah. The only states with a higher prevalence rate than Utah out of the states surveyed were Maryland and New Jersey. (CDC, 2016). autism spectrum disorder also affects White, non-

Hispanic children the most with 53.3 percent of all children with autism spectrum disorder identifying as White, non-Hispanic. autism spectrum disorder affects Black, non-Hispanic children, and Hispanic children similarly accounting for 21.4 percent and 19.9 percent respectively, of all children with a diagnosis of autism spectrum disorder nationwide. Finally, 5.4 percent of children who identify as another race/ethnicity than those just mentioned have a diagnosis of an autism spectrum disorder.

Interventions

In order to provide the best outcomes for those diagnosed with an autism spectrum disorder, interventions have been developed to address the deficits in social communication skills and RRBs experienced by those with an autism spectrum disorder. Ideally, interventions will be delivered early so comprehensive and intensive behavioral interventions have ample opportunity to address the full gamut of deficits experienced by those with an autism spectrum disorder. Early intensive behavioral interventions often include interventions for social skills, academic skills, receptive and expressive language, daily living skills, and more.

Additional interventions have been developed to address language deficits alone. Language interventions address receptive and express language skills, but do so through a wide variety of formats. The Picture Exchange Communication System (PECS) is one of the most commonly used interventions, but is also considered to be part of the alternative and augmentative communication (AAC) family of interventions. AAC interventions may include speech generating devices, sign language, and other pictorial communication systems. Total communication interventions, which involves combining sign language and verbal communication instruction (Goldy, 2009) is another potential language intervention.

On the other hand, interventions for social skills deficits, while not specific to autism spectrum disorder, have been researched extensively with use among autism spectrum disorder populations. These interventions may use a variety of methods to teach the skills including modeling (peer and video), social stories, role play, reinforcement contingencies, and others.

Daily living skills are those that are necessary to function within the larger context of the community and may contain some overlap with other types of interventions. For the purpose of this monograph, daily living skills are skills that may not necessarily lead to independent living, but allow for the individual with autism to access community resources such as academic learning, vocations, and general community use and interactions. In the meta-analysis by Roth et al. (2014), interventions that targeted different aspects of daily living skills were analyzed, rather than *all* daily living skills. Examples of daily living skills include: academic skills, adaptive skills, vocational skills, control of problem behaviors, and social skills.

Meta-analysis

Meta-analyses help readers understand how effective interventions are and what variables makes them work. This monograph will review meta-analyses in order to ascertain the effectiveness of early intensive behavioral interventions, language interventions, social skills, and daily living skill interventions. Meta-analyses use effect sizes to measure the magnitude of change brought about by an intervention, while also measuring the amount of change brought about by different factors involved with the implementation of the intervention ranging from the age of the target student to the location where the intervention is being implemented.

All effect sizes communicate the magnitude of change brought about by an intervention. However, there are different types of effect sizes and each requires a unique interpretation. There

are two main classes of effect sizes, namely parametric effect sizes, and nonparametric effect sizes. Parametric effect sizes are based on the normal curve and are appropriate for group design experiments. Parametric effect sizes are not appropriate for single case design experiments, due to single case data violation of the three main assumptions of parametric statistics. The first assumption violated by single case design research is the assumption of independence of data. Each datum point in single case design research is, ideally, used to predict the next datum point thereby violating the assumption that behavior at one point in time does not influence behavior at another point in time. The second assumption violated is the assumption of normalcy. This assumption assumes that data will be distributed evenly around a mean with equal amounts of data falling above and below the mean, and equal variances across phases. Instead, single case design data are rarely distributed normally, and ideally do not change at all during the baseline phase at a minimum which would also violate the assumption of normalcy. The third assumption that can be violated by single case data is the assumption that data fall into either an interval or ratio scale, meaning that the magnitude of behavior between scores is equal, rather than a ranking of severity.

There are two main types of parametric effect sizes: standardized mean difference and regression/correlation-based effect sizes. standardized mean difference effect sizes are calculated by subtracting the mean of the baseline data from the mean of the treatment data. This difference is then divided by the pooled standard deviation of the treatment and baseline data. Two of the most common standardized mean difference effect sizes are Cohen's d , and Hedges' g . While the two effect sizes are calculated slightly differently, both communicate the magnitude of change brought about by the treatment in terms of standard deviations. Cohen's d is best suited for larger N studies, while Hedges' g is better suited for small N studies as it contains a correction for

small N s. An example of how to calculate Cohen's d is given below where x_1 equals the treatment mean and x_2 equals the baseline mean, and s equals the pooled standard deviation.

$$d = \frac{x_1 - x_2}{s}$$

The formula for calculating the pooled standard deviation is given below. Note that n_1 equals the number of data points in the treatment phase, n_2 equals the number of data points in the baseline phase, s^2_1 equals the variance of the treatment phase and s^2_2 equals the variance of the baseline phase.

$$s = \sqrt{\frac{(n_1 - 1)s^2_1 + (n_2 - 1)s^2_2}{n_1 + n_2 - 2}}$$

The other main type of parametric effect size is regression/correlation-based effect sizes. These effect sizes explain the relationship between two variables and are interpreted as the amount of variance explained in one variable by another variable. These effect sizes may be calculated as part of hypothesis testing in the case of F tests and t tests, or may be calculated during regression or correlation analyses in the case of hierarchical linear modeling, multiple regression, or simple linear regression analyses. Common effect sizes among this family include Pearson's r^2 , R^2 , and ω^2 .

The other main family of effect sizes are nonparametric effect sizes. These effect sizes are not based off of the assumptions of the normal curve, independence of data, or interval/ratio scaling of data. Thus, effect sizes are ideally suited for analyzing data from single case design studies which utilize time series graphs to express changes in data. It is important to note that visually analyzing the data to ascertain the presence of an intervention effect remains the gold standard for analyzing single case design studies and is not replaced by the calculation of effect

sizes as a means of determining whether the intervention had an effect or if there was some other variable at work.

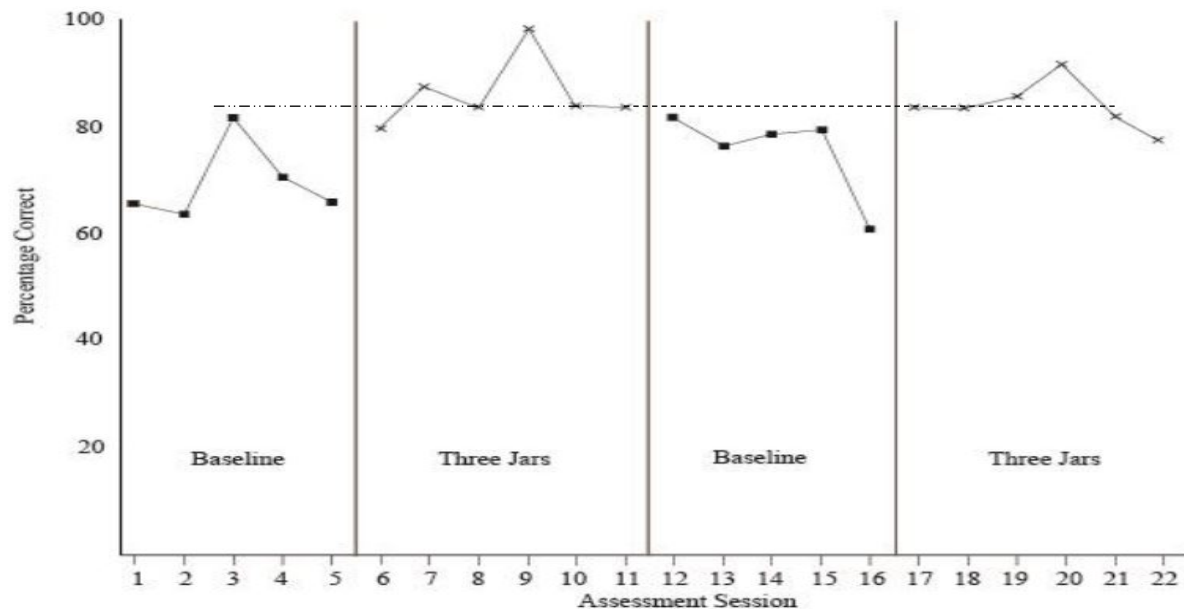
Nonparametric effect sizes are ideal for single case designs such as AB, ABAB/reversal designs, multiple baseline, multiple probe, changing criterion, and other designs that are variations of the aforementioned designs. Nonparametric effect sizes are generally calculated by comparing the amount of data that improved in a treatment phase over a baseline phase and are interpreted as the percentage of data that improved, or how often one can expect to see improvement in a given behavior. However, it is important to note that all nonparametric effect sizes are calculated differently and utilize different reference points within the baseline phase as the comparison for all data points in the treatment phase. This factor may lead to effect sizes that are larger, or smaller than other methods for calculating non parametric effect sizes.

Nonparametric effect sizes may be expressed as decimals or percentages expressing the ratio of improvement. Examples of additional effect sizes are improvement rate difference (IRD), nonoverlap of all pairs (NAP), points exceeding the median (PEM), and Tau U. Of the many nonparametric effect sizes available, percentage of nonoverlapping data (PND) is the most ubiquitous.

PND is a comparison of a single data point from the baseline phase to that of the entire intervention phase. First the highest datum point (or lowest) depending on whether the goal is to decrease or increase a behavior, is identified and used as the comparison point for the intervention phase. In the case represented in the graph below (Velazquez, 2013) the goal was to increase the behavior so all data points falling above the highest baseline point are considered to be an improvement and contribute to the effect size. In the example, 5/6ths of the data fall above the highest data points in the baseline phases thereby resulting in an overall PND effect size of

83.3%. Other effect sizes may use other singular reference points such as PEM, while others compare all pairs of data such as NAP and Tau U.

Figure 1 shows the effects of the Three Jars game on the whole class' math homework accuracy.



Velazquez, 2013

Search Methods

In order to provide the most comprehensive search possible, a total of eight databases were examined and included the following: Academic Search Premier, Education Full Text, ERIC, MedLine, Master File Complete, PsycInfo, PsycArticles, and Psychology and Behavior Sciences Collection. The following search terms, were used in different combinations to find the meta-analyses used in the analyses for this monograph: *early intensive **, *intervention*, *autism*, *language*, *total communication*, *social skills*, and *daily living skills*. The initial search resulted in a total of 159 potential articles. Inclusion criteria was then applied, requiring that chosen articles were in meta-analysis format and involved interventions for autism in one of the following categories: early intensive behavioral intervention, language intervention, social skills

intervention, or daily living skills intervention. These criteria resulted in a total of 10 meta-analyses for early intensive behavioral intervention S, 12 meta-analyses for language interventions, 10 for social skills interventions, and 1 for daily living skills interventions. Two additional meta-analyses were included that covered multiple topics, but were not considered to be meta-analyses of early intensive behavioral interventions, language interventions, or social skills interventions.

Several of the included meta-analyses came from the Cochrane Review database. The Cochrane Collaboration is a collective of reviewers and researchers that systematically examine interventions and health care practices through both systematic reviews and meta-analyses with the goal of better informing practitioners regarding existing interventions and treatments. The Cochrane Collaboration is a collection of volunteers from across the globe in more than 130 countries that band together to review the current literature. Cochrane reviews are not published in any specific journal, but are made available for free to the public to review.

Early Intensive Behavioral Intervention

early intensive behavioral interventions are interventions based on the principles of applied behavior analysis (ABA) and targeted towards children with autism between the ages of 18 months to 5 years. These interventions may address a wide variety of behaviors including, but not limited to, social skills, academic skills, disruptive behavior, and language ability. Some examples of interventions that are considered early intensive behavioral interventions are direct instruction/discrete trial training (DTT), Pivotal Response Treatment®, incidental teaching, and the Early Start Denver Model®.

Meta-analyses included in this monograph focused on a variety of factors that affect the efficacy of early intensive behavioral interventions including: interest based early intensive behavioral intervention, parent-mediated early intensive behavioral intervention, age of child at implementation, dosage, methodological quality of included studies, and other variables. Variables targeted in the studies included in the meta-analyses found were the core symptoms of autism (communication, interpersonal interactions, restricted/repetitive behavior (RRB), social development), IQ, adaptive behavior, language, and disruptive behavior. All early intensive behavioral intervention meta-analyses used standardized mean difference effect sizes, with some utilizing Cohen's *d*, and the rest utilizing Hedges' *g*. For the purpose of this monograph, the different types of effect sizes were not separated, but were instead combined. early intensive behavioral intervention was found to have a mean standardized mean difference effect size of 1.02 (-.78 to 4.93). 231 effect sizes were analyzed from 145 studies, though only 26 of those studies were considered unique studies. All of the meta-analyses included many of the same articles causing them to be analyzed multiple times by different researchers. A table of effect sizes by outcome is included in Appendix A. Selected tables from meta-analyses included are shown below.

TABLE 2: Average effect sizes and 95% confidence intervals for the different categories of child outcomes.

Type of comparison/child outcomes	Number		Average effect size	95% Confidence interval	Z-test
	Studies	Effect sizes			
<i>Baseline versus intervention</i>					
Prosocial behavior	4	10	3.55	1.76–5.33	4.49****
Communication	5	16	5.03	3.61–6.45	7.55****
Performance	8	46	2.92	1.87–3.98	5.59***
Negative behavior	6	25	2.25	0.92–3.56	3.50**
<i>Low versus high interest</i>					
Prosocial behavior	7	20	2.53	1.37–3.70	4.56****
Communication	4	8	1.07	0.17–2.20	2.22*
Performance	9	36	1.17	0.56–1.78	3.91***
Negative behavior	7	13	1.11	0.64–1.57	5.23****

* $p = .03$, ** $p = .0005$, *** $p = .0001$, **** $p = .0000$.

Dunst et al., 2012

Based on the results from the Dunst et al., 2012 meta-analyses it would appear that early intensive behavioral interventions are effective at improving prosocial behavior, communication skills, performance, and negative behaviors. It is important to note that interventions that incorporate child interests are more effective at improving those child outcomes than those that do not.

TABLE 1: Average effect sizes and 95% confidence intervals for interventions targeting different core features of autism spectrum disorders.

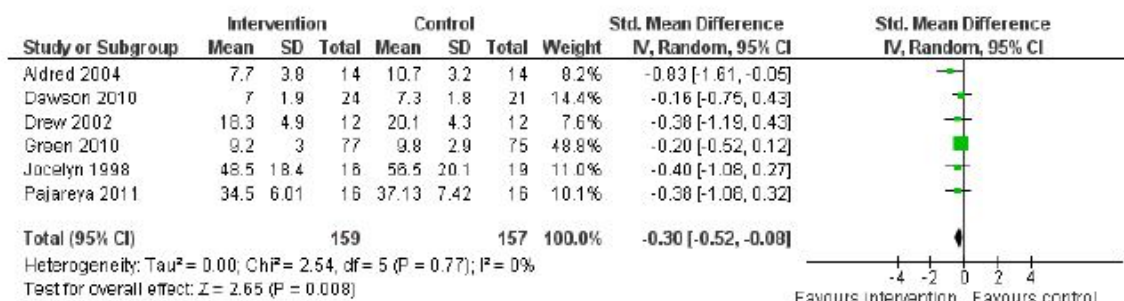
Type of comparison/core features	Number		Average effect size	95% Confidence interval	Z-test
	Studies	Effect sizes			
<i>Baseline versus intervention</i>					
Communication	5	21	4.04	2.76–5.33	6.55***
Interpersonal	4	16	3.66	2.40–4.93	6.16***
Repetitive behavior	4	40	1.56	0.54–2.57	3.10*
<i>Low versus high interest</i>					
Communication	3	21	1.52	0.55–2.50	3.26**
Interpersonal	3	10	3.78	1.75–5.80	4.23***
Repetitive behavior	5	32	0.85	0.48–1.21	4.75***

* $P = .0019$, ** $P = .0011$, *** $P = .0000$.

Dunst et al., 2012.

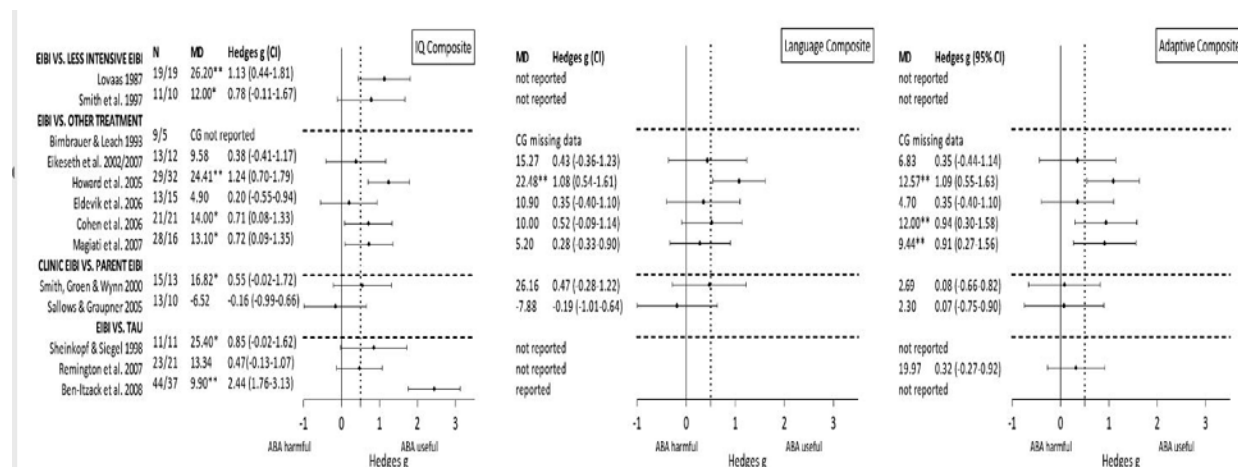
Again, it is clear that early intensive behavioral interventions have positive effects on the core features of autism, but again, interventions that incorporate the interests of the client are more effective than those that do not. This highlights the importance of incorporating child interests into treatment in order to make the most of time spent on interventions.

Figure 6. Forest plot of comparison: I Child communication and social development, outcome: I.9 Autism severity.



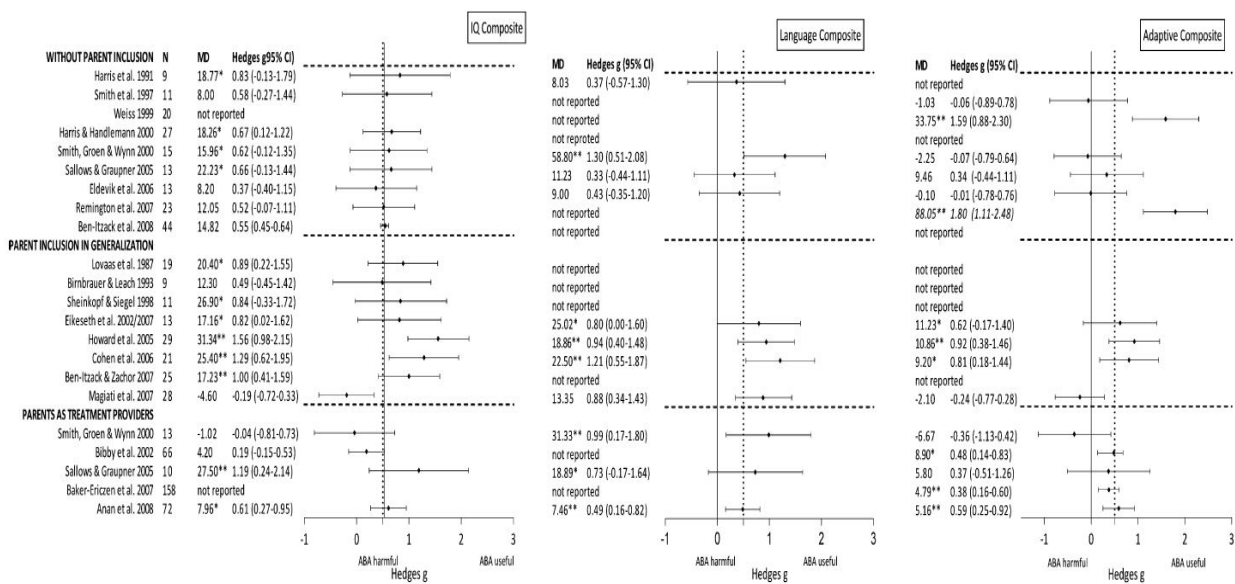
Oono et al., 2013

This table shows that intervening early with children with autism can improve the core symptoms of autisms of communication and social development.



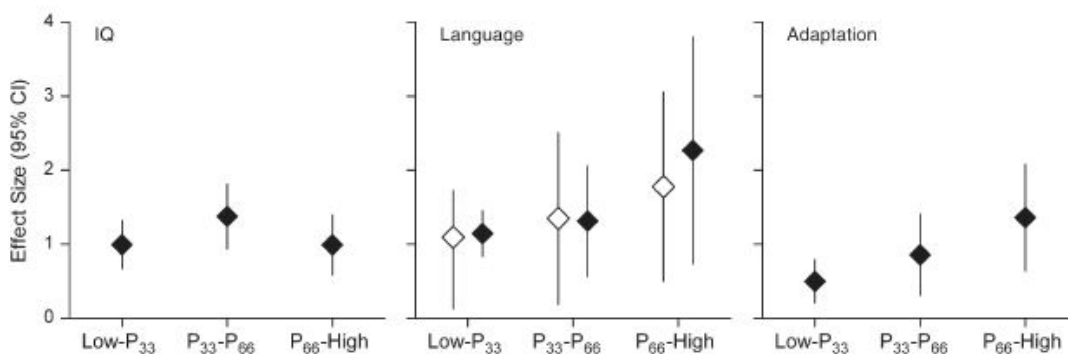
Strauss et al., 2013.

The table above indicates that early intensive behavioral interventions are more effective than both other interventions, such as play-based interventions (i.e., Floortime and PLAY Project), and treatment as usual for IQ, language, and adaptive behavior. Clinic-based early intensive behavioral interventions are not necessarily more effective than parent delivered early intensive behavioral interventions for IQ, language, but clinic-based early intensive behavioral interventions do appear to be very slightly better at improving adaptive behavior than parent delivered early intensive behavioral interventions.



Strauss et al., 2013

This table shows clearly that involving parents in generalization procedures provides much stronger effects for IQ, language, and adaptive behavior. However, it would appear that excluding parents during regular treatment does not significantly improve outcomes for IQ, language, or adaptive behavior, although some studies that excluded parents did have stronger effects than those that included parents. Thus, results were mixed regarding the effectiveness of parents as the main treatment providers. For language and adaptive behavior, parents as treatment providers provided clear improvements in related outcomes. However, some studies showed harmful effects for parents as treatment providers for IQ related outcomes, whereas some showed positive effects for those same outcomes.



Virues-Ortega et al., 2010. Note: Open diamonds represent expressive language outcomes while closed diamonds represent receptive language outcomes.

In general, it is thought that increasing dosage of treatment provides better outcomes. However, in the meta-analysis by Virues-Ortega and colleagues (2010) individuals that received between 1883.8 total intervention hours and 4129.3 total intervention hours had better IQ outcomes. For language and adaptive behavior outcomes increased dosage provided for better outcomes. This illustrates the importance of focusing the most intervention time on language and adaptive behavior outcomes, while still spending adequate time on IQ related outcomes.

Language

Language interventions are interventions focused on improving the receptive and expressive language skills of the client. In other words, language interventions help individuals improve their ability to understand others (receptive language), and their ability to help others understand them (expressive language). There are many different existing interventions to help individuals with autism spectrum disorder improve language skills whether the individual can verbalize or not. For those that are nonverbal, or only partially verbal, alternative and augmentative communication (AAC) interventions exist to help increase communication through pictorial and other symbolic means. 4 meta-analyses in this monograph focused on one particular

intervention within the AAC intervention family, the Picture Exchange Communication System (PECS). PECS is a multistage intervention that focuses on teaching individuals how to communicate by using pictures that represent verbs, nouns, and other parts of speech to convey anywhere from basic thoughts (i.e., requests) to more complex ideas (i.e., commentary on social issues).

Other AAC meta-analyses focused on interventions such as speech generating devices and other picture communication interventions. Certain apps exist that can turn common devices like an iPad or laptop into an AAC device (i.e., CoughDrop, ProLoQuo). However, the research on such apps is much more limited than research on PECS due to the cost of the programs, only recently becoming available, and limited licensing permission preventing the use of the app on more than one device.

Alternatives to AAC interventions focus on spoken language outcomes, but may also include instruction in American Sign Language (ASL). Total communication interventions focus on combined spoken language and ASL outcomes. Interventions for spoken language outcomes may be implemented in a variety of ways including, but not limited to, discrete trial training, incidental teaching, play, modeling, shaping, prompting, and more.

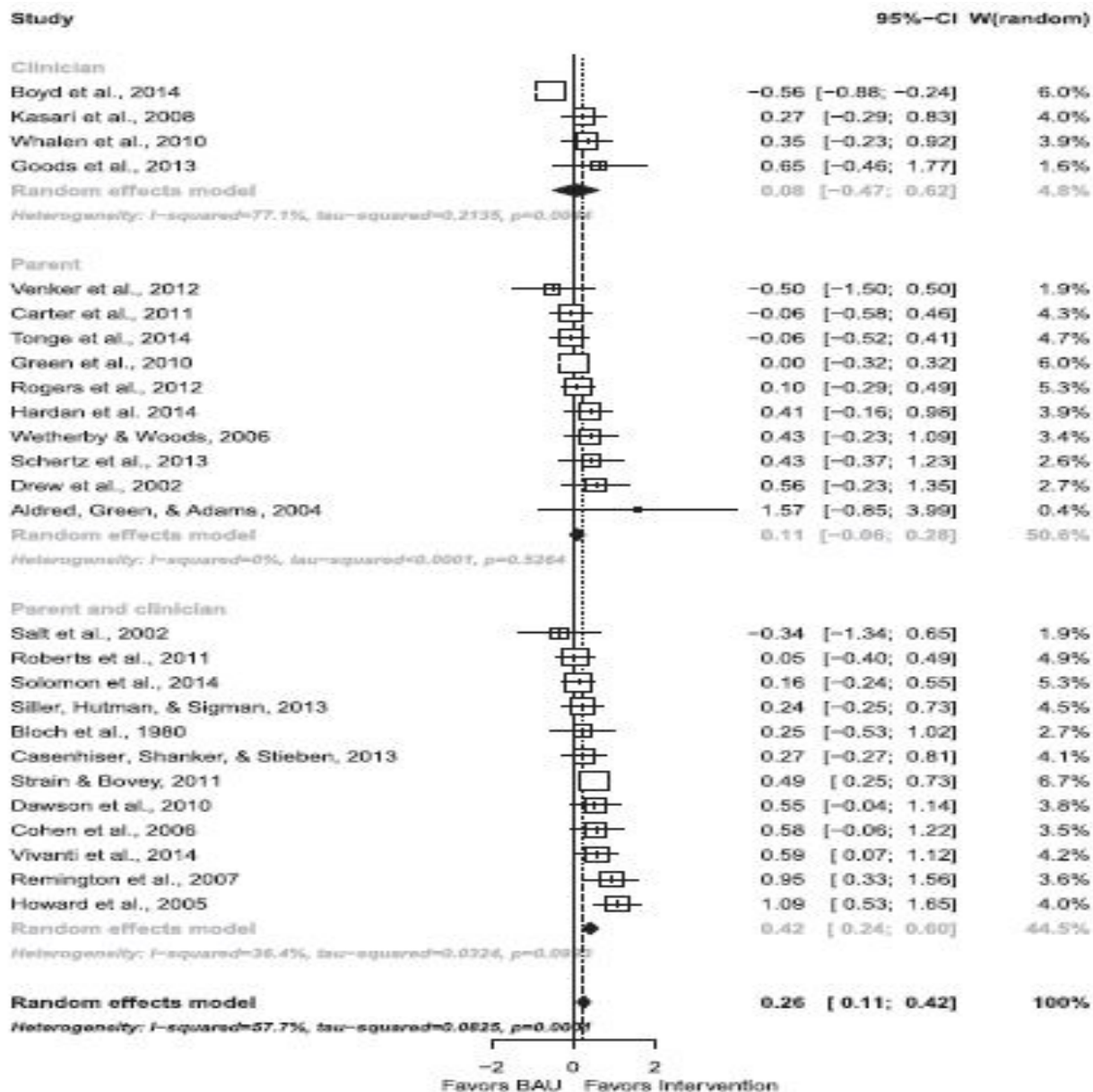
Similar to other interventions, all language interventions may be delivered by a variety of different individuals and may include a combination of service providers. clinicians, parents, teachers, or any combination thereof may provide the language interventions. Results from analyses indicated that effects for language interventions alone were not as strong as effects for early intensive behavior intervention. However, that is not to say that interventions for language are not efficacious. Rather, it is important to implement language interventions in such a manner

as to maximize effects. Such an intervention would focus on the original purpose and target of the intervention, and include both parents and clinicians as interventionists.

Overall, language interventions had a mean nonparametric effect size of 71.6% indicating an improvement in 71.6% of intervention data over baseline data. Language interventions had a mean partial correlation coefficient of 0.42, and a standardized mean difference effect size of 0.34. Though the magnitude of effect size may vary, all the effect sizes suggest that language interventions have some positive effect on improving receptive and expressive language outcomes. When comparing PECS to other interventions, PECS was found to have a nonparametric effect size of 70.6%, while all AAC interventions were found to have an effect size of 71.9%. PECS also had a mean standardized mean difference effect size of 0.27.

Results from the Goldy (2009) meta-analysis of functional communication interventions, which compared AAC interventions, verbal only interventions, and total communication interventions were analyzed separately due to the uniqueness of the methods used for the meta-analysis in comparison to the other included meta-analyses. Hierarchical linear modeling (HLM) was used to analyze data from single case studies in order to ascertain the effectiveness of each intervention type and to perform the moderator analysis. None of the actual effect sizes were reported, but based off of other data reported in the meta-analysis total communication, a combination of verbal instruction and sign language instruction, had better effects than either AAC interventions or verbal only interventions.

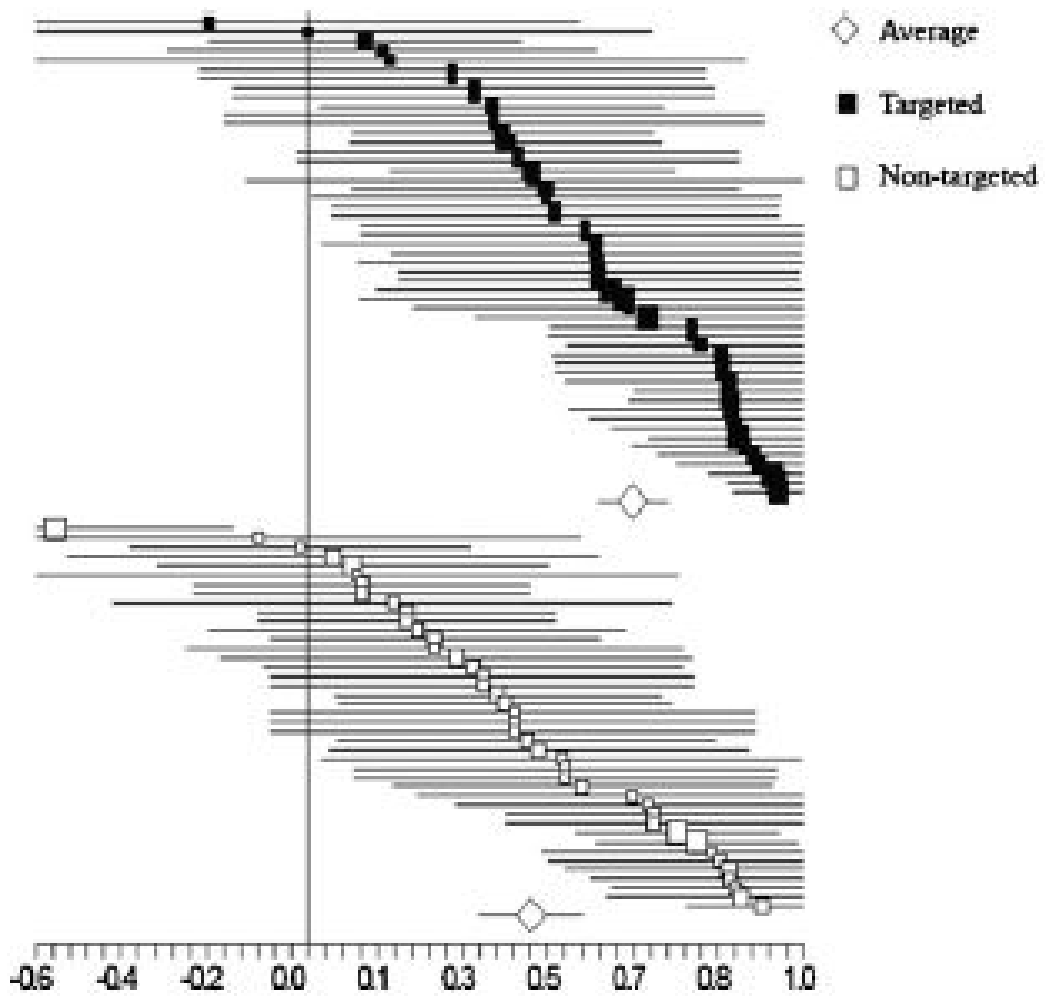
Selected tables from included meta-analyses follow:



Hampton et al., 2016

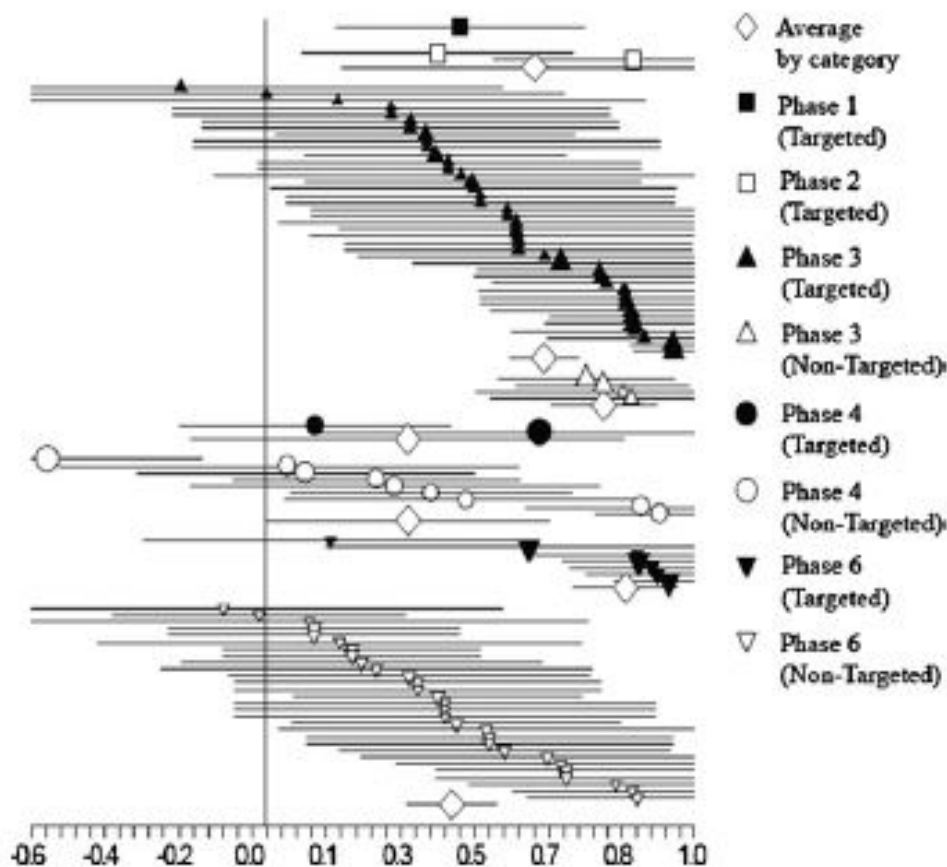
This table shows that outcomes for language can be positive when clinicians or parents are the main treatment providers. However, the most positive outcomes for language occur when parents and clinicians work together to provide treatment. This is likely due to the fact that parents will continue to implement the intervention at home, thereby allowing for increased

exposure to the intervention and also improving the generalization of the intervention to multiple settings which allows for more robust effects over time.



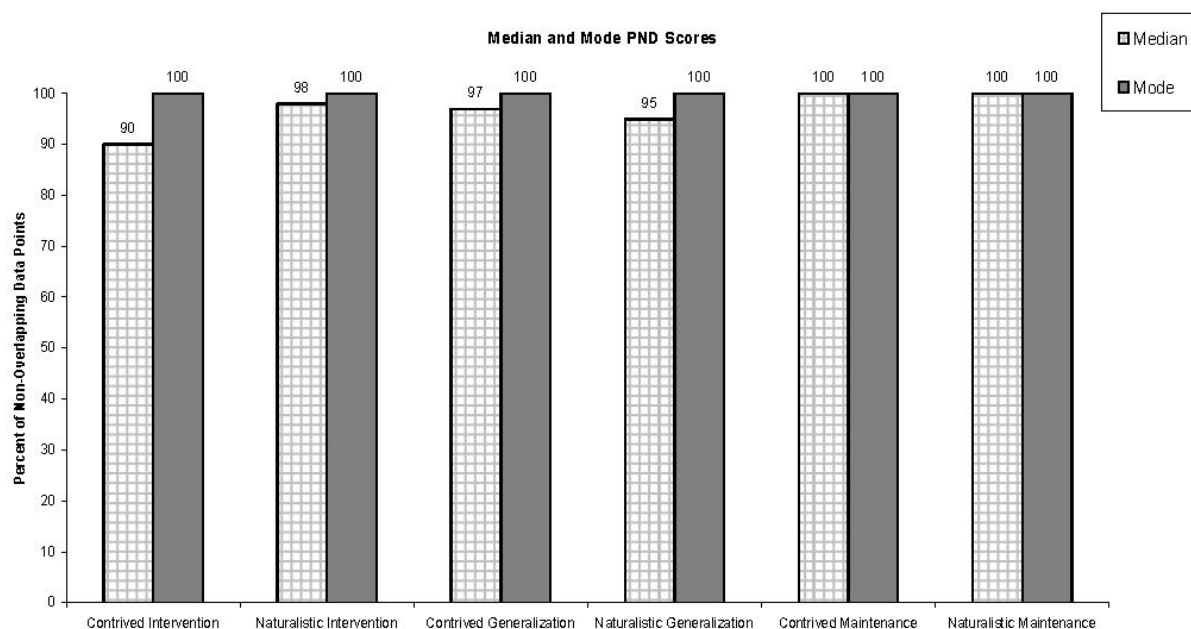
Ganz et al., 2012.

From this meta-analysis on PECS, the results highlight the importance of directing interventions to specific targets which will greatly improve outcomes directly related to the purpose of the intervention. As highlighted in the Ganz and colleagues' meta-analysis (2012), PECS is more effective, on average, at improving functional communication, rather than collateral outcomes such as speech production, or disruptive and aggressive behavior.



Ganz et al., 2012

This figure provides a breakdown of the effects of the different phases of PECS on both outcomes related to functional communication, and those that are considered to be more collateral effects. More specifically, as individuals progress through the PECS intervention, the effects on functional communication outcomes become stronger and the effects on non-targeted become less, and less, although PECS still has some effect on those outcomes. This is likely due to the increased ability to functionally communicate allowing individuals with autism spectrum disorder to have wants and needs met without having to resort to more aggressive means of communication.



Kane et al., 2010.

One of the major thoughts with interventions is that it is better to provide the intervention in naturalistic settings rather than in contrived, but carefully controlled settings. However, many argue that it is still possible to provide an efficacious intervention regardless of setting. Kane and colleagues (2010) compared language interventions delivered in contrived and naturalistic settings across intervention, generalization, and maintenance phases. Based on the figure above, which reports the median and mode effect sizes for both types of settings across intervention, generalization, and maintenance phases. Based off of this figure, it would appear that language interventions are equally effective in contrived and naturalistic settings. However, the next figure from the same meta-analysis is also illustrative and reveals different conclusions, but also shed

some light as to the shape of the distribution of effect sizes, hinting at a skewed distribution, which likely would be due to ceiling effects from using nonparametric effect size, and from publication bias.

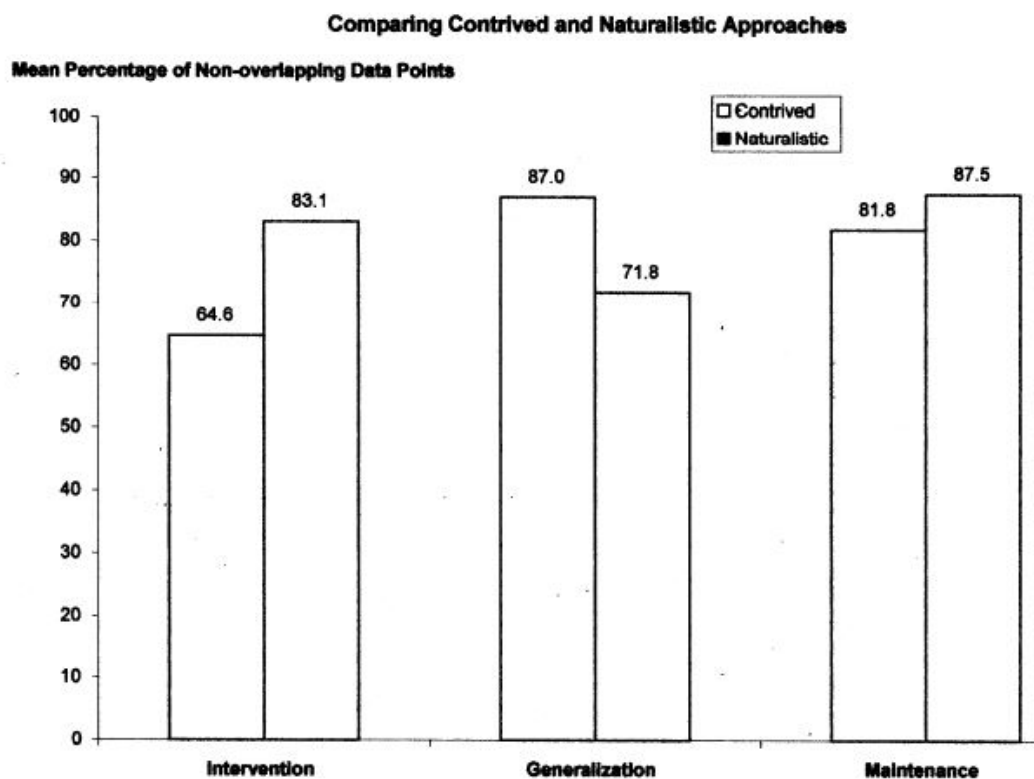


Figure 3 – Mean PND scores for both contrived and naturalistic approaches to teaching language skills across intervention, generalization, and maintenance effects. PND = Percent of Non-overlapping Data.

Kane et al., 2010

Kane and colleagues (2010) also used mean PND scores to compare naturalistic and contrived settings across intervention, generalization, and maintenance effects. For this figure, contrived settings are the bars on the left for each pair, while naturalistic settings are on the right. According to this figure, naturalistic language interventions have better effects than contrived language interventions in general, although contrived language interventions had better effects during generalization phases.

Social Skills

Deficits in social skills and social communication abilities are among the hallmark characteristics of autism spectrum disorder. Social skills and communication deficits can impact the ability to communicate about emotions, understand social cues and social scripts, as well as motivation to interact with others. These deficits can cause significant impairment regardless of intellectual functioning or adaptive behavior ability. In fact, social functioning now provides the main criterion for determining an individual with autism spectrum disorder as high functioning (American Psychiatric Association, 2013).

Many different interventions have been developed in order to address these deficits, but all are generally known as social skills interventions. Social skills interventions focus on interpersonal skills that help individuals follow social conventions and participate more fully in the communities they live in. Social skills interventions cover a wide variety of skills, and the interventions themselves will select from the general pool of social skills depending upon what population is targeted by the interventions. For example, a social skills intervention for children in school may focus on learning preparation, taking turns, reducing anxiety, imitation, body language, conversation skills, and the like. On the other hand, a social skills intervention for adolescents or adults may focus more exclusively on conversation skills and relationship maintenance skills.

Social skills interventions can come in a variety of different formats. interventions can be delivered in both individual and group formats, and may include a wide variety of components. One of the most ubiquitous social skills interventions is the Social Story™ intervention. Social Stories™ involve a character modeling a social skill within a story format. Other social skills

interventions may include peer/video self-modeling, role playing, social games, behavior momentum, music therapy, parent training, and naturalistic opportunities to practice the target social skills.

The meta-analyses included in this monograph took place in a variety of settings with specific interventions including social stories, scripts, peer and video self-modeling, behavior momentum, music therapy, and parent training. Interventions targeted skills such as social initiation (requests, play, interaction), joint attention, responses to affective behavior, and increasing compliments. Meta-analyses for social skills only used standardized mean difference effect sizes and nonparametric effect sizes. Overall, social skills interventions were found to have a nonparametric effect size of 73.8%, indicating an improvement in nearly three-quarters of all data over baseline data. Social skills interventions were also found to have a standardized mean difference effect size of 1.37, indicating an improvement of 1.37 standard deviations from pre-treatment to post-treatment. Social stories fell below the mean nonparametric effect size and had a mean effect size of 60.7% improvement. School-based social skills interventions had a nonparametric effect size above the mean effect size for all social skills interventions with a mean effect size of 85.6%. This result suggests that social skills learned in schools will, at least, be used in the schools where they were learned. Below are selected tables from the social skills meta-analyses included in this monograph.

Table 2
Mean of PND Scores with Social Stories

No	Reference	Intervention PND	Maintenance PND	Generalization PND
1.	Hanley-Hochdorfer et al. (2010)	19.02% Ineffective	38.54% Ineffective	No Data
2.	Litras et al. (2010)	75.21% Effective	100% Very effective	86.66% Effective
3.	Schneider & Goldstein (2010)	40.90% Ineffective	No Data	No Data
4.	Reichow & Sabornie (2009)	93.75% Very effective	100% Very effective	100% Very effective
5.	Chan & O'Reilly (2008)	87.82% Effective	100% Very effective	No Data
6.	Dodd et al. (2008)	63.88% Questionable	100% Very effective	No Data
7.	Ozdemir (2008)	100% Very effective	100% Very effective	100% Very effective
8.	Sansosti & Powell-Smith (2008)	71.63% Effective	100% Very effective	No Data
9.	Scattone (2008)	76.66% Effective	100% Very effective	No Data
10.	Crozier & Tincani (2007)	71.66% Effective	83.33% Effective	No Data
11.	Quilty (2007)	0% Ineffective	0% Ineffective	No Data
12.	Delano & Snell (2006)	87.77% Effective	70.95% Very effective	88.88% Effective
13.	Sansosti & Powell-Smith (2006)	55.84% Questionable	50% Questionable	No Data
14.	Scattone et al. (2006)	58% Questionable	No Data	No Data
15.	Adams et al. (2004)	20.62% Ineffective	No Data	No Data
16.	Barry & Burlew (2004)	98.33% Very effective	No Data	No Data
17.	Ivey et al. (2004)	50% Questionable	No Data	No Data
18.	Lorimer et al. (2002)	42.85% Ineffective	No Data	No Data
19.	Scattone et al. (2002)	87.69% Effective	No Data	No Data
20.	Thiemann & Goldstein (2001)	58.53% Questionable	34.48% Ineffective	21.66% Ineffective
21.	Hagiwara & Myles (1999)	35.33% Ineffective	No Data	No Data
22.	Kuttler et al. (1998)	100% Very effective	No Data	No Data

Sani Bozkurt et al., 2014.

Social Stories™ is an intervention developed to help improve a person's social skills.

There are 10 criteria that define a Social Story™, and can be found at

[http://carolgraysocialstories.com/wp-content/uploads/2015/09/Social-Stories-10.0-10.2-](http://carolgraysocialstories.com/wp-content/uploads/2015/09/Social-Stories-10.0-10.2-Comparison-Chart.pdf)

[Comparison-Chart.pdf](http://carolgraysocialstories.com/wp-content/uploads/2015/09/Social-Stories-10.0-10.2-Comparison-Chart.pdf). In essence, though, Social Stories™ are constructed around a basic

premise that the character in the story needs to make use of some social skill, which the character

eventually does. The idea behind a Social Story™ is that the character in the story models the

behavior that the person that the story is designed for needs to perform. Sani Bozkurt and colleagues in 2014 published a meta-analysis of Social Stories™ which provides a summary of the efficaciousness of the Social Stories™ intervention. Please note that the labels of “Very effective”, “Effective”, “Questionable”, and “Ineffective” are relatively arbitrary, but are based off of the recommendations of Scruggs and Mastropieri (2001). Sani Bozkurt and colleagues calculated effect sizes using the percentage of nonoverlapping data (PND) effect size method, which is a conservative estimate of the difference in data across the baseline and other phases being compared. Overall, there are mixed results concerning the level of effectiveness, but regardless it should be noted that with the exception of one study the Social Stories™ intervention consistently had positive effects for the recipients of the intervention. Also, it is important to recognize that the Social Stories™ intervention maintained its level of effectiveness across both maintenance and generalization phases for those studies that reported such data. For those studies with smaller effect sizes, the magnitude of the effect size did not change drastically across maintenance or generalization phases. Similarly, studies with larger effect sizes during the intervention phase had effect sizes similar in magnitude for both the maintenance and generalization phases.

Table 3
PND Categories for Comparison of Social Stories Alone and Social Stories with Additional Intervention

PND categories	Social story alone (n = 6)	Social story with additional intervention (n = 16)
Very effective	0%	25%
Effective	50%	25%
Questionable	17%	25%
Ineffective	33%	25%

This table exhibits the variability in the effectiveness of the Social Stories™ intervention, with half of all of the studies (three studies that used Social Stories™ alone, and eight that used Social Stories™ with an additional intervention) exhibiting smaller effects, and the other half exhibiting stronger effects (three studies that used Social Stories™ alone, and eight that used Social Stories™ with an additional intervention). The important factor to note is that stronger effects, overall, were evidenced when the Social Stories™ were used in conjunction with an additional intervention.

TABLE 1. Mean PND Scores by Type of Social Skills Intervention

Intervention type	Intervention		Maintenance		Generalization	
	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>
Collateral skills	75	7	93	5	51	2
Peer mediated	62	10	79	5	33	3
Child specific	71	15	87	5	67	1
Comprehensive	72	20	69	8	59	9

Note. PND = percentage of non-overlapping data points.

TABLE 2. Mean PND Scores by Format of Social Skills Intervention

Format	Intervention		Maintenance		Generalization	
	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>
Individual	72	24	84	12	63	8
Group	69	28	77	13	43	7

Note. PND = percentage of non-overlapping data points.

Bellini et al., 2007

These tables from the meta-analysis by Bellini and colleagues illustrate the fact that social skills do not typically generalize, or at least do not maintain their effects over time. It is

interesting to note social skills interventions that target collateral skills, are child specific, and comprehensive are relatively equal in effectiveness during the actual administration of the intervention. Interestingly, social skills interventions were more effective during maintenance phases than during the actual intervention phases, although this is most likely due to practice effects that are not always readily apparent at the beginning of the intervention phases.

The second table also provides important information as social skills interventions are often delivered in both individual and group formats. Generally, social skills interventions that are delivered in either individual format or group format are relatively equal in effectiveness during both intervention and maintenance phases. However, it would appear that effects remain stronger during generalization phases for social skills interventions delivered in the individual format than social skills interventions delivered in group formats.

TABLE 3. Mean PND Scores by Location of Social Skills Intervention

Location	Intervention		Maintenance		Generalization	
	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>
Classroom	76	28	88	16	67	8
Pullout	62	21	67	9	29	5

Note. PND = percentage of non-overlapping data points.

TABLE 4. Mean PND Scores by Age Group

Age group	Intervention		Maintenance		Generalization	
	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>
Preschool	70	21	74	8	65	7
Elementary	69	28	79	14	40	7
Secondary	76	9	99	5	71	2

Note. PND = percentage of non-overlapping data points.

Bellini et al., 2007

For practitioners in schools who deliver social skills interventions it is important to make the most of the resources that are available, including setting, to bring about the greatest effect. It is a common practice to pull students out of the classroom to deliver services to them so as to not disrupt instructional time for other students, or sometimes due to other circumstances. The first table here, illustrates the importance of *not* pulling students out of the classroom to deliver social skills interventions. Social skills interventions are considerably more effective when delivered in the classroom, than when delivered in pullout settings. This is most likely due to better generalization of the social skills to the setting where they would be used the most.

The second table in this set also provides useful information as to what age groups will respond best to social skills interventions. Initially, social skills interventions are equally effective with preschool, elementary, and secondary students. In time, though, effects become significantly less for the elementary school group than either the preschool or secondary groups, which remain similar in terms of the strength of the change brought about by the social skills interventions. This is brought up mainly to highlight the importance of doing more with elementary school students to ensure that effects are maintained for this group of students.

Daily Living Skills

The deficits that come with the core symptoms of autism can impact an individual with autism in matters of everyday living. Deficits in social communication can impact the ability to perform job duties, perform academically, and get assistance from others when needed. Individuals with autism may also have difficulty with feeding, managing anxiety, transportation, developing and maintaining relationships along with other difficulties that affect daily living in both small and large ways.

One meta-analysis (Roth, Gillis, & Reed, 2014) examined the efficacy of behavioral interventions to improve the daily living skills of adolescents and adults with autism. A wide variety of interventions were used and included: prompting, social stories, video modeling, token economies, video prompting, differential reinforcement, self-monitoring, mindfulness exercises, both singularly and in intervention packages.

Interventions targeted a wide variety of skills, but were divided by the authors into four categories: academic skills, adaptive skills, problem behavior, social skills, and vocational skills. Four articles targeting academic skills were included in the Roth and colleagues (2004) meta-analysis and focused on test taking strategies, words written in essays, and independently recording homework assignments. 19 articles targeting adaptive skills were analyzed and included skills such as washing dishes, food consumption, assistance seeking behavior, and safety skills. Five articles focused on problem behaviors with the majority emphasizing aggressive behavior, but perseverative speech, verbal aggression, straightening behavior, and compliance were also included. Eight articles targeted social skills including conversation initiation, asking questions, nonverbal behavior, and eye contact.

Overall, interventions for daily living skills for adolescents and adults were found to have positive effects on the targeted outcomes. Across all interventions and outcomes, interventions for daily living skills for adolescents and adults with autism spectrum disorder had a mean nonparametric effect size of 90.9%. The mean effect size for academic skills fell above the overall average (ES = 95.8%). Interventions for adaptive skills had a similar effect size to that of the global effect size (ES = 91.2%), as well as problem behavior (ES = 88.9%). The mean effect size for social skills intervention fell below the overall mean effect size, but was still similar (ES = 85%).

Conclusion

In conclusion, there are a plethora of interventions that exist to address the symptoms and deficits of autism spectrum disorder. Some interventions appear to have greater effects than others, but overall interventions for autism address the symptoms and other targeted behaviors with significant efficacy, although not perfectly. It is important to remember that effect sizes do not communicate whether the change in the dependent variable was actually brought about by the intervention but instead, simply communicate the magnitude of change in the dependent variable over the course of a study. Further, the validity of effect sizes is dependent upon the methodological rigor of the study from which the effect size was derived.

Meta-analyses, while not always controlling for methodological quality, provide a useful summary of the efficacy of interventions for different target populations, and different target behaviors among other variables. This information is communicated through effect sizes, which may be parametric (based off of the assumptions of the normal curve), or nonparametric. There are two main types of parametric effect sizes: standardized mean differences, and regression/correlation based effect sizes. Standardized mean difference effect sizes communicate change in terms of standard deviations, whereas regression/correlation based effect sizes communicate change in terms of how much variance one variable (treatment) explains of another variable (dependent variable). Nonparametric effect sizes communicate how much of the data during the intervention phase is an improvement over data in the baseline phase.

The results from the meta-analyses for early intensive behavioral interventions indicate positive effects for intervening early with an omnibus effect of 1.02. Positive effects for intervening early were found for IQ, receptive and expressive language, restrictive/repetitive

behavior, and the core symptoms of autism. These positive effects indicate the importance of intervening early in order to bring about the best outcomes possible.

The data gathered from meta-analyses strictly analyzing interventions for language indicated limited success while still resulting in positive change. Spoken language, AAC, and total communication interventions can improve receptive and expressive language outcomes, but the outcomes demonstrate high variability. AAC interventions, including PECS, had an overall effect size of 71.9%. PECS alone had a mean effect size of 70.6%. Total communication was apparently more effective than either AAC or spoken only interventions, while spoken language interventions were moderately effective. These results highlight the importance of selecting evidence-based interventions that provide the best outcomes.

Social skills interventions showed varying positive effects through a variety of media, while targeting a wide variety of outcomes. Social skills interventions for children with autism have been found to be efficacious, at least initially. Studies have been shown to have positive effects during maintenance and generalization phases, but there are many studies that do not report data for maintenance or generalization phases. This can sometimes make it difficult to truly conclude as to whether or not social skills interventions for children with autism will generalize or maintain effects (Sani Bozkurt et al., 2014). However, based upon results from meta-analyses that analyzed social skills interventions delivered through schools, it would appear that social skills interventions delivered in schools are more effective (ES = 76% if delivered in classrooms) than all social skills interventions combined (ES = 73.6%) (Bellini et al., 2007), thereby emphasizing the importance of teaching social skills in schools where children have opportunities to practice social skills and receive reinforcement for social skills applied throughout the day.

Results from the meta-analysis on daily living skills for adults and adolescents with autism show that strong, positive results are possible for a wide variety of outcomes related to daily living. Outcomes include vocational skills, academic skills, adaptive skills, problem behaviors, and social skills. Such strong results highlight the importance of intervening with individuals with autism regardless of age.

In closing, it is important to intervene with individuals with an autism spectrum disorder regardless of age or targeted outcome. It is important to select interventions that are evidence-based, and are most likely to bring about the desired effects. While it is important to take the effect size of an intervention into consideration when trying to decide on an intervention, it should be remembered that having a larger magnitude of effect size does not guarantee that an intervention will work as intended, or with the same strength of effect. It is always best to use the intervention that is most appropriate for the individual client, and will maximize the outcome for the amount of intervention received.

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