Kennedy Krieger Institute

Center for Autism & Related Disorders

A comprehensive resource for children with disabilities

June 15, 2011

Lewis Golinker, Esq.
401 East State Street, Suite 300
Ithaca, NY 14850

Dear Mr. Golinker:

I have been asked to review the evidence base related to the effectiveness of speech generating device (SGD) use by individuals with autism. This review is necessary to assess the validity of the statement that SGD use by persons with autism spectrum disorders (ASD) is "experimental." This statement is found in the CIGNA Medical Coverage Policy: "Autism Spectrum Disorders/Pervasive Developmental Disorders: Assessment and Treatment," Coverage Policy No. 0447, at p. 3 (2010).

The CIGNA Autism Treatment Coverage Policy does not define "experimental" care. Other CIGNA guidance requires requested care to be "medically necessary," one element of which is that the care is "in accordance with generally accepted standards of medical practice." Historically, care that is "in accordance with generally accepted standards of medical practice" is not experimental. CIGNA identifies the following as criteria to determine if care is "in accordance with generally accepted standards of medical practice:"

If care is based on:

- Credible scientific evidence published in peer-reviewed medical literature generally recognized by the relevant professional community;
- Physician and healthcare provider specialty society recommendations;
- The views of physicians and healthcare providers practicing in relevant clinical areas and
- Any other relevant factors.

Other CIGNA guidance states the peer-reviewed, scientific evidence (medical literature) must be "evidence based."

Thus, I have reviewed the relevant evidence, i.e., peer-reviewed, evidence based, scientific literature related to the effectiveness of SGD use by persons with autism. My investigation leads to a clear and unequivocal statement that the medical literature does ***not*** support the conclusion that SGD use by

3901 Greenspring Avenue Baltimore, Maryland 21211 (443) 923-7630/Telephone (443) 923-7560/Facsimile (443) 923-2645/TTY

persons with autism is "experimental." To the contrary, there is a substantial body of professional literature that demonstrates SGD use by persons with ASD is an effective intervention.

Before presenting detailed evidence to support this conclusion, I will first provide a summary of my professional experience in the field of Augmentative and Alternative Communication (AAC). Next, I will define SGDs within the larger context of the field of AAC and describe the medical conditions that SGDs are designed to treat. Following these descriptions, I will provide a definition of "evidence based practice" including a description of a hierarchy of research evidence for making evidence-based practice decisions and an accepted evidence-based practice standard for ASD. Finally, I will discuss the results and implications of existing peer-reviewed, evidence-based literature that addresses the research evidence in support of implementation of SGDs for individuals with ASD based on my independent review of the research evidence.

I. Professional Experience

I have over thirty years of experience as a speech-language pathologist serving individuals who have severe speech and language disorders affecting expressive communication. Since August 2008 I have served as the Program Director for the Achievements Therapeutic Day (preschool) Program and as supervisor of the speech-language pathologists who work in the outpatient clinic at the Center for Autism and Related Disorders (CARD) at Kennedy Krieger Institute in Baltimore, Maryland. In the outpatient clinic, I conduct speech-language and augmentative communication (AAC) evaluations for children with Autism Spectrum Disorders (ASD). I am also a co-investigator in a study examining developmental and augmented language intervention to improve expressive communication for children with ASD. The study is funded by *Autism Speaks*.

Prior to joining KKI, I was a clinical professor and director of the Speech-Language Clinic in the Department of Speech and Hearing Science at Arizona State University. While there, I developed and ran an AAC outpatient clinical service and I taught the graduate-level course in AAC. Before joining the faculty at Arizona State University, for 10 years, I was the Director of the Hattie B. Munroe Augmentative Communication Center at the University of Nebraska Medical Center. Additionally, during my time in Nebraska, I served as a consultant for the Nebraska Medicaid program. In this role I reviewed claims for Speech Generating Devices (SGD). From 1999-2001, I also was a member of the AAC professional work-group that assisted Medicare staff to develop national guidelines for assessment and funding of Speech Generating Devices (SGD). In addition to my clinical and academic experience, I have made extensive professional contributions in the area of AAC including co-authoring book chapters and research papers and delivering presentations at national and international conferences. I also developed the AAC Report Coach, a tool to help speech-language pathologists prepare complete reports following AAC or SGD evaluation. The AAC Report Coach is posted at www.aacfundinghelp.com.

A copy of my curriculum vitae is attached.

II. AAC Interventions

According to the American Speech-Language Hearing Association, "AAC is foremost, a set of procedures and processes by which an individual's communication skills can be maximized for functional

and effective communication." Augmentative and alternative communication intervention is a form of speech-language pathology treatment of individuals who have severe expressive communication disorders affecting speech and/or language functioning. The etiology of severe expressive communication disorders may be congenital disability that affects the development of functional speech and writing (e.g., cerebral palsy, mental retardation, genetic syndromes, hearing impairment, autism, etc.) or an acquired disability resulting in the loss of functional speech and writing (e.g., traumatic brain injury, stroke, degenerative disease, etc.). It is generally accepted by the profession of speech-language pathology that AAC interventions, including use of SGDs, are appropriate when an individual is unable to meet daily communication needs using natural communication methods, such as speech.

Regardless of the cause of the severe communication disorder, the goal of AAC intervention is to improve the current communicative functioning of the individual by teaching him/her to use AAC modalities to communicate un-met (with speech) *communicative needs or intents*. Communicative needs or intents are the individual's "reasons to" or "goals for" communication. These may include but are not limited to requesting (e.g., preferred items, locations, activities, etc.), commenting, conversation, answering questions, etc. Augmentative and alternative communication modalities can be *unaided communication systems* such as sign language and/or *aided communication systems* that can range from individual picture symbols to informal or commercial communication books to speech generating devices (SGDs). An SGD is a portable electronic device that provides speech output (digitized speech, synthesized speech or both) in response to a person's selection of picture symbols, letters, word, phrases or whole messages. As previously stated, augmentative and alternative communication intervention is implemented to increase the communicative functioning of individuals whose natural speech is not sufficient to meet daily communicative needs.

III. Evidence Based Practice

Evidence based practice is a systematic process of clinical decision making that integrates best research evidence with clinical experience/expertise and takes into account stakeholder perspectives when making decisions regarding assessment and treatment of a particular stakeholder (Schlosser & Raghavendra, 2004).

With regard to "research evidence" there has been considerable discussion regarding how to evaluate the quality of the evidence (i.e., research results). A variety of hierarchies for describing best evidence have been proposed; all have in common the placement of experimental-design research (group and single-case design studies) and meta-analyses of experimental-designed research at the top of the hierarchy (Schlosser & Raghavendra, 2004). However, evidence-based practice also incorporates evidence from non-experimental published literature such as quasi-experimental design studies and retrospective studies.

When conducting evidence-based review of the literature, in addition to the quality of the research evidence, clinicians and stakeholders are also concerned with the weight of the evidence. That is, does sufficient evidence exist to indicate that the assessment or treatment is effective for the condition for which it is being considered? In the area of practices for individuals with ASDs, the National Professional Development Center on ASD has proposed a standard for evidence based practice for ASD. The standard, which has been met with respect to the implementation of SGDs for individuals with ASD, is as provided below.

To be considered an evidence-based practice for individuals with ASD, efficacy must be established through peer-reviewed research in scientific journals using:

- *randomized or quasi-experimental design studies.* Two high quality experimental or quasi-experimental group design studies,
- *single-subject design studies.* Three different investigators or research groups must have conducted five high quality single subject design studies, or
- *combination of evidence.* One high quality randomized or quasi-experimental group design study and three high quality single subject design studies conducted by at least three different investigators or research groups (across the group and single subject design studies).

National Professional Development Center on ASD, posted for review at http://autismpdc.fpg.unc.edu/content/evidence-based-practices

IV. Literature Search and Review

As stated in the introduction, I identified and reviewed the "peer-reviewed, evidence based scientific literature" describing use of SGDs by persons with autism. My review examined whether this research literature demonstrated SGD use by persons with autism is effective.

I conducted a multi-source electronic search including CINAHL Plus, PsychINFO and MEDLINE between 1975 and December 2010. I located 31 studies published in peer-reviewed journals (see attached table) examining the outcomes of implementing SGDs with individuals with ASD. The electronic search was supplemented by hand search methods. The majority of the studies (24=75%) employed experimental designs (23 studies used single subject expermental designs and 1 used a group design). There were also 4 case study reports, 2 quasi-experimental (AB) studies and 1 retrospective study. As indicated in the attached table, the majority of these studies (23) were included in a recently published review of the literature examining the outcome of communication interventions involving speech-generating devices for children with autism (van der Meer and Rispoli, 2010).

All of the 31 studies listed on the attached table found positive outcomes of implementing SGDs with individuals with ASD. The studies addressed a wide range of outcomes. These outcomes included:

- learning to use SGDs to make requests,
- to reject,
- to label,
- to comment,
- to engage in topical talk,
- to repair communicative breakdowns,
- to increase the frequency of responses, and
- to increase the frequency of initiations.

The studies also reported collateral effects of learning to use SGDs. Positive outcomes were reported for:

- language comprehension,
- rate of language development,
- increases in communicative interactions,
- increases in communicative engagement, reduction of problem behaviors, and
- increases in natural speech (e.g., verbalizations, spoken words).

In contrast to my independent literature review and to the review conducted by the National Professional Development Center on ASD, the most recent update of the CIGNA Autism Treatment Coverage Policy (2010) did not identify the scope of its literature search and did not reference any evidence based research. Only 3 references were cited in the guideline and none represents evidence based research. Rather, one reference is a 10 year old textbook; the other two are review-articles describing evidence based research. Also noteworthy is that there is no discussion of the peer-reviewed, evidence based research discussed in the textbook (National Research Council, Educating Children with Autism, 2001); one of the referenced articles did not review any research study in which a person with autism used an SGD (Millar, Light & Schlosser, 2006); and there is no discussion of the 3 evidence-based studies reviewed in the other article (Schlosser & Wendt, 2008).

Failure to conduct a complete literature search may explain, but cannot justify CIGNA's conclusion that SGD use by persons with autism is "experimental and the implication from that conclusion that there is no research evidence demonstrating the effectiveness of SGDs for individuals with ASD.

Another flaw in the CIGNA Autism Treatment Coverage Policy is its apparent misinterpretation of the systematic reviews by Millar, Light & Schlosser (2006) and Schlosser and Wendt (2008) with regard to the purpose of these studies and the implications for the effectiveness of AAC intervention including SGDs to augment functional communication skills for children with developmental disabilities and/or children with ASD. The goal of both studies was to examine the effect of AAC intervention on speech production in children who were taught to use SGDs. In each case the authors found some improvement in speech production in the studies analyzed but the results were not consistent across subjects (i.e., some subjects' speech improved, some subjects' speech did not improve) and the amount of improvement was considered modest. Both studies' authors concluded that further research is warranted to examine the relationship between AAC intervention and speech production in children with developmental disabilities, Millar, Light and Schlosser, (2006) and children ASD Schlosser and Wendt (2008) respectively.

The CIGNA coverage policy authors appear to have interpreted these results to mean that AAC intervention has not been demonstrated to be an effective intervention for children with developmental disabilities and children with ASD. However, as they explained in their introduction, Schlosser and Wendt assumed that

> It is understood that the primary aim of AAC intervention is to facilitate a child's communicative competence through the use of multiple communication modalities that are by their very nature supplementing ("augmentative") or replacing ("alternative") natural speech... [A]although

> improvements in speech production per se are not a primary goal of AAC interventions, such outcomes do represent a welcomed bonus to AAC intervention efforts. Knowing whether AAC interventions facilitate or hinder speech production has the potential to inform current AAC intervention practices for children with autism in several ways. First, should AAC interventions be found not to hinder speech production (or even to enhance speech production), practitioners and families might be more inclined to support earlier adoption of AAC modalities and interventions rather than rely on a "wait-and-see" approach for children with limited or no functional speech. Second, if data were to show that some AAC interventions yield better speech production outcomes than others, practitioners and families could consider this evidence in their treatment selection decisions. (p. 213).

Additionally in their conclusions Schlosser and Wendt cautioned that their finding that the AAC intervention studies reviewed found modest gains on speech functioning for children with ASD does not invalidate the positive outcomes AAC interventions on targeted communicative behaviors of the subjects. This caution is illustrated by the following example. One of the studies in the review (Olive, de la Cruz, Davis, Chan, Lang, O'Reilly & Dickson, 2006) taught three children with autism to use SGDs to improve their requesting skills during play. Outcomes of the intervention on subjects' use of the SGD to make requests as well the effect of the intervention on the subjects' speech were monitored. Using a multiple probe design across subjects, the results of the intervention showed strong evidence of treatment effect regarding the subjects' learning to use a SGD to increase requesting behaviors during play. With regard to the outcomes on their speech production skills all subjects increased their vocalizations; however, none developed functional speech during the intervention.

Again, the purpose of both the systematic review of Millar, Light & Schlosser (2006), which included individuals with developmental disabilities in general and the review of Schlosser and Wendt (2008), which addressed individuals with ASD specifically was to examine the effect of SGD intervention on natural speech as reported in the studies reviewed. Therefore, the authors did not focus on the outcomes of SGD intervention on other modes communicative functioning (i.e., successful use of the target AAC intervention including SGDs to request, comment, engage in conversation, etc). However, given the longstanding history of concern regarding the potential for negative impact of SGD intervention on speech development, the results of both reviews were widely received as good news by those in the AAC field. That is, the results supported the practice of early adoption of AAC intervention to enable individuals with severe expressive communication disorders to achieve their fullest communicative potential without delay. It is highly ironic, therefore, that the conclusions of these papers have been misinterpreted by CIGNA to support a policy of non-coverage of SGDs for individuals with ASDs.

V. Analysis and Conclusion

In summary, the CIGNA conclusion that SGD use for persons with autism is experimental appears to be based on no review at all of peer-reviewed evidence based scientific literature. No peer-reviewed evidence based literature is referenced in the Autism Treatment Policy; not even the several studies discussed in two of the references CIGNA did review. CIGNA also conducted almost no investigation of the other factors it recognizes as indicators of whether a type of care is consistent with "accepted

standards of medical practice." These factors include the views of physician and other health care professional specialty societies, and the views of clinical professionals. Although several medical and other healthcare professional specialty societies have stated positions regarding SGD use by persons with autism, CIGNA referenced only the National Research Council and its text Educating Children with Autism. That book, however, is more than a decade old. By contrast, CIGNA appears to have not considered the more recent views of the American-Speech-Language-Hearing Association, the American Academy of Pediatrics, or the National Professional Development Center on Autism Spectrum Disorders, all of which support SGD use by persons with autism as effective. Among the many resources in which clinical professionals express their views of about the effectiveness of SGD use by persons with autism, CIGNA only referenced 2 articles, and appears to have misinterpreted the significance of their findings. Not considered at all are texts, such as Mirenda & Iocono, Autism Spectrum Disorders and AAC (2009) and the many articles in professional journals that support the conclusion that SGD use by persons with autism is effective.

In sum, the CIGNA conclusion in its Autism Treatment Coverage Policy that SGD use by persons with autism is experimental has no factual foundation. Instead, it reflects both CIGNA's failure to investigate the relevant evidence, and its misreading of the evidence that was reviewed. By contrast, there is a wealth of evidence CIGNA never considered that supports the effectiveness of SGD use by persons with autism. This evidence can be found in dozens of peer-reviewed, evidence-based scientific studies; in the written statements of policy of both medical and healthcare professional specialty societies, and in the texts and other contributions of practicing clinicians. Finally, having completed my analysis, a newly published meta-analysis came to my attention (Ganz, Earles-Vollrath, Heath, Parker, Rispoli & Duran, 2011). This study reviewed 8 articles that I also reviewed (see notation in attached table) and the conclusion was the same as mine: that SGDs are effective to improve the communication skills for people with ASD.

Sincerely,

Pamela Mathy

Pamela Mathy, Ph.D., CCC-SLP
Assistant Professor, Psychiatry
The Johns Hopkins School of Medicine
Program Director, Achievements Therapeutic Day Program
Manager Speech-Language Pathology
Center for Autism and Related Disorders
3901 Greenspring Avenue
Baltimore, MD 21211

References cited:

Ganz, J.B., Earles-Vollrath, T.I., Heath, A.K., Parker, R.I, Rispoli, M.J. & Duran, J.B. (Published on Line March 5, 2011). A meta-analysis of single case research studies on aided augmentative and alternative communication systems with individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, (DOI 10.1007/s10803-011-1212-2).

Millar, D. C., Light, J. C., & Schlosser, R. W. (2006). The impact of augmentative and alternative communication intervention on the speech production of individuals with developmental disabilities: A research review. *Journal of Speech, Language, and Hearing Research, 49*, 248-264.

Schlosser, R. W., & Raghavendra, P. (2004). Evidence-based practice in augmentative and alternative communication. *Augmentative and Alternative Communication, 20*(1), 1-21.

Schlosser, R., & Wendt, O. (2008). Effects of augmentative and alternative communication intervention on speech production in children with autism: A systematic review. American Journal of Speech-Language Pathology, 17(3), 212–230.

van der Meer, L., Rispoli, M., (2010). Communication intervention involving speech-generating devices for children with autism: A review of the literature. Developmental Neurorehabilitation, 13, 294-306.

Also see attached table.

Article	Cited in Review article(s)[1]	Speech Generating Device and speech type (D=digitized; S=Synthesized; B=both S & D)	Participants: Subjects with ASD/Total Subjects; Gender; Age range of subjects	Study aims and outcomes	Type of study
1. Beck, A., Stoner. J. , Bock, S., & Parton, T. (2008). Comparison of PECS and the use of a VOCA: A replication. *Education and Training in Developmental Disabilities. 43*, 198–216.	e.	GoTalk-D	3 out of 4 M, B, D (preschool aged)	1. Examined Picture Exchange Communication System (PECS) vs. SGD influence on vocalizations (% **intelligible** non-imitated utterances) -D & M Improved, **intelligible, spontaneous & utterance complexity** VOCA>PECS 2. Examined learning to use PECS or SGD to **request** preferred items -All Ss learned to request with PECS -D also learned to request with SGD 3. Generalization to home. -One S used SGD and showed preference for SGD over PECS at home	SS—Experimental-Alternating treatment design
2. Brady, N. (2000). Improved comprehension of object names following voice output communication aid use: Two case studies. *Augmentative & Alternative Communication.16*, 197–204.	a. e.	SpeakEasy-D	1 of 2 Girl with ASD; age 5 years	1. **Comprehension** of target vocabulary -The subject with ASD's comprehension of target vocab. increased from 40% to 100% 2. Use of SGD to **request** preferred items in joint activity routine. - The subject with ASD learned to discriminate and use total of 6 symbols on the SGD to make requests across two different routines	Case Study
3. Choi, H. ,O'Reilly, M., Sigafoos, J. & Lancioni, G. (2010). Teaching requesting		TechSpeak-D Vantage-B	2 of 4 Boys: Dan, Rob (Dx ASD used SGD); 7 years and	1. Examined subjects' ability to learn to **request** needed items using SGD -Both D and R met criteria for	SS-Experimental Multiple probe across

and rejecting sequences to four children with developmental disabilities using augmentative and alternative communication. *Research in Developmental Disabilities, 31*, 560-567.			8 years	**correct requesting** using SGD 2. Learning to **reject** wrongly offered items using SGD Both D and R met criteria for **correct rejecting** using SGD **3. Learning to re-request following rejection** - Both D and R met criteria for **correct re- requesting** using 4. Probed **generalization** to untrained activities -Both D and R met criteria for generalization to untrained activities	participants design
4. Durand, V. (1999). Functional communication training using assistive devices: Recruiting natural communities of reinforcement. *Journal of Applied Behavior Analysis. 32*, 247–267.	d.	Introtalker-D	2 of 5 Boys: Ron and David; 9.5 and 11.5 years	1. Following training to use an SGD, examined increase **unprompted** use of SGD to **request help and/or attention** - Unprompted SGD use increased from 0% at baseline to 9% (range, 0% to 23%) for Ron, and15% (range, 5% to 34%) for David 2. Examined **generalization** of unprompted use of SGD to **request help and/or attention** in community - Unprompted SGD use increased from 0% at baseline to12% (range, 4% to 22%) for Ron, and 9% (range, 6% to 12%) for David 3. Examined effect of Functional Communication Training (FCT) using SGD on **reducing "problem behaviors"** -With FCT training using SGD: Ron's problem behavior decreased from average 42% (range, 33% to 47%) pre to average 0.5% (range, 0% to 8%) post. David's problem behavior decreased from average	SS-Experimental Multiple base line across subjects design

				48% (range, 20% to 75%) pre to 5% (range, 0% to 30%) post.	
5. Dyches, T.T. (1998). Effects of switch training on the communication of children with autism and severe disabilities. *Focus on Autism and Other Developmental Disabilities, 13*, 151–162.	a.,b., d.	Big Red switch connected to Loop tape (analog speech); Jelly bean switch connected to CheapTalk-D	2/4 Boys: Alan, Nathan; 11.2 and 10. 4 years	Using an ABAB design, examined effect of SGD on: 1. **Number of communicative interactions** -Number of interactions increased with SGD for both subjects **2.** Number of **spontaneous communicative interactions** -Spontaneous communicative interactions increased with SGD for both subjects 3. Number of **independent (non-prompted) communicative interactions** using SGD - Independence communicative interactions increased with SGD for both subjects 4. Number **verbalizations** (natural speech) -One subject (Alan) increased amount of verbalizations and utterance length	SS-Experimental ABAB design
6. Franco, J., Lang, R., O'Reilly, M., Chan, J., Sigafoos, J. & Rispoli, M. (2009). Functional analysis and treatment of inappropriate vocalisations using a speech-generating device for a child with autism. *Focus on Autism & Other Developmental Disabilities. 24*, 146–	e.	GoTalk-D	1/1 Boy, 7.6 years	Examined effect of use of SGD to make relevant **requests.** -Subject learned to make requests using SGD resulting in: a. Substantial decrease in inappropriate voc when SGD present b. Substantial increase in engagement when SGD present c. SGD use generalized to two non-trained contexts	SS-Experimental Alternating treatments

155.					
7. Koppenhaver, D.A., Erickson, K.A., Harris, B., McLellan, J., Skotko, B.G., & Newton, R.A. (2001). Storybook-based communication intervention for girls with Rett Syndrome and their mothers. *Disability and Rehabilitation, 23*, 149–159.	d.	Big Mack-D; CheapTalk-D	6/6 Girls: age range 3.6 - 7	Examined effect of access to assistive technologies including SGDs on **frequency and amount of symbolic communication** during story reading activities. Result—All subjects increased their frequency and amount of symbolic communication (**labeling and commenting**) (over baseline) with assistive technology including SGDs	SS-Experimental Multiple baseline across behaviors (across phases)
8. Koppenhaver, D.A., Erickson, K., & Skotko, B.G. (2001). Supporting communication of girls with Rett Syndrome and their mothers in storybook reading. *International Journal of Disability, Development and Education, 48*, 395–410.	d.	Big Mack-D; CheapTalk-D	4/4 Girls: age range 3.6 - 7	With access to assistive technologies including communication symbols and SGDs, all subjects increased their frequency **labeling and commenting and appropriate symbolic communication**	SS-Experimental Multiple baseline across behaviors (across phases)
9. McMillan, J. (2008). Teachers make it happen: From professional development to integration of augmentative and alternative communication technologies in the classroom. *Australasian Journal*	e.	Not specified	4 children with ASD in study Boys: Age range 8 – 12 years	Examined the effects of a multiphase teacher training program and use of time-delay (a mileu teaching strategy) on **frequency of SGD** use (**initiations** and **responses** in school setting -Minimal change in the frequency of of SGD **responses** as a result of intervention -Significant increases in frequency of SGD **initiations** as a result of intervention	SS-Experimental Multiple baseline design across participant pairs

of Special Education. 32, 199–211.					
10. Mirenda, P., Wilk, D., & Carson, P. (2000). A retrospective analysis of technology use patterns of students with autism over a five-year period. *Journal of Special Education Technology. 15*, 5 – 16.		-Intellikeys/talk/pics (+computer)-S Introtalker/Alphatalker-D -Macaw-D -Speaking Dynamically+ computer-S Other	63 of 170 students received SGD loans 81% male 19% female Age range 5 – 17 years	This retrospective study examined the outcomes over a five-year period of providing assistive technology (including portable and computer-based SGDs) on a group of 170 students with ASD ranging in age from 5 years to 17 years. -Sixty three SGDs were loaned to students over that time period. Using a six-level scoring system (0=no use of technology – 5=technology very successful), approximately half of the SGD loans (49.2%) were rated successful to very successful (ratings 4-5) and one third were rated as having limited or some success (rating 2-3). Only 19% of the SGD loans were rated as unsuccessful (ratings 1-0). -Better outcomes were seen when assistive technology was received when the students were relatively young (5 years – 11 years) -Students estimated cognitive abilities did not appear to be related to successful technology use -Successful SGD use did not appear to be related to students' speech ability at the time their received their SGD -Student's whose speech improved to the point of no longer needing an SGD had at least limited functional speech prior to receiving their SGD	Retrospective Study
11. Olive, M., de la Cruz, B., Davis, T. N., Chan, J. M., Lang, R.	c. , e., f.	CheapTalk-D	3/3 Boys; Age range 45 -66 months	Examined effect of teaching use of SGD to make requests on: 1. **Prompted** and **independent**	SS-Experimental Multiple

B., O'Reilly, M. F., & Dickson, S. M. (2007). The effects of enhanced milieu teaching and a voice output communication aid on the requesting of three children with autism. *Journal of Autism and Developmental Disorders, 37*, 1505–1513.				**requests** using the SGD - No subjects used the SGDs during baseline—all learned to use SGDs to make independent **requests**. 2. Total **spontaneous independent requests** (any modality). -All subjects increased their total spontaneous independent requests following training with SGD -One subject also increased his **spontaneous vocalizations** following the SGD intervention.	probe across participants
12. Olive, M., Lang, R. & Davis, T. (2008). An analysis of the effects of functional communication and a voice output communication aid for a child with autism spectrum disorder. *Research in Autism Spectrum Disorders. 2*, 223–236.	e., f.	Touch Talk-D (participant's own voice)	1/1 Girl; 4 years	Examined effect of teaching requesting using an SGD in Functional Communication Training (FCT) on: 1. Rate of **requesting** -Subject increased rate of requesting over baseline following training to use SGD to request in FCT 2. Rate of **challenging behavior** -Challenging behaviors decreased to zero during FCT with SGD 3. Rate of **language development** base on standardized assessments -Proportional change index (PCI) scores showed more rapid improvement of language development in intervention phase.	SS-Experimental Multiple probe design across activities
13. Parsons, C. L., & LaSorte, D. (1993). The effect of computers with synthesized speech and no speech on the spontaneous	b., c.	Apple II GS computer + Echo IIb speech synthesizer- S with regular keyboard or external keyboard (Power Pad)	6/6 5 boys and 1 girl; age range 4.8 – 6.8 years	This study examined the effect of computer assisted communication intervention with and without synthesized speech on the **frequency of spontaneous utterances** (natural speech) by 6 children with ASD. -Intervention without synthesized	SS-Experimental Interactional Single-Subject design (additive and

communication of children with autism. *Australian Journal of Human Communication Disorders, 21*, 12–31.				speech produced no change in frequency of spontaneous utterances -In conditions where synthesized speech was added, an increase in spontaneous utterances was observed	reductive variants used to control for order effects
14. Romski, M.A., Sevick, R.A. & Adamson, L.B. (1999). Communication patterns of youth with mental retardation with and without their speech-output communication devices. *American Journal of Mental Retardation. 104*, 249 – 259.		WOLF (Adamlab)-S	2/13 Males: 22.8 and 14.5 years	This study compared subjects' communicative performance (**clarity** of conversational focus, **appropriateness** of information conveyed and the **exact information content** conveyed) with a "standard" communicative partner with and without the use of an SGD. Two of the thirteen subjects were diagnosed with ASD. All subjects were taking part in a longitudinal study of development of communication skills using an SGD. All subjects demonstrated successful use of their SGDs prior to the study. -The findings indicated that when the SGD was available during the interaction all subjects increased in **clarity** of conversational focus, **appropriateness** of information conveyed and the **exact information content** conveyed	Group--Experimental
15. Schepis, M., Reid, D., Behrmann, M. & Sutton, K. (1998). Increasing communicative interactions of young children with autism using a voice output communication aid and naturalistic	a., b., e. f.	Cheap Talk-D Black Hawk-D	4/4 3 boys and 1 girl; age range 3 – 5 years	1. Examined the use of naturalistic teaching procedures to teach SGD on a variety of functional communication behaviors including: **requesting items**, answering **yes/no questions**, and making **statements** and making **social comments** - All subjects learned to use a SGD to request items, respond to	SS-Experimental Multiple probe design across time and participants in two routines

teaching. *Journal of Applied Behavior Analysis. 31*, 561–578.				questions, and make social comments during snack or play. 2. Effect on SGD use and **natural communicative behavior** (gestures, vocalizations, and words). -Increases in natural communication behaviors were seen in all children when they had access to SGDs	
16. Schlosser, R., Blischak, D., Belfiore, P., Bartley, C.& Barnett N. (1998). Effects of synthetic speech output and orthographic feedback on spelling in a student with autism: A preliminary study. *Journal of Autism & Developmental Disorders. 28*, 309–319.	e., f.	LightWRITER-SL 35-S	1/1	Examined the effects of three feedback conditions print, speech, and combined print and speech implemented on a SGD on **1.** Percentage of **words spelled correctly** -Subject learned to spell target words in all three feedback conditions 2. **Learning efficiency** (trials to criteria) -Learning efficiency was speech>speech+ visual> print.	SS-Experimental Adapted Alternating Treatments Design
17. Schlosser, R. & Blischak, D. (2004). Effects of speech and print feedback on spelling by children with autism. *Journal of Speech, Language, and Hearing Research. 47*, 848–862.	e., f.	LightWRITER-SL 35-S	4/4	Examined the effects of three feedback conditions visual, auditory, and combined visual and auditory implemented on a SGD on **1.** Percentage of words **spelled correctly** -All subjects learned to spell target words 2. **Learning efficiency** (trials to criteria) -For 3 subjects learning efficiency was Print>Speech+Print>Speech; for 1 subject efficiency was Speech+Print>Speech>Print	SS-Experimental Adapted Alternating Treatments Design

18. Schlosser, R. W., Sigafoos, J., Luiselli, J., Angermeier, K.,Schooley, K., Harasymowyz, U., & Belfiore, J. (2007). Effects of synthetic speech output on requesting and natural speech production in children with autism. *Research in Autism Spectrum Disordes.. 1*, 139–163.	b., c., e., f.	Vantage-S	5/5 1 girl and 4 boys; age range 8 – 10 years	1. Evaluated efficiency of acquiring **requesting** skills with a SGD in two conditions a. Without speech output on SGD b. With speech output on SGD -All subjects improved effectiveness of requesting over baseline. Two out of five subjects made more improvement in the speech output condition. 2. Monitored changes in **elicited speech production** as a result of the overall intervention -One out of five of the subjects made increased in elicited speech production following intervention (not output specific).	SS-Experimental Adapted Alternating Treatment Designs
19. Sigafoos,. J, Didden, R. & O'Reilly, M. (2003). M. Effects of speech output on maintenance of requesting and frequency of vocalizations in three children with developmental disabilities. *Augmentative and alternative Communication. 19,* 37 – 47.	b., d., e.	Big Mack-D	2/3 Boys: Michael, Jason; aged 4 and 14 years	1. Subjects were initially taught to make **requests** during a snack activity using an SGD with speech output turned on (acquisition phase). -All subjects learned to make requests successfully in the acquisition phase. 2. Next subjects' **rates of requesting** with the SGD were compared across sessions where the **speech output was turned on or off**. -Following acquisition, all subjects maintained their use of the SGD to make request regardless of whether the speech was on or off. 3. Subject's **vocalizations** were also monitored (maintenance phase). -Both children with ASD showed a	SS-Experimental Multiple baseline across subjects

				high, steady rate of undifferentiated vocalizations throughout all phases of the study (baseline – maintenance)	
20. Sigafoos, J., Drasgow, E., Halle, J., O'Reilly, M., Seely-York, S., Edrisinha, C. & Andrews, A. (2004). Teaching VOCA use as a communicative repair strategy. *Journal of Autism and Developmental Disorders. 34*, 411–422.	b., e., f.	Big Mack-D	2 of 2 1 male; age 16 1 female; age 20	1. Examined subjects ability to learn use of SGDs to **repair communicative breakdowns** (when prelinguistic requesting is not acknowledged) -Both subjects learned to use the SGD to repair breakdowns during snack time 2. Examined use of SGD to **initiate requests** (without previous communicative breakdown -After learning the use of the SGD to repair, both subjects began using it to initiate requests	SS-Experimental Multiple baseline across subjects
21. Sigafoos, J., Green, V., Payne, D., Son, S., O'Reilly, M. & Lancioni, G. (2009). A comparison of picture exchange and speech generating devices: Acquisition, preference, and collateral effects on social interaction. *Augmentative and Alternative Communication. 25*, 99–109.	e.	Tech/Talk-D	1/1 1 Boy; aged 15 years	1. In the acquisition phase (study 1) the subject was taught to make **requests** during snack activities using PECS and using a SGD. -The subject rapidly learned to use both AAC systems to make requests (study 1). 2. In study 2 the subject's **preference** for using PECS or the SGD to make requests was examined -The subject did not show a clear preference for SGD or PECS to make requests. 3. In study 3, only the PECS system was used. The subject was taught to travel to the trainer to exchange the *I want* symbol to request a snack. The amount of time the subject spent	SS-Experimental Alternating treatments design

				in **social withdrawal** was also monitored in all three studies. -The use of PECS or SGD alone did not affect the duration of social withdrawal. The subject's social withdrawal was reduced only in study 3 when he was taught to travel to the trainer to exchange a symbol to make a request.	
22. Sigafoos, J., O'Reilly, M., Ganz, J., Lancioni, G. & Schlosser, R. (2005). Supporting self-determination in AAC interventions by assessing preference for communication devices. *Technology and Disability. 17,* 1–11.	a., d., e.	Big Mack-D; Tech/Talk-D; Mini-message mate-D	1 of 2 Boy; 12 years	1. In the acquisition phase subjects were taught to make **requests** using three different SDGs. -Subjects rapidly learned to make requests using all three SGDs and the communication board 2. After subjects learned to use all three devices a "choice assessment" was conducted to examine **preference for SGD** -Each subject showed a definite preference for a particular SGD (first choice assessment) 3. Next subjects were taught to make **requests** using a low tech communication board 4. Finally, another "choice assessment" was conducted to examine **preference for AAC method** (SGD or communication board) -Both subjects showed a preference for using their previously preferred SGD over the communication board	SS-Experimental Multiple baseline across subjects
23. Sigafoos, J., O'Reilly, M., Seely-York, S. & Edrisinha, C. (2004). Teaching students with developmental	a., e., f.	Tech/Talk-D	3 of 3 Two boys; aged 12 and 16 years One girl; aged 20 years	1. Subjects first were taught to use an SGD to make **requests** when the device was within reach -All subjects learned use of the SGD to make requests 2. Subjects next were taught to	SS-Experimental Multiple baseline design across subjects

disabilities to locate their AAC device. *Research in Developmental Disabilities. 25,* 371–383.				**locate their SGD** and bring it to the table to make requests -All subjects learned to locate the SGD and bring it to the table to make requests	
24. Sigafoos, J., O'Reilly, M.F., Seely-York, S., Weru, J. Son, S.H., Green, V.A., & Lanconi, G.E. (2004). Transferring AAC intervention to the home. *Technology and Disability. 26,* 1330 – 1334.	a.	TalkTrac Wearable Communicator (Ablenet)-D	1 of 1 Boy; aged 12	This study examined the subject's ability to learn to use an SGD to: 1. Make **requests** for preferred food/drink items and for preferred activities -The subject learned to use the SGD to make requests successfully 2. The ability of the individual to **generalize** use of the SGD to three non-clinical settings (Café, vending machine, home -The subject was successful in generalizing requesting to the three target settings	Case study
25. Son, S., Sigafoos, J., O'Reilly, M.& Lancioni, G. (2006). Comparing two types of augmentative and alternative communication systems for children with autism. *Pediatric Rehabilitation.* 9, 389–395.	a., e.	Tech/Talk-D	3 of 3 Two girls and one boy; age range 3 – 5 years	1. In the acquisition phase all subjects were taught to make **requests** during snack activities using PECS and using a SGD -All subjects rapidly learned to use both systems to make requests in the acquisition phase. 2. In the maintenance phase subjects **preference for AAC method** was examined—subjects were offered a choice of using PECS or the SGD to make requests -In the maintenance phase, one subject showed a preference for the SGD and two for PECS	SS-Experimental Alternating treatments design
26. Sonnenmeier, R., McSheehan, M. & Jorgensen C. (2005).	e.	Go Talk-D DynaMyte-S	1 of 1 One boy aged 10 years	This case study explored the use of a model of evidence-based practice (Beyond Access) designed to	Observational case study

A case study of team supports for a student with autism's communication and engagement within the general education curriculum: Preliminary report of the Beyond Access model. *Augmentative & Alternative Communication. 21*, 101–115.				engender school and family cooperation to employ evidence-based inclusive practices and AAC for s student with ASD. With input and training from the educational team, changes in the student's SGD (from Go Talk to DynaMyte) led to **increased opportunities for engagement** in the general education curriculum that led to increased opportunities for his learning of grade-level content	
27. Thunberg, G., Ahlsen, E. & Sandberg, A. (2007). Children with autistic spectrum disorders and speech-generating devices: Communication in different activities at home. *Clinical Linguistics & Phonetics. 21*, 457–479.	d., e.	Portable touch-screen computer with Clicker 3 (software)-S (three participants) Tech/Talk-B (one participant)	4 of 4 Four boys: age range 4 – 7 years	This observational case study examined the effect of SGD intervention for children with ASD in different activities in the home environment, measured by **engagement** in activity, **role in turn-taking**, and **communicative form, function** and **effectiveness**? -The results were positive for all children. The greatest increase in effectiveness was noted when the SGD could be used to fulfill goals and roles in the activity.	Case study
28. Thunberg, G., Ahlse´n, E. & Sandberg, A. (2009). Interaction and use of speech-generating devices in the homes of children with autism spectrum disorders—an analysis of conversational topics. *Journal of Special Education*	e.	Tech/Talk 2-B Portable touch-screen computer with Clicker 3 (software)-B	4 of 4 Four boys; age range 5 – 7.5 years	This observational case study examined the following questions: 1. Does the **pattern of conversational topics** being used change with respect to types, numbers, and initiators during the SGD intervention? -With the introduction of the SGD all four subjects increased their proportion of topics related to the ongoing activity and decreased their off topic contributions 2. How is **topic length** affected by	AB design

Technology. 24, 1–17.				the introduction of an SGD in different activities in the home setting? -Access to the SGD increased interaction as measured by topic length in all but one of the activities studied (5/6).	
29. Thunberg, G., Sandberg, A. & Ahlse´n, E. (2009). Speech-generating devices used at home by children with autism spectrum disorders: A preliminary assessment. *Focus on Autism & Other Developmental Disabilities. 24*,104–115.	e.	Portable touch-screen computer with Clicker 3 (software)-B	3 of 3 Three boys; age range 5 – 7 years	This study examined three broad questions. 1. How communication in different activities at home was affected by the introduction of an SGD as measured by **engagement** in activity, role in **turn taking, communicative form**, and **effectiveness**. -Following introduction of the SGD, the rate of child responses increased in 5 of the 6 activities studied -Communicative effectiveness increased for all participants for all activities studied following introduction of the SGD 2. How SGD intervention affected subjects' **communication development** as measured by the *Vineland Adaptive Behavior Scales* (VABS) -All subjects showed improvements on the VABS across all domains. With regard to communication domains, subjects improved in both receptive and expressive communication 3. The effect of using SGD on **oral speech** -Speech production increased following the introduction of the SGD for 2 out of 3 of the subjects.	AB Design

30. Trembath, D., Balandin,S., Togher, L. & Stancliffe, R. (2009). Peermediated teaching and augmentative and alternative communication for preschool-aged children with autism. *Journal of Intellectual and Developmental Disability. 34*, 173–186.	e.	Talara-32-D	3 of 3 Three boys; age range 3 – 5 years	This study examined the effect of peer-mediated teaching with and without an SGD on **communicative outcomes** of three children with ASD. -The results indicated that both peer-mediated teaching and peer-mediated teaching with a SGD led to statistically significant **increases in the number of communicative behaviors** produced by each child with autism during intervention play sessions -All three children **generalized** increased communicative behaviors to interactions with their peers during non-trained activity (morning tea) -Two of the subjects began to produce (using **natural speech**) words and messages contained on the SGD soon after the intervention was introduced	SS-Experimental Multiple baseline design
31. Van Acker, R. & Grant, S.H. (1995). An effective computer-based requesting system for persons with Rett syndrome. *Journal of Childhood Communication Disorders. 16,* 31-38.	a.	Amiga 500 computer with speech synthesizer (S), and touch screen with custom software developed for study	3 of 3 Three girls; age range 5.2 – 7.11 years	This study explored the use of computer-generated animated graphics with speech output to teach **requesting** to children with Rett Syndrome - Two students acquired successful requesting of all three items -One student acquired requesting of one of the items -Requesting seemed purposeful and generalized across settings and persons	SS-Experimental Changing conditions multiple baseline design across students

[1] Review articles:

a. Lancioni, G.E., O'Reilly, M. F., Cuvo, A. J., Singh, N. N., Sigafoos, J. & Didden, R. (2007). PECS and VOCAs to enable students with developmental disabilities to make requests: An overview of the literature. *Research in Developmental Disabilities. 28*, 468–488

b. Nunes, D. R. P. (2008). AAC Interventions for Autism: A research summary. *International Journal of Special Education. 23,* 17-26.
c. Schlosser, R.W. & Wendt, O. (2008). Effects of Augmentative and Alternative Communication Intervention on Speech Production in Children With Autism:
A Systematic Review. *American Journal of Speech-Language Pathology. 17*, 212–230
d. Snell, M.E., Brady, N., McLean. L., Ogletree, B.T., Siegel, E., Sylvester, L., Mineo, B., Paul, D., Romski, M.A. & Sevcik, R. (2010). Twenty Years of Communication Intervention Research With Individuals Who Have Severe Intellectual and Developmental Disabilities. *American Association on Intellectual and Developmental Disabilities. 115,* 364–380.
e. van der Meer, L.A.J. & Rispoli, M. (2010). Communication interventions involving speech-generating devices for children with autism: A review of the literature. *Developmental Neurorehabilitation. 13*, 294–306
f. Ganz, J.B., Earles-Vollrath, T.I., Heath, A.K., Parker, R.I, Rispoli, M.J. & Duran, J.B. (Published on Line March 5, 2011). A meta-analysis of single case research studies on aided augmentative and alternative communication systems with individuals with autism spectrum disorders. Journal of Autism and Developmental Disorders, (DOI 10.1007/s10803-011-1212-2).