SUMMARY OF AUTISM SPECTRUM DISORDERS RESEARCH

NATIONAL CENTER FOR SPECIAL EDUCATION RESEARCH

FY 2006 - FY 2015

Summarized by Amy Sussman

Introduction

The core symptoms exhibited by people with autism spectrum disorder (ASD) fall into two categories: (1) social communication and interaction deficits; and (2) restrictive and repetitive behaviors, interests, and activities (American Psychiatric Association, 2013). There is a great deal of diversity in the severity of these symptoms ranging from low or no verbal or social skills to high levels of these skills, which is why autism is now considered a "spectrum" disorder. Additional symptoms may include intellectual impairment, sensory sensitivity, attention and executive functioning problems, motor difficulties, and behavior problems (Johnson, 2004). According to the Centers for Disease Control and Prevention (2014), one in 68 children is now classified as having an ASD, a significant rise from previous estimates. The prevalence of ASD creates an extraordinary demand on schools, staff, and teachers to provide interventions that meet the educational needs of students with the disorder. Furthermore, the highly variable symptoms and the range of severity of symptoms creates a significant challenge in developing and implementing effective interventions that address the range of developmental and academic needs of students with ASD.

In 2007, in its second year of grant funding, the National Center for Special Education Research (NCSER), in the Institute of Education Sciences (IES), created the Autism Spectrum Disorders topic area. This topic area was created to support a program of research intended to improve outcomes for students in preschool through high school identified with ASD. Currently funded research focuses on *comprehensive school-based interventions*. An intervention is comprehensive, as defined by NCSER, when it is designed to address multiple outcomes. At a minimum, outcomes for funded research must include two or more from the following domains: developmental, cognitive, communicative, academic, social, behavioral, or functional outcomes. Research on ASD interventions, however, is supported across various topic areas within NCSER, including those where funded research focuses on only one outcome (e.g., social) or on earlier ages (e.g., toddlers). The majority of these projects focus specifically on individuals with ASD, though a few focus on individuals with ASD as a part of a larger group of which ASD is one disability.

NCSER has also funded a large-scale research and development center focused on supporting students with ASD in secondary school. This report summarizes the NCSER-supported research on children and youth with ASD across all research topics.

Developing and Testing the Promise and Efficacy of Interventions[1]

Most of the NCSER-funded ASD research focuses on one of two IES research goals: Development and Innovation or Efficacy and Replication.[2] Researchers funded to conduct IES Development and Innovation goal projects use an iterative process to develop an intervention that includes: (1) obtaining feedback from participants, (2) measuring the feasibility of implementing the intervention in the intended setting (e.g. classroom), and (3) conducting pilot testing of the intervention to

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[1] Intervention is defined by IES to mean the wide range of education curricula, instructional approaches, professional development, technology, and practices, programs, and policies that are implemented at the student, classroom, school, district, state, or federal level to improve student education outcomes.

[2] For more information regarding the goal structure used by IES, refer to the IES website (http://ies.ed.gov/funding/pdf/2015_84324A.pdf).

examine whether it has promise for improving child outcomes. Researchers funded to conduct IES Efficacy and Replication goal projects evaluate whether a fully developed intervention improves child outcomes using rigorous research methodology.[3] The following sections describe IES research projects funded within these two goals, focused on young children, older children, and adolescents and young adults with ASD.

Early Childhood

A number of NCSER's ASD research projects are focused on intervention in early childhood, primarily the preschool years. Identifying young children in need of services, either because they have a disability or are at risk for disability, is critical because decades of research evidence in child development and neuroscience suggests that early intervention improves a wide range of outcomes for children and that this improvement may have lasting effects into adulthood (Center on the Developing Child, n.d.; National Scientific Council on the Developing Child, 2010). For example, Johnson, Myers, and the Council on Children with Disabilities (2007) reported that factors associated with better outcomes for children with ASD include early identification that results in early enrollment in services.

The Centers for Disease Control and Prevention (2014) reported that 44% of children with ASD had received a comprehensive evaluation documenting developmental concerns by age 3. Detection of such early risk symptoms provides opportunities to intervene early. In fact, improved screening can detect ASD symptoms earlier than 3 years, with diagnosis frequently occurring before the age of 2 (Shaw & Hatton, 2009), leading to opportunities for even earlier intervention for children at risk for ASD.

Given that social and communication skill impairments are core symptoms of ASD, many of the NCSER-funded researchers are developing and testing interventions that concentrate on improving these skills. Many of these studies include very young children at risk for ASD who have difficulties in communication, behavior regulation, and developing early relationships. One NCSER-funded researcher, Aubyn Stahmer at the University of California, Davis, is adapting an intervention, *Teaching Social Communication to Children with Autism (TSC),* that has demonstrated promising results for preschoolers (Ingersoll & Wainer, 2013). Stahmer's *Project ImPACT* (Improving Parents as Communication Teachers) is adapting *TSC* for use with infants and toddlers (ages 12 through 24 months) at risk for ASD and their families. The intervention teaches early care educators and parents to facilitate their child's development using a blend of behavioral and developmental techniques during daily activities in natural settings. Another researcher, Linda Watson at the University of North Carolina, Chapel Hill is evaluating the efficacy of an early intervention program called *Adaptive Response Teaching* on improving outcomes for 12-month-old infants at high risk for ASD. In this program, interventionists meet with families in their homes to train the parents to teach their child various aspects of responsiveness (e.g., reciprocity, contingency, shared control, matching child's developmental level) during daily interactions. Using a randomized controlled trial,[4]

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[3] For more information regarding rigorous methodology, refer to the What Works Clearinghouse website (http://ies.ed.gov/ncee/wwc/).

[4] A randomized controlled trial (RCT) uses random assignment to place children, classrooms, or schools into either a treatment group that receives the intervention or a control group that does not receive the intervention. Random

Watson is examining the impact of the intervention on improving social communication, regulatory functioning, and general development as well as ameliorating the severity of symptoms.

Many interventions for children already diagnosed with ASD also focus on social and communication difficulties. For example, children with ASD exhibit issues with socially appropriate initiations and responses to others. To address this particular issue, Rebecca Landa at the Hugo W. Moser Research Institute at Kennedy Krieger, has developed a preschool curriculum supplement that can be integrated into existing academic curricula throughout the day to target core social and communication deficits exhibited by these children. This intervention, *Early Achievements*, includes activities that promote high levels of child engagement and strategies that blend principles from developmental science and applied behavior analysis.[5] This intervention is currently being examined for evidence of promise.

Hannah Schertz at Indiana University, Samuel Odom at the University of North Carolina, Chapel Hill, and Kathleen Baggett at the University of Kansas are conducting a randomized controlled trial to determine the efficacy of *Joint Attention Mediated Learning (JAML)*, an intervention for toddlers with ASD. This intervention directly targets foundational, preverbal social-communication competencies through parent-child interactions. These early competencies include focusing on faces, taking turns, and engaging in joint attention. Joint attention, the coordinating of visual attention with a social partner, is an early form of social sharing around mutual interests and is an important skill because it is a precursor to verbal language acquisition (Charman, 2003; Gulsrud, Hellemann, Freeman, & Kasari, 2014). Schertz and her research team are examining the impact of *JAML* on these competencies and on general language and social development outcomes for these toddlers. In another research project focused on improving the social-communication skills of young children with ASD, Linda Watson and Brian Boyd at the University of North Carolina, Chapel Hill developed an intervention to improve social-communicative functioning in preschool children with ASD; specifically, they are examining joint attention and symbolic play. This intervention, *Advanced Social-Communication and Play (ASAP)*, is implemented by education teams (teacher, teaching assistant, related service provider) and occurs in two contexts: (1) one-to-one sessions to promote skill acquisition and (2) group sessions to allow for the practice and maintenance of these social skills. Based on promising pilot study results (Dykstra, Boyd, Watson, Crais, & Baranek, 2012; Wilson, Dykstra, Watson, Boyd, & Crais, 2012), Boyd and Watson are now evaluating the efficacy of *ASAP* on social-communication skills, play (interactions with peers), language development, and classroom engagement of preschoolers with ASD.

In a recently funded project, Ann Kaiser at Vanderbilt University is testing the efficacy of an intervention aimed at improving social communication and language outcomes for toddlers with ASD. This intervention, *J-EMT*, blends two existing evidence-based interventions – *Enhanced Milieu Teaching*, which focuses on spoken language in natural situations, and *Joint Attention, Symbolic Play and Regulation*, which focuses on teaching the social foundations of communication through the context

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assignment, if conducted properly, ensures that the two groups are similar except for the intervention or treatment under investigation (Shadish, Cook, & Campbell, 2002).

[5] Applied behavior analysis (ABA) examines the functional relationship between the child's behavior and their environment, and uses learning principles, such as reinforcement, in order to increase positive behaviors and reduce interfering behaviors.

of play. Kaiser and her research team will be using a randomized controlled trial to evaluate the efficacy of this combined intervention.

Communication problems of children with ASD extend to speech and language impairments (Landa, 2007), and several NCSER-funded grants have targeted these areas for intervention development. For example, Steven Camarata at Vanderbilt University developed an intervention intended to improve receptive and expressive language in children in preschool (ages 3-6 years) with ASD and for children with cognitive impairments. As part of the development process, those taught expressive skills were compared to those taught receptive skills. The research team reported that students with ASD improved their language skills in both groups and that the procedures for teaching either of these skills could be readily implemented by school personnel. In addition, the development work suggested specific enhancements to the teacher training that could further improve outcomes (S. Camarata, personal communication, 2014).

Language impairments observed in children with ASD can also impede the ability to interpret and send appropriate verbal as well as nonverbal messages (Landa, 2007). To help address such delays, Hedda Meadan, Maureen Angell, and Julia Stoner at Illinois State University developed an intervention, *Parent-Implemented Communication Strategies*, to improve the social-pragmatic communication skills (i.e., use of language conventions and rules such as taking turns) to enable children to better communicate with others. Researchers worked with young children (ages 2-5 years) with developmental delays and limited expressive language skills, including those with ASD, to develop this intervention and assess its promise for impacting outcomes for these children. In this intervention, parents were trained and coached to use naturalistic teaching strategies (e.g., modeling for the child to imitate) in the context of everyday family activities as well as visual strategies[6] to provide cues for child behavior. The researchers report that in the pilot study, parents were able to implement the strategies with fidelity and reported positive effects on family interactions with the child, and there was growth in children's communication skills (Angell, Meadan, & Stoner, 2013).

As mentioned earlier, children with ASD may exhibit a wide variety of characteristics. Therefore, many interventions for children with ASD target a more comprehensive array of child outcomes including cognitive functioning and adaptive behavior in addition to social, communication, and language skills. Phillip Strain at the University of Colorado, Denver conducted a randomized controlled trial of *Learning Experiences – An Alternative Program for Preschoolers and Parents (LEAP)*, a comprehensive intervention for preschool children with ASD who are in inclusive classroom settings. In *LEAP* (Strain & Cordisco, 1993; Strain, Jamieson, & Hoyson, 1986), typically-developing children learn to interact with their peers with ASD, preschool teachers use naturally-occurring classroom situations for incidental teaching, and parents receive training for working with their children in the home. Results from the efficacy study indicated *LEAP* was an effective intervention. That is, children with ASD who experienced the full-scale *LEAP* intervention model (teachers received training and mentoring from *LEAP* staff as well as the intervention materials) demonstrated higher cognition, language, and social skills and a greater reduction in symptom severity and problem behaviors compared to children who experienced a reduced model (teachers only received the *LEAP* materials without any training; Strain & Bovey, 2011). These researchers are currently conducting a follow-up study to examine whether these gains persist 3 years after the

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[6] An example of a visual strategy is the use of visual (or picture-based) schedules, which visually represent the order of the child's activities during the day.

intervention ends, whether there are positive impacts in additional areas (e.g., academic achievement), and whether contemporaneous classroom quality is related to student outcomes.

Bonnie McBride at the University of Oklahoma Health Sciences Center and Irene Schwartz at the University of Washington are conducting efficacy trials for a community-based behavioral intervention. The intervention, *Developmentally Appropriate Treatment for Autism,* was developed for two age groups: *Project DATA* for preschool children (ages 3-5 years) and *Project DATA-Toddler* for toddlers (ages 18-30 months). The model incorporates natural settings, teaching children to interact with peers, intensive instruction, family support, coordination across services, and life skills for integration across school and community (preschoolers) or support for transition (toddlers). The researchers are conducting separate randomized controlled trials of each age-group intervention to examine whether children receiving intervention show greater gains in cognitive functioning, language, social skills, and adaptive behavior than children in the control group and to examine the impact on parental stress.

Samuel Odom at University of North Carolina, Chapel Hill and his research team compared two comprehensive treatment models for preschool children with ASD: (1) *LEAP,* and (2) *Treatment and Education of Autistic and Communication-Handicapped Children (TEACCH).* These interventions were compared to each other as well as to a set of high-quality comparison classrooms. As described earlier, *LEAP* relies on naturally occurring classroom situations, incidental teaching, and interactions with typically developing peers. In *TEACCH* (Mesibov, Shea, & Schopler, 2004) the approach to teaching is more structured through minimizing classroom distractions, increasing direct instruction, and establishing structured and predictable classroom routines. In the quasi-experimental study design, teachers in treatment classrooms had implemented the intervention for at least 2 years prior to the study. The researchers found that children in all conditions made significant improvement across the year and, with one exception (the *TEACCH* group had larger reductions in ASD symptom severity than children in the control group), there were no significant differences in outcomes between any of the groups on various measures of cognition, language, social skills, and behavior. Because all the classrooms were of high quality, the research team surmised that the improved performance in children across all three groups was due to common aspects of high-quality classrooms rather than to the unique features of each intervention (Boyd, Hume, McBee, Alessandri, Gutierrez, Johnson, Sperry, & Odom, 2014).

Helen Young and Ruth Falco at Portland State University are evaluating a comprehensive program for young children with ASD designed to improve a range of child outcomes. The intervention consists of multiple components including highly trained staff, parent education, school and home environments that support the learning of students with ASD, evidence-based teaching strategies, peer interaction strategies, and curricula designed specifically to use with students with ASD including *The Star Program: Strategies for Teaching based on Autism Research* (Arick, Loos, Falco, & Krug, 2004) and the *Autism Partnership Program: Parents & Educators Partnering to Improve Outcomes for Children and Youth with Autism* (Young, Rowan, Pardew, Sanford, & Falco, 2009). The researchers are using a randomized controlled trial to evaluate the efficacy of the program after one school year of participation on children's language, pre-academic skills, social skills, adaptive behavior, and cognitive skills.

A new project was recently funded to examine a comprehensive intervention for young children with and at risk for autism. Sally Rogers and Aubyn Stahmer at the University of California, Davis are modifying an existing evidence-based intervention (*Early Start Denver Model*) for use with infants and toddlers at risk for ASD and their families in low-income, ethnically diverse communities. This new intervention, *Community Adapted Early Start Denver Model*, is aimed at improving developmental outcomes and school readiness for at-risk children by ensuring the intervention is adaptable for use by community providers in Part C programs of the Individuals with Disabilities Education Act.

Early Childhood through Elementary School

A number of NCSER-funded research projects have focused on the age range covering the transition to kindergarten or from early education through elementary school for children with ASD. Most of these interventions target a comprehensive set of child outcomes. For example, Debra Kamps at the University of Kansas has modified and examined the *Peer Networks Intervention*, which has two components: (1) academic (*Reading Mastery* instruction in small groups) and (2) social communication skills (structured interactions with typically developing peers). The intervention is implemented over 2 years, with children from kindergarten to first grade. Kamps and her research team are examining a range of child outcomes in cognition, literacy, language, and social skills for participating and non-participating children. Findings indicate that children in the *Peer Networks Intervention* group had more total words expressed and number of different words spoken than children in a comparison group, with the largest difference observed between the groups after 2 years of intervention (Schmidt, Schmidt, Theimann-Bourque, Kamps, & Mason, 2014). Further, the researchers found a positive relationship between the peer network intervention provided by school staff at recess and student increases in communication (Mason et al., 2014; McFadden, Kamps, & Heitzman-Powell, 2014), as well as an association between implementation during free play in the classroom following instruction and improved student communication (Kamps, Mason et al., 2014). Additional reinforcements provided to students with difficulties generalizing the social skills they had learned through participating in the peer networks intervention resulted in increased ability to generalize their skills (Rosenberg, Schwartz, & Congdon, in press). Children in the peer networks intervention group, following implementation in kindergarten and first grade, showed more growth in their initiations to peers during social probes and generalization settings than did the business-as-usual comparison group. Children in the treatment group also showed more growth in language and adaptive communication, and teachers' ratings of prosocial skills revealed significantly greater improvements for the intervention group (Kamps, Thiemann-Bourque et al., 2014). Finally, children who were beginning readers at the start of kindergarten and who received literacy peer networks improved more in word recognition and nonsense word fluency than the comparison group (Kamps, Schwartz, Heitzman-Powell, Rosenberg, & Mason, 2015).

In another study in this age range, Aubyn Stahmer, while working at the University of California, San Diego, developed *Classroom Pivotal Response Teaching (CPRT)* for use with young children (ages 3-8 years). *CPRT* is an adaptation of the evidenced-based practice of PRT,[7] generally used one-on-one with individual children in the classroom. Pilot testing indicated that treatment group teachers increased their use of the intervention components and the engagement of the children increased

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[7] In Pivotal response training (PRT), a common behavioral technique among autism interventions, the child is provided with multiple cues and immediate reinforcement contingent upon the child's response to teach various skills and behaviors.

after the intervention. In addition, there was greater improvement in communication skills for children in the intervention group than for those in the comparison group, though the difference was not statistically significant (Stahmer, 2012). Stahmer, currently at the University of California, Davis, is now conducting a randomized controlled trial of CPRT to examine its impact on communication, object play, academic skills, social skills, behavior, and progress towards IEP goals for children in preschool through fifth grade.

Other NCSER-funded researchers focus on children with ASD who are already in elementary school. Amy Wetherby and Lindee Morgan at Florida State University are evaluating the efficacy of the SCERTS *(Social Communication (SC), Emotional Regulation (ER), and Transactional Supports (TS))* curriculum, a comprehensive treatment model that targets individualized intervention goals for children with ASD using behavioral and developmental approaches for improvement of social communication and emotional regulation. In addition, the model includes environmental and teaching supports (e.g., visual cues, adjustment of language use) for teachers and peers who interact with the child to support the child's learning. The researchers are using a randomized controlled trial to evaluate the developmental outcomes (i.e., cognitive ability, social skills, behavior, language and literacy) for children in kindergarten through second grade. Martin Volker, formerly at the State University of New York, Buffalo and Christopher Lopata at Canisius College developed an intervention adapted from a summer treatment program for use in school settings to address a variety of outcomes for students with high-functioning autism in first through fifth grade. The intervention components include social skills groups, therapeutic activities, computer instruction in facial and vocal emotion recognition, daily skills and reinforcement practice to reduce problem behaviors and symptoms, and parent training (i.e., understanding high-functioning autism, the intervention, and strategies for promoting social competence at home). Pilot tests demonstrated promising effects on student outcomes, including increased emotion recognition and social skills (Lopata, Thomeer, Volker, Lee, Smith, Rodgers, et al., 2013; Lopata, Thomeer, Volker, Lee, Smith, Smith, et al., 2012). Lopata and Marcus Thomeer at Canisius College were awarded another grant to evaluate the efficacy of this comprehensive school-based intervention on children's cognitive, communicative, social, and behavioral outcomes using a randomized controlled trial. Through a new NCSER training program, Early Career Development and Mentoring, Jennifer Ledford at Vanderbilt University is modifying and testing an intervention currently used with preschool children with ASD for use with children in kindergarten through second grade. The intervention includes small-group direct instruction with systematic response prompting[8] and typically developing peer models to teach children with ASD social and academic skills.

David Mandell at the University of Pennsylvania and his research team recently completed an efficacy study to evaluate the *Strategies for Teaching based on Autism Research (STAR) Program*, an intervention for children with ASD (ages 5–8) that matches behavioral techniques (e.g., *PRT*) to curriculum content (receptive and expressive language, pre-academic skills, play, functional routines). Classrooms were randomly assigned in pairs to participate in the *STAR* program or another program referred to as *Structured Teaching*, a less scripted program focused on teaching students with ASD based on the *TEACCH* program. The treatment and control programs were very similar except that the *STAR* program contains more components in a specified curriculum and uses one-to-one teaching strategies. Results indicated that both groups were equally effective in increasing

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[8] Systematic response prompting involves procedures for providing children with prompts and reinforcement in order to help them learn appropriate behavioral responses.

outcome scores in cognitive ability over an academic year, despite the fact that neither group attained high levels of fidelity. This may have been due to the overlapping components of the two interventions. An interaction was observed between group and fidelity score favoring the *STAR* group in both low and high fidelity conditions. In an exploratory analysis, researchers noted that the low fidelity *STAR* group was comprised of more experienced teachers that reportedly were not interested in changing their teaching practices, so the researchers suggest that these teachers may have already had *STAR* strategies in their teaching repertoire. Finally, children scoring lower on cognitive abilities at baseline gained more and there were more pronounced increases observed for younger children across groups, suggesting a possible developmental window of opportunity (Mandell, Stahmer, Shin, Xie, Reisnger, & Marcus, 2013).

Two recently funded studies focus on comprehensive professional development interventions for elementary school students with ASD. Tristram Smith at the University of Rochester is developing a comprehensive intervention for elementary school students with co-occurring ASD and intellectual disability. The *Students with Autism Accessing General Education (SAAGE)* intervention will use a coaching model to foster collaborative school teams to increase the quality of educational services and access to inclusive classrooms, ultimately improving social and academic outcomes in students with ASD and intellectual disability. Sam Odom at the University of North Carolina, Chapel Hill and his colleagues are testing the efficacy of the *National Professional Development Center on Autism Spectrum Disorders* model to improve outcomes for elementary school students (kindergarten through Grade 5) with ASD. The model uses a school-level team to assess program quality and use this information to inform program improvement, develop measurable student goals, link goals to evidence-based practices, and use these practices to support students in achieving their goals. The research team will evaluate this intervention using a randomized controlled trial.

Another newly funded project focuses specifically on improving the literacy skills of children with ASD as well as intellectual disabilities. Pamela Hunt at San Francisco State University is examining the efficacy of *Early Literacy Skills Builder*, an early literacy curriculum, through a randomized controlled trial with elementary school children (kindergarten through Grade 4) with ASD or severe intellectual disabilities. This curriculum, implemented in small groups within general education classrooms, focuses on using sounds, symbols, and stories to build a variety of literacy skills.

One development project focuses on a wide age range, bridging elementary and secondary school students. The researcher conducting this study, Earl Knowlton at the University of Kansas, is developing a remote-delivery technology, *Social Tele-Coaching*, for social skills coaching to augment an existing social skills program, *Skillsstreaming*. This program will use wireless and video conferencing from remote observation sites to reach students with Individualized Education Programs (IEPs), including those with ASD, that contain social/behavioral skills in at least one target goal.

Adolescence through Young Adulthood

With the increasing prevalence of children diagnosed with ASD over the past decade (Centers for Disease Control and Prevention, 2014), a growing population is in need of continued support as they reach adolescence and beyond. In addition to the difficulties these students face in navigating adolescent life, they must navigate increasingly complex social and academic systems in secondary schools. For example, problems with communication and social competence, defining features of

ASD, lead to struggles for these students in forming positive peer relationships (Carter, Common, et al., 2014; Locke, Ishijima, Kasari, London, 2010). Limitations in social-communication skills, as well as cognitive impairments, may also hinder academic learning (Fleury et al., 2014; Ricketts, Jones, Happé, & Charman, 2013). In addition, as these students transition out of high school and become young adults, it is unclear whether they will have the ability to hold a job or attend postsecondary school. Research analyzing data from the National Longitudinal Transition Study-2 (NTLS2) has indicated that 29% of young adults with ASD within their first 8 years after high school have never experienced employment, employment training, or postsecondary education; this represents the least productive community engagement of any disability category (Newman et al., 2011). The relative lack of knowledge regarding secondary and postsecondary school outcomes of adolescents with ASD has led to an increasing number of research studies to develop and test effective interventions. NCSER-funded research in this area thus far includes interventions focused on social competence and peer relationships, interventions designed to help students transition out of secondary school, and a large-scale, comprehensive intervention.

One research team has been awarded a series of NCSER grants for the purpose of developing interventions to enhance social skills in adolescents with ASD. Janine Stichter at the University of Missouri developed an intervention, the _Social Competence Intervention for Adolescents (SCI-A)_, to help middle school students with high-functioning ASD navigate their social environment. This intervention is a modification of a clinic-based intervention for school-based settings, and is designed to help students with recognition of facial expressions, sharing of ideas, conversational turn taking, recognition of emotions, and social problem solving. Preliminary evidence suggested that this intervention is associated with improvements in teacher reports of social skills and executive functioning, and direct measures of facial-expression recognition (Schmidt, Stichter, Lierheimer, McGhee, & O'Connor, 2011), and adding a peer-mediated intervention to the _SCI-A_ program further enhanced the generalization of social skills (Schmidt & Stichter, 2012). Stichter and her research team are currently evaluating the efficacy of the final version of this classroom intervention using a randomized controlled trial with middle school students to determine its impact on a variety of outcomes, including social problem solving, executive functioning, social perception, emotion regulation, and social communication. James Laffey at the University of Missouri and Stichter adapted the intervention to virtual reality technology. This intervention, _iSocial_, can be delivered via networked, 3D-based virtual learning environments for youth with no or limited access to face-to-face programs.

In another project examining peer intervention, Erik Carter at Vanderbilt University is using a randomized controlled trial to evaluate the efficacy of two peer interaction interventions – peer network and peer support – for improving social and behavioral outcomes for high school students with severe intellectual disabilities, including those with ASD. The peer support intervention involves one or more peers without disabilities providing social and/or academic support to a student with severe disabilities within an inclusive classroom. Peer networks connect a student with severe disabilities to a peer group of four to six students who meet regularly with the support of an adult facilitator. This randomized trial will assess the separate effect of the two interventions as alternatives to adult-delivered support models normally used in classrooms. Preliminary pilot data from the small-scale trial indicate there are distinct advantages to peer-mediated intervention relative to an exclusive reliance on individually assigned adult supports (Asmus et al., 2014; Carter, Asmus, et al., 2014).

NCSER-funded research projects now include those focused on the transition from high school to young adulthood. The increasing incidence of ASD is leading to more and more students aging out of the public school system; these adolescents and young adults are frequently unprepared with the life skills necessary to achieve positive outcomes such as employment or postsecondary education (Taylor & Seltzer, 2011). Toward this end, Erik Carter at Vanderbilt University developed *Project Summer*, a summer intervention designed to improve transition services for high school students with disabilities and to maximize engagement in summer employment and related activities. The intervention is aimed at students with a variety of disabilities, including significant disabilities such as ASD. Through pilot testing, Carter found that youth with severe disabilities participating in the intervention were 3.5 times more likely to participate in community-based work experiences during the summer and work more hours per week than their peers who did not participate in the intervention (Carter, Trainor, Ditchman, Swedeen, & Owens, 2009). In another project, Kevin Ayres at the University of Georgia is developing *iSKILLS*, an intervention that teaches life skills to middle and high school students with ASD and intellectual disabilities. The intervention is designed to be implemented on hand-held devices and seeks to improve skills such as independent living, employment, leisure, community involvement, and community navigation.

In addition to these research grants, NCSER is funding a large-scale Research and Development Center, the *Center on Secondary Education for Students with Autism Spectrum Disorders*. Led by Sam Odom at the University of North Carolina, Chapel Hill, the research team includes experts across multiple states and institutions. The team has developed and is currently evaluating a complex intervention for high school students with ASD that consists of the quality improvement and the implementation of evidence-based practices in four domains: academic performance in literacy; social competence and peer relations; personal responsibility, independence, and self-management; and transition and family. After 2 years of development including a series of pilot tests, the research team is conducting a randomized controlled trial to evaluate the efficacy of the full, comprehensive intervention.

Exploratory Research

In addition to the development and evaluation of interventions, NCSER funds research to explore relationships between components of the education setting that can be changed or modified (such as instructional strategies) and student outcomes. Under this Exploration goal, researchers also examine what factors (such as student or school characteristics) may moderate, or influence, the relationships. For example, exploratory research could determine for which children a certain classroom practice may work best to increase academic achievement. The ultimate aim of these exploratory studies is to accumulate knowledge that can be used in future research, particularly for the development of future interventions or assessments. The following section describes NCSER-funded exploratory research covering a wide age range, from young children to adolescents and young adults.

NCSER has funded three exploratory studies focused on students with ASD. The first study focuses on student-teacher relationships as young children transition to school. Prior research had found student-teacher relationships to be important for typically developing students' subsequent social and academic adjustment (Pianta & Stuhlman, 2004). Hypothesizing that this relationship may be especially important for children with ASD to protect them against later school adjustment problems, Jan Blacher at the University of California, Riverside is exploring the student-teacher

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relationships of young children with ASD entering preschool, kindergarten, or first grade, and following the children longitudinally through the middle of the following school year. The research goals include determining which child characteristics may contribute to "positive relationship quality" and how relationship quality relates to children's school outcomes. In addition, Blacher and her colleagues are examining parent and school factors that may influence these associations, as well as parent outcomes. Findings to date indicate that if a child exhibits problem behaviors, the psychological functioning of the parent was more likely to be negatively impacted (Blacher, Baker, & Berkovits, 2013). In addition, the researchers found that parents of children with ASD were more likely to experience higher levels of depression and more stress than parents of children with other disabilities (Zeedyk, Cohen, & Blacher, 2014).

The second study focuses on the social relationships of older children in elementary and secondary school. Peter Mundy at the University of California, Davis is examining social attention[9] in students with high-functioning autism. Attending to other people is important for social learning; at school, students must attend to others in order to receive meaningful information. Using virtual reality technology to create visual and auditory settings that emulate complex social environments, such as classrooms, Mundy is examining whether social attention is a pivotal and modifiable factor associated with the development of academic, learning, and social outcomes in students (ages 8-18) identified with ASD. Through a longitudinal comparison of children with ASD, attention deficit hyperactivity disorder (ADHD), and typical development over time, he is also investigating whether social attention impairment contributes to the inhibition of learning and social success, whether symptoms of ADHD moderate the impact of social attention on learning and development, and whether social attention can be enhanced with practice in social attention tasks.

The third study focuses on an exploration of school practices and outcomes for students with ASD ranging in age from 6 to adulthood. Mary Wagner, Xin Wei, and Jennifer Yu at SRI International are analyzing data from existing datasets – the Special Education Elementary Longitudinal Study (SEELS) and the National Longitudinal Transition Study-2 (NLTS2) – to determine what school-related interventions (e.g., tutoring, instructional accommodation) are associated with academic, social/behavioral, occupational, and independence outcomes for these children and youth. The researchers have begun by characterizing the pattern of services received by students at this range of age groups. They found that elementary school students with ASD are more likely than preschool students to receive adaptive physical education and specialized technology, but preschool students were more likely than elementary school students to receive interventions in learning strategies. Further, secondary school students are less likely than elementary school students to receive speech/language therapy, occupational therapy, and behavior management (Wei, Wagner, Christiano, Shattuck, & Yu, 2013). Results from these exploratory studies aim to inform the development of interventions.

Measurement

NCSER funds research projects to develop and test measurement instruments. Researchers funded to conduct Measurement studies are developing reliable and valid measures, which are important for

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[9] Social attention includes such processes as joint attention (described earlier), social orienting (prioritizing attention to people versus objects), and attention to faces (ability to focus on and process facial expressions).

a variety of purposes, including screening for disabilities, progress monitoring, and research. For example, improved screening assessments may help detect a risk for ASD at an earlier age or new measures may help determine an individual child's abilities and impairments in order to best target an intervention for that child. At this time, there is only one NCSER-funded Measurement project directly related to students with ASD. Nickola Nelson at Western Michigan University has been conducting research to validate the *Test of Integrated Language and Literacy Skills,* a measure used to identify whether a student has a primary language impairment or language-based learning disability and to develop profiles of students' language and literacy strengths and weaknesses. The measurement tool is for use with students (ages 6-18) with a variety of disabilities typically associated with language difficulties, including ASD. This measure is individually administered by practitioners to assess students' spoken and written language skills and includes subtests in vocabulary, phonemic awareness (i.e., ability to hear, identify, and manipulate individual sounds in spoken words), decoding (i.e., using the knowledge of letter-sound relationships to correctly read/pronounce written words), listening, reading comprehension, and writing.

Small Business Innovation Research

Through IES' Small Business Innovation Research (SBIR) program, NCSER supports contracts to small for-profit businesses that develop, iteratively refine, and market commercially viable technological products for students with or at risk for disabilities. Creative, research-based development and effective use of technology is important for assisting many children with disabilities. For children with ASD, technology is useful for a variety of purposes, such as communicating when language skills are impaired, learning and practicing social skills, or organizing and remembering tasks to complete throughout the day. Several of these SBIR projects focus on students with ASD. Through the SBIR program, Robert Tedesco at HandHold Adaptive, LLC developed *iPrompt,* which allows teachers to customize and present different visual supports for students with ASD using various mobile device platforms. The software incorporates video modules and a manual to support teacher use as well as various features to support students including picture schedules, visual countdown timers, and choice prompts to help set expectations, ease transitions between activities, increase attention to tasks, and develop social skills. Through another award, Tedesco is developing a tool for special education speech/language providers and caregivers to support students in kindergarten through Grade 12 who exhibit challenges in prosodic speech (i.e., sounds of spoken language that enhance meaning, such as fluctuations in pitch, syllable duration, and volume), including students with ASD. The product, *SpeechPrompts,* will be an application for Apple® iOS devices and will include a variety of features and therapeutic exercises to help special educators guide improvement in students' prosodic voice quality, which is hypothesized to strengthening their communication and social skills. Janey McMillan at the 3-C Institute for Social Development is developing a fully interactive, computer-based social intervention, the *Social Story Theatre,* for students in third through fifth grade with high-functioning ASD. This intervention uses animated scripts that address challenges in children's lives in order to facilitate social functioning with customizable avatars. Finally, Richard Levinson at Attention Control Systems, Inc. has developed a prototype of the *Planning Execution Assistant and Trainer,* an application for mobile devices that provides cues and support to nonverbal students with ASD in special education settings.

Final Comments

Children and youth with ASD face many challenges, as do their families, schools, and communities. The increasing number of children diagnosed with ASD has led to a large increase in research in numerous fields, such as special education, clinical and developmental psychology, and neuroscience. Whereas much of this research takes a biological or medical approach, including genetic studies, the research funded by NCSER focuses on intervention at a broader level in which educational and related settings play key roles in providing help to children with or at risk for ASD. Schools are important in that they provide the setting in which children learn to function in the world on multiple levels, including social interactions, learning and academics, and training for life skills after school. Schools also reach children and their families who may otherwise not receive needed services. Understanding, developing, and evaluating ASD interventions, as well as developing and validating relevant assessments, in education settings will propel us toward helping these children lead full lives. NCSER is well on its way toward building this knowledge base. As NCSER-funded projects are completed, they will help provide the evidence base to guide us toward the next steps in ensuring that children will be identified early and provided with supportive services they need to succeed.

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