PURDUE AUTISM RESEARCH CONFERENCE

POSTER SESSION PROGRAM

October 18, 2018
Purdue Memorial Union
Cumulative Sleep Loss and Challenging Behaviors during Treatment for Children with Autism

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Introduction: Sleep problems are common in children with autism spectrum disorder (ASD) and can exacerbate challenging daytime behaviors and ASD symptoms (1-3). In early childhood, individuals with ASD often receive intensive behavioral interventions using a center-based model, although few published studies have addressed how sleep may influence challenging behaviors in this developmental context.

Following models of sleep debt, the present study aimed to address the potential cumulative effects of sleep loss on challenging behaviors. Specifically, we explored the following research question: On sequential preceding nights in which a child has poor sleep, does he/she exhibit more challenging behaviors during center-based programming the following day?

Methods: This study included 42 children with ASD (2-10 years). All children had a medical ASD diagnosis and attended a behavioral intervention center five days per week. Sleep was assessed for five consecutive 24-hour periods (Sunday-Thursday) using an actigraph. Daytime behaviors were recorded during the child’s treatment hours by his/her behavioral clinician (Monday-Friday)-in conjunction with the sleep assessment schedule. Daytime behaviors included repetitive behaviors, aggression, negative affect, and self-injury. Partial-interval recording was implemented in five-minute intervals for the entirety of the treatment day, and clinicians indicated whether each behavior was observed within each interval.

Generalized linear mixed effects models were used to assess relations between sequential nights of sleep and each target behavior. Sequential measurements of sleep were calculated by maintaining a running average of sleep estimates over the course of the week. For example, Wednesday’s behavior would be predicted by the average of sleep for Sunday, Monday, and Tuesday.

Results: Overall, children who slept less at night engaged in more repetitive behaviors and more negative affect during the day. For every three hours of sleep missed (on average) over the previous consecutive nights, children engaged in ~one additional repetitive behavior and ~.50 negative affect expressions per hour. Additionally, for every three hours of WASO, children exhibited ~one additional negative affect expression per hour. See table 1 and figure 1.
**Discussion:** Our findings suggest that, in isolation, one night of poor sleep may not be concerning for a child’s challenging behaviors during treatment. Rather, consistent with the theories of sleep debt, unrecovered sleep loss across multiple preceding nights was associated with greater risk for challenging behaviors. Findings from the present study highlight sleep as one potential mechanism to reduce challenging behaviors—particularly when children exhibit extended patterns of maladaptive sleep (3).

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Measuring and Predicting Change in Autism

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Introduction: Autism Spectrum Disorder (ASD), a lifelong neurodevelopmental disorder, presents with impairments in communication and social interaction as well as areas of behavior, interests or activities that are restricted or repetitive. The reality that many of these individuals will need some level of support throughout their lifetime, is the emerging challenge for caregivers, support services and health professionals. The rising prevalence of ASD, recorded to be 1 in 59 in the United States, and its associated medical and mental comorbidities (e.g., gastro-intestinal symptoms and seizures), make it relevant for medical professionals to have adequate knowledge and perception of the special health needs of ASD individuals, right from the inception of their medical training [1]. This will ensure that ASD individuals receive appropriate treatments and preventative care. Measuring and predicting changes in the knowledge and attitude of providers who support this population, is therefore imperative. This abstract highlights the knowledge and attitude of the entry level medical students at a Midwestern campus.

Method: A survey was conducted amongst sixty of the entry level medical students that were participating in a service learning opportunity, conducted by the HANDS in Autism Interdisciplinary Training and Resource Center. The survey used was the Survey of Autism Awareness and Practice in Medicine (SAAP), designed by Dr. Naomi Swiezy and Dr. Tiffany Neal. The measure consists of questions concerning personal demographics, relevant training, attitudes and knowledge on autism. The survey was conducted as part of their participation.

Results: Findings related to the participants will be presented in relations to their knowledge, attitude and training preferences.

Discussion: Primary care clinicians play a fundamental role in the identification and treatment of individuals with ASD. Therefore, they must be appropriately trained in the care of such individuals. Results reveal that medical students have inadequate knowledge and perception of autism. Medical schools are seeking to increase studies on disabilities, including ASD, within the course of their study. Positive changes towards treatment, caring for special populations and integrated care for patients with ASD, can therefore be predicted and implemented. This will lead to positive prognosis in the treatment interventions provided for ASD individuals.

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Relationship between Early Communication Skills and ASD Risk in Infants with Down syndrome

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Introduction: The behavioral phenotype of Down syndrome (DS) is characterized by strengths in social responsivity and receptive language coupled with intellectual disability and weaknesses in expressive language (Fidler et al., 2009). Individuals with DS are at an elevated risk for a comorbid diagnosis of Autism Spectrum Disorder (ASD; 7-18%; Riley, 2009). Yet, there has been little research investigating early signs of the ASD in DS. Early identification of comorbid ASD in DS is imperative to achieving the best possible developmental outcomes. Thus, it is important to begin to understand and explore, which behaviors may be indicators of ASD risk in DS. The purpose of the present study was to examine the association between ASD risk and early communication in infants with DS.

Methods: Participants were 8 infants with DS between 8 and 18 months (M = 11.63 months; 6 males). As part of a larger battery, the Autism Observation Scale for Infants (Bryson et al., 2008) and the Mullen Scales of Early Learning (Mullen, 1995) were administered. Mothers completed the MacArthur-Bates Communication Development Inventory: Words and Gestures (Fenson et al., 2007).

Results: Results indicated significant positive correlations between ASD risk and Words Understood (r = .89), Phrases Understood (r = .91), Later Gestures (r = .74), and Total Gestures (r = .90). A positive trend was observed between ASD risk and Words Produced (r = .64) and Early Gestures (r = .66). The same pattern of results was observed when controlling for nonverbal cognitive abilities. While not significant, ASD risk was negatively associated with nonverbal cognition (r = -.24).

Discussion: The results of the present study are unexpected considering lower language abilities are generally related to increased ASD risk (Landa et al., 2012). One potential explanation is that at this time in development, both language skills and ASD risk are emerging and increasing in DS. Considering that language is delayed in DS, it is not surprising that between 8- and 18-months children show growth in these skills. As children age, it is likely that these areas will start to diverge and demonstrate similar trends of increased ASD symptomatology and lower language abilities, which has been found in older children with DS and comorbid ASD (Molloy et. al, 2009). Also, these findings may demonstrate early
phenotypic strengths in receptive language and gesture use. The present study has implications for identifying early markers of ASD in DS.

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Does Autism Risk Confer a Greater Risk for Sleep Problems?

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Background: Elevated rates of sleep problems have been reported in children with autism spectrum disorder (ASD), their parents, and their younger siblings. The mechanisms for familial sleep problems are unclear and problems may align with ASD risk, reflecting an element of the broader autism phenotype. Conversely, sleep implicates parents; therefore, sleep disruption in families could evolve from one child having a sleep problem.

Objectives: The objectives were to assess whether: (1) elevated autism risk is associated with elevated maternal and sibling sleep problems, (2) sleep problems align with developmental functioning/concerns, and (3) maternal sleep problems are associated with child sleep problems.

Methods: Participants included families raising children with ASD (high-risk group; n=45) and families with no history of ASD (low-risk group, n=55) who were part of a prospective, longitudinal study. When children were 30 or 36 months of age, mothers completed the Children’s Sleep Habits Questionnaire (CSHQ), the Child Behavior Checklist (CBCL), and the Pittsburgh Sleep Quality Index (PSQI). The children completed a developmental battery and were classified as having developmental concerns (DC group, n=36) or typical development (TYP group, n=36). Additionally, between 18 and 24 months of age, a subgroup of children (n=72) wore an actigraph to record their sleep for 7 days.

Results: Risk group status was not associated with sleep problems reported on the CSHQ or CBCL. Similarly, actigraphy-indexed sleep patterns were not significantly different across the risk groups. Compared to TYP group, sleep problems on the CSHQ were elevated for children in the DC group for sleep onset delay (p<.05), sleep anxiety (p<.05), and bedtime resistance (p=.05). Children in the DC group also had more general sleep problem reports on the CBCL (p<.01), slept less at night (p<.05) and had more variable nighttime sleep (p<.01). Maternal reports of their own sleep did not differ across risk groups or DC and TYP groups. However, mothers were more likely to endorse personal sleep problems
if their child had high nighttime sleep variability (measured via actigraphy), short sleep duration, sleep
distress, and general sleep problems (all p<.05).

Conclusions: Sleep problems in families raising children with autism do not align with ASD risk. Rather, sleep problems in this study were associated with developmental concerns. Having a child with a sleep problem, not a child with ASD, was associated with parents’ sleep problems. This study demonstrates the strong interconnectedness of family sleep in families with and without a history of ASD.

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School-based Interventions for Challenging Behavior of Adolescents with Developmental Disabilities

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**Introduction:** Adolescents with developmental disabilities (DD) may be riddled with specific developmental changes that result in the increase of prevalence of challenging behaviors (CB). Challenging behaviors are associated with poor outcomes in educational settings for students with developmental disabilities (Levy & Perry, 2011). There is limited research on school-based behavioral interventions that will reliably reduce challenging behaviors and produce positive outcomes for adolescents with DD.

Recent advancements in federal legislation (i.e., ESSA, 2015) mandated that educators use evidence-based practices to promote positive educational outcomes among students with disabilities. Although there are multiple studies regarding effective interventions to reduce and manage challenging behaviors, teachers and paraprofessionals may find that access to this research is not readily available. These advances in federal guidelines have prompted special education researchers to evaluate the evidence of existing research. Therefore, the purposes of this review are (a) to evaluate the quality of research on behavioral interventions for adolescents with DD using the Council for Exceptional Children (CEC) standards, (b) to summarize studies that met the CEC quality indicators related to study design and internal validity, and (c) to provide future directions and recommendations for practitioners and researchers regarding challenging behavior interventions implemented within school settings for adolescents with developmental disabilities.

**Methods and Results:** Multiple databases were electronically searched and systematically screened using a set of inclusion criteria. Screening results yielded 48 articles to be included in this review. Three graduate students independently evaluated the studies according to the CEC quality indicators and determined that only two articles met all indicators. Due to the limited number of studies that met all eight quality indicators, all studies that met the indicators related to internal validity and methodological rigor were coded for specific descriptive information. Eleven articles were summarized in terms of participant characteristics, intervention agent, school setting, challenging behavior, behavior function, intervention components, social validity, maintenance, and generalization.

**Discussion:** Results of this review showed that there is a paucity of research on school-based behavioral interventions for adolescents with DD that meet the rigorous CEC standards of quality. There is not
enough research to support that any of the interventions can be considered as an evidenced-based practice for adolescents with developmental disabilities.

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Development of the Social Motivation Interview: A Measure for Individuals with ASD

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Introduction: Social motivation in individuals with Autism Spectrum Disorder (ASD) is currently derived from the measurement of overt behaviors and neurological correlates, from which motivational processes are inferred (1,2). This approach has treated social motivation as a static intrinsic deficit pervasive across all individuals with ASD. This study describes the development of a measurement tool that is nuanced to assess both internal and external features of motivation in individuals with ASD. The Social Motivation Interview (SMI) is a novel interview measure which is developmentally-informed and appropriate for use in a wide age-range.

Methods: A two-phase methodological approach was adopted to develop the SMI. Phase 1 consisted of developing theoretically-informed items and refining an interview item pool based on expert consultation. Item-level content validity (I-CVI, 3) was derived from expert feedback. Phase 2 of the study sought to conduct pilot testing and establish psychometric properties of the measure.

Results: Content of the SMI was theoretically derived from self-determination theory (4) and the social motivation hypothesis of ASD (1). Social motivation was conceptualized as an interest or desire to engage in social situations. The SMI encompassed social cognition, interest/desire, awareness, and behavior. Thirty-three items comprised the initial item pool, which was sent to a panel of 5 experts in the field. The expert panel reviewed each item for content validity, including content relevance and importance. Any item I-CVI < 0.667 was subject to deletion or revision.

Pilot psychometric data was gathered a sample of youth with ASD (8-17 years; M = 12.84, SD = 2.61, 4 female) and their parents. Participants were communicative (MIQ = 100.12, SD = 18.0) and had a confirmed diagnosis of ASD. The SMI was jointly administered to child and caregiver dyads. Twenty-three items were retained for the final version of the SMI and scoring was obtained on each item by a trained clinician.

The items showed good unified reliability (α = 0.955). The Standard Error of Measurement (SEM) was 2.98. Item analysis revealed that there was minimal spread with respect to item difficulty, which hovered around 0 and did not exceed 1.5. Item discrimination exceeded 0.49 for each item indicating that items appropriately discriminated among test-takers who scored low and high. Participant acceptability ratings were high (M = 4.50, out of 5).
**Discussion**: Preliminary psychometric testing and participant acceptability indicates proof of concept of the SMI. We encourage future research to evaluate the structural validity and clinical utility of this measure.

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Preliminary Feasibility of PANDA, a Telehealth Assessment Battery of Prodromal Autism Risk

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Introduction: Characterizing early features of autism spectrum disorder (ASD) research studies in children with "high risk" neurogenetic syndromes such as fragile-X syndrome (FXS) and Angelman syndrome (AS) may inform heterogeneous pathways to ASD that can facilitate earlier and more targeted treatments. However, very few studies have characterized early ASD-related features in neurogenetic groups due to the high cost and travel burden associated with accessing children with low-incidence disorders. We have addressed this need through Parent-Administered Neurodevelopmental Assessment (PANDA), a remotely-administered, parent driven platform and assessment battery for assessing ASD risk via telehealth. The goal of the present study was to assess preliminary feasibility of PANDA in mother-child dyads who completed the battery via simulated remote assessment.

Methods: Per standard PANDA protocol, infants and their mothers were alone in the laboratory and the examiner relayed instructions, prompts, and task materials via phone and remote access of the participants’ computer. Infants and their mothers completed several tasks including placement of heart rate monitors, watching videos, neutral name calling, a temperament assessment, and reading a story, among others. Two independent raters behaviorally coded each task for the mothers’ independence, i.e. degree of examiner assistance, and implementation quality, i.e. compliance with instructions and prompts.

Results: Data collection and coding are ongoing (N=8 of 20). However, preliminary results suggest that 88% of tasks and prompts were administered by mothers with implementation quality that resulted in the targeted infant behavior. Further, 96% of tasks were completed with minimal additional support of the examiner. Tasks with high quality of implementation (5 or more mothers administered without error) included watching videos, name calling, temperament, and reading. As more data is coded, we hypothesize that age patterns may arise as preliminary data suggests lower implementation of tasks for younger infants with fussiness and crying causing most failures of implementation.

Discussion: Data suggests both high independence and implementation quality in completing most tasks. This indicates the tasks are appropriate for parent administration, but additional supports may be needed to help families with administration for tasks that tended to have lower quality implementations, such as heart rate monitors. Results support the continuation of remote assessments with adaptations for at-home administration based on both qualitative and quantitative data. The
impact of this work may provide lower-cost, remote access of early ASD risk detection for geographically dispersed or otherwise underserved populations.

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Characterizing Autism Spectrum Disorder Symptomatology in Children with Down Syndrome without Comorbid Autism

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Introduction: Down syndrome (DS) is the leading known genetic cause of intellectual disability. The DS phenotype includes expressive language weaknesses, relative to overall nonverbal cognitive delay, and strengths in social approach and motivation. Social cognition and pragmatic language abilities are understudied and less clear. Prevalence rates of comorbid autism spectrum disorder (ASD) in DS vary (DiGuiseppi et al., 2010; Kent et al., 1999), due in part to limited clinical tools for diagnosing ASD based on symptoms that may overlap with the DS phenotype. More research is needed to clarify the broader DS social communicative phenotype in order to accurately identify ASD in this population. The purpose of this study is to describe ASD symptomatology in a sample of children with DS without comorbid ASD.

Method: Thirty-six participants with DS, ages 6-11, completed an in-person assessment battery of language and cognition. Parents completed the Social Communication Questionnaire (SCQ) and Social Responsiveness Scale, 2nd edition (SRS-2). We used the SCQ to screen for ASD risk by excluding participants who scored at or above the clinical cutoff of 15 (recommended for disorders such as DS; Rutter et al., 2003). Thus, our final sample included 32 children with DS (Nonverbal IQ Mean = 58.63, SD = 9.91; 66% Female).

Results: With an average SRS-2 total T score of 60.13 (SD = 7.17; Range = 44-72), our participants showed elevated ASD symptoms relative to age-based norms (Mean = 50; t(31) = 7.98, p < .001). Importantly, 31% of our sample scored within the mild symptom range and 24% in the moderate symptom range, despite ruling out comorbid ASD risk. Closer examination of SRS-2 T scores across subdomains revealed elevated symptoms for Social Awareness, Social Cognition, Social Communication, and Restricted Interests/Repetitive Behaviors. Social Motivation scores, however, fell within normal limits. Interestingly, SRS-2 total T scores did not significantly correlate with nonverbal IQ (r = -.07, p = .69) or expressive language (r = .10, p = .60) and thus do not simply reflect deficits in those domains.

Discussion: This study demonstrates that some ASD-like symptoms captured by the SRS-2 may be present in individuals with DS without comorbid ASD. Instead, these characteristics may overlap with
the broader social communicative phenotype of DS. Our findings replicate and extend similar work conducted on older youth with DS (10-21 years) using the original SRS (Channell et al., 2015). Further clinical implications will be discussed.

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**Atypical Response to Caregiver Touch in Infants at High-Risk for Autism Spectrum Disorder**

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**Introduction:** Deficits in overt orienting of attention to auditory and visual input have been identified as among the earliest features that distinguish infants who develop autism spectrum disorder (ASD), and may play a critical role in the emergence of ASD symptoms. Touch is also a key channel through which we receive social information in our everyday lives; however, atypical response to tactile input is present in a majority of individuals with ASD, and is associated with greater socio-communicative impairments. The current study examined overt attentional orienting to caregiver-initiated touch in 12-month-old infants at high-risk for ASD (HRA) that did (HRA+) and did not (HRA-) meet later diagnostic criteria for ASD and low-risk comparison (LRC-) infants, and whether responsiveness to touch was related to ASD symptomology and language skills.

**Methods:** Trained coders, blind to group membership, evaluated the type and location of caregiver-initiated touches to infants during 10-minute play interactions (e.g., tap on the leg with or without a toy) along with infants looking behaviors before, during and after each touch. Infants’ looking behaviors were coded as “touch-related” (e.g., infant shifts attention to caregiver, touch-related toy, or touch location), “non-touch-related” (e.g. infant shifts attention to non-touch-related object or location) and “no-shift” (e.g., no attentional shift).

**Results:** Findings suggested that HRA+ infants had a significantly greater percentage of no-shift responses to caregiver touches compared to LRC- infants and marginally greater no-shift responses compared to HRA- infants indicating that infants in the HRA+ group were less responsive to caregiver touch compared to HRA- and LRC- infants. Additionally, HRA+ infants had a significantly lower percentage of touch-related shifts compared to LRC- infants and marginally lower touch-related shifts compared to HRA- infants. Lastly, our regression analyses indicated that touch responsivity at 12 months predicted ADOS severity scores, but not verbal DQ scores, at outcome in the HRA group.

**Discussion:** Findings suggest that infants that go on to receive a diagnosis of ASD more frequently fail to shift attention in response to caregiver touch, and when they do shift, are more likely to orient away from touch. These findings support both prior reports of impaired disengagement and social motivation in these infants indicating that infants later diagnosed with ASD may show atypical attention and social orienting patterns in response to tactile stimulation. Additionally, failure to respond to touch predicts ADOS severity scores at outcome suggesting that touch may be an early indicator of ASD severity.

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Dyadic interactions in children exhibiting the broader autism phenotype: Is the BAP distinguishable from typical development?

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Introduction: In families raising a child with an autism spectrum disorder (ASD), infant siblings are at elevated risk for ASD and other developmental concerns, including elements of the Broader Autism Phenotype (BAP). Typically, the BAP is indexed using standardized developmental assessments; however, these measures do not capture a number of social difficulties commonly associated with the BAP. The present study aims to expand our developmental understanding of the BAP by comparing children exhibiting the BAP to their typically developing peers on (1) standardized measures of development, and (2) social behaviors exhibited during dyadic play interactions.

Methods: As part of a prospective study, dyads were recruited from families with at least one older child with ASD (high-risk, n = 36), and families with no history of ASD (low-risk, n = 38). During laboratory visits at 12, 15, 18, and 24 months of age, infants completed a series of standardized assessments and a mother-child play interaction. Dyadic play interactions were micro-analytically coded for gaze, positive affect, and vocalizations to create theory-driven composites to index dyadic synchrony and responsiveness. Videos were also coded with an existing rating scheme for joint engagement and child responsiveness. Between 24 and 36 months, children completed an outcome visit and, following previously established criteria, children were assigned to BAP (n = 22) and TYP (n = 52) groups.

Results: Multilevel models, using restricted maximum likelihood to account for sample size and missing data patterns, revealed significant group differences on select constructs within the first two years. Language and cognitive differences emerged by 24 months of age, whereas dyadic differences were evident as early as 15 months. Specifically, children within the BAP outcome group exhibited more social difficulty with their mothers in terms of responsiveness and ratings of joint engagement, when compared to their typically developing peers.
**Discussion:** Overall, this study provides preliminary support for exploring the importance of dyadic exchanges in the BAP, which may inform later developmental outcomes and early intervention efforts. By examining group differences across four time points, the current study demonstrates that distinct patterns exist between BAP and TYP groups. In addition, including two distinct behavioral coding techniques to examine social difficulties helped address social/dyadic complexity that may be present in the BAP. Recognizing the increasing demand for elevated-risk interventions, these findings highlight several social constructs through which early interventions may identify risk and promote optimal development.

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The Use of Technology to Teach Reading Skills to Individuals with Autism Spectrum Disorder: A Review of Quality

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Introduction: Students with autism spectrum disorder (ASD) often exhibit challenges in reading and require additional supports to achieve grade-level academic standards. Recent legislations (e.g., ESSA, 2015) mandated that educators use evidence-based practices to support all students in making meaningful progress. However, educators often have difficulties in selecting and providing effective reading instructions for students with ASD.

The purpose of this literature review is to determine the quality of research on technology-based reading interventions for students with ASD and to summarize the studies with high-quality evidence. Experimental studies that used technology to teach reading skills to students with ASD will be systematically aggregated, and the articles will be evaluated according to quality rubrics of What Works Clearinghouse (WWC). Narrative characteristics of studies with high-quality evidence will be analyzed to provide practical information about how technology can be incorporated into reading interventions (e.g., type, role, availability of technology).

Method: Search Procedures: Experimental studies that used technology devices (e.g., computer, iPad, smartboard, smartphone, speech-generating device) to teach reading skills (e.g., vocabulary, comprehension) to students with ASD were systematically aggregated. Based on electronic search, title and abstract review, full-text review, and ancestral search procedures, a total of 23 empirical studies were identified for the review. The inclusion criteria used for this review were: (a) the study was published in an English peer-reviewed journal, (b) the study included empirical interventions, (c) at least one of participants was diagnosed with ASD, (d) at least one of dependent variables was a reading outcome (e.g., comprehension, vocabulary, fluency), (e) the study incorporated at least one type of technology (e.g., computer, iPad, smartboard).

Quality Review: The identified articles will be coded according to the WWC Procedures and Standards Handbook Version 4.0 (Institute of Education Sciences, 2017). The handbook provides standards for evaluating the methodological rigor of educational research.
**Narrative Review:** After identifying articles that meet the WWC standards with and without reservations, the narrative characteristics of studies with high-quality evidence will be summarized based on the following coding variables: (a) type of technology (i.e., hardware, software), (b) role of technology (e.g., delivering reading intervention, presenting reading materials), (c) interventionist (e.g., teacher, researcher, paraprofessional), (d) setting (e.g., general education classroom, computer lab), and (e) target outcome (e.g., vocabulary, comprehension).

**Results and Discussion:** Findings of the quality evaluation and narrative review will be summarized, and implications for researchers and educators will be discussed.

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Impaired experience dependent oscillations in V1 of Fragile X mice

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Fragile X syndrome (FXS) is the most common inherited form of autism, characterized by intellectual disability, hyperactivity/hyperarousal, and a high incidence of epilepsy. A handful of neurophysiological impairments have been identified in neurons of the mouse model of FXS (Fmr1 KO) thus far, including enhanced hippocampal long-term depression (LTD), an increased excitatory to inhibitory (E/I) ratio, and impaired functional connectivity. However, little is known about how experience dependent changes in neural activity are disrupted in FXS at the scale of individual circuits or neural ensembles. Our previous work has shown that perceptual training to visual stimuli over several days promotes the emergence of low-frequency oscillations in the primary visual cortex (V1), potentially reflecting the familiarity of the animal with the visual stimulus. We have discovered that these experience dependent oscillations are lower in power in local field potentials (LFPs), and shorter in duration among individual units in Fmr1 KO mice. Using directed information analysis, we found that perceptual training causes a net increase in information flow from cortical layer 5 to layer 4 fast spiking cells, a result which is attenuated in Fmr1 KO mice. Whole cell patch clamp recordings using channelrhodopsin-2 assisted circuit mapping (CRACM) verified these results, demonstrating significantly weaker synaptic strength of this connection in Fmr1 KO mice. Finally, visually evoked oscillations in Fmr1 KO mice were lower in frequency than WT controls, potentially reflecting differences in the intrinsic properties of the neurons driving these oscillations.

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Reducing Challenging Behavior in Children with ASD through Visual Schedule and Choice

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Introduction: In educational settings students are commonly required to engage in instructional activities that follow a structured sequence. While most children are able to progress from one activity to the next and comply with scheduled activities, children with autism spectrum disorder (ASD) often have difficulties in transitioning from one activity to the next, maintaining on-task behavior during an activity, and completing activities (Bryan & Gast, 2000; Spriggs, Gast, & Ayres, 2007). When children with ASD engage in challenging behaviors during routine activities, they may be physically and socially isolated from the rest of the class and may miss critical learning opportunities. This necessitates the development of interventions for individuals with ASD to reduce challenging behavior and increase independent engagement during activities.

Some researchers have demonstrated that offering visual activity schedules to children with ASD provides predictability and additional time for them to anticipate and process changes in the environment, which optimizes opportunity for activity engagement (Banda et al., 2009). Providing choice-making opportunities to children with disabilities has also been demonstrated by various research groups to have a positive effect on the reduction of challenging behavior (Carter, 2001; Rispoli et al., 2013; Smeltzer, Graff, Ahearn, & Libby, 2009). Examples of choice include which materials to use for an activity, where to complete an activity, or how to complete an activity.

The purpose of this single-case design study is to pilot an intervention package that incorporates the two strategies: (a) visual activity schedule and (b) choice.

Method: This study utilizes an alternating treatment design embedded within a reversal design. Through comparing different experimental conditions within each child, we demonstrate the impact of using visual schedule and choice within typical activities and routines on reducing challenging behavior of children with ASD. In baseline, each participant is presented with task demands without the presence of visual schedule or choice. In each intervention phase, each participant is exposed to two randomly alternating treatment conditions: (a) visual schedule and (b) visual schedule plus within-activity choice. The dependent variable is the percentage of intervals with challenging behavior during each 5-min session throughout baseline and treatment conditions.

Results: Preliminary findings of one participant shows that challenging behavior decreased in both treatment conditions compared to baseline. However, the visual schedule plus choice intervention
package appeared to be more effective in reducing challenging behavior than the visual schedule only intervention.

**Discussion:** While findings are preliminary, this study has demonstrated that visual schedule can potentially reduce challenging behavior in children with ASD during instructional activities and adding choice-making opportunities within each activity may further reduce rates of challenging behavior. Replication of intervention effects across more participants with ASD will be necessary to increase the generalizability of results.

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Atypical Visual Attention Patterns to Social and Non-Social Stimuli in the Broad Autism Phenotype

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Introduction: Differences in visual attention to social stimuli have been repeatedly observed in eye-tracking studies of individuals with autism spectrum disorder (ASD), especially in the context of competing information, such as objects associated with circumscribed interests (Sasson et al. 2008). Evidence of subtle differences in visual attention to social stimuli (e.g., faces) has also been reported in parents of individuals with ASD, particularly among those parents who display features of the broad autism phenotype (BAP; subclinical traits related to ASD including pragmatic language and personality features) (Adolphs et al. 2008). This study applied eye tracking during a passive viewing paradigm, adapted from Sasson and colleagues (2008), to examine patterns of visual attention to social vs. circumscribed/high interest stimuli, and their relationships with BAP features.

Methods: Thirty-eight parents of individuals with ASD, and 23 controls viewed 12 separate visual arrays on a Tobii T60 eye tracker for 10 seconds each. Each visual array included 12 luminance-matched gray-scale images drawn from both public domain and Sasson et al. (2008) of three image types: social (e.g., smiling people), neutral objects (e.g., table, gloves), and objects associated with circumscribed/high interest in ASD (e.g., trains, electronic devices). Image types were presented in randomized order to control for potential order effects. Analyses evaluated the proportion of total fixations (>100ms) and proportion of total fixation duration per image type. BAP status (positive (+; n=15) or negative (−; n=23)) was determined using the Modified Personality Assessment Scale (MPAS; Tyrer 1988). Associations were examined between visual attention and pragmatic language using the Pragmatic Rating Scale (PRS; Landa et al. 1992).

Results: Visual attention differed across parent groups, and in relationship to BAP features. Parents of children with ASD exhibiting more than one feature of the BAP (e.g., aloof and rigid BAP personality traits) looked less at social stimuli and more at competing high interest objects compared to BAP- parents (p < .01) and parent controls (p < .01). In the ASD parent group overall, reduced attention to social images was related to more pragmatic language violations (r = -.47, p < .01).

Discussion: Parents of individuals with ASD, and in particular those with BAP features, show reduced attention to social images in the context of competing high interest objects. Decreased visual attention to social images was also associated with greater pragmatic language violations. Together, this suggests that visual attention may be uniquely affected by the presence of BAP features.

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Parent and Therapist Perceptions of Brief Versus Extended Behavior Assessments for Children with Autism

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Research on current behavior analytic practices indicates that functional analyses are not commonly utilized outside of research and clinic contexts (Oliver, Pratt, & Normand, 2015; Roscoe et al., 2015). Rather, most behavior analysts deem descriptive assessments as sufficient for guiding treatment choice. Our research team, consisting of the University of Iowa, Marcus Autism Center, and the University of Houston-Clear Lake, is currently conducting an NIH-funded randomized controlled trial of functional analysis (FA) procedures to investigate whether FA procedures provide more effective or more efficient outcomes over current practice. Young children with autism are randomized to either a brief assessment model, which includes a one-hour antecedent analysis or a standard functional analysis, followed by treatment tailored to the assessment outcomes. As part of this study, we are interested in the social validity of FAs according to the parents of children being assessed and the therapists providing the assessments. This poster will provide data on the perception and acceptability of FA versus brief assessment methods for parents and therapists from our study. Additionally, we will discuss the implications for behavior analytic practice.

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Predicting Externalizing Behavior Problems in Children with Neurogenetic Syndromes

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Despite the common occurrence of externalizing behavior problems in children with neurogenetic syndromes (NGS), there is a paucity of research to describe the phenotypic characteristics of externalizing behaviors in these populations. However, previous literature surrounding typically developing (TD) children suggests that characteristics of temperament can predict the development of externalizing behavior problems. The aim of this study was to explore whether aggressive and attention problems can be predicted by characteristics of temperament in specialized populations, including children with Angelman syndrome (AS), Prader-Willi syndrome (PWS), and Williams syndrome (WS). We used spearman partial correlations to predict parent-report aggressive and attention problems, measured by the Child Behavior Checklist for Ages 1 ½-5, from characteristics of temperament (i.e. regulatory capacity, surgency, and negative affect), measured by the Early Childhood Behavior Questionnaire, in 109 toddlers and preschoolers. Next, we compared between groups of TD children (N=37) and children with NGS (N=72), as well as across NGS groups, to explore possible differential effects of temperament on externalizing behaviors. Results from correlational analyses suggested that negative affect and regulatory capacity were salient in predicting aggression, but not attention, in TD and AS groups specifically. Correlations suggested surgency also significantly predicted aggression in the AS group. Results from group interaction effects suggested significant group differences between TD and NGS groups in models predicting aggression from negative affect and regulatory capacity. Externalizing behaviors are a prevalent and troublesome issue for many families of children with NGS. The ability to predict externalizing behavior problems in these low-incidence populations will pave steps towards new methods of early identification, early intervention, and preventative treatments which promote improved outcomes for children with NGS and their families.

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**Introduction:** The broad autism phenotype (BAP) refers to a constellation of subclinical personality and language features in unaffected relatives of individuals with autism spectrum disorder (ASD). Features of the BAP may represent endophenotypes that can help to disaggregate the complex etiology of ASD. Whereas gold standard diagnostic tools exist for evaluating ASD, methods for characterizing the BAP are less consistent, and include direct assessment measures that have the benefit of objective, independent ratings based on concrete behavioral examples, as well as questionnaires that rely on self- or informant-reports and are therefore more efficient but susceptible to rater bias. Indeed discrepancies between self- and informant-reports have been observed (Sasson et al. 2014), pointing to a strong need to evaluate different measures of the BAP to determine the most accurate methods for characterizing this important construct. This study compared rates of the BAP using direct assessment measures and questionnaire data in mothers and fathers of individuals with ASD.

**Methods:** Parents of individuals with ASD (n=121 mothers, n=99 fathers) were assessed for personality and language features of the BAP using three different methods: 1) the Modified Personality Assessment Scale Revised (MPAS-R, Tyrer and Alexander 1988), a direct assessment interview, 2) the Broad Autism Phenotype Questionnaire (BAPQ, Hurley et al. 2007), and 3) the Pragmatic Rating Scale (PRS, Landa et al. 1992), which was used to assess pragmatic language during semi-naturalistic conversations. BAP status was established based on established cut-offs (Hurley et al. 2007).

**Results:** Questionnaires (BAP-Q) under-identified the BAP compared to direct assessment (MPAS-R) in both mothers and fathers, driven by under-reporting of Aloof features in particular (ps<.01). Self-reporting of Aloof was particularly reduced in fathers (compared to mothers) (p<.05). Self versus Informant differences on the BAP-Q were noted for the Rigid trait in both mothers (p<.05) and fathers (p<.10). No significant differences emerged between ratings of pragmatic language violations between direct assessment (PRS) and questionnaire measures (Pragmatic domain within the BAP-Q).
Discussion: Findings suggest that questionnaires may markedly under-classify the BAP, relative to objective, direct assessment measures of personality and pragmatic language. Sex differences were observed across measures-on direct assessment (MPAS-R), fathers were classified BAP more frequently than mothers. In contrast, questionnaires were more likely to classify mothers than fathers. Overall, results suggest that questionnaires are under-identifying the BAP in comparison to direct assessment. Such measure- and sex-related differences should be considered in studies of the BAP.

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Assessing Developmental Precursors of Psychiatric Symptoms in Neurogenetic syndromes using the Child Behavior Checklist: A Validation and Characterization study

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Introduction: Neurogenetic syndromes (NGS) are associated with elevated rates of anxiety, attention-deficit/hyperactivity, and autism spectrum disorders. However, little is known about the early emergence of these features in NGS given the relative dearth of psychiatric assessment measures and related research in young children with NGS. The present study addressed this need by examining developmental precursors of psychiatric symptoms using DSM-oriented scales of anxiety problems (AnxP), attention-deficit/hyperactivity problems (ADHP), and autism spectrum problems (ASP) from the Child Behavior Checklist for Ages 1½-5 (CBCL). Specifically, we aimed to investigate psychometric properties of these DSM-oriented scales and characterize early psychopathology profiles across multiple NGS.

Methods: 161 mothers completed the CBCL; 117 reported that their child had been diagnosed with Angelman syndrome (AS; n = 28), fragile X syndrome (FXS; n = 34), Prader-Willi syndrome (PWS; n = 22), or Williams syndrome (WS; n = 33), while the remaining 44 were low-risk controls (LRC) with no known developmental concerns. To examine initial psychometric properties, we calculated each DSM-oriented scale’s internal consistency and determined whether items within each scale loaded onto a single latent factor. To characterize early psychopathology profiles, we then contrasted DSM-oriented raw scores of each NGS against LRC using Wilcoxon rank-sum tests, where we expected atypically elevated scores for NGS.

Results: Internal consistency was acceptable across DSM-oriented scales (α > .71). However, unidimensionality varied considerably; model fit for ASP was adequate (RMSEA = .065, TLI = .915) and poorer for ADHP and AnxP (RMSEA > .146, TLI < .886). ASP was consistently elevated across NGS (zs > 3.43, ps < .001). Similarly, ADHP was elevated across NGS (zs > 4.30, ps < .001), except for PWS (z = 0.17, p = .869). AnxP was atypically elevated in FXS (z = 2.00, p = .045) and depressed in PWS (z = -2.85, p = .004). Final analyses will extend these preliminary results by using item-level analyses to enhance model fit and characterize clinical severity.

Discussion: The suboptimal validity of the DSM-oriented scales calls for cautious interpretations when applied to young children with NGS. Nevertheless, differential early psychopathology profiles were
observed, with substantial atypicalities most evident in FXS followed by AS and WS, suggesting distinctive trajectories of developmental psychopathology across NGS. Refining scoring procedures of current child psychiatric assessments and developing measures that are more valid and sensitive for NGS will advance theoretical understanding of broader gene-behavior relationships and inform syndrome-specific clinical interventions.

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Adults Diagnosed with High Functioning-Autism Disorder: A Concept Analysis of Individual Norm

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Introduction: Individuals considered to be high functioning-autism spectrum disorder (HF-ASD) may have advanced cognitive reasoning; however, there is an inability to understand other individuals’ behavioral motivations and difficulty internalizing social norms for personal growth (Scheeren, de Rosnay, Koot, & Begeer, 2013). Consideration of this inability leads to the understanding that current concepts in determining health behavior may not applicable to the HF-ASD population. The aim of this analysis is to define the concept of individual norm in the context of adults diagnosed with HF-ASD.

Methods: The approach outlined by Walker and Avant (2011) was utilized for this concept analysis. Interdisciplinary sources were analyzed for conceptual meaning and recurring themes. Databases utilized included: PubMed, PsycINFO, CINHAL, and JSTOR. The search engine of Google was utilized to locate dictionary definitions and various health organizations.

Results: The following definition of “individual norm” was revealed: an individual’s perception, adaptation, and response to information and potential consequences of personal health behavior. Such perceptions, adaptations, and responses are based on self-evaluation and the immediate environment with limited regard to peer and family influence.

Discussion: The new concept, “individual norm,” accounts for the unique dynamics presented by adults with HF-ASF, and which may impact health behaviors and actions. Healthcare providers and family members who are equipped with this definition may be able to more effectively communicate and, thus, support positive patient healthcare decisions.

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Acoustic Features of Infant Vocalizations Related to Symptoms of Autism Spectrum Disorder in Fragile X Syndrome

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Introduction: Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by atypical social communication and restricted and repetitive behaviors. Identifying early markers for ASD is a crucial step towards routing high-risk children to early intervention services and improving overall outcomes for this population. Recent literature suggests that features of infant vocalizations, such as volubility (rate of vocalizing), duration, and pitch, have shown promise in distinguishing infants who later develop ASD from those who are typically developing (TD). The present study examines this relationship in infants with fragile X syndrome (FXS), a population characterized by developmental delays and high rates of ASD. Previous literature has shown that atypical social communication (SC) often best predicts later ASD in infants with FXS, whereas restricted and repetitive behaviors (RRBs) are typically elevated across the FXS population regardless of ASD outcome. Thus, we hypothesize that atypical vocalization features at 9 months will be associated with higher ASD symptoms at 24 months in FXS, particularly for SC symptoms.

Method: This study presents secondary analyses of data from a previously published longitudinal study (R01MH0901194). Participants included 22 nine-month-old infants with FXS. We analyzed three features of vocalizations during a standardized examiner-child interaction: volubility (number of speech vocalizations per minute), average duration, and average pitch. We calculated nonverbal mental age (NVMA) by averaging the Visual Reception and Fine Motor age equivalents from the Mullen Scales of Early Learning, and we measured ASD outcomes at 24 months using the SC and RRB calibrated severity scores from the Autism Diagnostic Observation Schedule, Toddler Module.

Results: We correlated each 9-month vocalization feature with 24-month SC and RRB severity scores using Spearman’s partial correlations, controlling for 9-month NVMA. Volubility and duration demonstrated small effects with ASD symptom severity for both SC (volubility: $\rho =-.08$, $p=.732$; duration: $\rho =.08$, $p=.722$) and RRB (volubility: $\rho =-.15$, $p=.513$; duration: $\rho =-.16$, $p=.502$). Pitch demonstrated a medium-sized effect with SC symptom severity ($\rho =.40$, $p=.121$), but no effect with RRB symptom severity ($\rho =.002$, $p=.993$).

Discussion: Whereas volubility and duration demonstrated fairly weak relationships with both types of ASD symptoms, pitch demonstrated a medium effect with later ASD that was unique to SC symptoms. This may reflect emerging atypicalities in prosody that are present across the lifespan for many individuals with ASD. This study presents preliminary evidence that vocalization features, particularly pitch, may prove useful as early markers for the SC symptoms most relevant to later ASD diagnosis in FXS.

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A Quality Review of Interventions for Vocal Stereotypy of Individuals with Autism Spectrum Disorder

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Individuals with autism spectrum disorder (ASD) often engage in repetitive and stereotyped vocalizations that persist in the absence of social consequences, also known as vocal stereotypy. Persistent vocal stereotypy, due to its physical characteristics, greatly interferes with other people and decreases the chance of inclusion of the individuals with this behavior. Previous reviews (Lanovaz, et al. 2012; DiGennaro Reed, et al. 2012) have synthesized the literature on vocal stereotypy interventions, however, there has been no attempt to evaluate the quality of research. The purpose of this review is to summarize and evaluate the quality of vocal stereotypy intervention for individuals with ASD by using What Works Clearinghouse (WWC) Procedures and Standards (2016).

Studies were identified through systematic searches of three electronic databases: PsycINFO, Academic Search Premier, and ERIC. The inclusion criteria were: (a) was written in English, (b) included at least one participant in each study with a diagnosis of ASD, Asperger’s syndrome, or pervasive developmental disorder not otherwise specified (PDD-NOS), (c) disaggregated data of participants with ASD from participants without ASD, (d) included an intervention study with single-case experimental designs (AB design was excluded), (e) included a behavioral intervention as the independent variable, (f) included vocal stereotypy as a dependent variable, (g) disaggregated vocal stereotypy data from data of other behaviors, and (h) presented vocal stereotypy data in graphs appropriate for visual analysis. 61 articles met the inclusion criteria and were identified for the quality evaluation procedures. Each study was further analyzed and evaluated by experiment on What Works Clearinghouse (WWC) design standards (Kratochwill et al. 2010/2014, 2013). For the purpose of our review, these standards were categorized into the following coding variables: (a) systematic manipulation of independent variable, (b) collection of inter-assessor agreement (IAA), (c) score of inter-assessor agreement, (d) number of attempts to demonstrate effects over time, (e) number of data points per phase, and (f) additional criteria. 20 articles that included at least one experiment which met the standards with or without reservations were selected to summarize the descriptive information. The descriptive information was extracted according to the following features: (a) study design, (b) participant characteristics, (c) intervention setting, (d) interventionist, (e) intervention components, (f) intervention procedures, (g) study result. IOA was conducted on every stage of the searching and coding procedures.
This review identified 20 vocal stereotypy intervention studies which either met WWC design standards or met standards with reservations. The narrative characteristics of each of the 20 studies have been summarized. In the process of quality standards screening and narrative characteristics coding, some strengths as well as areas for improvement have been noticed and included in the discussion. In addition, limitations of this review and implications for future research had also been discussed.

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Aberrant Circuit Plasticity underlying Impaired Visual Familiarity in Fragile X syndrome

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Introduction: Fragile X Syndrome (FX) is the leading genetic cause of learning disability and has a high co-morbidity with Autism Spectrum Disorder (ASD). It has been reported that FX patients have visual perceptual abnormalities, but no study has been conducted to specifically test visual learning in FX. It was previously believed that the primary visual cortex (V1) only detects basic features of visual stimuli and relays this information to the higher cortical areas. However, our lab has recently demonstrated that V1 may distinguish familiar and novel visual stimuli and encode the familiarity with theta frequency oscillation. Our preliminary data suggest that the local connectivity changes may underlie this oscillation. Since learning deficit is a prominent symptom in FX patients, we hypothesize that familiarity-induced theta oscillations and their underlying circuit plasticity are impaired in FX patients compared to the neurotypical individuals.

Methods: To test this hypothesis, we have established a visual training paradigm followed by ex vivo Channelrhodopsin Assisted Circuit Mapping (CRACM), which combines whole-cell patch-clamp recordings and optogenetic stimulation to measure synaptic strength. We have crossed the Fmr1 KO (an FX mouse model) with Thy1-ChR2 mice, an optogenetics strain specifically expressing Channelrhodopsin 2 in layer 5 (L5) cortical pyramidal neurons. We then exposed FX mice and wild-type (WT) littermate controls with the Thy1-ChR2 background to 200 trials of sinusoidal gratings visual stimuli for 4 days and measured the circuit connectivity strength specifically from L5 to layer 4 (L4) and L5 recurrent connections.

Results: We have discovered a prominent increase of circuit connectivity from L5 to L4 fast-spiking neurons in WT, but not in FX mice. On the contrary, the connection from L5 to L5 regular spiking neurons was severely weakened in FX but remained stable in WT.

Discussion: This CRACM circuit connectivity result represents the evidence of the circuit mechanism underlying learning. The result confirmed that local circuit connectivity changes after visual learning in WT mice. The specific circuit changes observed here also agree with our simplified artificial circuit model of the oscillations. As predicted, the synaptic circuit connectivity was altered in FX mice, explaining the weakened familiarity-induced theta oscillation and visual learning.

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Feasibility of High Resolution Magnetic Resonance Spectroscopic Imaging in Children with Autism Spectrum Disorder

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Introduction: Despite the enormous genetic and phenotypic heterogeneity of Autism Spectrum Disorders (ASD), many studies suggest that an imbalance between excitation and inhibition during development might be a unifying underlying mechanism (1), which will possibly be reflected in relative concentrations of GABA and Glutamate in certain brain regions (2). The enzymes that synthesize GABA are reported to reduce by about 50% in autistic parietal and cerebellar cortices. Magnetic resonance spectroscopy (MRS) studies also reported lower GABA levels in several cortical regions of autistic subjects (2). However, those single voxel MRS studies can only measure metabolite concentrations in very few brain regions. And the voxel size is typically larger than 8cm. With the help of MRS imaging (MRSI), metabolite distributions over a much larger region of interest could be mapped with a sub-centimeter resolution. Although normal proton MRSI has been used in ASD research, MEGA-editing GABA-MRSI has not been applied. In this pilot study, two different GABA-MRSI sequences are applied to measure GABA and associated metabolites in thalamus, basal ganglia and adjacent cortex, and cerebellum.

Method: All scans were acquired using a Siemens Prisma 3-Tesla (Siemens, Erlangen, Germany) whole-body MRI scanner and a 64-channel phase array receive coil. The thalamus, basal ganglia and adjacent cortex GABA distributions are measured by a 3D spiral MEGA-LASER MRSI with real time shimming updates, motion correction and reacquisition with a voxel size of 20×20×14mm and a matrix size of 10×10×10 before interpolation (3). The cerebellum GABA and associated metabolites distributions are measured by a 2D concentric ring MEGA-sLASER metabolite-cycling MRSI without water suppression for real-time eddy current correction4 with a voxel size of 7.5×7.5×15mm and a matrix size of 32×32. Both sequences have a scan time of about 13 minutes with 2 averages. LCModel was used for metabolite quantification. Metabolite concentrations of brain subdivisions are calculated based on overlay of Freesurfer parcellation masks and metabolite concentration maps.
Results and Discussion: The overlay of MRSI grids and anatomy (left) and fitted spectrum and metabolites quantifications (right) of one voxel are displayed in Figure 1. Voxels with relative standard deviation (RSD) higher than 50% will be clipped. Most voxels have RSD lower than 30%. The concentration maps of a slice bypassing corpus callosum and third ventricle (left) and a slice in cerebellum (right) are shown in Figure 2. A larger cohort of ASD and control children will be recruited and studied after both sequences have been tested for reproducibility and reliability.

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Using Head-Mounted Eye Tracking to Examine Object Exploration during Naturalistic Parent-Child Interaction

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Introduction: Play and exploration behaviors are fundamental to the development of a child (1), and are thought to be abnormal in children with ASD (2-4). Here, we used eye tracking and video coding to assess underlying visual and manual object exploration during play in children with ASD in a naturalistic setting with their parent. We predicted that children with ASD, as compared to typically developing (TD) control children, would attend to fewer toys, fixate on those toys longer, and exhibit less coordination between visual and manual exploration.

Methods: Children with ASD (n=14) and TD children (n=15) between the ages of 24-48m participated in the study. Head-mounted eye trackers and video recording were employed to study the child’s allocation of visual and manual exploration behaviors during 3 minutes of free play with their parents, using a set of 24 toys in a naturalistic space resembling a toy room. After gaze calibration, data were manually coded to identify gaze targets and objects being held for each video frame.

Results: Overall, both groups of children displayed remarkably similar exploration tendencies. For visual exploration, both children with ASD and TD children viewed a similar number of toys [ASD: 19.6 (±3.0); TD: 21.0 (±2.1); t(27)=1.5, p=0.15] and exhibited similar median look durations [ASD: 0.8s (±0.2); TD: 0.8s (±0.3); t(27)=0.1, p=0.90]. For manual exploration, both groups of children held a similar number of toys [ASD: 10.5 (±3.3); TD: 10.0 (±3.9); t(27)=0.4, p=0.71] and exhibited similar median hold durations [ASD: 3.2s (±1.0); TD: 3.6s (±1.5); t(27)=0.9, p=0.40]. Both groups exhibited a similar proportion of holding time looking to the toy in their hand [ASD: 0.4 (±0.1); TD: 0.3 (±0.1); t(27)=0.4, p=0.73], suggesting comparable multimodal exploration behaviors.
Discussion: In contrast to our hypotheses, children with ASD exhibited rather typical levels of visual and manual exploration during free play with parents, suggesting that exploration behaviors might not be the source of abnormal play. Future studies should elucidate the factors underlying previously reported play abnormalities (i.e. number of toys, presence or absence of a social partner, familiarity of social partner). One possibility is that parent behaviors during an unconstrained free play interaction may scaffold typical levels of object exploration in children with ASD - a hypothesis that can be tested in future analyses. Future studies will also examine how individual differences in exploratory behaviors relate to later social and communicative abilities in typical and atypical development.

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