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14. ABSTRACT

The modern household can be a chaotic place, full of noise from radios, televisions, family members. The ability to separate speech from background noise is a critical skill for understanding spoken language in such environments. Recent studies suggest that adults with Autism Spectrum Disorders have particular difficulty recognizing speech in acoustically-hostile environments (e.g., Alcantara et al. 2004), but an underlying cause for this deficit remains unknown. This proposal tests our hypotheses that children with ASD will find it more difficult to separate the speech of different talkers than do their typically-developing peers. We also predict that they will fail to exploit visual cues on a talker's face to help in this task, further limiting their ability to process input and learn language on a typical schedule. We are still analyzing the data we have collected, but preliminary analyses suggest that while children with ASD and typically-developing children appear better able to recognize speech in quiet than in noise, the children with ASD are not specifically impaired in the noisy condition. Rather, the children with ASD performed more poorly than language-matched TD children in both quiet and noisy conditions, suggesting a more global difficulty in speech recognition.

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Autism, Listening in Noise

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INTRODUCTION

Much of the language input that children receive occurs in the presence of background noise, including noise from other talkers (Barker & Newman, 2004; van de Weijer, 1998). Studies suggest that adults with Autism Spectrum Disorders (ASD) may have particular difficulty recognizing speech in these types of acoustically-hostile environments (e.g., Alcántara, Weisblatt, Moore, & Bolton, 2004), but an underlying cause for this deficit remains unknown. If children with ASD are likewise less adept at separating speech from distractors than are their peers, they may be unable to learn language from many settings in which children are typically placed. In addition, one of the cues that typically-developing listeners use to help separate streams of speech is coordinated visual information from a talker's face, but children with autism have been reported to show abnormal visual processing for facial information (e.g. Klin et al., 1999; Wolf et al., 2008) and atypical visual scan patterns of faces (e.g., Klin, Jones, Schultz, Volkmar, & Cohen, 2002), and adults with autism have been shown to have difficulty using facial information to assist them in interpreting speech in difficult listening environments (Smith & Bennetto, 2007). The current proposal compares children with autism spectrum disorders (ASD) to typically-developing chronologically age-matched (CA) and language-age matched (LA) peers on the ability to understand speech that occurs in the presence of background noise (a distractor voice). We also examine their ability to exploit visual cues to assist in listening in noise, by testing the groups' speech recognition both when a face is visible and when it is not. We hypothesize that children with ASD will find both these tasks more difficult than will typically-developing children. Knowing whether toddlers with ASD have difficulties processing speech in the presence of acoustic distraction has the potential to greatly inform our understanding of the causes of language delay/disorder in this population, and will have vital implications for child-care and interventional practices (e.g., noise levels in home- and center-based treatment settings, &/or employing methods of enhancing the signal).

KEYWORDS: Autism, noise, facial cues, distraction, children

ACCOMPLISHMENTS

WHAT WERE THE MAJOR GOALS OF THE PROJECT?

The approved Statement of Work listed 6 tasks; below we describe each task in our statement of work, and their completion stage.

Task 1, human subjects approval, months 1-4
The beginning portion of the grant proposal was geared towards developing the necessary consent forms and recruitment documents for this proposal, and obtaining regulatory approval. This task was completed during this first year of the proposal.

Task 2, stimulus development, months 2-4
Our next task was to create the video and audio stimuli necessary for this experiment. This was originally completed in the first few months of the proposal, although pilot testing suggested that some of our stimuli needed alterations to maintain the attention of younger participants and those with ASD. Those stimulus changes were likewise completed during the first year of the proposal.

Task 3, ADOS training & reliability, months 1-5
As part of this study, we need to ensure that the children in our experimental group do indeed have a diagnosis on the autism spectrum. Although our department includes several clinical faculty with significant experience working with this population, none had previously had research training in conducting ADOS assessments. Thus our third task involved sending (at least) one grant staff member to receive training in these assessments, and conduct reliability measures so that we would be able to perform ADOS assessments for our participants. This was completed, and all participants with autism received ADOS assessments.

Task 4, recruitment, months 5-20
& Task 5, testing participants, months 6-24

These three tasks are ones that we had expected to have begun in the first year of the grant process, and to have completed by the end of the second year. Although we did begin recruiting children with Autism in year 1, the process of recruitment has gone more slowly than expected, such that we are not yet completely finished. This led to our request for a no-cost extension.

However, we have now completed recruitment (task 4) and testing (task 5) of children with autism. We are considering replacing a few control participants in the next few months, but have tested nearly complete sets of participants for both the language-matched and age-matched groups.

Our original plan had been to test 20 children with autism, 20 typically-developing children matched for chronological age, and 20 typically-developing children matched for language age; the latter would require testing additional children, since we could not know the language age of any given child (and thus whether they could serve as a match) until we had tested them.

We tested a total of 21 children with autism, although 3 of them did not meet criteria for ASD on the ADOS, despite having had an earlier diagnosis; as a result, we have complete usable data from 18 children with autism.

We also tested an additional 60 control participants. The majority of children with autism have both appropriate language matches and age matches. However, three of the children with autism had difficulty completing the language skills assessment as a result of behavioral difficulties; this led

them to have particularly low language scores that seemed unrepresentative. We are looking to match them on the basis of an alternative measure, but this matching has not yet been completed.

Task 6, coding and analysis

Subtask 1: Coding of primary experiment (to be completed by end of grant period)

Subtask 2: Transcription and coding of parent-child interactions (to continue beyond end of grant period)

The last few participants with autism have been tested only in the past 2 months; these participants have not been fully coded. All others have coded for the primary experiment, and most have been coded for a second coder for reliability.

In addition, we have also coded a wide array of additional data collected on participants: the ***Ages and Stages Questionnaire*** (Bricker et al., 1995) which assesses young children's fine and gross motor skills, communication, social skills, and problem solving; the ***Communication and Symbolic Behavior Scales Developmental Profile*** *(CSBS DP; Wetherby, Allen, Cleary, Kublin, & Goldstein, 2002; Wetherby, Goldstein, Cleary, Allen, & Kublin, 2003; Wetherby & Prizant, 1993; Wetherby, Watt, Morgan, & Shumway, 2007)* which evaluates communication ability; the ***Child Behavior Checklist***, preschool version (CBCL/1.5-5; Achenbach & Rescorla, 2000) which assesses behavioral and emotional problems; ***CHARGE Family Characteristics Questionnaire*** and Modified ***CHARGE Family Medical History Questionnaire***, which focus on other types of developmental delays or difficulties that might be present in the family as well as family medical history; the ***Broad Autism Phenotype Questionnaire*** (Hurley, Losh, Parlier, Reznick, & Piven, 2007) to provide additional data to characterize the family (particularly the parent who participates in the parent-child interaction, although in most cases we have data from both parents); the ***MacArthur-Bates Communicative Development Inventory*** (CDI; Fenson et al., 1994) which assesses expressive vocabulary acquisition; and the ***Childhood Autism Rating Scale*** (CARS) (Schopler, Reichler, & Rochen Renner, 1988) and ***Social Communication Questionnaire*** (SCQ) (Rutter, Bailey, & Lord, 2003) to further assess autism-related symptoms, such as restricted and repetitive behaviors (Lord, 1995). All of these have been collected and scored, and data is currently being collated.

Finally, all children participated in a parent-child interaction using a standard set of toys. These joint (parent-child) play sessions were videorecorded for later coding; we had anticipated that transcription of these sessions would continue beyond the grant period.

Task 7, final analysis

The final task was to analyze data and conduct all necessary reporting functions. This includes completing manuscript preparation, submitting data to the NDAR database for data sharing purposes, and submitting interaction transcriptions to CHILDES. These tasks are still ongoing, and were initially expected to go beyond the granting period.

WHAT WAS ACCOMPLISHED UNDER THESE GOALS?

As noted above, some of our key accomplishments have been:

- Finalization of, and approval of, plan for testing
- Creation and pilot testing of all stimuli/research design
- Training of relevant staff on the project
- Ensuring adequate procedures for testing and coding.
- Testing of over 80 participants, including 21 initially identified with autism spectrum disorders.

In addition, we have achieved the following key accomplishments as well:

- We confirmed that both children with and without autism had difficulty perceiving speech in noise.
- We reported data on a subset of our participants at the International Meeting for Autism Research (2015), in which we also reported that both neurotypical participants and those with autism showed stronger looking when they had the opportunity to see the face of the person speaking.
- So far, it appears that children with autism performed more poorly than even their language-matched peers (in addition to age-matched peers); however, they do not appear to be demonstrating differences in their susceptibility to interference from a distractor voice, nor in their ability to use facial cues.
- We anticipate having a more complete set of analyses completed within 4 months.

OPPORTUNITIES FOR TRAINING AND PROFESSIONAL DEVELOPMENT

Although our project was not designed to provide training or professional development opportunities per se, the primary doctoral student working on the project had the opportunity to gain enhanced experience working with and testing young children with autism, and both her and one other doctoral student received additional experience conducting ADOS assessments in this age group. A number of master's and undergraduate students pursuing degrees in speech-language pathology have gained experience with testing and scoring an array of clinical and parent-based assessments with both neurotypical children and those with ASD. In total, at least a dozen students have gained research experience while working on this project.

DISSEMINATION OF RESULTS

Initial results were reported at the International Meeting for Autism Research (2015); we are currently working on finalizing data analyses which we anticipate reporting in several ways:

- As peer-reviewed journal publications
- At the American Association for the Advancement of Science meeting in February, 2016 as part of a talk on children's ability to understand speech in noise
- At additional national conferences
- As part of the University of Maryland Autism Research Consortium Lecture Series in Support of Parents of Children with Autism

We also note that this grant funding was a substantial factor in the development of the University of Maryland Autism Research Consortium (UMARC), which has held nearly a dozen lectures geared specifically towards parents of children with autism. UMARC is also in the process of developing a number of other programs for families of children with autism in the community, as well as for students with autism on the UMD campus. Thus, although this was not an intended consequence of the grant *per se*, the grant has led to a number of activities geared towards enhancing public understanding of autism and supporting individuals with ASD and their family members.

FUTURE PLANS TO ACCOMPLISH GOALS

Although this grant has reached its conclusion, the project has not. We are continuing to analyze the wealth of data we collected, and will be reporting on these results over the course of the next year.

IMPACT

Impact from this project includes both the impact on the principal discipline and impact on society.

Because this project is not yet complete, its impact on the field to date is somewhat limited. However, knowing whether toddlers with ASD have difficulties processing speech in the presence of acoustic distraction has the potential to greatly inform our understanding of the causes of language delay/disorder in this population. Moreover, understanding both these children's ability to use facial cues will have important theoretical implications for understanding how children with autism process the perceptual information in their environment. Finally, identifying any source of difficulty in adverse listening environments enables potential input signal modifications; as such, these findings could also have vital implications for child-care and interventional practices (e.g., noise levels or signal enhancement methods in home- and center-based treatment settings).

The impact on society has primarily been indirect; this multi-investigator grant led to a new focus on autism on the UMD campus, and thus to the development of the University of Maryland Autism Research Consortium (UMARC). UMARC itself then branched into activities designed to support individuals with ASD and their family members and to enhance public understanding of autism. These activities have included:

- Participation at a number of community events, including Maryland Day and Autism Speaks walks
- The development of a monthly lecture series geared towards parents; to date, nearly a dozen lectures have occurred, with attendance at individual sessions being upwards of 30 people
- Development of a social interaction group for students at UMD with autism
- Discussions with community members regarding the development of additional community and sports programming

While these activities were not intended as part of this grant proposal, they are nonetheless a consequence of it; thus, this project has had a substantial impact on the community more broadly.

CHANGES/PROBLEMS

As noted in earlier reports, recruitment of this population was more challenging than expected, necessitating a no-cost extension. However, there have been no changes to our research plans and no deviations in our approved protocols.

PRODUCTS

Initial data was presented at the following conference:

Anderson, L. C., Newman, R. S. & Redcay, E. How multitalker environments affect speech understanding in autism. Poster presented at the 2015 International Meeting for Autism Research.

Results will also be presented at the upcoming meeting of the AAAS, and on http://autism.umd.edu/index.html.

PARTICIPANTS AND COLLABORATORS

Name	Project role	Person months (total)	Contribution	Additional funding information
Rochelle Newman	Principal Investigator	2	Dr. Newman has been involved in general oversight and data analysis.	Dr. Newman is fully funded by the University of Maryland.
Tess Wood	Project coordinator	6	Dr. Wood was responsible for initial set-up of the project, including stimulus creation and initial testing.	Dr. Wood was funded on this project in year 1 only.
Laura Anderson	Graduate student and project coordinator	6	Ms. Anderson was responsible for recruiting and testing participants, analyzing data, and conducting ADOS assessments.	Additional funding from the University of Maryland.
Elizabeth Redcay	Faculty collaborator	1	Dr. Redcay has been responsible for assisting with research design.	Dr. Redcay has not been funded by this grant, and is funded by the University of Maryland.
Nan Ratner	Faculty collaborator	0.5	Dr. Ratner has been responsible for assisting with research design.	Dr. Ratner has not been funded by this grant, and is funded by the University of Maryland.
Caroline Kettl & Catie Penny	Graduate student research assistants	0.5	They have been assisting with coding and collating data.	Ms. Kettl is funded by the University of Maryland.
Lesley Sand	Graduate student research assistants	0.5	Ms. Sand has been conducting ADOS assessments of participants.	Additional funding from the University of Maryland.

The PI on this proposal was never funded by it and funding for her was never part of the initial grant budget; during the course of the proposal, she has received support on two other grants:

NSF BCS1152109 "New tools for new questions: A multi-site approach to studying the development of selective attention in crib bilinguals"
NIH 1R01HD081127-01A1 “Toddlers’ listening and learning in noise: distraction vs. signal degradation”

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