Final Report

Language and Autism in Boys with Fragile X Syndrome (11/1/06-4/30/09)

A. Abstract

This study compared the conversational discourse skills of boys with fragile X syndrome with and without autism spectrum disorder (FXS-ASD, *n* = 30; FXS-O, *n* = 35), boys with ASD without FXS (ASD-O, *n* = 19), and boys with typical development (TD, *n* = 24). Language during an examiner-child interaction was coded for the boys' ability to maintain a topic of conversation, the frequency of perseveration, and question-asking skills. The results revealed that boys with FXS (FXS-O and FXS-ASD) used significantly more perseveration than did boys with TD. Further, boys with ASD (FXS-ASD and ASD-O) produced significantly more noncontingent discourse than did boys with FXS-O and boys with TD. However, both boys with FXS-O and FXS-ASD produced significantly less perseveration and noncontingent discourse than did boys with ASD-O. These findings suggest that some of the conversational discourse difficulties attributed to FXS (noncontingent language) may be due to autism in FXS, whereas other difficulties (perseveration) may be present in FXS regardless of autism status. Further, findings suggest that boys with FXS, whether or not they also have autism, may be less impaired in some aspects of pragmatic language than boys with ASD-O.

B. Specific Aims

Pragmatic language impairments compromise central aspects of social understanding and affect social functioning in significant ways -- impacting affected individuals' relationships with peers and adults at home, in school, and in the community at large. Many of the pragmatic difficulties attributed to FXS are also observed in autism. Due to the high comorbidity of FXS and autism (15% to 50%), it is possible that some pragmatic difficulties may be more related to autism and less to FXS. This study compared the conversational discourse skills of boys with FXS with and without ASD and boys with ASD without FXS in order to identify pragmatic language profiles that differentially cosegregate with FXS and autism or are overlapping. Determining whether a unique pragmatic phenotype exists for boys with FXS depending on the child's autism status has direct implications for targeting educational interventions and defining what variables should be targeted in medical treatment studies as well as studies of underlying neurobiology. The *Specific Aims* of the current study were to:

1. Identify differences in pragmatic skills that are syndrome-specific to FXS among children with FXS without ASD.
2. Identify differences in pragmatic skills specific to either FXS or to ASD in boys with FXS.

We hypothesized that boys with FXS-O and boys with FXS-ASD would use more perseveration in conversation than boys with ASD-O and boys with TD after controlling for differences in nonverbal mental age and receptive and expressive language levels. We further hypothesized that boys with ASD (FXS-ASD and ASD-O) would use more noncontingent language and ask more questions for known information than boys with FXS-O and boys with TD, and that boys with FXS-ASD would use more perseveration than boys with FXS-O. These hypotheses were partially supported by the results.

C. Background and Significance

Language Characteristics of Males with Fragile X Syndrome

Communication skills vary greatly among males with FXS, with most males having moderate to severe delays and others showing considerably less delay (Abbeduto & Hagerman, 1997; Roberts et al., 2001). While some research indicates specific syntax and/or semantic delays, other findings suggest that receptive and expressive vocabulary and receptive syntax are commensurate with cognitive level (Abbeduto et al., 2003; Price et al., 2007; 2008; Roberts, Hennon, et al., 2007; Roberts, Price et al., 2007; Sudhalter et al., 1991). There is general agreement, however, that pragmatic skills are particularly impaired in males with FXS. Males with FXS have been reported to use frequent perseveration (excessive self-repetition) on words, phrases, sentences, and topics; stereotyped speech; echolalia; inappropriate turn-taking; noncontingent (tangential or off-topic) language; and inappropriate eye contact (Cohen et al., 1991; Dykens et al., 1994; Ferrier et al., 1991; Hanson et al., 1986; Kau et al., 2002; Levy et al., 2006; Roberts, Martin et al., 2007; Sudhalter et al., 1990).

Language in Individuals with Autism without Fragile X Syndrome

Although individuals with ASD-O can have receptive and expressive difficulties in vocabulary and syntax, the difficulties vary greatly depending on individual overall cognitive and developmental levels (Dunn et al., 1996; Joseph et al., 2002; Kjelgaard & Tager-Flusberg, 2001; Pry et al., 2003; Tager-Flusberg, 2004). Individuals with autism generally have difficulty initiating and maintaining topics in conversation (Hadwin et al., 1997; Hale & Tager-Flusberg, 2005; Hauck et al., 1995; Tager-Flusberg & Anderson, 1991), are less responsive or respond to a conversational partner in a noncontingent or topically unrelated manner (Adams, 2002; Jackson et al., 2003; Tager-Flusberg & Anderson, 1991), and exhibit verbal perseveration (Boucher, 1977; Koegel & Frea, 1993). Question-asking in children with autism has been described as excessive, repetitive, and inappropriate (Filipek et al., 1999; McDougle et al., 1995; Ozbayrak; 1997; Wilkinson, 1998). Children with autism more often ask questions to which they already know the answer (Hurtig, Ensrud, & Tomblin, 1982) and to direct or affect another person's behavior rather than to seek information (Tager-Flusberg, 1989; 1997). In comparisons of individuals with FXS and autism, those with FXS used more repetitive speech, perseveration, and tangential language; less echolalia; and better turn-taking skills (Belser & Sudhalter, 2001; Ferrier et al., 1991; Sudhalter & Belser, 2001; Sudhalter et al., 1990).

Language and Autism in Males with Fragile X Syndrome

Language impairment is a defining feature of autism. Therefore, the presence of ASD in children with FXS likely affects language abilities, particularly in discourse, where severe deficits are observed universally in autism. Approximately 15-25% (with recent estimates as high as 52%) of males with FXS meet diagnostic criteria for autism, while other males with FXS exhibit autistic characteristics such as gaze aversion and stereotypic/repetitive behaviors without meeting autism diagnostic criteria (Bailey et al., 1998; Dykens & Volkmar, 1997; Hagerman, 2002; 2006; Hall et al., 2008; Rogers et al., 2001). Further, 5.5% of males with autism test positive for FXS (Dykens & Volkmer, 1997; Hagerman, 2002). A few recent studies have reported that children with FXS with more autistic characteristics score lower in overall language than children with FXS who have fewer autistic characteristics (Bailey et al., 1998; 2001; Philofsky et al., 2004; Rogers et al., 2001). Further, adolescents and adults with both FXS and autism have been found to score lower than those with FXS-O in receptive language and theory of mind (Lewis et al., 2006) and boys with FXS-ASD used more noncontingent language than boys with FXS-O in another recent study (Roberts, Martin et al., 2007).

Summary of Importance of Study

Pragmatic language deficits can compromise all aspects of social interactions, impacting relationships with peers and adults at home, in school, and in the community at large. Although there are indications in the literature that conversational skills may be particularly problematic for boys with FXS, very few studies have focused on this aspect of their communication profile. Further, due to the high comorbidity of FXS and autism (15% to 50%), it is possible that some pragmatic difficulties may be more related to autism and less to FXS. Thus, it is important to identify pragmatic language profiles that differentially cosegregrate with FXS and autism or are overlapping.

D. METHOD

Study Participants

The following groups participated in the current study: a) 35 boys with FXS without autism spectrum disorder (FXS-O); b) 30 boys with FXS and autism spectrum disorder (FXS-ASD); c) 19 boys with autism spectrum disorder without FXS (ASD-O); and d) 24 boys with typical development (TD). Boys with FXS and TD were drawn from two completed NIH funded studies: *Communication of Young Males with Fragile X Syndrome* (PI: Roberts) or *Speech of Young Males with Fragile X Syndrome* (PI: Roberts). Boys with ASD-O were drawn from the currently NIH funded study *Pragmatic Skills of Young Males and Females with Fragile X Syndrome* (PI: Losh).

Groups were similar according to nonverbal mental age (MA) on the *Leiter-R* (Roid & Miller, 1997), and nonverbal MA, receptive vocabulary on the *Peabody Picture Vocabulary Test-III* (PPVT-III; Dunn, et al., 1997), and expressive vocabulary on the *Expressive Vocabulary Test* (EVT; Williams, 1997) were used as covariates in statistical analyses. We currently administer the *Autism Diagnostic Observation Schedule* (ADOS; Lord et al., 1989) and the *Autism Diagnostic Interview-Revised* (ADI-R; Lord et al., 1994) for autism classification. These instruments are considered the gold standard tools for diagnosing autism. The ADOS is a standardized observation of children's communicative and social behavior. The examiner interacts with the child in a series of structured and semi-structured activities in order to elicit communicative and social behaviors possibly indicative of ASD. The ADI-R is a standardized, semi-structured, investigator-based interview. An examiner interviews the child's caregiver by presenting questions in the areas of communication, social development and

play, repetitive and restricted behaviors, and general behavior problems. If either assessment (ADOS or ADI-R) had not been administered or scored by the time of the present analyses, we based our autism classifications on clinical records. In the present study, the FXS-ASD and ASD-O groups included boys with autistic disorder (AD) and pervasive developmental disorder- not otherwise specified (PDD-NOS). Table 1 presents participant characteristics.

Table 1
Chronological Age (CA), Developmental Age (Leiter), Receptive Vocabulary Age (PPVT), and Expressive Vocabulary Age (EVT) in Years

		CA	Leiter AE	PPVT AE	EVT AE
Group	**N**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**
FXS-O	35	9.7 (3.1)	5.0 (1.0)	6.0 (1.4)	4.6 (1.2)
FXS-ASD	30	8.6 (3.0)	4.7 (1.0)	5.0 (1.7)	4.3 (1.2)
ASD-O	19	10.0 (1.9)	6.0 (1.0)	6.2 (1.7)	6.0 (1.7)
TD	24	4.4 (1.2)	4.7 (1.0)	5.4 (1.9)	5.0 (1.6)

Note. For contingent language and perseveration coding, data from boys with FXS and TD have been previously analyzed and reported (Roberts, Martin et al., 2007).

Assessments

Conversations that occurred during administration of the ADOS were examined. The ADOS includes a variety of developmentally appropriate social and play-based activities designed to elicit language and social behaviors from children. Coding schemes for examining contingent language, perseveration, and question-asking are described below.

Contingent Language. We examined the degree to which the child's turn was contingent, or topically related to the preceding turn, according to coding criteria adapted from Roberts and colleagues (1989) and similar to that of Short-Meyerson and Abbeduto (1997). Each intelligible turn was first coded for whether the topic was maintained or changed by the speaker. Turns that maintained the topic were coded further as one of the following types of topic maintenance: a) Elaborate - adds or requests significant new information (e.g., imaginative content, expression of a feeling or opinion); b) Adequate - adds minimal or no new information (e.g., simple responses, acknowledgments, and labeling); and c) Noncontingent - attempts to maintain the topic but does not fulfill the expectation of the previous turn (e.g., answering the question "What should we do if it rains?" with "Wet!"). Topic changes were coded as either a) Appropriate - occurs after a 3-second pause or the previous topic has been completed, or includes an introducer, or b) Noncontingent - occurs abruptly without pause time. Proportions were computed by dividing each summary variable by the total number of child turns. In addition, an overall Noncontingent Language variable was computed by dividing turns coded as either noncontingent maintenance or noncontingent change by the total number of turns.

Perseveration. Perseveration was coded when a child repeated words, phrases, sentences, or topics excessively according to criteria described by Roberts, Martin, and colleagues (2007). The proportion of perseverative turns was calculated by dividing the number of turns containing perseveration by the total number of child turns.

Question-Asking. The frequency of questions was calculated by dividing the total number of child questions by the total number of child utterances. We also coded questions for their function, or apparent reason or purpose. Function categories included a) Information-Seeking, b) Requesting object/action/permission, c) Asking for known information (information the child had been given previously during the interaction or subsequently showed that he had known), d) Conversational (e.g., clarification requests such as "huh?" or attention-getters such as "Lauren?"), and e) Unclear/Uncodable. Function codes were based on coding systems by James and Seebach (1982), Holzman (1972), and Tager-Flusberg (1989).

E. Results

Descriptive Analyses

Means and standard deviations (not adjusted for nonverbal MA or receptive and expressive vocabulary levels) for the proportion of turns categorized as elaborate, adequate, or noncontingent topic maintenance; appropriate or noncontingent topic change; and perseveration are presented in Table 2. For all groups, adequate maintenance made up the largest proportion of turns. The other categories of topic maintenance occurred considerably less often across all groups.

Table 2
Descriptive Statistics for Contingent Language and Perseveration

		Topic Maintain			Topic Change		Perseveration
		Elaborate	**Adequate**	**Noncontingent**	**Appropriate**	**Noncontingent**	
Group	**N**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**
FXS-O	28	.14 (.09)	.67 (.13)	.05 (.04)	.10 (.06)	.05 (.04)	.10 (.08)
FXS-ASD	26	.09 (.05)	.64 (.12)	.10 (.07)	.06 (.04)	.10 (.08)	.13 (.08)
ASD-O	19	.08 (.06)	.67 (.15)	.13 (.11)	.03 (.02)	.09 (.05)	.16 (.09)
TD	22	.19 (.10)	.64 (.09)	.03 (.02)	.11 (.04)	.03 (.03)	.05 (.05)

Means and standard deviations for the frequency of questions and the proportions of questions categorized as information-seeking, request, known information, conversational, or unclear/uncodable are presented in Table 3. Across groups, information-seeking was the most common type of question asked, followed by the conversational type. The other functions were less common across the groups.

Table 3
Descriptive Statistics for Question Frequency and Function

		Frequency	Function				
			Information-Seeking	**Request**	**Known Information**	**Conversational**	**Unclear/ Uncodable**
Group	**N**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**
FXS-O	35	.16 (.14)	.49 (.23)	.07 (.09)	.05 (.10)	.31 (.24)	.06 (.08)
FXS-ASD	30	.11 (.08)	.47 (.23)	.03 (.07)	.08 (.12)	.33 (.22)	.05 (.07)
ASD-O	13	.12 (.08)	.45 (.27)	.10 (.14)	.13 (.27)	.22 (.19)	.08 (.15)
TD	24	.14 (.09)	.56 (.22)	.04 (.06)	.04 (.08)	.33 (.23)	.02 (.04)

Group Comparisons

To address the study aims, statistical models testing for group differences were run only on variables for which we made hypotheses (noncontingent language, perseveration, and known questions). Between-group differences for perseveration were tested with one analysis of covariance (ANCOVA) using diagnosis as the categorical factor and controlling for nonverbal mental age, EVT age equivalent (expressive vocabulary), and PPVT age equivalent (receptive vocabulary). The model was run using SAS "PROC GLM" and tested with a three-degree-of-freedom F-test. All covariates were nonsignificant predictors. Model adjusted mean differences were tested and produced evidence for between-group differences (see Table 4). Post-hoc pairwise comparisons indicated differences between all groups with the exception of the two groups of boys with FXS. Boys with FXS (FXS-O and FXS-ASD) produced significantly more perseveration than boys with TD. However, boys with ASD-O used significantly more perseveration than all groups.

A second ANCOVA was run to assess between-group differences on the proportion of turns containing noncontingent language (either noncontingent maintenance or noncontingent change). In this model, EVT scores were negatively associated with the outcome ($p<.05$), so that higher expressive vocabulary levels related to less use of noncontingent language. Boys with ASD (FXS-ASD and ASD-O) used significantly more noncontingent language than boys with FXS-O and boys with TD. However, boys with ASD-O used significantly more noncontingent language than even the boys with FXS-ASD. Boys with FXS-O did not significantly differ from boys with TD on this variable. See Table 4.

Table 4
Adjusted Means (adjusted for nonverbal mental age and receptive and expressive vocabulary levels) and Between-Group Differences for Perseveration and Noncontingent Language

		Perseveration	Noncontingent Language
Group	**N**	**M (SE)**	**M (SE)**
FXS-O	28	.10 (.02)[a]	.10 (.02)[a]
FXS-ASD	26	.12 (.02)[a]	.18 (.02)[b]
ASD-O	19	.18 (.02)[b]	.26 (.02)[c]
TD	22	.04 (.02)[c]	.05 (.02)[a]

Note. Different superscripts within a column indicate significant differences. If groups share the same letter, differences were not significant.

Between-group differences for the proportion of known questions was tested with an ANCOVA using diagnosis as the categorical factor and controlling for nonverbal mental age, EVT age equivalent, and PPVT age equivalent. All effects were non-significant (see Table 5). However, there was marginal evidence ($p < .10$) for a between-group effect, with the boys with ASD-O showing the highest proportion of known questions. We continue to code additional samples to increase power for future analyses.

Table 5
Adjusted Means (adjusted for nonverbal mental age and receptive and expressive vocabulary levels) and Between-Group Differences for Proportion of Known Questions

		Known Questions
Group	**N**	**M (SE)**
FXS-O	35	.04 (.03)
FXS-ASD	30	.07 (.03)
ASD-O	13	.16 (.04)
TD	24	.04 (.03)
Note: No significant differences.		

F. Conclusion and Significance

This study compared the conversational discourse skills of boys who have FXS with and without ASD, boys with ASD-O, and boys with TD. After controlling for nonverbal mental age and receptive and expressive language skills, the results revealed that boys with FXS (FXS-O and FXS-ASD) used significantly more perseveration than did the boys with TD. Further, boys with ASD (FXS-ASD and ASD-O) produced significantly more noncontingent discourse than did boys with FXS-O and boys with TD. However, both boys with FXS-O and FXS-ASD produced significantly less perseveration and noncontingent discourse than did boys with ASD-O. These findings point to potentially important differences in the nature of language impairments observed in FXS and ASD. Additionally, a trend was observed where questions of boys with ASD-O tended more often to seek information already known to the child. These findings suggest that some of the conversational discourse difficulties attributed to FXS (noncontingent language) may be due to autism in FXS, whereas other difficulties (perseveration) may be present in FXS regardless of autism status. Further, as alluded to above, findings suggest that boys with FXS (FXS-O and FXS-ASD) may be less impaired in some aspects of pragmatic language than boys with ASD-O.

Our findings for boys with FXS are consistent with reports of perseverative language, poor topic maintenance, and inappropriate responses among individuals with FXS (Fryns et al., 1984; Hanson et al., 1986; Madison et al., 1986; Sudhalter et al., 1991). Our findings are not consistent with those of Sudhalter and Belser (2001) and Sudhalter and colleagues (1990), who reported that males with FXS used more tangential and perseverative language than those with autism without FXS. However, our participants were considerably younger than those studied previously. Perhaps, with age, males with FXS exhibit greater pragmatic language impairment and/or males with ASD-O exhibit less impairment.

Findings from this study have important implications for assessment and intervention for boys with FXS. First, autism status should be assessed and considered when planning intervention, as findings suggest that noncontingent language is not a particular weakness for boys with FXS-O whereas perseveration may be present regardless of autism status. Further, expressive vocabulary levels were negatively associated with noncontingent language use, indicating that boys with greater expressive vocabulary skills used less noncontingent language. This finding suggests that intervention focused on increasing productive vocabulary may also help to decrease noncontingent language (although group differences were still found after controlling for expressive vocabulary levels). We continue to study the discourse skills of boys with FXS and will utilize data being collected through companion projects to investigate further relationships between pragmatic language skills and an array of neuropsychological features that may be associated with the FXS phenotype.

G. PUBLICATIONS AND PRESENTATIONS

Related Publications

Price, J.R., Roberts, J.E., Hennon, E.A., Anderson, K.L., Sideris, J., & Berni, M.C. (2008). Syntactic complexity during conversation of boys with fragile X syndrome and Down syndrome. *Journal of Speech, Language, and Hearing Research, 51(1),* 3-15.

Price, J., Roberts, J., Vandergrift, N., & Martin, G. (2007). Language comprehension in boys with fragile X syndrome and boys with Down syndrome. *Journal of Intellectual Disability Research, 51(4),* 318-326.

Roberts, J.E., Chapman, R.S., Martin, G.E., & Moskowitz, L. (2008). Language of preschool and school-age children with Down syndrome and fragile X syndrome. In S.F. Warren & M.E. Fey (Series Eds.) & J.E. Roberts, R.S. Chapman, & S.F. Warren (Vol. Eds.), *Communication and language intervention series: Speech and language development and intervention in Down syndrome and fragile X syndrome* (pp. 77-115). Baltimore: Paul H. Brookes Publishing Co.

Roberts J. E., Chapman, R. S., & Warren, S. F. (Vol. Eds.) (2008). *Speech and language development and intervention in Down syndrome and fragile X syndrome.* Baltimore: Paul H. Brookes Publishing Co.

Roberts, J.E., Hennon, E.A., Price, J.R., Anderson, K., Vandergrift, N.A., & Dear, E. (2007). Expressive language during conversational speech in boys with fragile X syndrome. *American Journal on Mental Retardation, 112(1),* 1-17.

Roberts, J., Martin, G.E., Moskowitz, L., Harris, A.A., Foreman, J., & Nelson, L. (2007). Discourse skills of boys with fragile X syndrome in comparison to boys with Down syndrome. *Journal of Speech, Language, and Hearing Research, 50,* 475-492.

Roberts, J., Price, J., Barnes, E., Burchinal, M., Moskowitz, L., Malkin, C., Misenheimer, J., Hooper, S.R., Anderson, K., Edwards, A., Hennon, E.A., & Nelson, L. (2007). Receptive vocabulary, expressive vocabulary, and speech production of boys with fragile X syndrome in comparison to boys with Down syndrome. *American Journal on Mental Retardation, 112(3),* 177-193.

Roberts, J. E, Stoel-Gammon, C., & Barnes, E. F. (2008). Phonological characteristics of children with Down syndrome or fragile X syndrome. In S. F. Warren & M. E. Fey (Series Eds.) & J. E. Roberts, R. S. Chapman, & S. F. Warren (Vol. Eds.), *Communication and language intervention series: Speech and language development and intervention in Down syndrome and fragile X syndrom*e (pp. 143-169). Baltimore: Paul H. Brookes Publishing Co.

Related Presentations

Cooley, K., Martin, G.E., Moskowitz, L., Roberts, J., Sideris, J., & Estigarribia (2008, July). *Question-asking of boys with fragile X syndrome*. Poster session presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Edwards, A., Roberts, J., & Martin, G.E. (2008, July). *Does autism affect the vocabulary, speech, syntax, and language use of boys with fragile X syndrome?* Poster session presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Estigarribia, B., Roberts, J., Price, J., McKinney, K., & Sideris, J. (2008). *Expressive morphosyntax in boys with fragile X syndrome with and without autism*. Presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Roberts, J., Foreman, J.P., & Martin, G. (2007, April). *Conversational skills of boys with fragile X syndrome*. Presented at the annual meeting of the National Black Association for Speech-Language and Hearing, Charlotte, NC.

Harris, A., Martin, G., Zajac, D., Roberts, J., & Estigarribia, B. (2008, November). *DME of articulation rate in boys with fragile X syndrome.* Presented at the annual meeting of the American Speech-Language-Hearing Association, Chicago, IL.

Harris, A.A., Zajac, D.J., Roberts, J.E., Martin, G.E., Weismer, G., & Estigarribia, B. (2008, July). *Do boys with fragile X speak faster than their peers?* Presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Loiselle, V., Roberts, J., Malkin, C., Martin, G., Estigarribia, B., & Spencer, A. (2008, July). *Vocabulary, grammar, and language use of children with fragile X syndrome and Down syndrome.* Presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Martin, G.E. (2008, October). *Verbal perseveration in fragile X & Down syndrome*. Presented at Fall Research Forum, Division of Speech and Hearing Sciences, University of North Carolina, Chapel Hill, NC.

Martin, G.E., Barnes, E., Roberts, J., Long, S., & Spencer, A.R. (2008, July). *Conversational speech of boys with fragile X syndrome or Down syndrome.* Presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Martin, G.E., Moskowitz, L., & Roberts, J. (2008, July). *Speech, language of preschool and school-age boys with fragile X syndrome: Research findings and implications for practice.* Presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Martin, G.E., Moskowitz, L., Roberts, J., & Nelson, L. (2007, November). *Question-asking in boys with fragile X and Down syndrome*. Presented at the annual meeting of the American Speech-Language-Hearing Association, Boston, MA.

Martin, G.E., Roberts, J., & Assal, J. (2008, July). *Verbal perseveration in boys with fragile X syndrome compared to boys with Down syndrome.* Presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Martin, G.E., Roberts, J., Assal, J., & Sideris, J. (2008, November). *Verbal perseveration in boys with fragile X syndrome & Down syndrome*. Presented at the annual meeting of the American Speech-Language-Hearing Association, Chicago, IL.

Malkin, C., Roberts, J., Estigarribia, B., Martin, G., Spencer, A., Gucwa, A., & Price, J. (2008, July). *Narrative skills of boys with fragile X with and without autism spectrum disorder.* Presented at the biannual meeting of the National Fragile X Foundation, St. Louis, MO.

Roberts, J. (2008, August). *Speech and language in fragile X syndrome, Down syndrome and autism*. Presented at Fall Research Forum, Division of Speech and Hearing Sciences, University of North Carolina, Chapel Hill, NC.

Roberts, J., & Martin, G.E. (2007, October). *Fragile X, autism, and Down syndrome: Findings and issues in studying language profiles in longitudinal studies*. Presented at Frank Porter Graham Child Development Institute Seminar Series, University of North Carolina, Chapel Hill, NC.

Roberts, J. & Martin, G.E. (2008, February). *Speech and language in children with Down syndrome, fragile X syndrome, and autism: Research and directions*. Presented at Current Topics in Medical and Human Genetics Seminar Series, University of North Carolina, Chapel Hill, NC.

Roberts, J., Martin, G.E., Barnes, E., Price, J., Zajak, D., & Callahan-Mandulak, K. (2007, November). *Speech and language in fragile X and Down syndrome*. Presented at the annual meeting of the American Speech-Language-Hearing Association, Boston, MA.

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