Pragmatic Language and its relation to Executive Functioning, Adaptive Functioning and Attention-Deficit/Hyperactivity Disorder in Children with Autism Spectrum Disorder

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Dedication

The author wishes to “dedicate this Masters Thesis to Lillie Coker who dedicated her life to educating others and inspired me to never stop learning, growing and helping those in need.”
Acknowledgements

The author wishes to “acknowledge the Speech and Hearing Department of the George Washington University for giving me the opportunity to be part of this incredible community, for supporting and guiding me throughout my graduate school career and for providing me with the knowledge to be successful in this field.”
Abstract

Pragmatic Language and its relation to Executive Functioning, Adaptive Functioning and Attention-Deficit/Hyperactivity Disorder in Children with Autism Spectrum Disorder

Pragmatic language difficulties are commonly documented in individuals with autism spectrum disorder; however, little research exists that looks at pragmatic language in relation to executive functioning, adaptive functioning, and attention deficit hyperactivity disorder (ADHD) symptoms in this population. The current study had two aims: (1) determine the structural and pragmatic language profile of relative strengths and weaknesses among individuals with autism spectrum disorder using the Children’s Communication Checklist-2 (CCC-2) and (2) examine relationships between pragmatic language as measured by the CCC-2 and the following: executive functioning as measured by the Behavior Rating Inventory of Executive Function, adaptive functioning as measured by the Vineland Adaptive Behavior Scales, and ADHD symptomatology as measured by the ADHD Rating Scale. Results revealed a relative strength in structural language and a relative weakness in pragmatic language among individuals with autism spectrum disorder on the CCC-2. Furthermore, results showed pragmatic language to be associated with aspects of executive functioning, adaptive functioning, and ADHD symptomatology. This relationship suggests that treatment of executive functioning or adaptive functioning could result in positive outcomes in ameliorating pragmatic language deficits (or vice versa) in individuals with autism spectrum disorder.
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Introduction

Pragmatics:

Pragmatic language impairment exists when there is a mismatch between language and the situation in which it is used resulting in an inappropriate employment of language to a particular situation (Volden & Lord, 1991). Pragmatics is an aspect of language necessary for communication and interaction with others allowing for full participation within the community and navigating the social world. It involves the range of communicative functions (reasons for talking); the frequency of communication (turn-taking, topic maintenance and change, requests for clarification); the flexibility to modify language for different listeners and social situations; and the ability to convey a coherent and informative narrative (Paul & Norbury, 2012). Pragmatic language impairments can be expressed in the context of a variety of psychiatric disorders or neurological insults, including but not limited to schizophrenia (Mueser, Bellack, Douglas & Morrison, 1991), social phobia (Beidel et al., 2014), attention-deficit/hyperactivity disorder (ADHD) (Nijmeijer et al., 2008), traumatic brain injury (Douglas, 2010), and right hemisphere damage (Martin & McDonald, 2003). However, pragmatic language difficulties are perhaps most commonly associated with autism spectrum disorder (ASD; Landa, 2000; Tager-Flusberg et al., 2005; Young, Diehl, Morris, Hyman & Bennetto, 2005). Individuals with higher functioning ASD (HF-ASD) often perform in the average to superior range on standardized (particularly structural) language measures with pragmatics often being the only area of deficit (Reichow, Salamack, Paul,
Volkmar & Klin, 2008). The Diagnostic and Statistical Manual of Mental Disorders-5th Edition (DSM-5; APA, 2013) states that individuals with ASD have persistent deficits in social communication and social interaction across multiple contexts. For example, there are deficits that include difficulties with the back-and-forth inherent to conversational discourse, failure to initiate or respond to social interactions, poor nonverbal communication such as eye contact and body language, and difficulty with developing, maintaining and understanding relationships (APA, 2013). There is a large amount of evidence for pragmatic language difficulties in ASD. In their review of the literature, Martin and McDonald (2003) documented these difficulties in ASD as well as other clinical groups (e.g., right-hemisphere damage and traumatic brain injury). They found evidence for pragmatic language difficulties in ASD that included overly literal language comprehension (Baron-Cohen, 1997; Happé & Frith, 1996; Happé, 1993), difficulty understanding humor (Ozonoff & Miller, 1996), socially inappropriate and disinhibited comments (Dewey & Everard, 1974; Tsai & Scott-Miller, 1988), conversations characterized by tangents and excessive talking (Attwood, 1997; Szatmari, Bartolucci, & Bremner, 1989), formal pedantic language (Ghaziuddin & Gerstein, 1996; Kerbeshian, Burd, & Fisher, 1990), poor verbal fluency and inefficiency conveying information (Szatmari et al., 1989), prosody impairments (Happé & Frith, 1996; Shriberg et al., 2001), and difficulty reading emotion and facial expression (Happé & Frith, 1996; Ozonoff, Pennington, & Rogers, 1990; Prior, Dahlstrom, & Squires, 1990).
Tools for measuring pragmatic abilities, valid norms for pragmatic language development, and objective criteria for pragmatic performance are relatively (compared to structural language measures) limited (Young et al., 2005). As a result, various approaches have been used to measure pragmatics such as informant (e.g., parent, teacher, self) report questionnaires, naturalistic or lab-based observations, and standardized laboratory measures such as the Test of Pragmatic Language (TOPL – Phelps-Terasaki & Phelps-Gunn, 1992). Perhaps the most commonly utilized tool is the Children’s Communication Checklist (CCC; Bishop, 1998) and its derivations (i.e., CCC-2 (Bishop, 2003), Communication Checklist – Adult (CC-A) (Whitehouse & Bishop, 2009) which have been proven effective in documenting pragmatic language deficits in a variety of clinical populations (Geurts et al., 2004; Bishop & Baird, 2001; Nathan, 2002; Botting, 2004; Bishop, 2010; Philofsky, Filder & Hepburn, 2007; Whitehouse, Coon, Miller, Salisbury, & Bishop, 2010). By documenting pragmatic language difficulties in clinical groups known to have these impairments these findings support the validity of these questionnaire-based assessment tools. Moreover, individuals with ASD tend to be the most pragmatically impaired compared to other clinical groups on this measure (Botting, 2004). Finally, Bishop’s revised version of the checklist, the CCC-2 (Bishop, 2003) has also been shown to differentiate between pragmatic language impairments and structural language impairments in ASD (i.e., relatively superior structural language) and specific language impairment
The CCC-2 has also been shown to be more effective than other assessment measures for pragmatics. Volden and Phillips (2010) administered the TOPL to participants with ASD and matched typically developing peers and gave the CCC-2 to the participants’ caregivers. Results showed that the TOPL identified 56% of the ASD participants as being pragmatically impaired while the CCC-2 identified 82% of the ASD participants as being pragmatically impaired. It was concluded that the CCC-2 (compared to the TOPL) had better sensitivity in identifying pragmatic issues among children with ASD who also had age appropriate structural language skills. The CCC-2 has also been shown to be effective as a screening tool for ASD and the broader autism phenotype in typically developing siblings of children with ASD (Bishop et al., 2006; Charman et al., 2007). The CC-A (Whitehouse et al., 2010) also serves as an informant rated assessment tool of language and communication skills but unlike the CCC-2, it is tailored to the adult population. Whitehouse et al. (2010) found the CC-A to be effective in identifying communicative dysfunction in ASD probands as well as their parents.

Although there is now well-established research documenting pragmatic language impairments in ASD, how these impairments relate to other important domains of functioning (e.g., executive and adaptive functioning) in ASD remains largely unexplored.
Executive Functioning:

Executive functioning (EF) involves cognitive control processes that include inhibition of actions, restraining and delaying responses, attending selectively, setting goals, planning and organizing, generativity, flexibility and working memory (Singer & Bashir, 1999; Barkley, 1997; Eslinger & Biddle, 2000; Pennington, Bennett, McAleer, & Roberts, 1996; Bishop & Norbury, 2005; Landa & Goldberg, 2005). Executive dysfunction therefore can hinder an individual’s ability to fully function in a world where higher thinking processes are necessary. The majority of research assessing EF in ASD involves lab tasks such as the Wisconsin Card Sorting Test assessing cognitive flexibility and tower tasks (e.g., the Tower of London) measuring multiple EF demands, including planning. EF is important in ASD because it is associated with adaptive functioning and ASD symptomatology (Liss et al., 2001; Pugliese et al., 2015). In ASD these EF tasks have provided mixed results with some revealing ASD deficits while others do not (Kenworthy, Yerys, Anthony & Wallace, 2008; Hill, 2004). Recently, ecologically valid assessments have been used to assess EF in ASD with more consistently documented deficits emerging (Kenworthy et al., 2008). Ecological validity is defined as the degree to which task performance corresponds to real-world performance with particular emphasis on the inferences drawn from the task performance as opposed to the task itself (Chaytor, Schmitter-Edgecombe, & Burr, 2006). An example of an ecologically valid assessment of EF includes the Behavioral Assessment of the Dysexecutive
Syndrome (BADS) which contains six measures to assess planning, organization, shifting, inhibition, novel problem solving, and temporal judgment by requiring the subject to engage in familiar everyday activities such as searching for lost keys (Wilson, Alderman, Burgess, Emslie, & Evans, 1996). Another ecologically valid way to assess EF is to use informant reports such as the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) which assesses everyday executive control and produces eight non-overlapping clinical scales, including Inhibit, Shift, Emotional Control, Monitor, Working Memory, Plan/Organize, Organization of Materials, and Initiate (Gioia et al., 2000). To date, research using the BRIEF to assess EF in ASD finds global EF deficits in ASD (Granader et al., 2014; Rosenthal et al., 2013; Chan et al., 2009) with a peak EF problem in flexibility (on the Shift scale). Granader et al. (2014) examined results from parent-completed BRIEFs among 411 children with ASD and 467 age and sex matched typically developing children. They found elevated scores (indicative of more EF problems) in the ASD group across all BRIEF scales with the most prominent deficit on the Shift (i.e., flexibility) scale. Similarly, Rosenthal et al. (2013) compared different age groups of children with ASD on EF measures finding that older children with ASD exhibited more EF problems (i.e., with increasing age there were increasing working memory difficulties) relative to the BRIEF standardization sample as well as a developmentally invariant peak impairment in flexibility (Shift scale scores).
Whether pragmatic language skills are associated with impairments in EF in ASD however remains unclear. Pragmatic language skills could regulate responses that are appropriate to the context by inhibiting inappropriate responses, using working memory to remember what has been said in order to respond appropriately, attending to the message as well as the non-verbal behavior of the speaker (e.g. prosody, gestures) and organizing and planning one’s response. Research has shown that pragmatic language skills are related to working memory deficits (Akbar, Loomis, & Paul, 2007; Freed, Lockton, & Adams, 2012). Executive dysfunction could therefore result in poor pragmatic language skills. Bishop and Norbury (2005) looked at children with HF-ASD, Specific Language Impairment, Pragmatic Language Impairment and a group of (age, gender, and non-verbal ability) matched typically developing peers and found significant correlations between pragmatics and the EF domain of generativity. In other words, children with impaired pragmatics also often showed poor generativity skills. They concluded that these children have poor skills in generating ideas relevant to the context. Overall, there is limited research that explores the relationship between EF and pragmatic language in ASD.

**Adaptive Functioning:**

Adaptive functioning can be thought of as an individual’s ability to function in the natural social environment across a multidimensional set of skills (Oswald & DiSalvo, 2003). The presence of social and communication deficits in
individuals with ASD negatively impacts these adaptive functioning skills making it difficult for an individual with ASD to function independently in everyday situations. Adaptive skills are considered one of the most important outcome measures in ASD because they measure one’s success in navigating society’s many everyday challenges (Williams, Mazefsky, Walker, Minshew, & Goldstein, 2014). Nevertheless, how well pragmatic language impairments predict adaptive skills in ASD remains largely unknown (Volden et al., 2009).

One study has used standard lab tasks of pragmatic language in order to examine its association with adaptive functioning. Volden et al. (2009) assessed pragmatic language using the TOPL in 37 children with HF-ASD and investigated its correlations with scores from the Vineland Adaptive Behavior Scale (VABS; Sparrow et al. 1984), the most commonly utilized tool for assessing adaptive functioning. This study found that pragmatic language scores did not predict adaptive functioning suggesting the need to utilize a more sensitive measure of pragmatic language skills as observed in everyday settings (e.g., the CCC-2) in future studies.

**Co-morbidity with Attention-Deficit/Hyperactivity Disorder (ADHD):**

ADHD is a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development characterized by wandering off task, difficulty sustaining attention, inability to delay gratification and desiring immediate rewards (APA, 2013). Several forms of psychopathology
are highly comorbid with ASD with ADHD being one of the most common 
(Keen & Ward, 2004; Simonoff et al., 2008; Leyfer et al., 2006). Similar to ASD, 
ADHD is also associated with pragmatic language difficulties (Geurts & 
Embrects, 2008). For example: 1) excessive talking during times that one should 
be listening; 2) difficultly producing organized and fluent speech for specific 
purposes when elicited rather than during spontaneous conversation; 3) 
dominating conversations and not responding appropriately to verbal cues from 
conversational partners; and 4) possible difficulty with higher level language 
comprehension especially for inferences and story elements (Green, Johnson & 
using the CCC-2 in ASD, SLI, ADHD, and typically developing matched peers 
and found that both ASD and ADHD groups showed more difficulty with 
pragmatic language than structural language. In addition, they found that the 
added presence of impulsivity, a behavior characteristic of ADHD, as measured 
by the Preschool Behavior Questionnaire (PBQ; Smidts & Oosterlaan, 2005), in 
the ASD and SLI groups was associated with greater structural and pragmatic 
language difficulties. Timler (2014) also found that the CCC-2 could be used as a 
screener to identify children with ADHD who are at elevated risk for language 
impairment. The DSM-5, unlike its predecessor, the DSM-IV, allows co-morbid 
diagnoses of ASD and ADHD. Given that prior studies have found that the 
presence of ADHD symptoms in ASD exacerbated deficits in EF, particularly 
working memory, and adaptive functioning (Yerys et al., 2009), how this
Comorbidity could affect pragmatic language skills is of particular importance as it might represent a ‘double hit’ or additive model of pragmatic language deficits.

**Research Aims:**

Pragmatic language is a nearly universally impaired domain of functioning in individuals with ASD (Landa, 2000, Tager-Flusberg et al., 2005; Young et al., 2005). Pragmatic language deficits are likely associated with both adaptive functioning and EF in ASD. Therefore, these relationships were examined empirically by examining links between pragmatic language skills as measured by the Children’s Communication Checklist - 2 (CCC-2) and both adaptive functioning deficits as measured by the Vineland Adaptive Behavior Scale and real-world EF utilizing the BRIEF after accounting for nuisance factors such as age, IQ (as measured by the Wechsler Scales), and structural language abilities (also measured with the CCC-2). Furthermore, the presence of comorbid ADHD symptomatology in ASD was examined to determine whether it exacerbates pragmatic language deficits given that each of these disorders independently exhibits pragmatic language problems.

**Variables:**

*Independent Variables:* The independent variable in this study is pragmatic language functioning as measured by the CCC-2.
**Dependent Variables:** The dependent variables in this study include:

1. Executive functioning as measured by the BRIEF
2. Adaptive functioning as measured by the Vineland Adaptive Behavior Scale
3. ADHD symptomatology as measured by the ADHD Rating Scale
Methods

Participants:

This study used archival data conducted in compliance with standards established by the institution’s IRB including procedures for informed consent. Participants were evaluated for clinical or research purposes in the autism center of a children’s hospital. All participants with ASD met DSM-IV or DSM-5 diagnostic criteria as assessed by an experienced clinician. All ASD participants also received the Autism Diagnostic Interview or Autism Diagnostic Interview-Revised (Le Couteur et al., 1989; Lord et al., 1994) and/or the first or second edition of the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000; ADOS-2; Lord et al., 2012). The ADOS and ADI were administered by a trained, research-reliable clinician. All ASD participants’ scores on the ADI and/or ADOS met cut-off for the category designated as ‘Broad ASD’ according to criteria established by the NICHD/NIDCD Collaborative Programs for Excellence in Autism (see Lainhart et al., 2006). Exclusion criteria for the ASD group included an IQ < 70 or any known co-morbid medical conditions, such as fragile X syndrome or other genetic disorders, and brain trauma/injury. See Table 1 for information on subject demographic characteristics and functioning level.
Table 1. Subject demographic and clinical characteristics.

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>10.40</td>
<td>2.72</td>
<td>98</td>
</tr>
<tr>
<td>Full Scale IQ*</td>
<td>104.84</td>
<td>18.78</td>
<td>95</td>
</tr>
<tr>
<td>BRIEF Global Executive Composite*</td>
<td>65.86</td>
<td>10.30</td>
<td>98</td>
</tr>
<tr>
<td>BRIEF Behavior Regulation Index*</td>
<td>65.00</td>
<td>12.07</td>
<td>98</td>
</tr>
<tr>
<td>BRIEF Metacognition Index*</td>
<td>64.66</td>
<td>9.69</td>
<td>98</td>
</tr>
<tr>
<td>Vineland - Communication†</td>
<td>83.90</td>
<td>12.75</td>
<td>88</td>
</tr>
<tr>
<td>Vineland - Daily Living Skills†</td>
<td>87.41</td>
<td>15.60</td>
<td>88</td>
</tr>
<tr>
<td>Vineland - Socialization†</td>
<td>79.62</td>
<td>13.21</td>
<td>86</td>
</tr>
</tbody>
</table>

Note: Full Scale IQ and Vineland scores are reported as standard scores ($M=100$, $SD=15$); BRIEF scores are reported as T scores ($M=50$, $SD=10$)

Measures:

**Children’s Communication Checklist – 2 (CCC-2; Bishop, 2003)**

The Children’s Communication Checklist (CCC-2) is a measure designed to assess children’s communication skills in the areas of pragmatics, syntax, morphology, semantics, and speech in children aged 4 to 16 years, 11 months who use full sentences and whose primary language is English. The current study utilized the parent report version of this questionnaire to rate the frequency that the child demonstrates the communication behavior described in each item. The CCC-2 contains 70 items scored on a Likert-type scale, with the first 50 (e.g., Does not recognize when other people are upset or angry) scored from 0 (less than once a week or never) to 3 (several times (more than twice) a day (or always)), and the remaining 20 (e.g., Makes good use of gestures to get his or her meaning across) with the same ranges of scores, but reverse scored.

The purpose of the CCC-2 is to identify children with pragmatic language
impairment, children who may have a speech and language impairment that require a further comprehensive speech and language assessment, and children who may require further assessment for ASD. Raw scores are converted to a scaled score which are used to determine the General Communication Composite (GCC) Standard Score. The GCC is expressed as a standard score that has a mean of 100 and a standard deviation of 15. The current study utilized the Structural and Pragmatic Language subtest scores as variables of interest.

**Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia et al., 2000)**

The Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia et al., 2000) is an 86-item informant (for the current study, parent) report that measures EF-related behaviors in children aged 5-18 years. Ratings of the items follow a Likert-type scale from 1 (Never) to 3 (Often). The BRIEF provides an overall Global Executive Composite score, which can be broken down into two higher-order indices: the Behavioral Regulation Index and the Metacognition Index. The Behavior Regulation Index is in turn composed of the Inhibition, Shift, and Emotional Control scales while the Metacognition Index includes the Initiate, Working Memory, Planning and Organization, Organization of Materials, and Monitor scales. Higher T-scores (Mean=50, Standard Deviation=10) are indicative of more difficulties such that T-scores ≥ 65 are suggestive of clinical impairment (Gioia et al., 2000). The scores for the BRIEF indices were utilized as variables of interest in the current study.
The Vineland Adaptive Behavior Scales-II is a semi-structured interview that is administered to parents as a measure of how many age appropriate, adaptive behavioral skills a child or adult exhibits in their natural environment (Sparrow et al., 2005). For school-age children and adults the VABS-II has three main domains: Communication, Daily Living Skills, and Socialization. Higher scores indicate better functioning. From the VABS-II dependent variables of interest include the Socialization, Communication, and Daily Living Skills. These scores are expressed as standard scores (Mean = 100, Standard Deviation = 15).

The ADHD Rating Scale (DuPaul, Power, Anastopoulos, & Reid, 1998) assesses severity in inattention and hyperactivity/impulsivity symptoms. This 18-question scale yields two domains: inattention and hyperactivity/impulsivity. For each question, parents use a 0-3 scale to rate the participant. A higher score indicates greater symptom severity, and a score of 2 or 3 is considered a significant symptom; six or more significant symptoms in either the inattention or hyperactivity/impulsivity domains meet criteria for an ADHD diagnosis. Scores from the inattention and hyperactivity domains served as variables of interest in the current study.
Data Analysis:

The profile of structural and pragmatic language function on the CCC-2 was examined using repeated measures ANOVA in this sample of children with ASD. In order to examine associations between pragmatic language and executive functioning, adaptive skills, and ADHD symptomatology, hierarchical multiple regressions were completed with CCC-2 Pragmatic Language scores serving as the independent variable and BRIEF Index scores, Vineland domain scores, and ADHD Rating Scale scores serving as the dependent variables. CCC-2 Structural Language scores and demographic predictors (i.e., age and Full-Scale IQ) were entered in the first block (serving as control/nuisance variables), followed by the CCC-2 Pragmatic Language scores in the second block.
Results

A repeated measures ANOVA revealed a main effect of scale ($F=31.55$, $p<.001$) indicating that there was not a flat profile of scores across CCC-2 scales. Children with ASD in this sample showed the lowest scores in the domain of nonverbal communication and highest scores in the domains of speech, syntax, and semantics (see Table 2). Scaled scores of 4 or lower on the CCC-2 indicate significant clinical impairment (i.e., $2+ \text{ standard deviations below the population mean of } 10$). Over half of the children with ASD in this sample scored two or more standard deviations below the population mean on the nonverbal communication scale (see Table 2).


<table>
<thead>
<tr>
<th>Measure</th>
<th>$M$</th>
<th>$SD$</th>
<th>% scoring 1+ SD below the mean</th>
<th>% scoring 2+ SD below the mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech</td>
<td>8.14</td>
<td>3.01</td>
<td>34.7 %</td>
<td>13.3 %</td>
</tr>
<tr>
<td>Syntax</td>
<td>8.69</td>
<td>3.14</td>
<td>27.6 %</td>
<td>12.2 %</td>
</tr>
<tr>
<td>Semantics</td>
<td>8.10</td>
<td>2.49</td>
<td>37.8 %</td>
<td>6.1 %</td>
</tr>
<tr>
<td>Coherence</td>
<td>6.70</td>
<td>2.96</td>
<td>55.1 %</td>
<td>28.6 %</td>
</tr>
<tr>
<td>Initiation</td>
<td>6.51</td>
<td>2.56</td>
<td>62.2 %</td>
<td>28.6 %</td>
</tr>
<tr>
<td>Scripted Language</td>
<td>7.09</td>
<td>2.43</td>
<td>50.0 %</td>
<td>20.4 %</td>
</tr>
<tr>
<td>Context</td>
<td>6.46</td>
<td>2.85</td>
<td>59.2 %</td>
<td>33.7 %</td>
</tr>
<tr>
<td>Nonverbal</td>
<td>4.83</td>
<td>2.66</td>
<td>81.6 %</td>
<td>53.1 %</td>
</tr>
<tr>
<td>Social Relationship</td>
<td>5.71</td>
<td>2.70</td>
<td>71.4 %</td>
<td>39.8 %</td>
</tr>
<tr>
<td>Interests</td>
<td>6.26</td>
<td>2.79</td>
<td>66.3 %</td>
<td>31.6 %</td>
</tr>
</tbody>
</table>

*Note: CCC-2 scores are reported as scaled scores ($M=10$, $SD=3$)*

None of age, IQ, or structural language was a significant predictor of Behavior Regulation Index scores; however, pragmatic language was (see Table
3). Age also was not a significant predictor of Metacognition Index scores, but IQ was. Nevertheless, pragmatic language predicted additional variance in Metacognition Index scores above and beyond IQ (see Table 3).

Table 3. Language scores regressed onto age, IQ, and real world executive function ratings.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE B</th>
<th>t</th>
<th>B</th>
<th>SE B</th>
<th>t</th>
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<td></td>
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<tr>
<td>Behavior Regulation Index</td>
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<tr>
<td>Step 1</td>
<td></td>
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<tr>
<td>Age</td>
<td>-0.74</td>
<td>0.46</td>
<td>-1.61</td>
<td>-0.09</td>
<td>0.34</td>
<td>-0.26</td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>-0.10</td>
<td>0.07</td>
<td>-1.44</td>
<td>-0.20</td>
<td>0.05</td>
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<tr>
<td>Step 2</td>
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<td></td>
<td></td>
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<tr>
<td>Age</td>
<td>-0.62</td>
<td>0.42</td>
<td>-1.47</td>
<td>-0.04</td>
<td>0.34</td>
<td>-0.12</td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>-0.01</td>
<td>0.07</td>
<td>-0.09</td>
<td>-0.17</td>
<td>0.06</td>
<td>-3.10**</td>
</tr>
<tr>
<td>Structural Language</td>
<td>0.41</td>
<td>0.66</td>
<td>0.62</td>
<td>0.42</td>
<td>0.53</td>
<td>0.80</td>
</tr>
<tr>
<td>Pragmatic Language</td>
<td>-2.79</td>
<td>0.68</td>
<td>-4.11**</td>
<td>-1.38</td>
<td>0.54</td>
<td>-2.55*</td>
</tr>
</tbody>
</table>

* p < .05, ** p < .01.

Age and IQ were significant predictors of adaptive communication skills; however, structural and pragmatic language scores were not. In contrast, pragmatic language was a significant predictor of not only Daily Living Skills, but also Socialization skills, while none of age, IQ, and structural language was predictive of these two adaptive functioning domains (see Table 4).
Table 4. Language scores regressed onto age, IQ and adaptive functioning scores.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
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</tr>
<tr>
<td></td>
<td>Communication</td>
<td></td>
<td></td>
<td>Daily Living Skills</td>
<td></td>
<td></td>
<td>Socialization</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
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<td>-2.33*</td>
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<td></td>
<td>-1.02</td>
<td>0.34</td>
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<tr>
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<td>0.06</td>
<td><strong>4.13</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.15</td>
<td>0.05</td>
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<tr>
<td>Age</td>
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<td>0.47</td>
<td>-2.53*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.01</td>
<td>0.62</td>
</tr>
<tr>
<td>Full Scale IQ</td>
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<td>0.07</td>
<td><strong>2.59</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.10</td>
<td>0.09</td>
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<tr>
<td>Structural Language</td>
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<td>0.68</td>
<td>1.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>0.90</td>
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<tr>
<td>Pragmatic Language</td>
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<td>0.71</td>
<td>1.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.16</td>
<td>0.95</td>
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</table>

Regression analysis revealed IQ, but none of age, structural and pragmatic language, to be a significant predictor of inattention symptomatology (see Table 5). However, pragmatic language was a significant predictor of hyperactivity symptomatology while age, IQ, and structural language were not (see Table 5).

Table 5. Language scores regressed onto age, IQ, and ADHD symptomatology ratings.

<table>
<thead>
<tr>
<th>Predictor</th>
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<tr>
<td></td>
<td>Inattention</td>
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<td></td>
<td>Hyperactivity</td>
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<tr>
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<td>0.15</td>
<td>1.00</td>
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<tr>
<td>Full Scale IQ</td>
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<td>0.02</td>
<td>-3.62**</td>
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<td></td>
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<tr>
<td><strong>Step 2</strong></td>
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<tr>
<td>Age</td>
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<td>0.93</td>
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<td>0.02</td>
<td>-3.41**</td>
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<tr>
<td>Pragmatic Language</td>
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<td>0.18</td>
<td>-1.58</td>
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</tbody>
</table>

*Note: Inattention = CASI ADHD inattention symptom count; Hyperactivity = CASI ADHD hyperactivity symptom count*

*p ≤ .05, **p < .01.
Discussion

The current study examined (1) the profile of structural and pragmatic language skills within a relatively large group of children with ASD without intellectual disability and (2) the associations of structural and pragmatic language with EF, adaptive functioning and ADHD symptomatology. The profile of language functioning in children with ASD was characterized by weaknesses in pragmatic language relative to structural language. Furthermore, pragmatic language, unlike structural language, was associated with components of EF, adaptive functioning and ADHD symptomatology.

In general, previous studies have found that individuals with ASD are more impaired on the CCC-2 than other clinical populations, such as specific language impairment, pragmatic language impairment, ADHD, or Williams syndrome (Botting, 2004; Helland et al., 2012; Philofsky et al., 2007). Although there is no control group in the current study, utilizing the standardization sample (i.e., norm-referenced scores) as an index of atypicality, we find a relative strength in structural language scales (e.g., speech, syntax, and semantics) and a relative weakness in pragmatic language scales (e.g., nonverbal communication) among children with ASD. This pattern of findings in ASD corroborates a growing literature (Bishop & Baird, 2001; Geurts et al., 2004; Norbury et al., 2004; Volden & Phillips, 2010). For example, studies by both Reisinger, Cornish and Fombonne (2011) and Geurts and Embrecht (2008) found that individuals with ASD have more pragmatic than structural language difficulties compared to
typically developing/clinical control groups with nonverbal communication also being one of the most impaired subtest scores. Two studies looked at populations that had been excluded from this study (e.g., intellectual disability, neurogenetic disorders such as fragile X syndrome). Results found that individuals with sex chromosome trisomies (e.g., XXY/Klinefelter’s syndrome) showed impairments across all scales with particular weakness on the pragmatic language scale of context (Bishop et al., 2015). The profile of individuals with intellectual disability showed impairments in pragmatic language, however, individuals with ASD showed more severe pragmatic impairments (Botting, 2004).

EF is a well-established area of impairment among children with ASD (Chan et al., 2009; Kenworthy et al., 2008; Granader et al., 2014) and, in fact, several treatments have been developed to target these deficits in ASD (e.g., Unstuck and On Target!; Kenworthy et al., 2014). As predicted, we found that pragmatic language predicted both components of EF measured in this study, behavioral regulation and metacognition from the BRIEF over and above the influences of age (no correlation with EF) and IQ (associated with metacognition). At least one previous study has found correlations between EF using performance-based tasks (e.g., generativity/verbal fluency as measured by the Use of Objects task and Pattern Meanings task; response inhibition as measured by the Walk Don’t Walk task from the Test of Everyday Attention for Children) and pragmatic language as measured by the CCC (Bishop & Norbury, 2005). However, to our knowledge, the current study is the first to link pragmatic
language functioning and real-world EF (using the BRIEF) in a group of individuals with ASD. These findings also corroborate prior work in ADHD. In particular, it might be, as suggested by Geurts et al. (2004), that EF accounts for the pragmatic language difficulties found in individuals with ADHD while both EF and theory of mind deficits underlie pragmatic language difficulties in individuals with ASD. In that sense, EF difficulties might be a shared route to pragmatic language difficulties in ADHD and ASD, though the particular components of EF contributing to pragmatic failures could differ for each of these groups, given their unique EF profiles (e.g., Gioia et al., 2002).

Adaptive functioning is one of the primary indices of outcome in ASD groups, and as such, serves as a valuable correlate of pragmatic language skills. Pragmatic language as measured by the CCC-2 was predictive of performance on the daily living skills and socialization subscales of the Vineland Adaptive Behavior Scales–II (VABS-II). Utilizing a performance-based measure of pragmatic language, Reichow et al. (2008) also found that pragmatic language, as measured by the CASL, was positively associated with the adaptive social functioning, as measured by the VABS-II, in ASD. Our results, on the other hand, are inconsistent with findings from Volden et al. (2009) who, using another performance-based measure, the TOPL, did not find pragmatic language to be associated with any subscale scores from the VABS. However, a later study conducted by Volden and Phillips (2010) concluded that the CCC-2 had better sensitivity to identify pragmatic issues in ASD; therefore, inconsistent results
could relate to both a different measure being used in the study and the reduced sensitivity of the TOPL. Taken together, there appears to be a positive association between pragmatic language and adaptive (particularly social) functioning in ASD.

ADHD and ASD are commonly comorbid with one another (Leyfer et al., 2006), and both disorders are known to have pragmatic language impairments, though they are more severe in ASD (Geurts et al., 2004; Green et al., 2014). The presence of ADHD symptoms in the context of ASD has been shown to exacerbate ASD-related deficits in other domains (Geurts et al., 2004; Yerys et al., 2009). Yerys et al. (2009), for example, found that ADHD symptoms exacerbated adaptive functioning and metacognition (working memory) impairments in ASD. Accordingly, we found that pragmatic language skills were associated with hyperactivity (not inattention) symptoms, in particular, in ASD. Previous research in the context of ADHD alone has shown a significant relationship between pragmatic language functioning and both hyperactivity and inattention symptoms (Green, Johnson, & Bretherton, 2014). Overall, the current study’s findings are consistent with our hypothesis that ADHD+ASD may represent a ‘double hit’ or additive model, whereby comorbid ADHD symptoms in ASD serve, if anything, to worsen pragmatic language deficits. Although this association had, until now, not been explored previously in ASD, at least one other study also pinpointed impulsivity/hyperactivity as a key predictor of
pragmatic language problems in young children with ADHD (Geurts & Embrechts, 2008).

Limitations:

There are several limitations to consider in the current study. For example, there was no typically developing or clinical control group, however, the present study relied upon a representative and recently acquired standardized sample to assess impairments and relative strengths and weaknesses in ASD. In addition, due to IQ<70 being an exclusion criterion, the results from this study cannot be applied to individuals with both ASD and ID. Furthermore, this study relied on results from parent report as opposed to direct observation. It should be noted, however, that parents as the primary caregivers of their children, are the most knowledgeable informants of their children’s behavior and therefore will have had the largest window in which to observe these behaviors to provide reliable reports.
Conclusions/Future Research

Future research should explore the possibility of cascading positive influences from interventions that target EF (e.g., Unstuck and On Target!; Kenworthy et al., 2014) in ASD. Given that the current study suggests associations between pragmatic language and EF, improving EF might result in a ‘knock-on’ effect that serves to improve some pragmatic language skills as well. This is also true for adaptive functioning in that treating pragmatic language deficits or targeting them in therapy could have positive outcomes in adaptive functioning skills in ASD. However, because this study involved cross-sectional analyses, it is impossible to determine causality and primacy in terms of which behavior has the initial impact to influence the others. Longitudinal/Treatment studies would be better suited to assess causal relationships between pragmatics and these other related behavioral constructs (e.g., EF and adaptive functioning).
References


