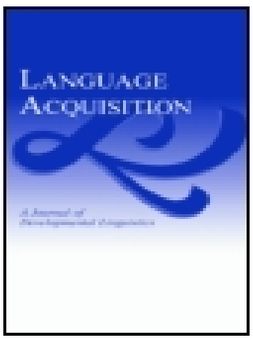

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On links between language development and extralinguistic cognitive knowledge: What we can learn from autism

Jeannette Schaeffer[a], Stephanie Durrleman[b], and Inge-Marie Eigsti[c]

[a]University of Amsterdam; [b]University of Geneva; [c]University of Connecticut

ABSTRACT

This Special Issue on linguistic and cognitive development in children with autism spectrum disorder (ASD) arose from the 42nd Boston University Conference on Language Development (BUCLD) (2017), when Jeannette Schaeffer, Stephanie Durrleman, and Inge-Marie Eigsti organized a symposium on this topic. It shows that the study of language development in ASD provides a unique perspective on the associations between the development of syntax, pragmatics, intelligence, theory of mind, and working memory. In addition, it emphasizes the importance of studying children with ASD across the spectrum and across research groups. Such research serves to address an important question in (typical) language acquisition—whether the acquisition of pragmatics and/or syntax requires general intelligence, working memory, phonological memory, and theory of mind, or vice versa.

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The idea for this Special Issue on linguistic and cognitive development in children with autism spectrum disorder (ASD) originated at the 42nd Boston University Conference on Language Development (BUCLD) (2017), when Jeannette Schaeffer, Stephanie Durrleman and Inge-Marie Eigsti organized a symposium on this topic. We are grateful for the feedback we received during this symposium and are delighted for this opportunity to present our work in *Language Acquisition*.

Language acquisition by individuals with ASD provides a window into cognitive development, including language and its subcomponents: While certain areas of cognition seem to develop at a typical speed and in a typical order, the development of other areas of cognition is protracted or impaired. Our future aim is to extend the international research on language and extralinguistic cognition in autism described here beyond Europe and North America into other communities, to streamline methodologies, compare different languages, and to create larger data sets. Using ASD as a testing ground, these efforts will contribute to the understanding of linguistic development and its relation to the development of cognition. As such, our work will provide novel insights into typical language acquisition as well as into linguistic theory. In the remainder of this introduction, we briefly present the main topics and cohesion of the three articles collected for this Special Issue.

ASD is characterized by "persistent deficits in social communication and social interaction" (DSM-5, APA 2013). While pragmatics (i.e., the social use of language, or language in context) is consistently a domain of significant impairment (Baron-Cohen 1988; Eigsti et al. 2011; Marinis et al. 2013; Novogrodsky 2013; Schaeffer 2016/2018, a.o.), not all areas of pragmatics seem to be impaired (Chevallier et al. 2010; Kuijper, Hartman & Hendriks 2015; Kissine et al. 2015, a.o.). Furthermore, while syntax is often assumed to be intact in children with ASD who have fluent speech, research also indicates significant syntactic deficits (Kjelgaard & Tager-Flusberg 2001; Eigsti & Bennetto 2009; Perovic, Modyanova & Wexler 2013; Zebib et al. 2013; Terzi et al. 2014; Durrleman et al. 2014; Janke & Perovic 2015; Tuller et al. 2017, a.o.).

CONTACT Jeannette Schaeffer J.C.Schaeffer@uva.nl University of Amsterdam, Amsterdam 1012 VB, Netherlands.

This raises numerous questions, such as:

(i) What areas of pragmatics are spared in children with ASD?
(ii) What areas of syntax are impaired in children with ASD?
(iii) How is pragmatic/syntactic acquisition related to, or dissociated from, extralinguistic cognition, such as intelligence, (working) memory, and theory of mind?

The study of atypical developmental trajectories of language acquisition can illuminate the typical process by revealing when domain-general processes are *obligatory* for syntactic or pragmatic development and vice versa. This Special Issue explores the aforementioned questions by examining language development in children with ASD in Dutch, French, English, and Danish.

Schaeffer examines the relation between syntactic, pragmatic, and extralinguistic development in Dutch-speaking children with ASD without intellectual disability . Her prior work has shown that, despite intact knowledge of even complex syntactic constructions, certain linguistic structures that are driven by pragmatics, such as article choice (that is, the choice between a definite and an indefinite article) and direct object scrambling (that is, the position of the object with respect to the adverb or negation), are impaired in elementary school children with ASD (Schaeffer 2016/2018; 2017; Schaeffer, van Witteloostuijn & Creemers 2018). Schaeffer's analysis presented in this Special Issue finds no evidence that the pragmatic weaknesses of Dutch-speaking children with ASD without intellectual disability are related to working memory, inhibition, intelligence, or theory of mind; however, she reports a correlation between direct object scrambling scores and phonological memory. As such, Schaeffer's results suggest that syntactic and much extralinguistic development can proceed despite difficulties in pragmatics, although there may be a link with memory. The finding of a correlation between phonological (or verbal short-term) memory and direct object scrambling is consistent with other reports describing a link between memory and pragmatics. For example, Schuh, Eigsti & Mirman (2016) reported an association between working memory and discourse (specifically, use of common ground knowledge in comprehension), over and above the influence of theory of mind abilities. As direct object scrambling involves not only pragmatics but also syntax (word order), the correlation between memory and direct object scrambling found by Schaeffer could also indicate a link between memory and syntax. This is consistent with, for example, Durrleman & Delage (2016), who report a significant correlation between mastery of clitic pronouns and working memory after controlling for nonverbal reasoning, suggesting a specific link between complex syntax and working memory capacities (rather than general intelligence) (see also Eigsti 2009).

It should be noted that Schaeffer's project includes only children with ASD intellectual disability and without grammatical impairment (as evidenced by their CELF scores), which raises the question as to whether language difficulties of more impaired children do show associations with deficits in extralinguistic cognitive functions. Recent research grouping data across the universities of Tours and Geneva identifies four ASD subgroups: children with ASD with intellectual disability and syntax impairment, , children with ASD without intellectual disability and syntax impairment, and children with ASD without intellectual disability and normal syntax (Prévost et al. 2017). The existence of these subgroups suggests that the development of syntax and *intelligence* is somewhat dissociable. However, language development across the ASD spectrum could be related to theory of mind or working memory, a possibility that is addressed by Durrleman (syntax—theory of mind) and Eigsti (pragmatics—working memory) in this Special Issue.

Durrleman explores syntax and theory of mind in French-speaking children with ASD across the spectrum, focusing on complement clauses of verbs of communication (*John said that aliens landed in his backyard*). These complements have been claimed to be crucial for belief-attribution in both TD and ASD. However, they are of particular importance in ASD because they may serve to represent subjective truths without implying mental-state verbs, which are difficult for this population (Tager-Flusberg & Joseph 2005). The first study assesses the hypothesis that mastery of sentential complements relates to theory of mind task performance in a *privileged* way as compared to executive

functions, also claimed to influence theory of mind performance (Pellicano 2007). Results show that theory of mind but not executive function correlates with performance on complementation in both ASD and TD children, suggesting a privileged role for complements in theory of mind performance in general (Durrleman & Franck 2015). The second study evaluates whether sentential complements relate not only to theory of mind task *performance* but also to theory of mind *reasoning*. Results confirm that mastery of complements significantly correlates with performance on a nonverbal theory of mind task in ASD, although not TD, suggesting that sentential complements are particularly useful for theory of mind reasoning in ASD, where mentalizing is affected (Durrleman et al. 2016). Finally, preliminary results in a third study suggest that complementation training in children with ASD yields improved theory of mind, suggesting that enhancing complementation may be effective for theory of mind remediation (Durrleman, Gatignol & Delage 2017).

Eigsti builds on prior research examining extralinguistic correlates of language-pragmatic ability in English-speaking children with ASD, in particular working memory. Results from eye-tracking demonstrated the critical role of working memory in the ability to monitor common ground knowledge—a critical component of language pragmatics (Schuh, Eigsti & Mirman 2016). Highly verbal teens with ASD, matched on theory of mind to teens with typical development, are more likely to fixate on items that are not in common ground and are thus not salient targets of discourse, suggesting difficulty in updating representations of information in working memory. This deficit is exacerbated for those individuals with the lowest scores on external assessments of working memory (Jillian, Eigsti & Dan 2016). Results suggest that even controlling for theory of mind, working memory capacity constrains common ground representation (i.e., pragmatic language) in ASD; deficits in extralinguistic cognitive factors, in particular working memory, influence language-pragmatic skills. In this Special Issue, Eigsti presents a study that tests the role of cognitive load—specifically, verbal mediation—in theory of mind. Adolescents with ASD or typical development completed a false belief task with a simultaneous verbal or nonverbal load task. Under verbal load, the ASD group showed less efficient processing of false belief compared to true belief information, and this ability was associated with pragmatic language ability in the ASD group. These results are consistent with the theory that verbal mediation is critical for false belief understanding in ASD but not typical development.

In summary, this Special Issue shows that the study of language development in ASD provides a unique perspective on the associations between the development of syntax, pragmatics, intelligence, theory of mind, and working memory. In addition, it emphasizes the importance of studying children with ASD across the spectrum and across research groups. As such, we tried to lay the groundwork for future analyses of combined data sets. By tackling similar questions, across multiple methods/ages, it is possible to collectively yield a larger sample size and thereby further address the aforementioned interesting questions. Such research serves to address an important question in (typical) language acquisition—whether the acquisition of pragmatics and/or syntax requires general intelligence, working memory, phonological memory, and theory of mind or vice versa.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Stephanie Durrleman http://orcid.org/0000-0003-1883-5703
Inge-Marie Eigsti http://orcid.org/0000-0001-7898-1898

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