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This Section of *Epidemiology and Psychiatric Sciences* regularly appears in each issue of the Journal to describe relevant studies investigating the relationship between neurobiology and psychosocial psychiatry in major psychoses. The aim of these Editorials is to provide a better understanding of the neural basis of psychopathology and clinical features of these disorders, in order to raise new perspectives in every-day clinical practice.

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Language disturbances in ADHD

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This article aims to review the studies exploring language abilities in attention deficit hyperactivity disorder (ADHD; with or without comorbid language impairment) focusing on oral speech discrimination, listening comprehension, verbal and spatial working memory as well as on discourse analysis and pragmatic aspects of communication and language comprehension.

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According to the DSM-IV-TR (APA, 2000), the Attention Deficit Hyperactivity Disorder (ADHD) is characterized by persistent and severe levels of hyperactivity/impulsivity and/or symptoms of inattention, interfering with normal functioning in social, educational and working environments. Even if not included in the core diagnostic criteria of ADHD, language disturbances may often be present (Baker & Cantwell, 1992; Camarata & Gibson, 1999), affecting both linguistic and pragmatic domains. Indeed, hyperactive/impulsive symptoms may result in speaking without thinking or respecting the conversational turn in conversations, interrupting others' speech and talking excessively. These symptoms may reflect an association between ADHD and difficulties in pragmatic aspects of communication. Interestingly, such kinds of impairments (i.e. inappropriate and impulsive behaviours in conversations and relationships), which have been reported in ADHD (Oram *et al.* 1999; Kim & Kaiser, 2000) (Table 1), are somewhat similar to those described in pervasive developmental disorders (Bishop & Baird, 2001; Geurts & Embrechts, 2008) (Table 1) and schizophrenia (Tavano *et al.* 2008; Bellani *et al.* 2009, 2010).

Inattentive symptoms appear to be linked also with language comprehension difficulties, since children do not apparently listen and do not follow teacher's instructions. In their study, Baker & Cantwell (1992) realized indeed that there is a strong association between language impairments (LI) and ADHD (Table 1). Achievement and cognition problems are related to both conditions, and so it is a challenge to define which deficits belong to ADHD, which ones to LI alone and which ones are shared by the two conditions, although the presence of LI is suggested to represent the crucial factor (Cohen *et al.* 2000).

Other authors have mainly focused on working memory abilities in ADHD children, with or without language impairments, reporting different results

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Table 1. *Studies exploring the association between language disturbances and ADHD*

Study	Subjects	Children age range (years)	Language tests	Findings
Baker & Cantwell (1992)	Children with: ADHD + SL disorder ($n = 65$)	6.0–15.3	• Goldman-Fristoe Test of Articulation • Denver Articulation Screening Test • PPVT • Receptive-Expressive-Emerging Language Scale • Test of Auditory Comprehension of Language • Token Test for Children • Illinois Test of Psycholinguistic Abilities • Carrow Elicited Language Inventory • Memory for Sentences Test • Detroit Test of Learning Aptitude	All children presented linguistic deficits: 78% speech articulation, 69% language-processing, 58% expressive language, 34% receptive language.
Oram *et al.* (1999)	Children with: ADHD ($n = 25$), ADHD + LI ($n = 28$), non-ADHD controls ($n = 24$)	7–11	• Test of Word Finding • Rosner's Auditory Analysis Test • CELF-R	ADHD-only children had poor performance on the CELF-R Formulated Sentences subtest.
Cohen *et al.* (2000)	Children with: ADHD + LI ($n = 36$), ADHD ($n = 69$), OPD + LI ($n = 30$), OPD ($n = 31$)	7–14	• PPVT-R • EOWPVT-R • TROG • TOLD Grammatic Understanding and Grammatic Comprehension • CELF-R • DTLA-3-Word Sequences and Story Construction • TAAS • PAT • The Pragmatics Checklist	ADHD + LI and OPD + LI children had poorer language, pragmatic and narrative skills than ADHD and OPD children (exceptions: CELF-R Word Structures subtest and PAT).
Kim & Kaiser (2000)	Children with: ADHD ($n = 11$), TD children ($n = 11$)	6–8	• PPVT-R • TOLD-2 Primary • TOPL • the Pragmatic Protocol	In ADHD children poorer performances on the TOLD-2 sentence imitation and word articulation subtests, speaking quotient and speech-language quotient. More inadequate pragmatic behaviours.

Bishop & Baird (2001)	Parents (*P*) and Teachers (*T*) of children with: Autistic Disorder (*P* = 17; *T* = 15), Asperger Syndrome (*P* = 31; *T* = 23), PDDNOS (*P* = 40; *T* = 28), ADHD (*P* = 22; *T* = 16), SLD (*P* = 9; *T* = 11), Normal Controls (*n* = 31)	5–17	• CCC	ADHD group had low scores on the CCC pragmatic composite similar to Asperger or PDDNOS groups, as evaluated by Parents and Teachers.
McInnes *et al.* (2003)	Children with: ADHD (*n* = 21), ADHD + LI (*n* = 18), LI (*n* = 19), Normal Controls (*n* = 19)	9–12	• PPVT-III • EVT • CELF-3 Receptive Language and Expressive Language • Word Attack WRMT-R • Block Design WISC-III • Narrative and Expository Passage Comprehension Tasks • Comprehension Monitoring Ability-Error Detection Tasks • Verbal and Spatial Memory tasks (Span and Working Memory measures)	The ADHD patients comprehension was impaired in listening to spoken expository passages (inferences and monitoring of instructions), poorer verbal working memory, spatial span and spatial working memory.
Jonsdottir *et al.* (2005)	Children with: ADHD-C + SLI (*n* = 19), ADHD-C non-SLI (*n* = 15), Normal Controls (*n* = 15)	8½–12½	• K-ABC • TOLD-2I	ADHD-C + SLI children had poorer performance only on verbal working memory tasks.
Martinussen & Tannock (2006)	Children with: ADHD (*n* = 62), ADHD + RD/LI (*n* = 32), RD/LI (*n* = 15), Normal Controls (*n* = 34)	7–13	• Digits Forward and Digits Backward subtests from the WISC-III • Finger Windows task from the WRAML	Worse verbal storage in children with RD/LI and ADHD + RD/LI. Deficits in visual-spatial storage and verbal and visual-spatial central executive functions in all clinical groups.
Mathers (2006)	Children with: ADHD (*n* = 11), TD children (*n* = 11)	8–12	• Use of an interactive software to generate an animated cartoon • Three language-sampling tasks (providing a story retell text, providing a recount text and providing a procedural text) • Writing texts task	In ADHD children more abandoned utterances in spoken texts, spelling and punctuation errors in written texts and more tangential and unconnected information.

Continued

Table 1. *Continued*

Study	Subjects	Children age range (years)	Language tests	Findings
Geurts & Embrechts (2008)	Parents of children with: ADHD ($n = 29$), ASD ($n = 29$), TD ($n = 29$)	7–14	• CCC-2	Children with ASD and children with ADHD presented similar pragmatic difficulties, as reported by parents.

ADHD-C, ADHD-Combined subtype; ASD, Autism Spectrum Disorder; CCC, Children's Communication Checklist; CELF-R, Clinical Evaluation of Language Fundamentals-Revised; DTLA-3, Detroit Test of Learning Aptitude-3; EOWPVT-R, Expressive One Word Picture Vocabulary Test-Revised; EVT, Expressive Vocabulary Test; K-ABC, Kaufman Assessment Battery for Children; LI, Language Impairment; OPD, Other Psychiatric Diagnoses; PAT, Photo Articulation Test; PDDNOS, Pervasive Disorder Not Otherwise Specified; RD/LI, Reading Disorder/Language Impairment; PPVT, Peabody Picture Vocabulary Test; PPVT-R, Peabody Picture Vocabulary Test-Revised; SL, Speech-Language; SLD, Specific Learning Disability; SLI, Specific Language Impairment; TAAS, Test of Auditory Analysis Skills; TD, Typical Developing; TOLD, Test of Language Development; TOLD-2I, Test of Language Development-2 Intermediate; TOPL, Test of Pragmatic Language; TROG, Test for the Reception of Grammar; WISC-III, Wechsler Intelligence Scales for Children-III; WRAML, Wide Range Assessment of Memory and Learning; WRMT-R, Woodcock Reading Mastery Test-Revised.

(McInnes *et al.* 2003; Jonsdottir *et al.* 2005; Martinussen & Tannock, 2006) (Table 1). For example, McInnes *et al.* (2003) described altered listening comprehension, spatial span, and verbal and spatial working memory in ADHD children without comorbid LI. In contrast, Jonsdottir *et al.* (2005) showed that working memory abilities were impaired only in ADHD children with language problems. Martinussen & Tannock (2006) noted that working memory may be compromised independently of comorbid reading or language deficits in ADHD. Additionally, in 2006, Mathers analysed the texts of ADHD children observing more abandoned utterances, spelling and punctuation errors, avoidance, tangential and unconnected information in comparison with typical developing children (Table 1).

In conclusion, pragmatic aspects, verbal working memory and discourse analysis seem to be affected in ADHD, being related to language abilities but, partially, also to general executive functions (Cohen *et al.* 2000). Therefore, comorbidity with language disorders in children with ADHD should consistently be detected and, when present, taken into account for intervention strategies, being a good indicator of inattention. Future studies should further characterize the correlations between language impairments and higher cognitive dimensions, trying to plan innovative and specific interventions for ADHD with or without LI.

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