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□ 원 저 □

Characteristics of Language Profiles for Children with Autism Spectrum Disorder Depending on the Coexistence of Attention-Deficit Hyperactivity Disorder

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ABSTRACT

Objectives : The objective of this study was to investigate the characteristics of language profiles according to whether or not Korean children with autism spectrum disorder(ASD) also have ADHD, and to examine the relationship with executive function.

Methods : Participants in the study were boys with ADHD aged 6 to 11 years who visited the clinic from January 2012 to December 2013. In this study, 25 boys with ASD were included, and completed scales included the Korean version of Autism Diagnostic Interview-Revised(K-ADI-R), Korean version of Autism Diagnostic Observation Schedule(K-ADOS), Korean ADHD Rating Scale(K-ARS), and Korean-Conners' Parent Rating Scale(K-CPRS). They also completed neuropsychological tests and assessed language profiles. Patients were categorized into two groups(with ADHD and without ADHD). T-test and Multivariate analysis of covariance (MANCOVA) was used for analysis.

Results : Statistically, no difference was found in receptive and expressive language ability between the ASD groups with and without ADHD. However, a lower score in Test of Problem solving(TOPS) was observed for ASD with ADHD than for ASD without ADHD, with problem solving and finding cues showing significant differences.

Conclusions : These findings suggest that language profiles in the ASD group without ADHD could be similar to those in the ASD group with ADHD, but comorbid ADHD could lead to more difficulty in linguistic ability for problem solving and could be related with executive function of the frontal lobe.

KEY WORDS : Autism spectrum disorder · Attention-deficit hyperactivity disorder · Language · Executive function.

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INTRODUCTION

Autism spectrum disorder(ASD) is a developmental disorder that has persistent deficits in social communication and social interaction and shows restricted and repetitive patterns of behavior, interests, or activities.[1] This is called 'Autism spectrum disorder(ASD)' because DSM 5, the newly revised diagnostic and statistical manual of mental disorders (United States), describes that patients are on a continuous line from a patient group with severe symptoms to a patient group with mild symptoms.[1-3]

Initial theories for the cause of ASD were related with inappropriate nurturing by parents or psychological factors of the patients, but such arguments are currently discredited.4 Recently suggested causes of ASD include organic factors relevant to abnormality in the function or structure of the brain and environmental factors,[5-10] or an interaction of organic and environmental factors.[11,12] A widely-accepted theory suggests that ASD is a syndrome that is expressed by a number of causes.[13,14]

As a kind of syndrome, ASD shows diverse patterns. The core symptoms of many children with ASD include persistent deficits in social communication and social interaction and restricted and repetitive patterns of behavior, interests, or activities. Among these, persistent deficits in social communication and social interaction are observed in most children with ASD, and are important core symptoms that distinguish them from normal children. In this regard, language is the most important element in social communication and social interaction, and thus, a difference in the linguistic ability of each individual is a major element that determines qualitative parts in the domains of the aforementioned two symptoms. As has been reported in previous studies, the impairment of linguistic ability in children with ASD leads to difficulties in the social domain in the future, and is also related with the resulting prognosis of the children. It is a distinct characteristic that distinguishes them from normal children.[15]

Studies on the social/linguistic characteristics of children with ASD have been ongoing. According to the findings of previous studies, developmental language disorder(DLD) shows a qualitative difference from ASD in terms of language development, but the two disorders have common characteristics in some developmental features and cognition. In particular, it was reported that the two disorders accompany other behavioral problems while sharing the common characteristics of delayed language development and lack of sociality.[16,17] According to a study performed in Korea on receptive vocabulary and expressive vocabulary in ASD, an analysis of linguistic characteristics for children with ASD(20−50 months old) showed that the impairment of receptive vocabulary was more distinct than that of expressive vocabulary.[15] This indicates that expressive vocabulary is better preserved than receptive vocabulary, and it is related with the characteristic symptom of child patients such as echolalia. The distinct characteristic of children with ASD due to the impairment of receptive vocabulary brings about considerably negative effects during the acquisition and development of social skills, and thus induces difficulties in developing theory of mind. In other words, the linguistic characteristics of ASD affect the prognosis of children with ASD in relation to deficits in characteristic social communication and interaction.[15]

The expression of diverse symptoms in children with ASD including social/linguistic problems could induce various different behavioral problems depending on the presence of comorbid symptoms, and the degree of the expression of symptoms could vary depending on the coexistence of psychiatric disorder. In other words, children with ASD could show different behavioral and psychiatric symptoms depending on the clinical pattern of the comorbid psychiatric disorder.[16] And children with ADHD also could show the aspect about social problems that similar to aspects shown in children with ASD. But, due to the diverse clinical patterns of children with ASD, if a sufficiently careful assessment is not made when a child with ASD visits a psychiatric clinic, only attention-deficit hyperactivity disorder(ADHD) would be diagnosed while ASD is overlooked, or vice versa. If ADHD is overlooked, therapeutic intervention for child patients with ASD(e.g., sensory integration therapy, speech therapy and occupational therapy) would be unexpectedly limited by unsuitable goals, and thus the therapy outcomes would be affected.

Thus, studies on ASD and comorbid disorder have been ongoing, and existing studies on the analysis of developmental problems among ASD, DLD, and ADHD have suggested associations among the three child groups.[16,17] According to Geurts,[18] the comparison of the linguistic characteristics between school age children with ASD and school age children with ADHD indicated similarities. The linguistic characteristics of these groups were not significantly different, as shown by the fact that both of them had difficulty in the pragmatic aspect of language rather than in the structural aspect. Also, it was found that for ADHD, difficulty in the use of language occurs due to impulsivity rather than inattention,[18] and this linguistic difficulty occurs before the age of 5 and continues until adolescence, causing difficulties in attention or social activity. As mentioned earlier, it is known that the impairment of linguistic ability is closely related with difficulties in social activity. Therefore, for the treatment of patients with ASD who visit a hospital with the chief complaint of language delay or language developmental disorder, understanding the linguistic

characteristics depending on the coexistence of ADHD is very important for providing information on vulnerable areas in terms of language development and for determining required and helpful therapeutic intervention.

This study aimed to examine the linguistic characteristics of school-aged children with ASD in clinical applications, and to investigate the difference in linguistic characteristics in the presence of comorbid ADHD. In addition, the objective of this study was to examine the effect of ADHD on the linguistic characteristics of ASD, and to investigate the relevant aspects of ADHD.

The hypotheses of the study are as follows. First, there is no significant difference in the structural aspect of language between ASD and ADHD, and thus, it was thought that such result could be obtained in the speech test regarding receptive and expressive vocabulary for ASD children with ADHD and ASD children without ADHD. Second, it was thought that ASD children with ADHD would show lower performance in the pragmatic aspect on the speech test compared to the ASD group without ADHD, rather than in the structural aspect, due to the comorbid disorder. Lastly, it was expected that ASD children with ADHD would show a difference in the detailed test related to the use of language due to distinct aspects compared to ASD without ADHD.

MATERIALS AND METHODS

1. Participants

The subjects of this study were children between the ages of 6 and 10 who conducted a language development test among the new outpatients who visited the psychiatric clinic for children and adolescents in Severance Children's Hospital between January 2012 and December 2013 with the chief complaint of ASD-related problems, and data were collected from 51 male children. The research subjects were limited to children diagnosed with ASD based on the DSM 5 diagnosis standard; and those with age limitation and lack of speech test data and child patients diagnosed with organic psychosis due to brain damage were excluded. They were then classified into a child group diagnosed only with ASD(28 subjects) and an ASD child group with comorbid ADHD(23 subjects). This study was approved by the Institutional Review Board(approval number : 2015-06-003).

2. Demographic characteristics

For the demographic characteristics of the two groups, sex, average age and results at the time of the speech test, and intelligence were surveyed. The intelligence of the research subjects was measured using the Korean Educational Developmental Institute's Wechsler Intelligence Scale for Children(KEDI-WISC). ASD was diagnosed by a child psychiatrist based on DSM 5 using clinical interview and reference data, and the tests used for this purpose include the Korean version of Autism Diagnostic Interview-Revised(K-ADI-R) and the Korean version of Autism Diagnostic Observation Schedule(K-ADOS). The presence of comorbid ADHD was diagnosed using the scales of attention tests including the Korean ADHD Rating Scale(K-ARS) and the Korean-Conners' Parent Rating Scale(K-CPRS).[19-22)]

3. Language assessment

The results of the speech-language assessment performed by the speech therapy center of the psychiatric clinic for children and adolescents in Severance Children's Hospital were used for the research and analysis. The speech-language assessment used for the research was based on the results of the Receptive & Expressive Vocabulary Test(REVT) measured through vocabulary test tools by a speech therapist, and include the Receptive & Expressive Vocabulary Test-Receptive(REVT-R) and the Receptive & Expressive Vocabulary Test-Expressive(REVT-E). Also, the Test of Problem solving (TOPS) that had been standardized in Korea by Bae et al. was performed, which is a test developed for measuring upper level language skills that verbalize the logical thinking process of children.[23)] This test consists of a total of 50 questions on 17 scenes that express problem situations, and is made up of three categories that measure linguistic problem solving ability. The three categories include 'Cause and reasoning'(whether one can understand the cause or reason for each situation), 'Problem solving and inferencing'(whether one can properly suggest an alternative for problem solving), and 'Finding cues and supposition'(measuring the ability to suppose circumstantial clues or future situations). Lastly, the Korean Oral Syntax Expression Comprehension Test (KOSECT) that had been standardized in Korea by Bae et al. was performed.[24)] In this test, pictures are presented to children between the ages of 4 and 9, and a target sentence is spoken to them. Then, the children are made to point at a picture among the three pictures. It is a test that can examine the strength and weaknesses of children regarding the meaning of syntax over the multiple lower domains of language.

4. Analysis procedure

The statistical processing of the research data was carried out using SPSS version 18.0. To examine the demographic characteristics between the groups, T-test was performed. To examine the difference and statistical validity in the speech test items between the groups, Multivariate analysis of covariance(MANCOVA) was performed. It was selected to correct the intelligence, which had a high correlation between

the detailed speech test items and could affect the speech assessment, as covariate; and type 1 errors could be reduced through this. In the two-sided test, statistical significance was assigned based on the significance level of $p<0.05$.

RESULTS

1. Comparison of demographic characteristics

Among a total of 51 child patients, the child group diagnosed with ASD only included 28 child patients, and the child group with ASD and ADHD included 23 child patients. The total patient group consisted of males, and thus differences based on sex were not considered. Also, for the total patient group, the results of the test for new outpatients who visited the hospital were used. Accordingly, all the patients had not taken drugs, and thus the effect of drugs could be excluded.

The average age of the total patient group was 7.72(±1.15) years. The child group diagnosed with only ASD had an average age of 7.62(±1.14) years, and the child group with ASD and ADHD had an average age of 7.84(±1.19) years. Thus, there was no statistically significant difference($p>0.05$).

The average total intelligence quotient of the total patient group was 95.61(±20.47), where the average verbal intelligence quotient was 96.83(±18.01) and the average performance intelligence quotient was 98.40(±19.90). Looking at each child group, the child group diagnosed with only ASD had an average total intelligence quotient of 99.11(±19.32), and the child group with ASD and ADHD had an average total intelligence quotient of 91.35(±21.44). The result of the T-test showed that there was no significant difference between the two groups($p>0.05$). For the verbal intelligence quotient, there was also no statistically significant difference between the two groups. However, for the performance intelligence quotient, the child group diagnosed with ASD only had a value of 103.82(±21.97), and the child group with ASD and ADHD had a value of 88.26(±20.61). Thus, there was a significant difference between the two groups($p<0.05$)(Table 1).

2. Comparison of linguistic characteristics between the two groups

Based on the results of REVT, the REVT-R and REVT-E of the two child groups were compared. The group diagnosed only with ASD had an average REVT-R score of 84.18 (±22.19) and an average REVT-E score of 84.57(±16.64). These scores were higher than those of the child group with ASD and ADHD[an average REVT-R score of 75.57(±15.32) and an average REVT-E score of 78.87(±11.87)]. Despite this difference, when a multivariate test was performed for the above scores by correcting for intelligence, there was no significant difference between the two groups(REVT-R $p>0.05$, REVT-E $p>0.05$)(Table 2).

3. Comparison of detailed speech test items between the two groups

For the speech test results of the two groups, the values of

Table 1. Demographic and clinical scores of participants

		Mean(SD)		p value
		ASD group(n=28)	ASD & ADHD group(n=23)	
Age, y		7.62(1.13)	7.84(1.19)	0.501
Measures of intelligence	FSIQ	99.11(19.32)	91.35(21.44)	0.186
	VIQ	96.11(19.13)	94.43(23.36)	0.784
	PIQ	103.82(21.97)	88.26(20.61)	0.012*

Group differences tested using t-square test. All participants were man. * : significant group differences at $p<0.05$, 2tailed, measured with t tests. ASD : autism spectrum disorder, ADHD : attention-deficit hyperactivity disorder, SD : standard deviation, FSIQ : full scale intelligence quotient, VIQ : verbal intelligence quotient, PIQ : performance intelligence quotient, NA : not allocable

Table 2. Comparisons of language profile in 2 groups

		Mean(SD)		p value
		ASD group(n=28)	ASD & ADHD group(n=23)	
REVT	REVT-R	84.18(22.19)	75.57(15.32)	0.141
	REVT-E	84.36(16.64)	78.87(11.87)	0.334
	Cause & reasoning	11.46(4.17)	9.26(3.81)	0.113
TOPS	Problem solving & inferencing	10.61(5.76)	6.57(2.97)	0.010*
	Finding cues & supposition	7.07(4.91)	4.17(3.21)	0.047*
KOSECT		43.36(11.47)	42.65(10.14)	0.902

* : significant group differences at $p<0.05$, MANCOVA controlled for intelligence as covariates. ASD : autism spectrum disorder, ADHD : attention-deficit hyperactivity disorder, SD : standard deviation, REVT-R : Receptive & Expressive Vocabulary Test- Receptive, REVT-E : Receptive & Expressive Vocabulary Test- Expressive, TOPS : Test of Problem solving, KOSECT: Korean Oral Syntax Expression Comprehension Test

the TOPS items including 'Cause and reasoning,' 'Problem solving and inferencing' and 'Finding cues and supposition' and the KOSECT items were compared, and the differences were examined. In terms of the KOSECT items, the score of the child group with ASD and ADHD[42.65(±10.14)] was lower than that of the group diagnosed with only ASD[43.36 (±11.47)], but there was no statistically significant difference ($p>0.05$).

Looking at the detailed items of TOPS, the differences in the 'Problem solving and inferencing' and 'Finding cues and supposition' scores between the child group diagnosed with only ASD[10.61(±5.77) and 7.01(±4.91), respectively] and the child group with ASD and ADHD[6.57(±2.97) and 4.17 (±3.21), respectively] were more distinct than the differences in the 'Cause and reasoning' scores. In the multivariate analysis that corrected for intelligence, there was also a significant difference('Problem solving and inferencing' $p<0.05$, 'Finding cues and supposition' $p<0.05$). For 'Cause and reasoning,' there was no statistically significant difference between the two groups($p>0.05$)(Fig. 1, Table 2).

DISCUSSION

The group of 51 children with ASD who had taken a speech test in this study was divided into 28 children diagnosed with only ASD and 23 children with ASD and ADHD, and the differences in the demographic indices, speech test characteristics, and detailed test items were examined. A discussion of the results follows.

When the intelligence scores of the two groups were compared, there was no significant difference found between the two groups in total intelligence or in verbal intelligence, but for performance intelligence, the child group diagnosed with only ASD had a significantly higher score. In other words, the child group with ASD and ADHD did poorly on the performance intelligence test compared to the child group diagnosed with only ASD. According to existing studies on the relationship between ADHD and intelligence,[25,26] the performance intelligence of those diagnosed with ADHD is impairedted more significantly than the verbal intelligence, and items related to attention or processing speed showed distinct impairment. Regarding this deviation of verbal intelligence and performance intelligence, some studies reported the opposite results, and thus further research including on motivation or cultural differences among participants is needed in the future. However, considering that other studies suggest the potential of using this characteristic as a diagnostic tool for ADHD,[26,27] the impairment of performance intelligence could be regarded as one of the characteristics induced by ADHD symptoms, and this could be explained by the impairment of impulsivity control and performance ability observed in ADHD children, compared to general children. The fact that the child group with ASD and ADHD showed significantly lower performance intelligence than the child group diagnosed with only ASD in our study indicates that when ASD accompanies ADHD, children are affected by the symptoms of ADHD.

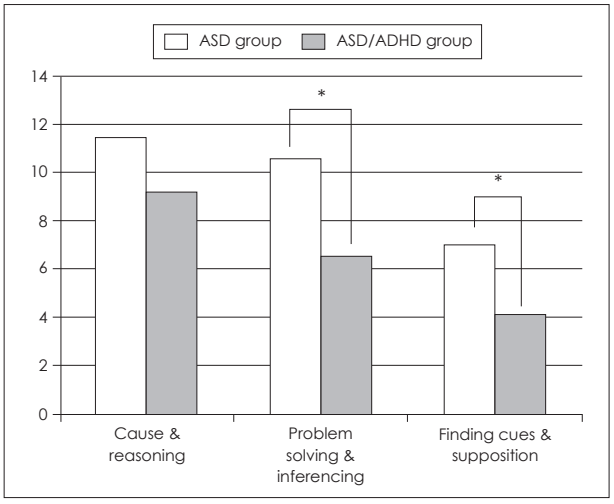

Fig. 1. Difference of score about TOPS in 2 groups. * : significant group differences at $p<0.05$, MANCOVA controlled for intelligence as covariates. ASD : autism spectrum disorder, ADHD : attention-deficit hyperactivity disorder.

However, for the REVT results of the children diagnosed with only ASD and the children with ASD and ADHD in this study, there was no significant difference between the two groups. According to the findings of existing studies mentioned earlier, both ASD children and ADHD children have linguistic difficulty in the pragmatic aspect rather than the structural aspect, which suggests that ASD children and ADHD children have similar linguistic characteristics. Considering this, it is thought that although ASD children have comorbid ADHD, a significant difference between the two groups would not be observed by REVT which is a measurement tool for vocabulary rather than the use of language. In other words, it is difficult to estimate correlation for linguistic ability depending on comorbid ADHD using a test that simply measures vocabulary in relation to the structure of language, and thus no significant difference between the two groups could be measured in this study. The result of REVT showed that there was no significant difference in vocabulary between the child group diagnosed with only ASD and the child group with ASD and ADHD, but it is difficult to analyze the difference in the impairment of linguistic ability between the two groups. In addition to REVT, KOSECT was analyzed in this study, and the result also showed that there was no significant difference between the child group diagnosed only with ASD and the child group diagnosed with ASD and ADHD.

As explained earlier, KOSECT, which showed no difference between the two groups, is a tool that examines the lower domain of language(whether one understands syntax in sentences). In other words, this indicates that the coexistence of ASD and ADHD had no significant effect on the lower domain of language.

On the other hand, in the case of TOPS, a significant difference could be observed in 'Problem solving and inferencing' and 'Finding cues and supposition' excluding 'Cause and reasoning.' Unlike KOSECT, which examines the lower domain of language, TOPS is known to be a tool that examines the upper domain of language, which verbalizes logical thinking processes and measures linguistic problem solving ability. Based on this, the fact that the child group with ASD and ADHD showed no significant difference in KOSECT yet showed a difference in TOPS compared to the child group with ASD indicates that the presence of comorbid ADHD affected the upper domain of language such as logical thinking or linguistic problem solving ability rather than the lower domain of language such as simple understanding of syntax. The performance intelligence result of this study showed that children were affected by comorbid ADHD symptoms. Thus, the question of which symptom of ADHD affects the linguistic problem solving ability of ASD children needs to be examined. In the study of Geurts mentioned previously,[18] ADHD children showed difficulty in the pragmatic aspect of language, similar to ASD children, which was due to the impulsivity of ADHD children, rather than inattention. Therefore, the fact that the child group with ASD and ADHD showed a greater impairment of linguistic ability than the child group diagnosed with only ASD in our study could be due to the effect of impulsivity from comorbid ADHD. In other words, the child group with comorbid ADHD has higher impulsivity than the child group diagnosed with only ASD, and thus the performance ability of language use could deteriorate. In various neuropsychological studies on ADHD, it has been reported that the failure of behavioral response suppression in ADHD due to the impairment of frontal lobe function induces the decline of executive function, including logical thinking or linguistic function). In the case of comorbid ADHD, the decreased frontal lobe function affects high level linguistic ability and logical thinking as well as showing clinical symptoms such as the decline of impulsivity, and thus, the function of linguistic problem solving deteriorates. In other previous studies,[28,29] it was reported that ADHD children had similar vocabulary or verbal ability to ASD children but showed weaker sentence comprehension(reading and understanding sentences), and that this was associated with impulsivity-related symptoms. These results are consistent with the findings of our study, in which comorbid ADHD induced difficulties in linguistic ability or logical thinking due to the impairment of frontal lobe function.

Then, the degree of comorbid ADHD's effect on frontal lobe function, linguistic problem solving ability, and social communication also needs to be considered. In various previous studies,[30-32] it was reported that the abnormality in the frontal lobe observed in the brain structural approach of ADHD children was also observed in ASD children, and in particular, this was related with difficulties in social cognition and social interaction. According to the findings of the above studies, frontal lobe function and related high level linguistic thinking function could only deteriorate due to ASD. However, when children diagnosed with only ASD and children with ASD and ADHD were compared in our study, the children with ASD and ADHD showed lower problem solving ability than the children diagnosed with only ASD. In other words, the frontal lobe function that had already impaired due to ASD alone was deteriorated further due to comorbid ADHD. For children with comorbid ADHD, the impairment of frontal lobe function was more distinct in the expression of ASD symptoms, and this induced larger difficulties in the linguistic problem solving ability of the patients.

To summarize, when children diagnosed with only ASD and children with ASD and ADHD were compared, comorbid ADHD seemed to have no effect on their existing ability to understand vocabulary or syntax. However, comorbid ADHD significantly impaired the use of language such as logical thinking and problem solving through language, and this would have a large effect on the prognosis of ASD children.

The limitations of this study are as follows. First, it is difficult to generalize the result of this study because the number of samples was limited and only male children were examined. This is thought to be the effect of excluding patients with severe intelligence impairment, the aim of which was to minimize the effect of intelligence in this study. Although the number of subjects was inappropriate for generalization, this is thought to be an inevitable problem for the maximum correction of the effect of intelligence. Second, the relationship between linguistic performance for each major symptom of ADHD(e.g., inattention and impulsivity) and speech test characteristics was not included in this study, and as such, it is difficult to clearly associate impulsivity with linguistic performance ability. In addition, the severity of ASD symptoms was not considered, and thus, studies on association depending on each detailed symptom need to be performed in the future. Third, communication includes both non-verbal and verbal parts, and it is insufficient to mention the correlation of linguistic problem solving ability or executive function based only on low performance in a speech test. Thus, more detailed studies are needed in the future.

However, in this study, it was found that impulsivity-related symptoms or comorbid disorder had an important role in the linguistic problem solving ability and characteristics of ASD children. This study was the first study in Korea to examine the impairment of frontal lobe-related executive function in the linguistic aspect for ASD with comorbid ADHD. In this regard, the association needs to be demonstrated further based on various additional studies or brain imaging test results for actual relevant parts, and executive function cannot be represented by linguistic functions alone. However, our study would be a paper that presented an alternative approach since it evaluated both the lower domain of language(e.g., vocabulary and syntax) and the upper domain of language(e.g., logical thinking and linguistic problem solving ability) and also selected a method that approaches a problem in the linguistic aspect which had not been easily achieved in existing research. Also, by directly examining the significance between the two groups, rather than a simple hypothesis, this study could be a step forward towards the pathology relevant to the linguistic problem solving ability of ASD children. It is thought that the major symptoms associated with the linguistic problem of ASD children depending on comorbid disorder, and relevant brain parts. could be investigated by addressing the limitations of our study, and this would be an important foundation for developing a better protocol of linguistic intervention and speech therapy.

Between the child group diagnosed with only ASD and the child group with ASD and ADHD, there was no distinct difference in the ability to understand vocabulary or syntax, and the developmental linguistic characteristics were similar. However, in the TOPS of the children with comorbid ADHD, lower performance was observed in 'Problem solving and inferencing' and 'Finding cues and supposition'. This indicates that the increase in impulsivity and the difficulty in frontal lobe executive function due to comorbid ADHD could be related with linguistic ability. In other words, through further studies on this, symptoms relevant to the linguistic problem of ASD children would be improved by treatment and intervention.

REFERENCES

(1) **American Psychiatric Association.** Diagnostic and Statistical Manual of Mental Disorders, DSM 5. Washington, DC: American Psychiatric Association;2013.

(2) **Benjamin JS, Virginia AS, Pedro R.** Kaplan & sadock's synopsis of psychiatry behavioral sciences/clinical psychiatry (11th Ed). Philladelpia: Wolters kluwer;2014.

(3) **Volkmar FR, Lord C, Bailey A, Schulz RT, Klin A.** Autism and pervasive developmental disorders. J Child Psychol Psychiatry 2004;45:135-170.

(4) **Volkmar FR.** Autism and the pervasive developmental disorders. In: Lewis M, Baltimore, William & Wilkins, editors. Lewis's Child and Adolescent psychiatry(4th Ed). Philladelpia: Wolters kluwer;2007.

(5) **Folstein SE, Rosen SB.** Genetics of autism: complex a etiology for a heterogeneous disorder. Nat Rev Genet 2001;2:943-955.

(6) **Rimland B.** Infantile autism: the syndrome and its implication for a natural theory of behavior. New York: Appleton-Century Crofts;1997.

(7) **Piven J.** The biological basis of autism. Curr Opin Neurobiol 1997;7:708-712.

(8) **Stokstad E.** Development: New hints into the biological basis of autism. Science 2001;294:34-37.

(9) **Ornitz EM, Ritvo ER.** The syndrome of autism: a critical review. Am J Psychiatry 1976;133:609-621.

(10) **Demyer MK.** Research in infantile autism: a strategy and its results. Biol Psychiatry 1975;10:433-452.

(11) **Weiland IH.** Development of psychotic children and their siblings. Develop Med Child Neurol 1964;8:552-560.

(12) **Mahler MS.** On early infantile psychoses: the symbiotic and autistic syndromes. J Am Acad Child Psychiatry 1965;4:554-568.

(13) **Smalley SL.** Genetic influences in autism. Psychiatr Clin North Am 1991;14:125-139.

(14) **Smalley SL.** Genetic influences in childhood onset psychiatric disorders: autism and attention-deficit/hyperactivity disorder. Am J Hum Genet 1997;60:1276-1282.

(15) **Seol KI, Song SH, Kim KL, Oh ST, Kin YT, Im WY, Song DH, Cheion KA.** A comparison of receptive-expressive language profiles between toddlers with autism spectrum disorder and developmental language delay. Yonsei Med J 2014;55:1721-1728.

(16) **Cho SJ, Kwak YS, Kang GM.** A study on comorbid disorders and associated symptoms of pervasive developmental disorder children J Korean Acad Child Adolesc Psychiatry 1999;10:64-75.

(17) **Comings DE, Comings BG.** Clinical and genetic relationships between autism-pervasive developmental disorder and Tourette syndrome: A study of 19 cases. Am J Med Genet 1991;39:180-191.

(18) **Geurts HM, Embrechts M.** Language profiles in ASD, SLI, and ADHD. J Autism Dev Disord 2008;38:1931-1943.

(19) **Yoo H, Kwak Y.** Korean version of Autism Diagnostic Observation Schedule(ADOS). Seoul: Hakjisa;2007.

(20) **Yoo H.** Korean version of Autism Diagnostic Interview-Revised(ADI-R). Seoul: Hakjisa;2007.

(21) **Bahn GH, Shin MS, Cho SC, Hong KE.** A preliminary study for the development of the assessment scale for ADHD in adolescents : reliability and validity for CASS. J Korean Acad Child Adolesc Psychiatry 2001;12:218-224.

(22) **Park EH, So YK, Kim YS, Choi NK, Kim SJ, Noh JS, Ko YJ, Kim YS.** The reliability and validity of Korean-Conners' parent and teacher rating scale. J Korean Acad Child Adolesc Psychiatry 2002;14:183-196.

(23) **Bae SW, Im SS, Lee JH.** Test of Problem solving(TOPS). Seoul: Seoul Community Rehabilitation Center;2000.
(24) **Bae SW, Im SS, Lee JH, Jang HS.** Korean Oral Syntax Expression Comprehension Test(KOSECT). Seoul: Seoul Community Rehabilitation Center;2004.
(25) **Min JW, Lee WH, Hong MH, Bahn GH.** A pilot studty of the usefulness of intelligence test in assessment of attention-deficit hyperactivity disorder. J Korean Acad Child Adolesc Psychiatry 2012;23:196-203.
(26) **Assesmany A, McIntosh DE, Phelps L, Rizza MG.** Discriminant validity of the WISC-III with children classified with ADHD. J Psychoeduc Assess 2001;19:137-147.
(27) **Hong KE.** Korean textbook of child psychiatry. Korea: Hakjisa;2014.
(28) **Kim KW, Jo SJ, Kim WS.** Research trends in reading skills of children with autism spectrum disorder. J Spec Educ 2015; 16:307-330.
(29) **Asberg J, Dahlgren SO, Sandberg AD.** Basic reading skills in high-functioning Swedish children with autism spectrum disorders or attention disorder. Res Autism Spectr Disord 2008; 2:95-109.
(30) **Lee MJ, Ahn SW, Kim HJ, Seo YK.** Brain science approach of childhood disorder; reading disability, ADHD and autism. J Spec Educ 2007;8:153-172.
(31) **Filipek, PA.** Neuroimaging in the developmental disorders: The state of the science. J Child Psychol Psychiatry 1999;40: 113-128.
(32) **Casey BJ, Castellanos FX, Giedd JN, Marsh WL, Hamburger SD, Schubert AB, Vauss YC, Vaituzis AC, Dickstein DP, Sarfatti SE, Rapoport JL.** Implication of right frontostriatal circuitry in response inhibition and attention deficit-hyperactivity disorder. J Am Acad Child Adolesc Psychiatry 1997;36:374-383.