

전산화 신경인지기능검사를 이용한 주의력결핍/과잉운동 장애의 주의력결핍특성에 관한 연구

CHARACTERISTICS OF ATTENTION DEFICIT OF ADHD ON COMPUTERIZED NEUROCOGNITIVE FUNCTION TESTS

정선주* · 신민섭* · 하규섭** · 홍강의**†

Sun-Ju Chung, M.D.,* Min-Sup Shin, M.A.,*
Kyoo-Seob Ha, M.D.,** Kang-E Hong, M.D.**†

요 약 :

본 연구는 전산화 신경인지기능검사(Computerized Neurocognitive Function Tests)를 이용하여 주의력결핍/과잉운동장애(ADHD) 환자의 주의력결핍 특성을 규명하고자 하였다. 연구 대상자는 서울대학교병원 소아정신과에 내원한 ADHD 환자 30명(남자 22명, 여자 8명)으로, 평균 연령은 7.5세였다. 검사 도구는 컴퓨터화된 신경인지기능검사(Computerized Neurocognitive Function Tests)로, 주의력결핍 특성(Attention Deficit)과 과잉운동 특성(Hyperactivity)을 평가하였다. 연구 결과는 다음과 같다. ADHD 환자는 정상 대조군에 비해 주의력결핍 특성(Attention Deficit)이 유의하게 높았으며, 과잉운동 특성(Hyperactivity)도 유의하게 높았다. 특히, 주의력결핍 특성(Attention Deficit)은 인지 과정(cognitive process)과 관련이 있는 것으로 나타났다. 또한, 과잉운동 특성(Hyperactivity)은 주의력결핍 특성(Attention Deficit)과 관련이 있는 것으로 나타났다. 본 연구의 결과는 ADHD 환자의 주의력결핍 특성을 규명하는 데 도움이 될 것으로 기대된다.

중심 단어 : ADHD, 주의력결핍, 과잉운동, 컴퓨터화된 신경인지기능검사, 인지 과정(cognitive process), 과잉운동 특성(Hyperactivity), 주의력결핍 특성(Attention Deficit), (Douglas, 1983a), (Attention deficit/Hyperactivity disorder), (attention)

* Division of Child & Adolescent Psychiatry, Seoul National University, Children's Hospital, Seoul
 ** Division of Neuropsychiatry, Seoul National University Hospital, Seoul
 †Corresponding author

(: , , (tonic change of vigilance)
)
 /

가 가
 (van deer Meere 1995) /

가
 (phasic change of vigilance)
 (preparedness)

가 가
 Zahn (1991) (disruptive behavior disorder)
 (preparatory interval) 2 , 4 , 8

1. 경계력(Vigilance)
 (Mackworth 1950) ' ' 가 ,
 가 가 가
 (attention capacity) 가 가 가

(Corkum Siegel 1993). (level of 가 (temporal uncertainty)
 vigilance) ainty)
 (target stimuli)

2. 선택적 주의력(Selective attention)
 (Continuous Performance Test (distraction,
 (CPT))(Rosvald 1956) (monitoring task))
 가 /
 가 ' (pay attention) ' (nonselective)

(van deer Meere 1995) (Davidson Prior 1978 ; Hiscock 1979)
 / (signal detection theory) (perceptual

sensitivity) (decision criterion level)

(Sostek 1980 ; Neuchterlein 1983).

(frontal lobe)

3. 지속적 주의력(Sustained attention)

(monitoring task) 가
/ 가
(CPT) /

가 가
(flexibility),
/ 가
가
(single photon emission
computed tomography : SPECT)

(Neuchterlein 1983 ; O'Dougherty 1984 ; Prior 1985 ; Werry 1987 ; Schachar 1988 ; Smith 1989).

가
(Sieg 1995).

가
(group by time interaction)
(Corkum Siegel 1993)

(self regulation inhibition)
가 (Douglas 1988b)

(Sykes 1973).

4. 정보처리과정(Information processing)

(input) (re-
sponse)
가
가

가
가
가
가
가

가 . Hoy
(1978) / 2
가

5

Leung Connolly(1994)
가

연구 대상 및 방법

가 가 가

1. 연구 대상
1996 2 1996 8

5. 실행능력(Executive function)
(goal directed activity)

(1) DSM-
(American Psychiatric Association, 1994)

/ (2) 가

가 (3) , ,
(neurofibromatosis) 3

(4) DSM - , , 20 5%

(5) Methylphenidate, pemoline,
D - amphetamine, clonidine, antipsychotics, antide-
pressant 2

2) 신호 탐지 검사(Signal detection : SIGNAL)

(dis-
tractor)가

(1) 가 15
가 15
(2) 가 (Home Situation
Questionnaire) 16 50%
(School situation Questionnaire)
12 50% 4
(3) KEDI - WISC 가 80 0.75
3.75
20 6% 14

3) 지속적 주의력 검사(Continuous Attention : DAUF)

가
가
(3) DSM - 가 가
(4) Methylphenidate, pemoline,
D - amphetamine, clonidine, antipsychotics, anti -
depressant 5 5
(5) 가 (Conner's
Abbreviated Teacher's and Parent's rating scale) 2 1
0.3 25
10 (6) 20%
23

4) 교차현상검사(Crossover : CROSS)
(Warning signal)
가 가
(imperative stimuli)가

2. 사용 도구-신경심리학적 검사도구

1) 경계력 검사(Vigilance : VIGIL)
가 가 (preparedness)
117 가 (ATT -
가 20 가

Table 2. Level of vigilance-results from Vigilance (VIGIL)^A & Selective attention-results from Signal detection (SIGNAL),^A Continuous attention (DAUF)^A

Measure	ADHD ⁷⁾	Control	p value
CR ¹⁾ -VIGIL	13.6 (3.1)***	18.9 (1.2)	.000
CE ²⁾ -VIGIL	16.7 (14.7)***	1.8 (1.8)	.000
MRT ³⁾ -VIGIL	1.0 (0.2)***	0.8 (0.2)	.000
S.D. of RT ⁴⁾ -VIGIL	0.4 (0.1)***	0.2 (0.1)	.000
CR-SIGNAL	34.1*** (5.4)	44.7 (5.7)	.000
CR-DAUF	68.5* (42.5)	99.6 (48.1)	.03
CE-SIGNAL	18.5* (30.8)	2.4 (2.2)	.027
CE-DAUF	150.2* (42.5)	81.6 (63.7)	.019
d ⁵⁾ -SIGNAL	0.88*** (0.03)	0.94(0.03)	.000
d ⁵⁾ -DAUF	0.63** (0.15)	0.72(0.17)	.006
β ⁶⁾ -SIGNAL	0.18*** (0.05)	0.24(0.02)	.000
β ⁶⁾ -DAUF	0.19** (0.26)	0.42(0.28)	.008

A : Mean values are shown, with S.D. in parenthesis
 CR¹⁾ : Number of correct response
 CE²⁾ : Number of commission error
 MRT³⁾ : Mean Reaction time
 S.D. of RT⁴⁾ : Standard deviation of reaction time
 d⁵⁾ : Perceptual sensitivity
 β ⁶⁾ : Decision criterion level
 ADHD⁷⁾ : Attention-Deficit/Hyperactivity disorder
 *p<0.05 **p<0.01 ***p<0.001 : Significantly different from patients with ADHD by Student's t-test.

3) 경계도의 위상성 변화

Table 4
 (preparatory interval)

Table 3. Vigilance-time on task effect^A : results from Vigilance (VIGIL)

Group	ADHD ⁴⁾				Control			
	Block 1	Block 2	Block 3	Block 4	Block 1	Block 2	Block 3	Block 4
CR ¹⁾ ,a,b,c	3.9(1.1)	3.8(1.1)	2.9(1.3)	2.9(1.7)	4.7(0.9)	4.8(0.39)	4.7(0.7)	4.7(0.6)
CE ²⁾ ,a,b,c	2.0(1.6)	5.7(5.8)	4.9(4.4)	4.2(4.7)	0.6(1.1)	0.4(0.7)	0.4(0.7)	0.7(0.9)
MRT ³⁾ ,a,b(msec)	96.0(20.2)	104.2(20.5)	105.8(25.3)	107.8(29.4)	67.9(16.4)	75.5(18.3)	76.9(20.9)	85.8(26.9)

A : Mean values are shown, with S.D. in parenthesis
 CR¹⁾ : Number of correct response
 CE²⁾ : Number of commission error
 MRT³⁾ : Mean Reaction Time
 ADHD⁴⁾ : Attention-Deficit/Hyperactivity disorder
 Statistical test results are significant main and interaction effect from repeated measure ANOVA indicated by superscripts, where ^a = main effect for group ^b = main effect for block ^c = group × block interaction

Table 4. Level of preparedness to response-results from Crossover(CROSS)^A

Group	ADHD ²⁾		Control	
	Regular ^{a,b}	Irregular ^{a,b}	Regular	Irregular
PI ¹⁾ (sec)\series				
1 ^{a,d}	341.7(75.5)*	460.9(80.1)**	264.0(61.4)	362.3(48.5)
3 ^a	383.1(79.8)**	385.6(71.2)**	289.9(62.8)	297.5(45.6)
7 ^{a,d}	402.3(81.8)**	372.3(81.2)*	314.3(59.8)	306.5(51.9)

A : Mean values are shown, with S.D. in parenthesis
 PI¹⁾ : Preparatory interval
 ADHD²⁾ : Attention-Deficit/Hyperactivity disorder
 *p<0.05 **p<0.01 ***p<0.001 : Significantly different from patients with ADHD by Student's t-test
 Statistical test results are significant main and interaction effect from repeated measure ANOVA indicated by superscripts, where ^a = main effect of group (ADHD, control), ^b = main effect of PI (1sec, 3sec, 7sec), ^c = group × PI interaction, ^d = main effect of series (regular/irregular) ^e = group × series interaction

(regular series) 가 가

(ir-regular series) 가 가

(temporal uncertainty) 1 3

2) 지속적 주의력(Sustained attention) 가

3. 선택적 지속적 주의력(Selective sustained attention) 과제수행결과

-신호탐지 검사(SIGNAL), 지속적 주의력 검사(DAUF)

1) 선택적 주의력 (Table 2)

Table 5

Table 6

(d' : perceptual sensitivity), (: decision criterion level) 가

(internal perceptual evidence) 가

Table 5. Sustained attention-time on task effect : results form Signal detection(SIGNAL)^A

Group	ADHD ⁴⁾				Control			
	Block 1	Block 2	Block 3	Block 4	Block 1	Block 2	Block 3	Block 4
Measures								
CR ¹⁾ .a,b	10.0(1.9)	9.2(2.07)	6.9(2.3)	8.8(4.8)	12.3(1.7)	12.4(1.4)	10.1(2.8)	9.9(2.2)
CE ²⁾ .a	3.2(4.3)	7.0(15.22)	3.9(6.7)	4.2(8.0)	0.7(0.7)	0.6(0.8)	0.4(0.7)	0.3(0.7)
MRT ³⁾ .a,b (msec)	164.8(40.5)	164.7(36.9)	193.1(44.8)	180.5(33.3)	152.5(30.7)	144.9(34.0)	162.1(47.3)	161.2(44.2)

A : Mean values are shown, with S.D. in parenth
 CR¹⁾ : Number of correct response CE²⁾ : Number of commission error
 MRT³⁾ : Mean Reaction Time ADHD⁴⁾ : Attention-Deficit/Hyperactivity disorder
 Statistical test results are significant main and interaction effect from repeated measure ANOVA indicated by superscripts, where ^a = main effect for group ^b = main effect for block ^c = group×block interaction

가 , 가 , 가 (3) , 가
 가 / (2) 가
 가 가
 4. 정보처리 과정 (Table 7)-반응결정력 검사 /
 1 , /
 2 5. 실행능력-주의력 감독 조절능력 (Table 8)
 /
 3 가 B /
 가 가
 가
 1 3 가 가 가 /
 4가

Table 6. Sustained attention-time on task effect : results from Continuous attention(DAUF)^A

Group	ADHD ⁴⁾					Control				
	Block 1	Block 2	Block 3	Block 4	Block 5	Block 1	Block 2	Block 3	Block 4	Block 5
CR ¹⁾ . ^a	14.9 (9.0)	13.7 (8.5)	13.8 (8.9)	13.0 (10.2)	13.2 (8.5)	19.6 (10.2)	19.4 (10.0)	18.7 (11.2)	19.9 (10.6)	22.1 (10.2)
CE ²⁾ . ^a	32.4 (24.6)	29.9 (22.6)	25.7 (21.8)	23.7 (21.4)	27.4 (25.2)	16.7 (13.4)	17.0 (15.0)	15.6 (12.2)	15.7 (14.6)	16.7 (17.7)
MRT ³⁾ (msec)	83.1 (17.8)	87.7 (21.4)	89.6 (24.6)	77.8 (20.0)	82.6 (23.4)	93.1 (23.1)	92.3 (23.7)	90.5 (17.3)	86.3 (22.3)	91.1 (18.5)

A : Mean values are shown, with S.D. in parenthesis

CR¹⁾ : Number of correct response

CE²⁾ : Number of commission error

MRT³⁾ : Mean Reaction Time

ADHD⁴⁾ : Attention-Deficit/Hyperactivity disorder

Statistical test results are significant main and interaction effect from repeated measure ANOVA indicated by superscripts, where ^a = main effect for group ^b = main effect for block ^c = group × block interaction

Table 7. Information processing capacity-results from Reaction Unit (RG)

	ADHD ⁶⁾			Control		
	C1 ⁷⁾	C2 ⁸⁾	C3 ⁹⁾	C1	C2	C3
CR (%) ¹⁾ . ^{a,b}	91.6** (11.0)	85.8** (14.5)	82.9** (13.4)	99.4 (2.1)	98.7 (4.1)	94.5 (7.3)
CE (%) ²⁾ . ^{a,b,c}	7.0* (7.0)	7.8*** (1.1)	25.7** (19.6)	2.6 (4.1)	1.1 (2.4)	10.7 (6.2)
RT ³⁾ . ^{a,b}	599.3** (142.9)	611.1** (98.2)	709.3 (119.1)	485.1 (74.8)	520.2 (74.8)	636.4 (121.3)
DT ⁴⁾ . ^b	339.4** (59.3)	380.9** (66.9)	444.3 (128.8)	291.9 (46.0)	333.4 (40.6)	449.9 (102.8)
MT ⁵⁾ . ^a	250.0* (99.1)	205.9 (61.9)	239.2* (104.6)	185.8 (41.7)	177.9 (42.5)	179.4 (56.3)

A : Mean values are shown, with S.D. in parenthesis

CR (%)¹⁾ : Percentage of correct response/total target stimuli

CE (%)²⁾ : Percentage of commission error/total nontarget stimuli

RT³⁾ : Response Time

DT⁴⁾ : Decision Time MT⁵⁾ : Motor Time

ADHD⁶⁾ : Attention-Deficit/Hyperactivity disorder C1⁷⁾ : Condition 1 C2⁸⁾ : condition 2 C3⁹⁾ : condition 3

*p<0.05 **p<0.01 ***p<0.001 : Significantly different from patients with ADHD by Student's t-test.

Statistical test results are significant main and interaction effect from repeated measure ANOVA indicated by superscripts, where ^a = main effect of group (ADHD, control), ^b = main effect of condition, ^c = group × condition interaction

Table 8. Executive function test-Supervisory Attentional Control(SAC)

	ADHD ²⁾ (n=21)	Control (n=22)	p value
Category fluency	12.8 (4.4)**	17.6 (4.9)	.001
Verbal fluency	16.8 (6.6)*	22.6 (9.1)	.020
Trailmaking test B-total reaction time	175.1 (83.2)**	116.7 (45.0)	.008
SPM ¹⁾ -total correct response	30.4 (8.7)***	42.3 (8.1)	.000

A : Mean values are shown, with S.D. in parenthesis

SPM¹⁾ : Standard progressive matrices ADHD²⁾ : Attention-Deficit/Hyperactivity disorder

*p<0.05 **p<0.01 ***p<0.001 : Significantly different from patients with ADHD by Student's t-test

/

고찰

가 ‘ ’

/

가

/

가 /

가

가

/

(low stimulus environment) ’

(high stimulus environment) ’

가

가

/

(Neuchterlein 1983 ; Prior 1985 ;

Werry 1987 ; O’ dougherty 1988 ; Schachar (underarousal theory)(Zentall 1983) -

1988 ; Smith 1989). van der Meere /

(1995) 가 (suboptimal activation state)

가

가

가

1,

2

3

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가 가 , ,
 / , 가
 가 / /
 paired associate learning 가 /
 (Conte 1986) 가 가 가 가
 가 (Zahn 1991), . Strauss Lehtinen(1947)
 가
 가 가
 (van deer Meere 1992) .
 /
 가 가
 가 가
 (Environmental Manipulation) 3 / 가
 / 가 1
 가 가 가
 가 가 가
 가 가 (su-
 / pervisory attentional control : SAC)
 1 , 3 , 7 / B
 가 가 가 가
 (Zahn 1991) 가
 (/ 가
 : /), (self regu-
 (1, 2, 8 : 1, 3, 7) lation & inhibition)
 / (prefrontal
 lobe)
 (Luria 1973 ;
 Contingent Negative Variation(CNV) Gorenstein 1989 ; Barkley 1991).
 / 가
 /

(reticular activation system : RAS)가
(brain stem)

가

가
TOVA

(network)

가

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(motivation), (reward),

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6가

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Sun-Ju Chung, M.D., Min-Sup Shin, M.A.,
Kyoo-Seob Ha, M.D., Kang-E Hong, M.D.

Division of Child & Adolescent Psychiatry, Seoul National University, Children's Hospital, Seoul

Characteristics of attention deficit of attention-deficit hyperactivity disorder (ADHD) were investigated by administering six computerized attention tests of Vienna Test System and four neuropsychological tests to children aged 6-12, with ADHD (n = 21) and age-matched normal control children (n = 22). The findings indicated that ADHD children show lower level of vigilance, more decline of performance in vigilance task on time, and impaired preparedness to response. They also have selective attention deficit on monitoring tasks, but did not have sustained attention deficit compared with normal control children. On the tasks with overload their information processing capacity, ADHD children show more impulsive response pattern than normal control children. The performance of ADHD was worse than control on the neuropsychological tests sensitive to frontal lobe dysfunction. The presence of "These" attention deficits supports the theory that the defect of ADHD is due to the dysfunction of more than one brain region, including brain stem reticular formation and frontal lobe.

KEY WORDS : Attention-deficit hyperactivity disorder · Attention deficit · Neurocognitive · Test · Children.