www.jkns.or.kr 10.3340/jkns.2010.48.6.506 Print ISSN 2005-3711 On-line ISSN 1598-7876
J Korean Neurosurg Soc 48 : 506-517, 2010

Clinical Article

Development of a Cognitive Level Explanation Model in Brain Injury : Comparisons between Disability and Non-Disability Evaluation Groups

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Objective : We investigated whether Disability Evaluation (DE) situations influence patients' neuropsychological test performances and psychopathological characteristics and which variable play a role to establish an explanation model using statistical analysis.
Methods : Patients were 536 (56.6%) brain-injured persons who met inclusion and exclusion criteria, classified into the DE group (DE; n = 300, 56.0%) and the non-DE group (NDE; n = 236, 44.0%) according to the neuropsychological testing's purpose. Next, we classified DE subjects into DE cluster 1 (DEC1; 91, 17.0%), DE cluster 2 (DEC2; 125; 23.3%), and DE cluster 3 (DEC3; 84, 15.7%) via two-step cluster analysis, to specify DE characteristics. All patients completed the K-WAIS, K-MAS, K-BNT, SCL-90-R, and MMPI.
Results : In comparisons between DE and NDE, the DE group showed lower intelligence quotients and more severe psychopathologic symptoms, as evaluated by the SCL-90-R and MMPI, than the NDE group did. When comparing the intelligence among the DE groups and NDE group, DEC1 group performed worst on intelligence and memory and had most severe psychopathologic symptoms than the NDE group did. The DEC2 group showed modest performance increase over the DEC1 and DEC3, similar to the NDE group. Paradoxically, the DEC3 group performed better than the NDE group did on all variables.
Conclusion : The DE group showed minimal "faking bad" patterns. When we divided the DE group into three groups, the DEC1 group showed typical malingering patterns, the DEC2 group showed passive malingering patterns, and the DEC3 group suggested denial of symptoms and resistance to treatment.

KEY WORDS : Disability evaluation · Brain injury · Malingering.

INTRODUCTION

Given the proven growth of legal applications for neurosurgery and neuropsychology, it logically follows that neurosurgeons and neuropsychologists have increased personal interactions with agents of the legal system. These interactions can have many positive consequences, including enhanced income, interprofessional understanding, and research opportunities[45]. However, there can also be negative consequences. With increasing industrial development, increases in accidents and calamities can give rise to complications and conflicts, and these are as great a burden to a neurosurgeon as is the disability evaluation (DE) itself. Such complications include the necessity of clarifying the interactions between cause and effect, the public scrutiny of cherished beliefs, and, worst of all, an erroneous DE[24].

Predicting the outcome of a brain injury entails a most complicated process. It is as important to note discrepancies between predictions and reality as it is to document general trends, and exceptions to these general trends occur at all points along the severity continuum[27]. Thus, patients whose injuries seem mild, as measured by most accepted methods, may have relatively poor outcomes, both cognitively and socially. Conversely, certain other patients, classified as moderately to severely injured, have enjoyed surprisingly good outcomes[9,27,31,39]. Brain injury DE is a scientific and medical decision-making process, but a scientist must engage in fair, impartial, public decision-making and accept the legal

• Received : June 1, 2010 • Revised : September 24, 2010
• Accepted : December 27, 2010
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responsibility pertaining thereunto. Brain injured patients and their families may have external incentives, such as financial compensation and placement of legal responsibility, to create malingered or factitious symptoms. Malingered neurocognitive dysfunction (MND) in brain injury patients is characterized by an external incentive to malinger and a definite negative response bias. MND can be categorized into definite, probable, and possible MND[37]. However, these MND categories for diagnosing "malingering" are not aways acceptable. Although over 300 publications on this topic have appeared, these issues are still controversial. Brain imaging data or other physiological evaluations may explicate these categories[4]. The limited information on the neurocognitive functions of brain injury patients is another problem with the DE process. With forensic patients, in particular, it is essential to use formal, officially approved, and published standard tests. Assessment of this group of patients through the use of a theoretical experimental paradigm may lead to scientific argument and disagreement, and could be the cause of other complications[17].

These problems and complications of the DE process cannot be helped in some situations and can result in a dilemma. Solutions for these problems depend on knowledge, rather than learning, on personal experience, and on the neurosurgeon's conscience. In this study, we sought to understand the conscious and unconscious mechanisms of latent external incentives in forensic patients with brain injuries. Therefore, we investigated whether DE situations influence patients' neuropsychological test performances and psychopathological characteristics and sought a variable that could establish an explanation model, using statistical analyses and controlling for medical treatment progresses and demographical factors.

MATERIALS AND METHODS

Subject selection, classification, and verification procedures

Initial participants were 947 patients, from 18 to 80 years old, who received hospital or ambulant treatment for a brain injury from July 1998 to May 2009. After excluding patients who had a neurological abnormality before their brain injury, a secondary head trauma, psychiatric disease, mental retardation, or a history of a chronic disease for the preceding 6 months, as well as those who did not complete the neuropsychological tests due to serious brain damage, we had 536 participants.

We classified subjects into either the disability evaluation group (DE; n = 300; 56.0%) or the non-disability evaluation group (NDE; n = 236; 44.0%) according to the purpose of the neuropsychological testing they had received. For the DE group, the purpose of the neuropsychological tests was disability evaluation. The NDE group had undergone neuropsychological testing for treatment only, but they would undergo neuropsychological tests for disability evaluation in the future.

Subsequently, we classified patients into DE cluster 1 (DEC1), DE cluster 2 (DEC2), and DE cluster 3 (DEC3), via two-step cluster analysis using 3 intelligence scores, 4 memory indexes, validity and clinical scales in MMPI and SCL-90-R, to specify the characteristics of this group. There were 91 patients (17.0%) in DEC1, 125 patients (23.3%) in DEC2, 84 patients (15.7%) in DEC3, and 236 patients (44.0%) in NDE.

Materials

Korean Wechsler Adult Intelligence Scale[40,44]

The K-WAIS is a psychometric instrument for assessing potential ability to perform purposeful behavior, using standardized questions and tasks. It consists of 6 verbal and 5 performance tests.

Korean Memory Assessment Scale[22,42]

The MAS is a comprehensive, standardized memory assessment battery, designed to fulfill ordinary clinical assessment needs in a manner suitable for various kinds of clinical situations and demands[27]. Williams[42] developed the original version of the MAS, and Lee, Park, An, Kim, & Jeung[22] performed a validation study of this Korean version of the MAS (K-MAS).

Korean Boston Naming Test[3,16]

The KBNT was developed as a way of measuring naming ability, making a distinctive diagnosis of patient dementia, and tracing a disease progress by discriminating patients with severe aphasia.

Symptom Checklist-90-revised[7,14]

The SCL-90-R is a self-report symptom inventory. It can be used as primary tool to select patients who need professional help.

Minnesota Multiphasic Personality Inventory[18]

The MMPI is an instrument for objectively measuring abnormal behavior. It is one of the tests widely used to assess mental functioning and personality in brain injured patients, but its primary purpose is psychiatric diagnostic classification.

Methods

We used the retrospective method, collecting material from

each patient's chart. First, we collected the medical history, such as the patients' demographic data, whether the patient had lost consciousness, duration of unconsciousness at the time of the injury, time elapsed since the brain damage, and the clinical data. All patients received a neuropsychological test, and the implementation and mental health clinic psychologist, performed the analysis. We based our estimation of each patient's premorbid intelligence on the method created by Kim[15], using birth year and educational level.

Statistical analysis

We performed statistical processing on the data from the chart reviews using SPSS (MS Windows Release 17.0). These post hoc analyses consisted of frequency analysis (χ^2 and Fisher Exact tests), mean difference analysis (t-test), two-step cluster analysis, and Dunnett's method; we considered the results significant at the $p < 0.05$ level.

RESULTS

Comparisons of the demographic and clinical factor between DE and NDE group

Demographic comparison of the DE and NDE groups showed a significant difference between the two groups on whether they were married or not ($p < 0.05$), but there was no significant difference between DE and NDE groups with regard to gender and age. Moreover, there were no significant differences between the two groups regarding educational level, occupational distribution, and residence location. With regard to premorbid estimated intelligence, there was no significant difference between the two groups on verbal (101.81 ± 8.81), performance (102.02 ± 8.34) and full-scale intelligence (102.15 ± 9.23) (Table 1).

A comparison of the groups' clinical characteristics showed a significant difference with regard to the brain injury's cause

Table 1. Demographic data on the 536 subjects

Variables	DE (n = 300) (%)	NDE (n = 236) (%)	Total (n = 536) (%)	p value
Gender				
Male	221(73.7)	179 (75.8)	400 (74.6)	0.565
Female	79 (26.3)	57 (24.2)	136 (25.4)	
Age				
Below 29 years	83 (27.7)	57 (24.2)	140 (26.1)	0.402
30-39 years	65 (21.7)	47 (19.9)	112 (20.9)	
40-49 years	105 (35.0)	85 (36.0)	190 (35.4)	
50-59 years	40 (13.3)	44 (18.6)	84 (15.7)	
Above 60 years	7 (2.3)	3 (1.3)	10 (1.9)	
(Mean ± SD) (years)	37.82 ± 11.50	39.43 ± 10.86	38.53 ± 11.22	0.098
Marriage*				
Married	175 (58.3)	164 (69.5)	339 (63.2)	0.023
Unmarried	105 (35.0)	67 (28.4)	172 (32.1)	
Etc.	20 (6.7)	5 (2.1)	25 (4.7)	
Educational periods				
1-6 years	44 (15.6)	27 (11.4)	71 (13.2)	0.066
7-9 years	48 (16.0)	43 (18.2)	91 (17.0)	
10-12 years	138 (46.0)	88 (37.3)	226 (42.2)	
Above 13 years	70 (23.4)	78 (33.1)	148 (27.6)	
Mean, SD (years)	11.12 ± 2.64	11.46 ± 2.65	11.27 ± 2.65	0.138
Occupation				
None	56 (18.8)	43 (18.3)	99 (18.6)	0.299
Unskilled laborer/farmer	169 (56.7)	139 (59.1)	308 (57.8)	
Merchant	40 (13.4)	23 (9.8)	63 (11.8)	
Clerical worker	33 (11.1)	30 (12.8)	63 (11.8)	
Place of residence				
Urban	220 (73.6)	177 (75.3)	397 (74.3)	0.690
Rural	79 (26.4)	58 (24.7)	137 (25.7)	
Premorbid intelligence estimates (Mean ± SD)				
Verbal intelligence	101.25 ± 8.69	102.51 ± 8.94	101.81 ± 8.81	0.102
Performance intelligence	101.42 ± 8.08	102.78 ± 8.61	102.02 ± 8.34	0.062
Full Scale intelligence	101.53 ± 9.07	102.93 ± 9.39	102.15 ± 9.23	0.084

N : numbers of patients, DE : disability evaluation group, NDE : Non-disability evaluation group, SD : standard deviation

($p < 0.001$). In particular, pedestrian accident was the cause for many of the DE patients. Additionally, there was a significant difference with regard to the brain injury's classification ($p < 0.001$). However, there was no significant difference in the areas of whether they had lost consciousness, required an operation, or required hospitalization. There was also no significant difference between the groups in the time interval between brain injury and assessment (Table 2).

Comparisons of the intelligence and cognitive function between DE and NDE group

Table 3 shows summaries of the K-WAIS subscale score analyses for the DE and NDE groups. There were significant differences between the groups on Verbal Intelligence (DE, 87.19 ± 15.91; NDE, 91.95 ± 16.71; $p < 0.001$), as well as on Information (DE, 7.52 ± 3.00; NDE, 8.62 ± 3.05; $p < 0.001$), Digit Span (DE, 7.52 ± 2.85; NDE, 8.22 ± 3.37; $p < 0.05$), Vocabulary (DE, 7.86 ± 3.10; NDE, 8.61 ± 3.32; $p < 0.01$), Arithmetic (DE, 7.22 ± 3.27; NDE, 7.86 ± 3.48; $p < 0.05$), Comprehension (DE, 8.07 ± 3.55; NDE, 9.22 ± 3.62; $p < 0.001$), and Similarity (DE, 8.42 ± 2.65; NDE, 9.24 ± 2.92; $p < 0.001$), among the verbal intelligence subscales. On the Performance Intelligence subscale, there were significant differences between the two groups in Picture completion

Table 2. Clinical characteristics of the 536 subjects

Variables	DE (n = 300) (%)	NDE (n = 236) (%)	Total (n = 536) (%)	*p* value
Causes of brain injury				
In car accident	134 (44.7)	64 (27.1)	198 (36.9)	0.001
Pedestrian accident	139 (46.3)	51 (21.6)	190 (35.4)	
Industry calamity	10 (3.3)	43 (18.2)	53 (9.9)	
Violence by others	2 (0.7)	8 (3.4)	10 (1.9)	
Cerebrovascular accident	5 (1.7)	46 (19.5)	51 (9.5)	
Developmental disorder	1 (0.3)	0 (0.0)	1 (0.2)	
Self injury	1 (0.3)	10 (4.2)	11 (2.1)	
Others	8 (2.7)	14 (5.9)	22 (4.1)	
Main types of brain injury				
Cerebral contusion	96 (32.0)	59 (25.0)	155 (28.9)	0.001
Skull fracture	52 (17.3)	33 (14.0)	85 (15.9)	
Cerebral hemorrhage	205 (68.4)	134 (56.8)	339 (63.2)	
Cerebral concussion	22 (7.3)	24 (10.2)	46 (8.6)	
Diffuse axonal injury	29 (9.7)	13 (5.5)	42 (7.8)	
Pneumoencephalus	7 (2.3)	5 (2.1)	12 (2.2)	
Cerebral infarction	2 (0.7)	14 (5.9)	16 (3.0)	
Hypoxic brain damage	3 (1.0)	2 (0.8)	5 (0.9)	
Brain stem injury	0 (0.0)	1 (0.4)	1 (0.2)	
Brain Atrophy	5 (1.7)	4 (1.7)	9 (1.7)	
No evidence of brain injury	16 (5.3)	32 (13.6)	48 (9.0)	
Unknown	21 (7.0)	20 (8.5)	41 (7.6)	
Loss of consciousness				
Absent	55 (18.3)	78 (33.1)	133 (24.8)	0.227
Present	245 (81.7)	158 (66.9)	403 (75.2)	
Below 20 minutes	20 (8.2)	25 (15.8)	45 (11.2)	
20-60 minutes	18 (7.4)	12 (7.6)	30 (7.5)	
1-24 hours	47 (19.3)	25 (15.8)	72 (17.9)	
1-7 days	65 (26.6)	46 (29.1)	111 (27.6)	
Above 7 days	94 (38.5)	50 (31.7)	144 (35.8)	
Operation				
Yes	111 (37.0)	83 (35.2)	194 (36.2)	0.662
No	189 (63.0)	153 (64.8)	342 (63.8)	
Hospitalization				
Yes	272 (90.7)	213 (90.3)	485 (90.5)	0.459
No	28 (9.3)	23 (9.7)	51 (9.5)	
Time interval between brain injury and assessment				
(Mean ± SD) (months)	16.62 ± 24.70	19.87 ± 19.81	18.05 ± 22.71	0.100

N : numbers of patients, DE : disability evaluation group, NDE : non-disability evaluation group, SD : standard deviation

(DE, 7.05 ± 2.75; NDE, 7.66 ± 2.96; $p < 0.05$), Picture arrangement (DE, 7.40 ± 2.85; NDE, 8.27 ± 2.79; $p < 0.001$), and Digit symbol (DE, 6.86 ± 2.86; NDE, 7.48 ± 2.98; $p < 0.05$) but not in Block design or Object assembly.

Table 3. Comparisons of verbal, performance, full scale intelligence quotients and subscale scores between DE and NDE groups

Variables	DE (n = 300) (mean ± SD)	NDE (n = 236) (mean ± SD)	*p* value
Verbal intelligence subscale			
Information	7.52 ± 3.00	8.62 ± 3.05	0.001
Digit span	7.52 ± 2.85	8.22 ± 3.37	0.011
Vocabulary	7.86 ± 3.10	8.61 ± 3.32	0.008
Arithmetic	7.22 ± 3.27	7.86 ± 3.48	0.029
Comprehension	8.07 ± 3.55	9.22 ± 3.62	0.001
Similarity	8.42 ± 2.65	9.24 ± 2.92	0.001
Verbal intelligence	87.19 ± 15.91	91.95 ± 16.71	0.001
Performance intelligence subscale			
Picture completion	7.05 ± 2.75	7.66 ± 2.96	0.014
Picture arrangement	7.40 ± 2.85	8.27 ± 2.79	0.001
Block design	8.20 ± 2.87	8.49 ± 2.91	0.259
Object assembly	7.99 ± 2.76	8.26 ± 3.04	0.285
Digit symbol	6.86 ± 2.86	7.48 ± 2.98	0.014
Performance intelligence	84.75 ± 14.48	87.87 ± 15.12	0.015
Full scale intelligence	85.47 ± 15.21	89.78 ± 15.85	0.001

N : numbers of patients, DE : disability evaluation group, NDE : non-disability evaluation group, SD : standard deviation

Table 4. Comparisons of K-MAS scores and K-BNT percentile score between DE and NDE groups

Variables	DE (n = 300) (mean ± SD)	NDE (n = 236) (mean ± SD)	*p* value
K-MAS			
Subscale scores			
Verbal span	5.74 ± 3.39	6.27 ± 3.67	0.088
Visual span	7.79 ± 3.64	7.56 ± 3.64	0.452
List learning	4.93 ± 3.02	5.50 ± 3.39	0.042
List recall	4.28 ± 3.34	4.92 ± 3.84	0.042
Delayed list recall	4.41 ± 3.33	5.36 ± 3.93	0.009
Prose memory	6.44 ± 3.34	6.62 ± 3.28	0.534
Delayed prose memory	6.24 ± 3.42	6.30 ± 3.45	0.841
Names-faces	5.02 ± 3.34	5.14 ± 3.65	0.685
Delayed names-faces	4.97 ± 3.34	5.18 ± 3.53	0.483
Visual reproduction	6.50 ± 3.65	6.22 ± 3.54	0.371
Visual recognition	6.25 ± 3.37	6.56 ± 3.56	0.316
Delayed visual recognition	5.49 ± 3.49	5.87 ± 3.77	0.220
Verbal memory process scores			
Intrusions	2.44 ± 3.32	2.25 ± 3.57	0.527
Clustering : list learning	0.18 ± 0.11	0.20 ± 0.33	0.312
Clustering : list recall	0.21 ± 0.19	0.26 ± 0.63	0.200
Clustering : delayed list recall	0.25 ± 0.23	0.28 ± 0.42	0.213
Cued recall : list recall	7.16 ± 3.18	7.56 ± 3.43	0.172
Cued recall : delayed list recall	7.17 ± 3.23	7.75 ± 3.57	0.052
List recognition	9.70 ± 2.76	9.95 ± 2.71	0.291
Summary scale scores			
Immediate memory	81.72 ± 17.95	82.44 ± 19.07	0.650
Verbal memory	74.89 ± 16.04	77.15 ± 17.67	0.127
Visual memory	80.01 ± 18.67	79.48 ± 18.78	0.746
Global memory	73.72 ± 16.84	74.68 ± 17.64	0.524
K-BNT			
Percentile score (%)	28.70 ± 32.53	39.06 ± 34.69	0.001

N: numbers of patients, DE: disability evaluation group, NDE: non-disability evaluation group, SD: standard deviation

In addition, there were significant differences between the groups on Performance Intelligence (DE, 84.75 ± 14.48; NDE, 87.87 ± 15.12; $p < 0.05$) and Full-scale Intelligence (DE, 85.47 ± 15.21; NDE, 89.78 ± 15.85; $p < 0.001$).

Table 4 gives summaries of the K-MAS subscale score analyses, verbal memory process scores, summary scale scores, and Boston Naming Test score percentages for the DE and NDE groups. On the K-MAS subscales, there were significant differences between the groups on List learning (DE, 4.93 ± 3.02; NDE, 5.50 ± 3.39; $p < 0.05$), List recall (DE, 4.28 ± 3.34; NDE, 4.92 ± 3.84; $p < 0.05$), and Delayed list recall (DE, 4.41 ± 3.33; NDE, 5.36 ± 3.93; $p < 0.01$). There were no significant differences between the two groups on any Verbal Memory Process Scale scores or Summary scale scores. On the other hand, there were significant differences between the two groups on the Boston Naming Test score percentages on recall (DE, 28.70 ± 32.53; NDE, 39.06 ± 34.69; $p < 0.001$).

Comparisons of the psychopathological and personality characteristics between DE and NDE group

Table 5 shows summaries of the SCL-90-R score analyses for the DE and NDE groups. There were significant differences between the two groups in the subscores of Somatization (DE, 1.79 ± 0.88; NDE, 1.54 ± 1.00; $p < 0.01$), Obsessive-Compulsive (DE, 2.17 ± 0.86; NDE, 1.92 ± 1.05; $p < 0.01$), Interpersonal Sensitivity (DE, 1.87 ± 0.94; NDE, 1.66 ± 1.07; $p < 0.05$), Depression (DE, 2.09 ± 0.94; NDE, 1.85 ± 1.11; $p < 0.01$), Anxiety (DE, 1.89 ± 1.01; NDE, 1.70 ± 1.12; $p < 0.05$), Phobic Anxiety (DE, 1.76 ± 1.12; NDE, 1.55 ± 1.16; $p < 0.05$), Paranoid Ideation (DE, 1.76 ± 1.12; NDE, 1.55 ± 1.16; $p < 0.05$), and Psychoticism (DE, 1.61 ± 0.92; NDE, 1.41 ± 1.03; $p < 0.05$), but not in Hostility. Addi-

Table 5. Comparisons of SCL-90-R scores between DE and NDE groups

Variables	DE (n = 300) (Mean ± SD)	NDE (n = 236) (Mean ± SD)	*p* value
Subscale scores			
Somatization	1.79 ± 0.88	1.54 ± 1.00	0.003
Obsessive-compulsive	2.17 ± 0.86	1.92 ± 1.05	0.003
Interpersonal sensitivity	1.87 ± 0.94	1.66 ± 1.07	0.018
Depression	2.09 ± 0.94	1.85 ± 1.11	0.007
Anxiety	1.89 ± 1.01	1.70 ± 1.12	0.037
Hostility	1.81 ± 1.08	1.69 ± 1.22	0.235
Phobic anxiety	1.76 ± 1.12	1.55 ± 1.16	0.040
Paranoid ideation	1.61 ± 1.03	1.41 ± 1.10	0.030
Psychoticism	1.61 ± 0.92	1.41 ± 1.03	0.025
General index scores			
General symptomatic index	1.86 ± 0.86	1.65 ± 1.00	0.009
Positive symptom total	70.44 ± 18.82	62.85 ± 25.04	0.001
Positive symptom distress level	2.23 ± 0.69	2.16 ± 0.80	0.112

N : numbers of patients, DE : disability evaluation group, NDE : non-disability evaluation group, SD : standard deviation

Table 6. Comparisons of MMPI scores between DE and NDE groups

Variables	DE (n = 300) (Mean ± SD)	NDE (n = 236) (Mean ± SD)	*p* value
Validity Scales			
Lie	49.93 ± 11.30	50.53 ± 11.05	0.533
Infrequency	66.19 ± 15.91	61.67 ± 16.31	0.001
Correction	47.11 ± 10.66	49.28 ± 11.59	0.025
Clinical Scales			
Hypochondriasis	66.46 ± 11.25	63.87 ± 12.00	0.010
Depression	64.76 ± 12.99	64.76 ± 12.99	0.089
Hysteria	65.35 ± 11.09	63.66 ± 11.35	0.082
Psychopathic deviate	58.93 ± 10.84	58.74 ± 11.22	0.844
Masculinity-Femininity	50.76 ± 10.18	49.81 ± 9.34	0.268
Paranoia	65.01 ± 16.01	61.81 ± 17.30	0.027
Psychasthenia	66.11 ± 11.81	63.18 ± 13.99	0.010
Schizophrenia	67.13 ± 13.37	63.61 ± 15.32	0.006
Hypomania	52.74 ± 10.81	51.83 ± 10.81	0.336
Social introversion	59.60 ± 13.01	57.88 ± 13.47	0.134

N: numbers of patients, DE: disability evaluation group, NDE: non-disability evaluation group, SD: standard deviation

tionally, on the General Index scores, there were significant differences between the two groups in General symptomatic index (DE, 1.86 ± 0.86; NDE, 1.65 ± 1.00; $p < 0.01$) and Positive Symptom total (DE, 70.44 ± 18.82; NDE, 62.85 ± 25.04; $p < 0.001$) but not in Positive symptom distress level.

Table 6 shows summaries of the MMPI score analyses for the DE and NDE groups. Of the Validity scales, there were significant differences between the two groups in Infrequency (DE, 66.19 ± 15.91; NDE, 61.67 ± 16.31; $p < 0.001$) and Correction (DE, 47.11 ± 10.66; NDE, 49.28 ± 11.59; $p < 0.05$). On the Clinical scales, there were significant differences between the two groups in Hypochondriasis (DE, 66.46 ± 11.25; NDE, 63.87 ± 12.00; $p < 0.05$), Paranoia (DE, 65.01 ± 16.01; NDE, 61.81 ± 17.30; $p < 0.05$), Psychasthenia (DE, 66.11 ± 11.81; NDE, 63.18 ± 13.99; $p < 0.05$), and Schizophrenia (DE, 67.13 ± 13.37; NDE, 63.61 ± 15.32; $p < 0.01$).

Comparisons of the demographic and clinical factor between DEC groups and NDE group

Comparison results of the three DECs and the NDE on demographics and premorbid estimated intelligence showed no significant differences among the groups. Comparison of the groups' clinical characteristics showed a significant difference among the groups regarding classification according to cause ($p < 0.001$), type of brain injury ($p < 0.01$), and whether the patient lost consciousness ($p < 0.01$). But any statistically significant difference among loss of consciousness period regarding intelligence, neurocognitive function, and psychopathology were not founded in post-hoc confirmatory analysis.

Comparisons of the intelligence and cognitive function between DEC groups and NDE group

(Table 7)

K-WAIS intelligence quotients and subscale scores analyses results for the four groups(those three disability evaluation cluster groups and the one non-disability evaluation group): There were significant differences among the groups on the Verbal intelligence subscale ($p < 0.05$), and DEC1 and DEC2 groups significantly differed from the NDE group on the Verbal intelligence subscales, except for Similarity ($p < 0.05$). With regard to Similarity, there were significant differences between DEC2 and NDE groups ($p < 0.05$). On the Performance intelligence subscale, there were significant differences among the groups, except on Object assembly ($p < 0.01$), and DEC1 group significantly differed from NDE group on Picture completion ($p < 0.01$), Picture arrangement ($p < 0.001$), and Digit symbol ($p < 0.05$). While DEC3 did not significantly differ from NDE on the Performance intelligence subscale, DEC2 group significantly differed from NDE group on Digit symbol ($p < 0.05$). There were significant differences among the groups on verbal ($p < 0.001$), performance ($p < 0.001$), and full-scale intelligence ($p < 0.001$). The DEC1 group differed significantly from the NDE group for all areas of intelligence quotient ($p < 0.001$), while the DEC2 group significantly differed from the NDE group on Verbal ($p < 0.05$) and Full-scale intelligence ($p < 0.05$). Moreover, there were no significantly differences between the DEC3 and NDE groups.

K-MAS summary scales and subscales scores analyses results for the four groups : On the subscale scores, there were significant differences among the groups in Verbal ($p < 0.001$) and Visual spans ($p < 0.001$), List learning ($p < 0.05$), List recall ($p < 0.01$), Delayed list recall ($p < 0.001$), Delayed prose memory ($p < 0.05$), Names-faces ($p < 0.01$), Delayed names-faces ($p < 0.001$), Visual reproduction ($p < 0.01$), Visual recognition ($p < 0.001$), and Delayed visual recognition ($p < 0.001$). The DEC1 group significantly differed from the NDE group on Verbal span ($p < 0.05$), List recall ($p < 0.05$),

Table 7. Comparisons of intelligence quotients, K-MAS index scores and K-BNT score among DEC and NDE groups

Variables	DEC (n = 300)			NDE (n = 236)	p value
	DEC1(n=91) (mean ± SD)	DEC2(n=125) (mean ± SD)	DEC3(n=84) (mean ± SD)	(mean ± SD)	
Intelligence					
Verbal intelligence	83.43 ± 17.26†	87.18 ± 14.91*	91.30 ± 14.96	91.95 ± 16.71	0.001
Performance intelligence	80.90 ± 15.90†	85.53 ± 13.43	89.26 ± 13.20	87.87 ± 15.12	0.001
Full scale intelligence	81.56 ± 16.56†	85.27 ± 14.20*	90.00 ± 14.03	89.78 ± 15.85	0.001
K-MAS summary scale scores					
Immediate memory	77.25 ± 17.19	79.22 ± 16.46	90.26 ± 18.17†	82.44 ± 19.07	0.001
Verbal memory	73.13 ± 15.80	73.14 ± 15.31	79.42 ± 16.65	77.15 ± 17.67	0.012
Visual memory	74.64 ± 16.86	78.35 ± 18.20	88.30 ± 18.63†	79.48 ± 18.78	0.001
Global memory	69.92 ± 15.55	71.77 ± 15.97	80.75 ± 17.53*	74.69 ± 17.64	0.001
K-BNT					
Percentile score (%)	23.50 ± 30.98†	27.98 ± 32.34†	35.42 ± 33.66	39.06 ± 34.69	0.001

*$p < 0.05$, †$p < 0.01$, ‡$p < 0.001$, p value of Dunnett's t-test. N : numbers of patients, DEC : clustered disability evaluation group, NDE : non-disability evaluation group, SD : standard deviation

Delayed list recall ($p < 0.01$), Visual recognition ($p < 0.01$), and Delayed visual recognition ($p < 0.01$). The DEC2 group significantly differed from the NDE group on List learning ($p < 0.05$), List recall ($p < 0.05$), and Delayed list recall ($p < 0.01$), while the DEC3 group significantly differed from the NDE group on Visual span ($p < 0.01$), Names-faces ($p < 0.05$), Delayed names-faces ($p < 0.05$), Visual reproduction ($p < 0.05$), and Visual recognition ($p < 0.05$). On Verbal memory process scores, there were significant differences among the groups on Cued recall at Delayed list recall ($p < 0.05$) and List recognition ($p < 0.05$), but there were no significant differences between each DEC group and the NDE group. There were significant differences among the groups on the Summary scales ($p < 0.05$ or $p < 0.01$), but only the DEC3 group showed a significant difference with the NDE group on Immediate ($p < 0.01$), Visual ($p < 0.01$), and Global memory ($p < 0.05$).

On the Boston Naming Test scores, there were significant differences among the groups ($p < 0.001$); in particular, the DEC1 and DEC2 group significantly differed from the NDE group ($p < 0.01$).

Comparisons of the psychopathological and personality characteristics among DEC groups and NDE group

Fig. 1. shows summaries of the SCL-90-R score analysis for the four groups. There were significant differences among the groups on the all the subscales ($p < 0.001$), and the DEC1 and DEC3 groups significantly differed from the NDE group on all of the subscales ($p < 0.01$). However, the DEC2 group showed a significant difference from the NDE group on Somatization ($p < 0.05$) and Obsessive-compulsive ($p < 0.05$). There were significant differences among the groups on the all of the General index scores ($p < 0.001$). The DEC1 and DEC3 groups significantly differed from the NDE group on all of the general index scores ($p < 0.01$), but the DEC2 group showed a significant difference from NDE group on just the Positive symptom total ($p < 0.001$).

Fig. 2. shows summaries of the MMPI score analysis for the four groups. There were significant differences among the

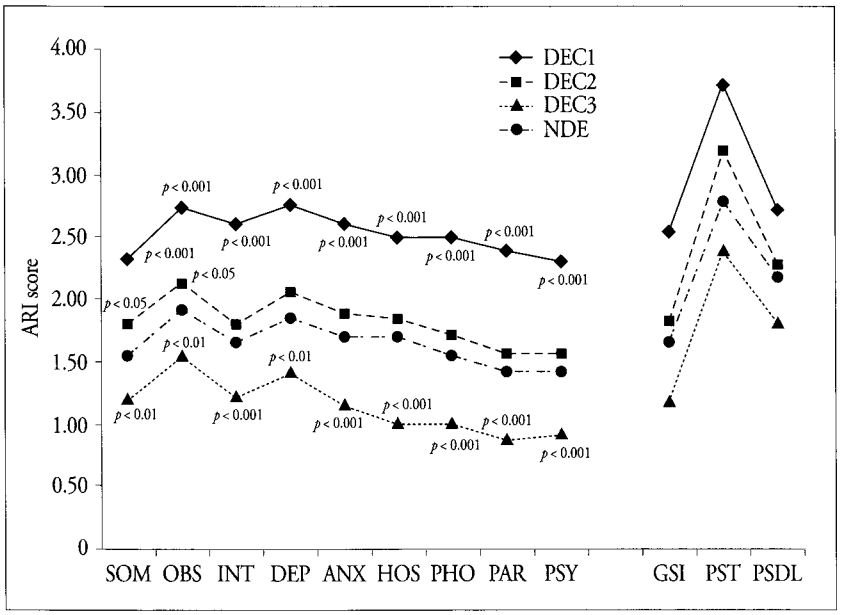

Fig. 1. Comparisons of SCL-90-R scores among DEC and NDE groups*. *p values of Dunnett's t-test results among DEC and NDE are marked, ARI : average rating for item, DEC : clustered disability evaluation group, NDE : non-disability evaluation group, SOM : somatization, OBS : obsessive-compulsive, INT : interpersonal sensitivity, DEP : depression, ANX : anxiety, HOS : hostility, PHO : phonic anxiety, PAR : paranoid ideation, PSY : psychoticism, GSI : general severity index, PST : positive symptom total, PSDL : positive symptom distress level.

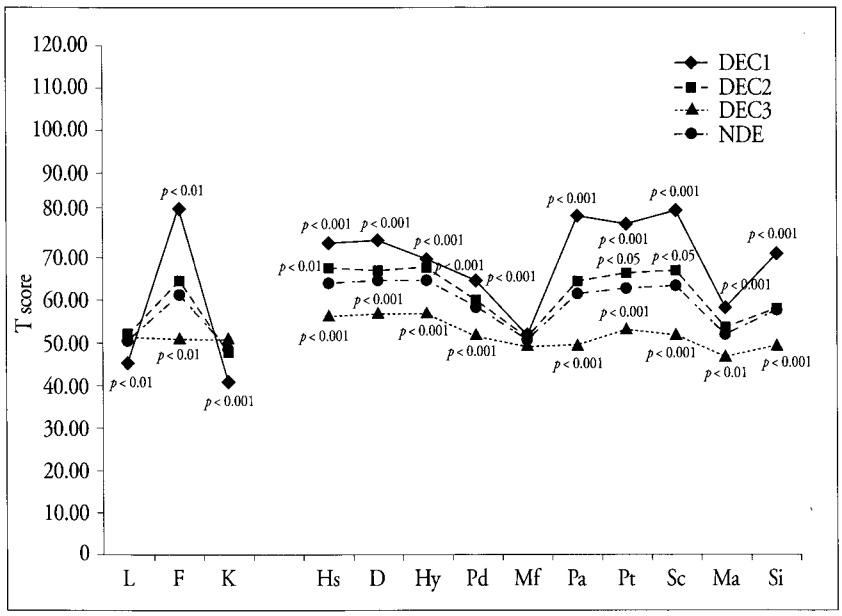

Fig. 2. Comparisons of MMPI scores among DEC and NDE groups*. *p values of Dunnett's t-test results among DEC and NDE are marked , DEC : clustered disability evaluation group, NDE : non-disability evaluation group, L : lie, F : infrequency, K : correction, Hs : hypochondriasis, D : depression, Hy : hysteria, Pd : psychopathic deviate, Mf : masculinity-femininity, Pa : paranoia, Pt : psychasthenia, Sc : schizophrenia, Ma : hypomania, Si : social introversion.

groups on all of the Validity scales ($p < 0.001$). The DEC1 group significantly differed from the NDE group on all of the Validity scales ($p < 0.01$), and the DEC3 group showed a significant difference from the NDE group on Infrequency ($p < 0.001$). There were significant differences among the groups on the Clinical scales, with the exception of Masculinity-Femininity ($p < 0.001$). In addition, the DEC1 and DEC3 groups significantly differed from the NDE group on the Clinical scales, again, with the exception of Masculinity-Femininity ($p < 0.01$). The DEC2 group significantly differed from the NDE group on Hypochondriasis ($p < 0.01$), Hysteria ($p < 0.01$), Psychasthenia ($p < 0.05$), and Schizophrenia ($p < 0.05$).

DISCUSSION

Conducting a neurosurgical and neuropsychological evaluation, and, particularly, a neurosurgical disability evaluation, regarding the outcome of a brain injury can be conceptualized as a scientific endeavor. When performing a forensic evaluation, appropriate use of logical and scientific reasoning is critical for the avoidance of diagnostic errors[20]. However, failure to analyze cases critically and scientifically will result in either over- or under-evaluation of the brain injury outcome in cases of neurocognitive deficits secondary to a preexisting condition, especially a psychiatric condition (whether or not it correlates to the brain injury), or in cases of neurocognitive deficits secondary to conscious or unconscious malingering when performing neuropsychological tests (due to extra incentives).

In the present study, we compared patients who were categorized into the same type except for the presence or absence of real, extra incentives. That is, the DE group was under DE at the time, and the NDE group was under treatment but would need DE in the future. Controlling for contaminating or confounding demographic and clinical variables, we excluded patients who were in a distressed emotional state, had a psychiatric disorder, had a pre-existing developmental/cognitive or neurological disorder, or suffered from alcohol or drug abuse. We analyzed the demographic and clinical factors affecting the brain injury outcome and then verified the results in a preliminary statistical analysis. Some variables, which we did not successfully control, were marital status (in demographic factors), cause and type of brain injury (in clinical factors). However, we controlled and counterbalanced most demographic factors affecting brain injury outcome, such as age, gender, academic attainment, job, and premorbid intelligence. Of the clinical factors, the differences between DE and NDE were not sampling biases but multiple types of brain injury and different distributions of brain injury causes. In their study, Park and Kim[34] suggested that DE of industrial calamity patients were suspended than other patients with brain or other injuries due to prolonged psychosocial dysfunction. For this reason, treatment duration and distribution of industrial calamity patients between DE and NDE groups are different, but in confirmatory post hoc statistical analysis among causes of injury, they did not showed any significant statistical difference. With regard to brain injury types, brain injury severity was a more influential factor than was type of brain injury. Studies have not shown consistent results regarding prognosis and type of brain injury[25,29]. Regarding other clinical factors, treatment duration and brain injury severity as GCS and others did not show any differences.

With regard to comparisons of intelligence between the DE and NDE groups, the DE group showed lower intelligence than the NDE group did, except on the Block design and Object assembly subscales. We expected lower intelligence in the DE group, but the degree of difference in intelligence was smaller than in simulated malingering studies[2,11,12,30]. This suggests that the DE situation had an effect on test-taking attitude intentionally or no intentionally, but the severity of faking-bad was not as severe as was the simulation or conscious faking-bad behaviors of a normal subject, and the DE situation had less of an effect on Block design and Object assembly subscales performances. KMAS summary scale scores and recognition subscales scores did not show statistically significant differences, but List learning, List recall, and Delayed list recall subscale scores did show statistically significant differences. Memory dysfunction is a common complaint following brain injury[1,26,33]. There are several known organic memory dysfunction patterns[6,38], but malingers frequently lack sufficient knowledge to mimic true memory disorder symptoms and are likely to over-portray impairment severity or produce improbable assessment outcomes that are inconsistent with those of cooperative brain-injured patients[8,28]. The DE group did not show malingered memory dysfunctions patterns, i.e., the same or lower recognition performance than recall performance[41], but did show lower effort on the performance of the effortful task of recall memory. In comparisons of subjective psychopathologic symptoms, evaluated via the SCL-90-R, the DE groups showed more severe psychopathologic symptoms than NDE group did, with the exception of Aggression and the Positive symptom distress index scores. This means that multiple neurotic symptoms and aggression symptoms are common between the groups, but the DE groups could not simulate sophisticated psychopathologic symptoms. On the MMPI, considering the more subjective psychopathologic symptoms, the more psychotic symptoms are prominent[23], the

DE group mainly simulated psychopathologic symptoms using psychotic symptoms.

Using cluster analysis, we divided the DE group into three groups for further analysis. Comparing demographic and clinical factors among the groups, we found duration of loss of consciousness showed a statistically significant difference, but the post hoc statistical analysis among groups regarding duration of loss of consciousness did not show a statistically significant difference for most dependent variables. Unlike patients with severe brain injury[43], predicting brain injury outcomes for patients with mild and moderate brain injury is not appropriate[9]. In this study, we excluded all severe brain injury patients, which had no effect on group classifications, statistically. With regard to intelligence comparisons among DE groups and the NDE group, the DEC1 group showed lower performances than the NDE group did at all intelligence quotients and subscales. The DEC2 group showed lower performances than the NDE group did on Verbal intelligence quotient, Full scale intelligence quotient, and some of subscales. However, the DEC3 group did not show any differences from the NDE group. On the K-MAS, the DEC1 group showed lower performances than the NDE group did on some subscales, including the visual recognition scale, but the DEC2 group showed higher performances than the NDE group did on most memory functions. In comparisons of subjective psychopathologic symptoms as evaluated by the SCL-90-R, the DEC1 group showed more severe subjective symptoms on all subscales. The DEC2 group showed more severe subjective symptoms on the Somatization and Obsessive-Compulsive scales, but the DEC3 groups showed fewer subjective symptoms than the NDE group did. On the MMPI, the DEC1 group showed an elevation on the psychotic scales, in particular, a mean score on the Infrequency scale of T = 81. However, the DEC3 group showed fewer symptoms and a better adaptation level than the NDE group did. In summary, as compared to the NDE group, the DEC1 group was similar to an intentional malingering group. The DEC2 group unconsciously exaggerated their own symptoms, using defense mechanism such as somatization (similar to neurotic patients). The DEC3 group consciously or unconsciously under-evaluated their own symptoms and denied problematic symptoms. These results correlated to memory function level. That is, the higher the memory function in brain-injured patients, the lower their severity of subjective symptom severity and the fewer complaints[19].

In neuropsychological settings, malingering can occur in any of several patterns: false or exaggerated symptom reports, intentional poor performance on neuropsychological tests, or a combination of symptom exaggeration and intentional performance deficit[10,21]. We could classify the DEC1 group as the malingering group, because they exaggerated their reports of subjective psychiatric symptoms on the SCL-90-R, performed more poorly on neuropsychological tests than did the NDE group, did not show characteristic MMPI patterns but did have a profile with all subscales elevated (centered on the psychotic subscales : Paranoia, Psychasthenia, and Schizophrenia), and gave intentionally poor performances on intelligence and memory tests. Traditional psychoanalytic thought views somatoform conditions as a process of psychological conflict "conversion" into physical symptoms; however, many authors criticize this formulation, because researchers cannot specify and/or merge with current cognitive science knowledge the actual mechanism by which the conversion occurs[4,36].

Alternatively, we may explain the DEC2 group's symptomatic and neurocognitive characteristics by the nonconscious generation of nonorganic physical and cognitive symptoms[4], by an "autosuggestive disorder" based on the supervisory attention system[32], as secondary to an attentional awareness system dysfunction, as an inhibitory mechanism based on prefrontal physiology[36], or as active use of cognitive strategies (constructive cognition)[5]. Therefore, the DEC2 group did not consist of active but passive malingers, as a result of unintentional or nonconscious processes.

The DEC3 group showed fewer subjective symptoms, lower psychopathology, and higher cognitive functioning than the other groups. They reported fewer complaints, under-evaluated their own brain-injury disability, and/or showed an honest test-taking attitude on their neuropsychological tests. These attitudes may be desirable. However, they could be regarded as a refusal of treatment. Brain-injured patients may refuse treatment due to beliefs that brain injury is not curable and/or that brain-injured persons could be regarded as insane[13]. Characteristics as seen in the DEC3 group may also be caused by a decrease in self-awareness and self-perception abilities, a disagreement between patient and spouse (patients may be mainly concerned with physical rehabilitation, while spouses are concerned about all affected functions, including physical, psychological, and cognitive). Furthermore, patients may misunderstand or forget their symptoms after their discharges because of anosognosia, decreased memory, or decreased information-processing abilities[35]. The DEC3 group's characteristics suggest denial of symptoms and resistance to treatment.

A limitation of this study was the method of controlling for demographic and clinical factors affecting outcome of brain injury. We used statistical controls for homogeneous grouping between or among groups. More reliable and valuable research will be needed for quality control of variables such as

brain injury site and duration of consciousness loss.

CONCLUSION

In this study, we compared DE and NDE groups based on control of demographic and clinical factors among the groups. The DE group showed minimal "faking bad" patterns and simulated malingering or "faking bad" test-taking less than normal subjects would. When we divided the DE group into three groups, the DEC1 group showed typical malingering patterns in subjective symptoms, psychopathology, and neurocognitive functions; the DEC2 group showed passive malingering as a result of unintentional or nonconscious processes; and the DEC3 group's characteristics suggested denial of symptoms and resistance to treatment.

• Acknowledgements
This research was supported by the Yeungnam University research grants in 2008.

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