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Impact of Childhood Maltreatment on Cognitive Function and Its Relationship With Emotion Regulation in Young Adults

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Objectives: Childhood maltreatment can negatively impact cognitive development, including executive function, working memory, and processing speed. This study investigated the impact of childhood maltreatment on cognitive function in young adults using various measurements, including computerized tests, and their relationship with emotional dysregulation.
Methods: We recruited 149 healthy individuals with and without maltreatment experiences and used the Wechsler Adult Intelligence Scale IV (WAIS-IV) and a computerized battery to analyze cognitive function.
Results: Both the WAIS-IV and computerized tests revealed that individuals with a history of childhood maltreatment had decreased cognitive function, especially in terms of working memory and processing speed. These individuals tended to employ maladaptive emotion regulation strategies. Among cognitive functions, working memory is negatively related to maladaptive emotion regulation strategies such as catastrophizing.
Conclusion: This study highlights the effects of childhood maltreatment on cognitive function in young adulthood. Moreover, the study suggests clinical implications of cognitive interventions for improving emotion regulation and cognitive function in individuals with a history of childhood maltreatment.

Keywords: Childhood maltreatment; Working memory; Processing speed; Rumination; Catastrophizing.

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INTRODUCTION

Childhood maltreatment includes physical, emotional, and sexual violence and neglect that might impair children's health or impede their normal development. Additionally, childhood maltreatment is a remarkable global health concern [1]. Childhood maltreatment can have long-term consequences. Furthermore, childhood maltreatment is not only strongly correlated with the occurrence of mood disorders, including depressive disorders [2,3], but also with other mental health-related problems. Maltreatment experiences in early life alter various neurocognitive functions that can instill sensitivity to mental health problems [4]. Additionally, childhood maltreatment can have detrimental effects on the development of various brain regions involved in emotion or reward processing [5].

Maltreatment negatively affects cognitive development, including executive function, memory, working memory, and processing speed [6]. Structural changes in the hippocampus are typically associated with cognitive deterioration in maltreatment experiences [7,8]. Decreased hippocampal volume may be associated with susceptibility to psychological trauma [9] and is frequently observed in typical mental disorders such as major depression [10]. Therefore, maltreatment can significantly impair the development of various cognitive functions, potentially serving as a vulnerability factor for mental illnesses.

Various studies have examined the relationship between emotional processing impairment and maltreatment. Maltreatment experiences make recognizing emotional stimuli [11], maintaining appropriate emotions, and acquiring interpersonal skills difficult [12,13]. Emotional processing and cognitive function can have a mutual influence. Cognitive

functions such as working memory and processing speed are reportedly related to the use of emotional control techniques such as reappraisal [14], and working memory training can increase emotional control [15]. Furthermore, emotions affect attention, learning, memory, and reasoning [16]. Difficulties in emotion regulation can be associated with a decrease in processing speed [17], which is a common cognitive impairment even in depression [18]. However, studies reporting the relationship of maltreatment experiences with emotion regulation difficulties, and cognitive impairment in young adults remain limited.

Hence, this study aimed to 1) demonstrate the effects of maltreatment on cognitive function in young adults using various cognitive measurements, including computerized tests, and 2) observe the relationship between maltreatment experiences and emotional dysregulation, as well as cognitive function.

METHODS

Participants

All participants were recruited through notices posted on the online bulletin boards of public or college Internet communities in Daegu, Korea. Online questionnaires were created using SurveyMonkey (https://www.surveymonkey.com). Healthy young adults with or without a history of maltreatment were recruited to participate in the study and facilitate an understanding of the research process. The exclusion criteria were acute or chronic psychiatric or medical diseases, history of head trauma, or history of drug or alcohol addiction. Of the 200 participants, 34 had a history of psychiatric diagnoses or treatment. Additionally, we excluded 15 participants who reported clinically significant depressive symptoms (score ≥25 on the Center for Epidemiologic Studies Depression [CES-D] scale) and two participants who were suspected of having major depressive disorder based on our screening tool (MINI Patient Health Survey) [19]. In total, 149 healthy participants were included in the analysis. This study was conducted in accordance with "The Code of Ethics of the World Medical Association (Declaration of Helsinki)" for experiments involving humans. This study was approved by the Institutional Review Board of Kyungpook National University Chilgok Hospital (KNUCH2021-07-010-001). Informed consent was obtained from all participants upon enrollment in the study.

Measures

Cognitive assessments

This study utilized the Wechsler Adult Intelligence Scale-IV (WAIS-IV) [20], which is the most frequently used measurement tool to evaluate cognitive function in clinical practice. The WAIS-IV evaluates full-scale intelligence quotient (IQ) and employs four index scales: verbal comprehension, perceptual reasoning, working memory, and processing speed.

We also used the Central Nervous System Vital Signs (CNS-VS) computerized battery (https://www.cnsvs.com/) to assess cognitive function. The CNS-VS can detect cognitive abnormalities using a normative database [21]. The parameter consists of 10 tests, the results of which are combined to produce 15 separate standardized domain scores: composite memory, verbal memory, visual memory, psychomotor speed, reaction time, cognitive flexibility, complex attention, processing speed, executive function, simple attention, motor speed, social acuity, reasoning, sustained attention, and working memory.

All cognitive assessment scores were standardized, with a mean of 100 and a standard deviation of 15.

Psychological assessments

To evaluate childhood maltreatment experiences, we used the Early Trauma Inventory Self Report-Short Form (ETISR-SF), a 27-item questionnaire evaluating four types of traumatic experiences: general trauma, physical, emotional, and sexual abuse [22]. The Korean version used in this study was standardized in 2012 [23]. We employed the ETISR-SF to categorize participants into maltreatment and non-maltreatment groups. Given that the standard cutoff score of the ETISR-SF has not been validated, we opted for a cutoff point of 8 for two reasons. First, the score of 8 exceeds 2 standard deviations from the mean scores of the nonclinical sample in a validation study conducted in Korea [23]. A previous study used this criterion to divide the participants into low and high trauma groups [24]. Second, a score of 8 was above the highest quartile in our samples. Although maltreatment prevalence differed according to sex, maltreatment type, and country of residence, the prevalence rate of self-reported maltreatment experiences was approximately 20%–30% [25].

To evaluate depressive symptoms, we used the Korean version of the CES-D, a 20-item questionnaire [26,27]. The level of difficulty in emotional control was assessed using the Difficulties in Emotion Regulation Scale (DERS) [28]. The DERS provides a comprehensive evaluation of the emotional difficulty in adults, with high total scores, indicating a greater degree of emotional difficulty. The Korean version of the scale was standardized in 2007 [29]. We also used the Cognitive Emotion Regulation Questionnaire (CERQ), a self-report questionnaire, to assess nine cognitive emotion regulation strategies (five adaptive and four less adaptive) [30]. The Korean version of the scale was validated in 2013 [31]. Additionally, we employed the Korean version of Spielberger's State-

Trait Anxiety Inventory (STAI) [32,33], and the scores of trait anxiety from the STAI were used to evaluate the participants' level of anxiety.

Statistical analysis

An independent t-test was used to compare demographic, psychological, and emotion regulation differences as well as the outcomes of the cognitive assessments between the maltreatment and non-maltreatment groups. Additionally, an analysis of covariance was applied to control for the effects of depressive and anxiety symptoms on cognitive ability. Furthermore, the association between cognitive assessments and difficulties in emotional regulation was elucidated using Pearson's and partial correlation coefficients, as well as multiple linear regression. Age, sex, education, and depressive symptoms measured by the CES-D were used as covariates in the partial correlation analysis. All analyses were conducted using Jeffrey's Amazing Statistics Program 0.18.2 (https://jasp-stats.org).

RESULTS

Group differences in demographic and psychological characteristics

Age differed significantly between the two groups (t=2.43, p=0.016), whereas sex and education did not. The maltreatment group exhibited higher scores on the CES-D (t=3.19, p=0.002), DERS (t=2.66, p=0.009), and maladaptive strategies in the CERQ (t=2.55, p=0.012) than those displayed by the non-maltreatment group. Symptoms of anxiety and adaptive strategies for cognitive emotion regulation demonstrated no significant differences between the two groups. Table 1 presents detailed information on the participants' demographic and psychological characteristics.

Group differences in IQ measured by the WAIS-IV

The maltreatment group had lower full-scale IQ scores (F=16.43, p<0.001) on the WAIS-IV than those of the non-maltreatment group. Among the WAIS-IV subscales, perceptual reasoning, working memory, and processing speed scores were lower after controlling for age, sex, education, and depressive symptoms in the maltreatment group than in the non-maltreatment group (all p-values <0.01). Verbal apprehension subscale scores were not significantly different between the two groups. Fig. 1 presents the detailed results.

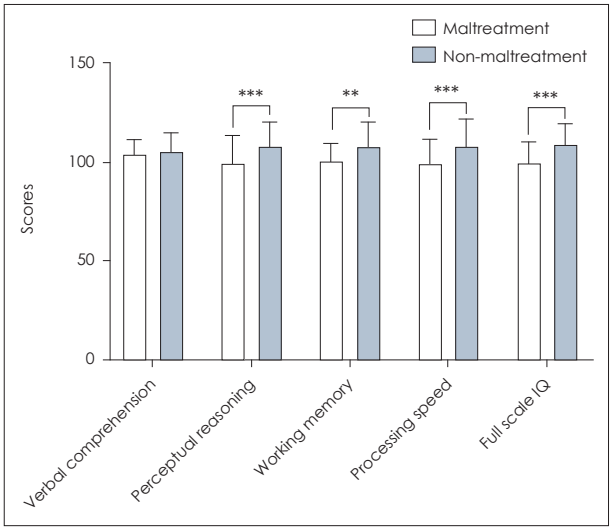

Fig. 1. Group differences in Wechsler Adult Intelligence Scale IV scores after controlling the age, sex, education and Center for Epidemiologic Studies Depression scores. **p<0.01; ***p<0.001. IQ, intelligence quotient.

Table 1. Epidemiological and psychological characteristics in the maltreatment and non-maltreatment (control) groups

Characteristic	Maltreatment (n=36)	Non-maltreatment (n=113)	t or χ^2	p
Age (yr)	26.22±5.56	24.07±4.30	2.43	0.016
Sex			0.06	0.807
Male	19	57		
Female	17	56		
Education			1.63	0.202
High school graduate	20	76		
College graduate	16	37		
CES-D	15.69±4.61	13.11±4.12	3.19	0.002
STAI	46.61±8.22	43.42±9.49	1.81	0.073
DERS	92.94±21.37	83.96±16.34	2.66	0.009
CERQ (adaptive strategies)	65.58±14.27	64.36±13.55	0.46	0.643
CERQ (maladaptive strategies)	42.61±9.52	37.88±9.75	2.55	0.012

Data are presented as mean±standard deviation or numbers only. Adaptive strategies: The sum of the scores of acceptance, refocusing on planning, putting into perspective, positive refocusing, and positive reappraisal. Maladaptive strategies: The sum of the scores of self-blame, other-blame, rumination, and catastrophizing. CERQ, Cognitive Emotion Regulation Questionnaire; CES-D, Center for Epidemiological Studies-Depression; DERS, Difficulties in Emotion Regulation Scale; STAI, State-Trait Anxiety Inventory

Table 2. Group differences in cognitive function measured by computerized battery

Variables	Maltreatment (n=36)	Non-maltreatment (n=113)	t value	F value†
Neurocognition index	98.61±14.20	105.80±10.10	-3.35**	9.22**
Composite memory	102.31±19.76	101.71±14.64	0.20	0.03
Verbal memory	104.78±16.26	102.52±16.50	0.72	0.40
Visual memory	99.89±18.84	100.77±14.59	-0.29	0.06
Psychomotor speed	103.14±12.48	115.02±14.88	-4.33***	14.90***
Reaction time	90.83±15.79	99.81±16.36	-2.89**	7.40**
Complex attention	97.72±27.09	103.84±13.76	-1.79	2.15
Cognitive flexibility	99.19±19.02	108.48±16.19	-2.87**	7.34**
Processing speed	99.03±15.84	110.47±18.10	-3.40***	9.62**
Executive function	99.94±17.55	108.81±15.95	-2.83**	7.45**
Social acuity	94.11±13.81	94.58±14.07	-0.17	0.27
Reasoning	107.89±12.20	110.88±11.41	-1.35	2.12
Working memory	99.06±10.07	105.85±10.50	-3.41***	9.78**
Sustained attention	101.25±9.27	106.06±11.49	-2.29*	4.06*
Simple visual attention	91.81±54.53	103.31±13.49	-2.07*	2.73
Motor speed	104.06±11.29	111.60±12.22	-3.28**	8.28**

Data are presented as mean±standard deviation. *p<0.05; **p<0.01; ***p<0.001; †adjusted for age, sex, education, and CES-D scores, degree of freedom=143. CES-D, Center for Epidemiological Studies-Depression

Group differences in cognitive function measured by computerized test

Among the cognitive function variables measured by the CNS-VS, the neurocognition index, psychomotor speed, reaction time, cognitive flexibility, processing speed, executive function, working memory, sustained attention, and motor speed were significantly lower in the maltreatment group than in the non-maltreatment group after controlling for age, sex, education, and depressive symptoms (all p-values <0.05). Table 2 lists the detailed statistical values.

Relationship between cognitive function and emotion regulation patterns

A partial correlation analysis was performed after controlling for age, sex, education, and depressive symptoms. Significant correlations were identified between working memory and CERQ subscales including rumination (r'=-0.197, p=0.017) and catastrophizing (r'=-0.166, p=0.046) (Table 3).

The multiple linear regression analysis demonstrated that among cognitive functions, working memory had a significant effect on catastrophizing (t=-2.055, p=0.042), a subscale of CERQ (Table 4).

Relationship between Korean version of WAIS-IV and maltreatment subtypes

In the partial correlation analysis, emotional abuse exhibited a negative relationship with working memory and processing speed, while physical abuse demonstrated a negative correlation with working memory function (all p-values < 0.05). Supplementary Tables 1 and 2 display detailed results.

DISCUSSION

This study revealed that individuals who experienced childhood maltreatment exhibited decreased working memory and processing speed in both the WAIS-IV and computerized battery assessment compared to those without such experiences. The decline in working memory was associated with catastrophizing, a maladaptive cognitive emotion regulation mechanism, and was weakly correlated to rumination.

The level of maltreatment was generally higher in our study than that reported by a Korean non-clinical group in a previous study. The average score of the ETISR-SF was 4.42 in our study, whereas the validation study evaluated a non-clinical sample and reported a score of 2.33 [23]. Our participants were not previously diagnosed with mental disorders and were excluded from the screening tool if they were suspected of having major depressive disorder. However, considering that they demonstrated interest and volunteered for this study, the degree of maltreatment was presumed to be relatively higher than that in the healthy general population. Furthermore, the maltreatment group exhibited significantly more depressive symptoms than those demonstrated by the non-maltreatment group, consistent with the results of previous studies that identified a strong association between depressive symptoms and early-life interpersonal violations in non-clinical populations [34]. Additionally, the maltreatment group reported difficulties in emotion regulation and a height-

Table 3. Pearson's and partial correlation between cognitive functions and cognitive emotion regulations (n=149)

	Verbal comprehension	Perceptual reasoning	Working memory	Processing speed	Full-scale IQ
Acceptance					
r	0.103	-0.101	0.013	-0.121	-0.047
r'	0.111	-0.066	0.018	-0.146	-0.034
Refocusing on planning					
r	0.136	-0.007	0.102	-0.003	0.074
r'	0.151	-0.001	0.082	0.025	0.087
Putting into perspective					
r	0.063	-0.106	0.053	-0.024	-0.013
r'	0.061	-0.107	0.046	-0.009	-0.01
Positive refocusing					
r	<0.001	-0.087	0.083	0.035	0.005
r'	0.021	-0.118	0.069	0.033	-0.006
Positive reappraisal					
r	0.080	-0.044	0.084	-0.127	-0.007
r'	0.086	-0.051	0.064	-0.099	-0.003
Self-blame					
r	0.032	-0.067	-0.018	-0.053	-0.047
r'	0.022	-0.037	0.010	-0.067	-0.033
Other-blame					
r	0.019	-0.03	-0.129	0.077	-0.021
r'	0.003	-0.036	-0.129	0.028	-0.046
Rumination					
r	-0.095	-0.164*	-0.224**	-0.087	-0.200*
r'	-0.111	-0.116	-0.197*	-0.104	-0.182*
Catastrophizing					
r	-0.123	-0.079	-0.198*	-0.009	-0.139
r'	-0.145	-0.037	-0.166*	-0.023	-0.124

r, Pearson's correlations. r', partial correlations. Conditioned on variables: age, sex, education, and CES-D scores. *p<0.05; **p<0.01.
CES-D, Center for Epidemiologic Studies Depression; IQ, intelligence quotient

ened reliance on maladaptive strategies for emotion regulation, consistent with prior research findings in the general population [35,36]. These results indirectly support the reliability of classifying participants into maltreatment and non-maltreatment groups.

Our study suggests that working memory and processing speed differed between the two groups. According to Cattell's theory, general fluid intelligence is related to novel problem-solving skills [37]. Moreover, fluid intelligence is also significantly associated with working memory [38]. The increase in general fluid intelligence was mediated by changes in the processing speed, suggesting a connection between the two [39]. Chronic stress, such as childhood abuse, can damage hippocampal neurons, resulting in a volume reduction in the hippocampus [8]. These alterations in hippocampal structure and function contribute to impediments in learning and memory, which are linked to a decrease in general fluid intelligence, a crucial element of learning [40-42]. Therefore, our findings suggest that childhood maltreatment can cause abnormalities in brain structure or function through chronic stress, resulting in a decline in cognitive domains closely related to general fluid intelligence.

Among the four indices of the WAIS-IV, verbal comprehension displayed no difference between the maltreatment and non-maltreatment groups (Supplementary Tables 1-3). In the previous study, among the four indices, verbal comprehension has been suggested to be highly related to crystallized intelligence [43]. Crystallized intelligence refers to the cognitive domain associated with problem-solving skills that are already established within an existing culture and obtained through education. That encompasses knowledge previously acquired by individuals [44]. Therefore, in the case of verbal comprehension, it can be said that cognitive functions in different domains are evaluated compared to the other three indices. Unlike fluid intelligence, crystallized intelligence encompasses the accumulation of knowledge and skills over a

Table 4. Multiple linear regression analysis (enter method) for explaining catastrophizing and rumination using cognitive measures (n=149)

	Unstandardized coefficient		95% CI of B	Standardized coefficient	t	p
	B	SE		β		
Catastrophizing						
Verbal comprehension	-0.010	0.036	-0.081 to 0.061	-0.027	-0.285	0.776
Perceptual reasoning	0.004	0.026	-0.048 to 0.056	0.014	0.138	0.891
Working memory	-0.063	0.031	-0.124 to -0.002	-0.218	-2.055	0.042*
Processing speed	0.018	0.024	-0.029 to 0.065	0.069	0.740	0.461
Rumination						
Verbal comprehension	0.010	0.036	-0.061 to 0.080	0.026	0.270	0.788
Perceptual reasoning	-0.021	0.026	-0.072 to 0.031	-0.078	-0.793	0.429
Working memory	-0.059	0.031	-0.120 to 0.001	-0.204	-1.931	0.056
Processing speed	0.005	0.024	-0.042 to 0.051	0.019	0.201	0.841

*$p < 0.05$. CI, confidence interval; SE, standard error

person's lifetime [45]. Therefore, in this cognitive domain, functionality is expected to remain stable irrespective of individual stress events. The authors infer from this perspective that significant differences between maltreatment and non-maltreatment groups are unlikely, unlike in other cognitive domains.

Furthermore, according to the results of Pearson's and partial correlation analyses of the cognitive functions and maltreatment subtypes, physical and emotional abuse was associated with a decrease in the cognitive domains related to general fluid intelligence (Supplementary Tables 1 and 2). McLaughlin et al. [46] suggested that early psychosocial deprivation experiences, such as emotional neglect, can affect cognitive function due to a lack of various environmental and social interactions. Moreover, emotional and physical abuse were important traumatic events that could be associated with cognition in adults [47]. In another study conducted among adolescents, physical abuse negatively affected executive functioning and related cognitive domains [48]. Our results are consistent with these existing findings and are significant as they suggest that emotional and physical abuse in childhood can affect cognitive function in adulthood.

Our results indicated a significant relationship between working memory and maladaptive emotion regulation patterns, including rumination and catastrophizing. Working memory is the function of holding specific information at a moment and subsequently utilizing such information, serving as an internal resource for regulating emotions [49]. Various studies have demonstrated the beneficial effects of working memory in decreasing maladaptive emotion regulation patterns. In recent studies, emotion regulation ability improved after 20 days of working memory training, which might have enhanced the function of attention control measured by electroencephalography [15]. Additionally, 10 sessions of online cognitive control training can help reduce maladaptive emotion regulation patterns such as brooding [50,51] and rumination [52]. Furthermore, combining working memory training and mindfulness meditation can reduce excessive worry, possibly owing to improved attentional control [53]. The ability to update emotional information related to the working memory can modulate the emotion regulation efficacy [54]. Therefore, working memory related to cognitive control may play a pivotal role in emotion regulation compared to other cognitive abilities, as corroborated by our findings.

Our study has several limitations. First, the impact of childhood maltreatment may be related to other factors such as its duration and the age at which maltreatment began; however, these effects were not considered [55]. Second, factors such as parental intelligence, which can be directly related to cognitive function, were not evaluated. Third, the selection of our cutoff point may appear somewhat arbitrary; however, when we experimented with various cutoff points ranging from six to nine, we observed similar results (Supplementary Table 3). Finally, the participants were recruited from a community-based institution; thus, the results cannot be generalized to the entire population. In the future, additional reviews of multiple institutions in multiple regions may be required.

CONCLUSION

Despite the limitations mentioned above, our study suggests that childhood maltreatment experiences are associated with difficulties in emotion regulation in adulthood, and that maladaptive emotion regulation strategies could be easily applied by individuals with such experiences. In addition,

childhood maltreatment experiences can negatively affect cognitive functions, such as processing speed and working memory, in adulthood. Additionally, decreased working memory function is linked to the use of maladaptive emotional control strategies. Appropriate cognitive training can help improve emotion regulation in adults who have experienced childhood maltreatment. However, further studies are required to confirm this hypothesis.

Supplementary Materials

The online-only Data Supplement is available with this article at https://doi.org/10.5765/jkacap.240001.

Availability of Data and Material

Data will be made available on an appropriate request.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Sang Won Lee. Data curation: Min Seok Kim, Sang Won Lee, Jihyun Nam. Formal analysis: Sang Won Lee. Funding acquisition: Sang Won Lee. Investigation: Sang Won Lee, Kyungmin Kim. Methodology: Sang Won Lee. Resource: Sang Won Lee. Supervision: Sang Won Lee. Validation: Kyungmin Kim, Seung Jae Lee. Writing—original draft: Kyungmin Kim, Min Seok Kim, Sang Won Lee. Writing—review & editing: Kyungmin Kim, Min Seok Kim, Seung Jae Lee, Sang Won Lee.

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