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Relationship among Eating Behavior, Effortful Control, and Working Memory in Female Young Adults

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Abstract

The management of eating behavior plays an important role in health maintenance. In this study, we investigated the relationship between eating behavior and effortful control in female young adults. Participants completed the questionnaire measures of effortful control and eating behaviors and Stroop cognitive interference task. The results showed that restrained eating was positively correlated with activation control; emotional eating was negatively correlated with inhibitory control and attentional control; external eating was negatively correlated with inhibitory, activation, and attentional control. The scores for activation control and restrained eating were higher for participants with a low Stroop error rate than for those with a high Stroop error rate. These results indicate that restrained eating has a different association with effortful control than doing emotional and external eating.

Keywords

Executive Function, Working Memory, Effortful Control, Eating Behavior

1. Introduction

The management of eating behavior plays an important role in health maintenance. However, it is not easy for individuals to decide how much and what to eat, because the type and quantity of food eaten vary according to individual characteristics such as age, gender, amount of physical activity, and preference.

Effortful control is the ability to inhibit a dominant response and to perform instead a subdominant response [1]. That is, effortful control is the ability to voluntarily activate or inhibit impulses to act [2]. Effortful control is involved by attention [1]. Attention is a multifaceted cognitive domain that is required for efficient perception, learning, memory, and reasoning. Research has shown that effortful control is related to eating pathology [3]-[5]. In one study, patients with eating disorders and bingeing/purging behavior scored significantly lower on the Effortful Control Scale (ECS) [6]. In contrast, other studies have found that effortful control is not associated with severe weight cycling [7], and that the interaction between sensitivity to reward and effortful control does not predict weight cycling [7]. Although some research shows no association between effortful control and eating behaviors [8], other research indicates that lower effortful control is associated with more eating disorder symptoms [9]. In one study, eating disorder symptoms were related to low levels of effortful control and strongly related to high levels of Behavioral Inhibition Scale reactivity (anxiety) [10]. Thus, the findings in this area are contradictory.

Working memory is conceptualized in executive function [11], and is the active process by which information is maintained in short-term memory stores and manipulated during performance of complex, goal-directed tasks [12]. It is reported that executive function and effortful control are associated and overlapping constructs [13]. Indeed, working memory is considered vital to higher-order cognitive abilities such as planning [14], problem solving [15], delayed goal execution [16] and overall fluid intelligence [17] [18]. Therefore, working memory is considered important in the management of eating behavior.

In this study, we investigated the relationship among eating behavior, effortful control and working memory in female young adults.

2. Materials and Methods

2.1. Participants

Participants were 26 female Japanese university students (age 20.6 ± 0.5 years). The inclusion criteria were females aged between 20 and 22 years. Participants completed an anonymous questionnaire that included items related to cognitive function and eating behavior.

All participants provided informed consent and the study received the approval of the Human Ethics Committee of the Graduate School of Human Development and Environment, Kobe University.

2.2. Measures

To measure effortful control, we used the Japanese version of the ECS [19], which was developed from the original ECS included in the Adult Temperament Questionnaire [20]. The Japanese version of the ECS consists of 35 items, each of which is rated on a 4-point Likert scale (untrue = 1, slightly untrue = 2, slightly true = 3, true = 4) to yield a total score ranging between 35 and 140. It includes the following three subscale scores:

1) the ability to voluntarily manage attention (attentional control or the ability to focus/shift attention when needed = EC-attentional [12 items, range 12 - 48]); 2) the ability to inhibit a dominant response (inhibitory control or the ability to inhibit behavior = EC-inhibitory [11 items, range 11 - 44]); and 3) the ability to activate a subdominant response (activation control or the ability to activate behavior = EC-activation [12 items, range 12 - 48]).

Eating behavior was assessed using the Japanese version of the Dutch Eating Behavior Questionnaire (DEBQ) [21] originally developed by van Strien [22]. The validity and reliability of the Japanese version of the DEBQ has been evaluated in a previous study [21]. The DEBQ is a 33-item self-rated questionnaire comprising three subscales: restrained eating (10 items), emotional eating (13 items), and external eating (10 items). Restrained eating is paradoxical dietary restraint (food intake is initially reduced to lose or maintain body weight, but is followed by increased consumption and binge eating). Emotional eating is eating in response to negative emotions, and external eating is eating in response to the sight or smell of food [22]. Participants rated each DEBQ question from 1 for "never" to 5 for "very often". Responses to each question were added together for each subscale, and then divided by the number of questions on each subscale to produce a score between 1 and 5.

The Stroop task was used to measure cognitive interference. In the Stroop interference task, participants are required to name the color of a written color word displayed on the monitor while inhibiting the tendency to read the word itself. Inhibitory control is required when the color in which the word is printed and the color denoted by the word are incongruent. In the present study, we used a computerized version of the Stroop task, which included two experimental blocks (one congruent, one incongruent) of 40 trials each. Congruent trials consisted of color words that were displayed in the corresponding color. In incongruent trials, the color of the color word was different to the color denoted by the word. The error response rate was calculated by dividing the number of error trials by the total number of trials.

2.3. Data Analysis

Pearson's product-moment correlation coefficient was used to test the association between cognitive function and eating behavior. Student's t-test was used to evaluate the between-group difference. The statistical level for significance was set at 0.05. Statistical analysis was performed using SPSS® 22.0 J for Windows (SPSS Inc., Chicago, USA).

3. Results

The mean ECS scores (for inhibitory control, activation control, and attentional control) and DEBQ scores are shown in Table 1. Using the Stroop task error rate, participants were divided into two groups: a high error group and a low error group.

Table 2 shows the relationship between DEBQ and ECS scores. Restrained eating was significantly positively correlated with activation control ($r = 0.508$, $p < 0.001$). Emotional eating was significantly negatively correlated with inhibitory control ($r =$

Table 1. Effortful control, eating behavior, and Stroop test scores (n = 26).

Subscale	Score
ECS	
Inhibitory control	31.0 ± 4.7
Activation control	32.0 ± 5.1
Attentional control	28.1 ± 5.5
DEBQ	
Restrained eating	30.6 ± 6.9
Emotional eating	28.3 ± 11.4
External eating	35.9 ± 5.5
Stroop test (interference)	
Error Rates	3.2 ± 4.6

Data are mean ± standard deviation. ECS: Effortful Control Scale, DEBQ: Dutch Eating Behavior Questionnaire.

Table 2. Correlation coefficients between eating behavior and effortful control.

	Inhibitory Control	Activation control	Attentional Control
Restrained eating	0.252	0.508*	0.081
Emotional eating	−0.407*	0.338	−0.088
External eating	−0.769*	−0.696*	−0.454*

Data are Pearson's correlation coefficients. *$p < 0.05$.

−0.407, $p < 0.001$). External eating was significantly negatively correlated with inhibitory control ($r = -0.769$, $p < 0.001$), activation control ($r = -0.696$, $p = 0.002$), and attentional control ($r = -0.454$, $p < 0.001$).

Table 3 shows that the DEBQ scores for restrained eating were significantly higher for participants in the low error rate group than for those in the high error rate group ($p < 0.001$). In addition, the ECS scores for activation control were significantly higher for participants in the low error rate group than for those in the high error rate group ($p < 0.001$).

4. Discussion

We attempted to clarify the relationship between eating behavior and effortful control in Japanese female students. We also verified the association of working memory with eating behavior and effortful control.

First, restrained eating was positively correlated with activation control. Emotional eating was negatively correlated with inhibitory and attentional control, and external eating was negatively correlated with inhibitory control, activation control, and attentional control. Effortful control is the ability to inhibit a dominant response and to perform instead a subdominant response [1]. Activation control is the capacity to perform

Table 3. Association of Stroop test scores with effortful control and eating behavior.

	Low error rate group (n = 12)	High error rate group (n = 14)
ECS		
Inhibitory control	32.3 ± 4.3	29.1 ± 5.0
Activation control	34.1 ± 4.4*	29.6 ± 5.0
Attentional control	28.6 ± 5.5	27.2 ± 6.0
DEBQ		
Restrained eating	33.9 ± 5.1*	26.5 ± 6.0
Emotional eating	28.1 ± 9.6	28.4 ± 12.7
External eating	34.3 ± 4.8	37.4 ± 5.7

Data are mean ± standard deviation. *Student's t-test showed a significant difference between the low error rate group and the high error rate group ($p < 0.05$). ECS: Effortful Control Scale, DEBQ: Dutch Eating Behavior Questionnaire.

an action when there is a strong tendency to avoid it [1]. Emotional eating and external eating are associated with disinhibition [23]. Disinhibition in eating behavior, which is partly characterized by the propensity to eat opportunistically in response to environmental cues, has long been associated with obesity in both youths and adults [24]. Previous work has shown that disinhibition is also negatively related to restrained eating [22]. These researches support the present findings. Thus, the present findings indicate that effortful control relates differently to restrained eating, emotional eating, and external eating.

Second, scores for activation control and restrained eating were higher in the low error rate group than in the high error rate group. One aspect of attention has been conceptualized in the model of working memory [12] [25]. Working memory is the active process by which information is maintained in short-term memory stores and manipulated during performance of complex, goal-directed tasks [12]. Previous studies have shown that better working memory is associated with higher effortful control in both children [26] and adults [27]. The present findings are not inconsistent with these results.

Some previous reports on the relationship between working memory and eating behaviors have found that uncontrolled eating is associated with low levels of working memory [28]. Rigid restraint is associated with attentional bias to food and shape-related stimuli, whereas flexible restraint correlates with impaired working memory [29]. Other studies have found associations between dieting and poorer working memory performance [30] [31]. In contrast, the present findings show that restrained eating was higher in the group with better working memory performance than in the group with poorer performance. The reasons behind this pattern of results are not clear. However, consistent and sustained eating restraint is needed to control food intake and lose weight, and this may require working memory. Future research should examine this possibility.

Two study limitations should be noted. This study used a cross-sectional design, which limits the possibility of drawing inferences about the direction of effects. In addition, our samples were convenience samples drawn from a limited area of Japan, and the number of the samples was a little less.

5. Conclusion

In the present study, restrained eating was positively correlated with activation control; emotional eating was negatively correlated with inhibitory control and attentional control; external eating was negatively correlated with inhibitory, activation, and attentional control. Activation control and restrained eating scores were higher in the low error rate group than in the high error rate group. These findings indicate that restrained eating has a different association with executive functions than doing emotional and external eating.

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Conflict of Interest

The authors report no conflicts of interest in this work.

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