Progress in Nutrition 2021; Vol. 23, N. 1: e2021023 DOI: 10.23751/pn.v23i1.8780

Original article

Effect of plate color on dietary intake in young people with mild intellectual disabilities

Woon Ji Kim[1,], Eun Young Jung[2,*], Eun Young Park[3]*

[1]Graduate School of Childhood and Special Education, Jeonju University, Jeonju 55069, Republic of Korea
[2]Department of Home Economic Education, Jeonju University, Jeonju 55069, Republic of Korea
[3]Department of Secondary Special Education, Jeonju University, Jeonju 55069, Republic of Korea
[*]Eun Young Jung and Woon Ji Kim contributed equally to this study.

Summary. This study aimed to investigate whether plate color affects dietary intake in young people with mild intellectual disabilities. The experiment employed a within-subjects, repeated-measures design. A portion of fried rice (400 g) was presented on a white plate, red plate, or blue plate. Twenty subjects (12 male, 8 female; aged 15–21 years) took part. Although the amount served was always the same, most of the subjects (80%) estimated that the amount of fried rice on a white plate was more than the amount in a regular rice bowl. In contrast, 50% or 40% of the subjects perceived the amount of fried rice on the red or blue plate, respectively, to be more than the amount in a regular rice bowl. Plate color did not have a significant effect on the amount consumed. There were no significant differences in satiety and hunger ratings across conditions for 2 hours after each test meal. Young people with intellectual disabilities, who are less influenced by the environment as a result of their cognitive deficits, may be forced to rely more on internal factors than on external factors.

Key Words: intellectual disability, plate, color, food consumption

Introduction

The mechanism controlling eating behavior is very complex and involves a number of factors (1). Recently, the importance of visual signal as one of the external factors regulating dietary intake has been revealed (2, 3). The visual signal arising from cognitive cue may affect neural mechanisms in the brain. The visual signal may stimulate, but also contribute to, satiety (2). Specifically, it has been shown that visual signal relating to color influences dietary intake (4, 5). Color may help to attract attention, convey messages, and create feelings (6). Such effects of color have been demonstrated to influence emotional responses and eating behavior (7, 8). This suggests that modifying plate color, while not directly related to the food itself, can also influence dietary intake (9, 10).

Intellectual disability (ID), also known as general learning disability or mental retardation, is a generalized neurodevelopmental disorder characterized by significantly impaired intellectual adaptive functioning. Clinically, ID is a subtype of cognitive deficit, which subtype of cogniterm to describe any characteristic that acts as a barrier to the cognition process (11-13). People with ID may be forced to rely more on internal factors than external factors as a result of their cognitive deficits when making judgments. In the context of eating, internal factors, such as gastric distension and release of intestinal peptides, may lead them to eat the amount of food needed to achieve comfortable satiety (2). This study was carried out to investigate whether the external factor of plate color affects dietary intake in people with ID.

Materials and methods

Subjects

Young people with mild ID were recruited from a special school in South Korea. All subjects were diagnosed with mild ID (i.e., a performance IQ of 55–75) and had no other disabilities. Potential subjects

were interviewed to determine that they were in good health, were not currently following a weight-loss diet or trying to gain weight, were not using medication known to affect dietary intake or appetite, had no food allergies or food restrictions that would affect dietary intake, and regularly ate 3 meals per day. Potential subjects completed the following questionnaires: Eating Attitudes Test (EAT-40) (14), which detects symptoms of an eating disorder; Zung Self-Rating Depression Scale (Zung Questionnaire) (15), which is an indicator of depression; and color blindness test (16). Potential subjects were excluded if they scored ≥ 30 on the EAT-40, ≥ 40 on the Zung Questionnaire or color blind who cannot distinguish between colors.

Procedures

The experiment employed a within-subjects, repeated-measures design. Subjects visited the laboratory on 3 different days, separated by at least 1 week and were served a test meal on different colored plate on each visit. Subjects were asked to keep their evening meals and activity levels as similar as possible on the days before each test day, and to refrain from consuming any food or energy-containing beverages for 3 hours before the experiment. At the start of each test meal, subjects were seated in individual cubicles. They were not allowed to read or work during the meal.

For each meal, a portion of fried rice was presented on a white plate, red plate, or blue plate, as shown in Figure 1. Plates used in this study were all of the same material, shape, and size (porcelain, rounded, and 28 cm in diameter). All conditions for each test meal, except for plate color, were also the same. The amount of fried rice served (400 g) was determined to be a generous portion for one person in Korea. Each portion contained 165.0 kcal, 29.5 g of total carbohydrates, 0.5 g of sugar, 3.0 g of protein, 3.5 g of total fat, 1.2 g of saturated fat, 5.0 mg of cholesterol, and 305.0 mg of sodium per 100 g. Subjects were instructed to consume as much of it as they would like, to the point of comfortable satiation. They were allowed to request additional fried rice. During each test meal, investigators counted the number of spoonfuls taken and the number of chews per spoonful during each meal. The exact clock times at meal initiation and completion were recorded. The amount of the meal consumed was calculated by weighing the plate before and after the meal. After

Figure 1. Picture of different-colored plates with and without fried rice

completing every condition, we asked the subjects how they perceived the amount of fried rice on each color plate to compare with the same amount of fried rice in a regular rice bowl. The study was approved by the Ethical Committee for Human Experimentation of Jeonju University (jjIRB-170417-HR-2017-0510). Written informed consent was obtained from the subjects.

Visual analogue scale ratings for satiety and hunger

Subjective satiety and hunger were measured using a 100 mm visual analogue scale (VAS). This scale was anchored by the descriptors "not at all" and "extremely." While young people with mild ID can provide self-reports, there is evidence that they are less accurate in localizing their mood and slower to acknowledge it (17, 18). Subjects were therefore selected such that they could report themselves satiety and hunger using a VAS before and after a meal. Subjects completed the VAS 4 times on each test day: immediately before and after the test meal, and hourly for 2 hours after the meal. And subjects were also presented with 10 g samples of fried rice, which were rated using a VAS for palatability (pleasantness of appearance, odor, taste, and texture).

Statistical analysis

All statistical analyses were performed using SPSS Statistics 23 (IBM Co., NY, USA). Data were analyzed using a repeated measures ANOVA with Bonferroni-adjusted pairwise comparisons. The results are reported below in the form mean ± standard error of the mean. Differences in means were considered significant at $p<0.05$.

Results

Twenty subjects (12 male, 8 female) were selected for participation, and all completed the study. Subjects ranged in age between 15 and 21 years old (mean 17.8 years). They had an average height and weight of 163.3 cm (males, 168.9 cm; females, 155.1 cm) and 64.5 kg (males, 71.4 kg; females, 54.1 kg), respectively. Subjects' characteristics are shown in Table 1. Palatability ratings revealed no significant differences among the test meals (data not shown).

Subjects' perception of the amounts of food on different-colored plates is shown in Table 2. Although

Table 1. Subjects' characteristics

Item	Subjects Total (n=20)	
	Male (N=12)	Female (N=8)
Age (yrs)	17.8 ± 0.3	
	17.7 ± 0.4	18.1 ± 0.5
Height (cm)	163.3 ± 2.6	
	168.9 ±3.4	155.1 ± 1.6
Weight (kg)	64.5 ± 4.2	
	71.4 ± 5.7	54.1 ± 4.1
BMI (kg/m^2)	23.8 ± 1.2	
	24.7 ± 1.5	22.6 ± 1.8
Body fat mass (kg)	19.4 ± 2.4	
	19.8 ± 3.4	18.7 ± 3.3
% Body fat (%)	28.6 ± 2.3	
	25.8±2.7	32.9±3.7
Lean body mass (kg)	45. 1±2.6	
	51.6±3.0	35.5±1.6

Values are means ± standard error of the mean. BMI; body weight (kg)/[height (m)]^2

Table 2. Perception of amount on different-colored plates in young people with mild intellectual disabilities

Plate color	Perception of amount	N (%)	
White plate	More than the amount in a regular rice bowl	16 (80)	20 (100)
	Less than the amount in a regular rice bowl	1 (5)	
	Same as the amount in a regular rice bowl	3 (15)	
Red plate	More than the amount in a regular rice bowl	10 (50)	20 (100)
	Less than the amount in a regular rice bowl	1 (5)	
	Same as the amount in a regular rice bowl	9 (45)	
Blue plate	More than the amount in a regular rice bowl	8 (40)	20 (100)
	Less than the amount in a regular rice bowl	2 (10)	
	Same as the amount in a regular rice bowl	10 (50)	

all meals contained the same amount of food, most of the subjects (80%) estimated that the fried rice portion served on a white plate was larger than the amount of fried rice in a regular rice bowl. On the other hand, 50% or 40% of the subjects perceived the fried rice portions served on red plate or blue plate, respectively, to be larger than the amount of fried rice in a regular rice bowl.

Figure 2 shows the amount consumed, eating time, number of spoonfuls taken, and number of chews per spoonful for test meals served on different-colored plates. Plate color did not have a significant effect on the amount of fried rice consumed by young people with mild ID (Figure 2-A): there was no significant difference in the average amount consumed from a white plate (469.8 g), red plate (430.2 g), or blue plate (430.4 g), $p>0.05$. Regardless of plate color, subjects took similar amount of time to eat the test meals (Figure 2-B): there was no significant difference in the average amount of time spent eating from a white plate (10.5 minutes), red plate (11.7 minutes), or blue plate (10.0 minutes), $p>0.05$. Furthermore, the number of spoonfuls taken and number of chews per spoonful did not differ significantly by plate color, $p>0.05$ (Figure 2-C and D). Figure 3 presents the VAS results on subjective satiety and hunger ratings before and after the test meals served on different-colored plates. The initial ratings of satiety and hunger did not differ for different-colored plates, and similarly there were no significant differences in satiety and hunger ratings by plate color for 2 hours after eating the test meal.

Discussion

The present study investigated whether or not plate color would exert a significant influence on the

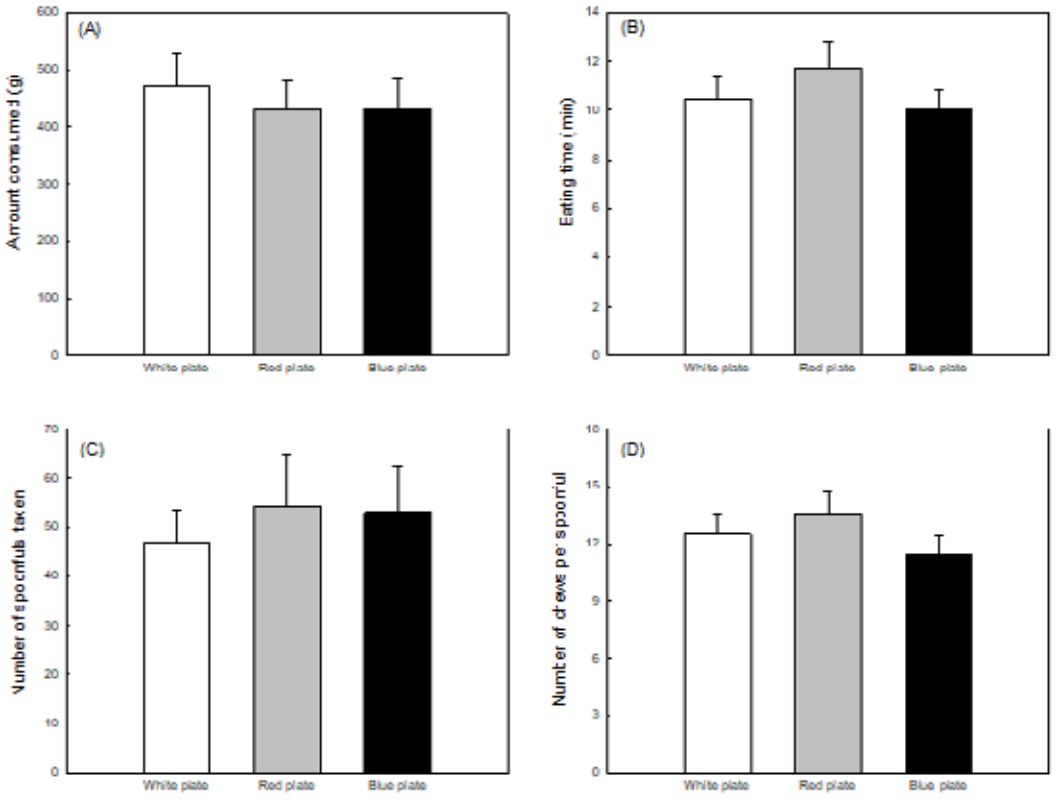

Figure 2. Amount consumed (A), eating time (B), number of spoonfuls taken (C) and number of chews per spoonful (D) of test meal on different-colored plates in young people with mild intellectual disabilities. Values are means ± standard error of the mean.

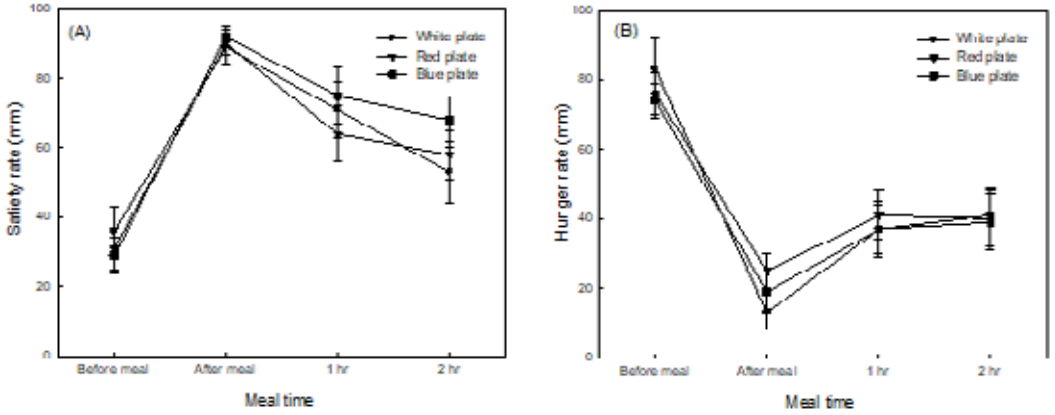

Figure 3. Satiety (A) and hunger (B) ratings of test meal on different-colored plates in young people with mild intellectual disabilities. Values are means ± standard error of the mean.

amount of food perceived and consumed by young people with mild ID. In situations where consumption occurs on a more habitual level and therefore outside focused attention, consumption behavior is more susceptible to situational cues than to conscious intentions (19, 20). Because of the susceptibility to situational cues in situations where eating occurs incidentally, situational cues that trigger a stop reaction may be highly beneficial in order to avoid overconsumption (21). Plate design that makes use of visual illusion is one of the external factors that may independently affect perceived food quantity and subsequent dietary intake (22, 23). Research by van Ittersum and Wansink (24) illustrated that this type of visual illusion influenced serving behavior when there was a color contrast between the food and plate. People served themselves more food when the food and plate had similar coloring (low color-contrast condition). Conversely, people served themselves less food when the food and plate were different colors (high color-contrast condition).

The present study extends previous research on how visual illusion applies to food on a plate. We hypothesized that the effects of this type of visual illusion would apply to the plate color surrounding food. To test this hypothesis, we collected data on the perceived amounts of food served on the different-colored plates used in the study. We hypothesized that a white plate would cause a fixed amount of white food to appear larger than would a red plate or blue plate of the same size. Most of the subjects (80%) estimated that the amount of food on a white plate was more than the amount in a regular rice bowl, while 50 or 40% of the subjects perceived that the same amount of food served on a red plate or blue plate, respectively, was more than the amount in a regular rice bowl.

In accordance with research by Weintraub and Cooper (25), we expected subjects in the low color-contrast condition (fried rice served on a white plate) to overeat more than those in the high color-contrast conditions (fried rice served on a red or blue plate). The rationale for this is that differences in color contrast between the food and the plate influence the extent to which a visual illusion takes effect (24, 25). In the present study, although young people with ID perceived different amounts of food according to plate color, they consumed a similar amount of food over a similar period of time in each condition, regardless of plate color. Young people with ID, who are less influenced by the environment as a result of their cognitive deficits, may be forced to rely more on internal factors than on external factors. Behavioral observations of subjects' responses to plate color did not support the hypothesis that visual cues associated with perceived food quantity alter dietary intake. The results of this study revealed that plate color did not affect the amount consumed, eating time, number of spoonfuls taken, or number of chews per spoonful in young people with mild ID.

In conclusion, in contrast to typically developing young people, young people with mild ID seem largely unaffected by changes in plate color in a laboratory setting. This study was the first trial to investigate the effects of an external factor on food consumption in young people with mild ID. Future trials based on the food environment of young people with mild ID must be conducted in order to determine how the food environment might be manipulated for effective health and weight management interventions. Additional research is needed to evaluate the extent to which perceptual factors relating to external factors exert their effects on young people with mild ID.

Acknowledgements: The authors are grateful to our volunteers for participating in the study.

Author disclosures: None of the authors have any conflicts of interest associated with this study. None of the authors had a financial interest or personal affiliation that compromised the scientific integrity of this work.

Reference

1. Mantau A, Hattula S, Bornemann T. Individual determinants of emotional eating: A simultaneous investigation. Appetite 2018;130:93-103.
2. Linné Y, Barkeling B, Rössner S, Rooth P. Vision and eating behavior. Obesity 2002;2:92-95.
3. Barkeling B, Linné Y, Melin E, Rooth P. Vision and eating behavior in obese subjects. Obesity 2003;1:130-34.
4. Heckler SE, Childers TL. The role of expectancy and relevancy in memory for verbal and visual information: what is incongruency? J Consum Res 1992;4:475-92.
5. Stillman JA. Color Influences Flavor Identification in Fruit-Flavored Beverages. J Food Sci 1993;4:810-2.
6. Fugate DL. Atmospherics, the marketing concept, and a marketing tool for hospitals. J Hosp Mark 1991;6:37-51.
7. Kaiser P. Physiological response to color. Color Res Appl 1984; 9: 29-36.
8. Singh S. Impact of color on marketing. Manage Decis 2006;6:783-89.
9. Garber Jr LL, Hyatt EM, Starr Jr RG. The effects of food color on perceived flavor. J Marketing Theory Pract 2000;4:59-72.
10. Clydesdale FM. Color as a factor in food choice. Crit Rev Food Sci Nutr 1993;1:83-101.
11. Aylward E, Burt D, Thorpe LU, Lai F, Dalton A. Diagnosis of dementia in individuals with intellectual disability. J Intellect Disabil Res 1997;2:152-64.
12. Katz G1, Lazcano-Ponce E. Intellectual disability: definition, etiological factors, classification, diagnosis, treatment and prognosis. Salud Publica Mex 2008;50:132-41.
13. Wehmeyer ML, Buntinx WH, Lachapelle Y, et al. The intellectual disability construct and its relation to human functioning. Intellect Dev Disabil 2008;4:311-8.
14. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The eating attitudes test: psychometric features and clinical correlates. Psychol Med 1982;4:871-8.
15. Zung WW. The Depression Status Inventory: an adjunct to the Self-Rating Depression Scale. J Clin Psychol 1972;28:539-43.
16. Gordon N. Colour blindness. Public Health 1998;112:81-4.
17. Foley DC, McCutcheon H. Detecting pain in people with an intellectual disability. Accid Emerg Nurs 2004;4: 196-200.
18. Hennequin M, Morin C, Feine J. Pain expression and stimulus localisation in individuals with Down's syndrome. Lancet 2000;9245:1882-87.
19. Genschow O, Reutner L, Wänke M. The color red reduces snack food and soft drink intake. Appetite 2012;2:699-702.
20. van't Riet J, Sijtsema SJ, Dagevos H, De Bruijn G-J. The importance of habits in eating behaviour. An overview and recommendations for future research. Appetite 2011;3: 585-96.
21. Wansink B. Environmental factors that increase the food intake and consumption volume of unknowing consumers. Annu Rev Nutr 2004:455-79.
22. McClain A, van den Bos W, Matheson D, Desai M, McClure SM, Robinson TN. Visual illusions and plate design: the effects of plate rim widths and rim coloring on perceived food portion size. Int J Obes 2014;5:657-62.
23. Stewart PC, Goss E. Plate shape and colour interact to influence taste and quality judgments. Flavour 2013; 2: 27.
24. Van Ittersum K, Wansink B. Plate size and color suggestibility: the Delboeuf Illusion's bias on serving and eating behavior. J Consum Res 2011;2:215-28.
25. Weintraub DJ, Cooper LA. Coming of age with the Delboeuf illusion: Brightness contrast, cognition, and perceptual development. Dev Psychol 1972;6:187-97.

Correspondence:
Eun Young Park
Department of Secondary Special Education,
Jeonju University, 303 Cheonjam-ro, Wansan-gu,
Jeonju 560-759,
Republic of Korea.
Tel: 82. 63. 220. 3186
Fax: 82. 63. 220. 2053
Email: eunyoung@jj.ac.kr