Consumer Perception of GM Food:
Factors that Influence Purchasing of GM Food in South Korea

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Abstract

This study examined how the consumers' perception of GM food affects their purchasing behavior. In addition, this study investigated how the amount of knowledge a consumer has regarding GM food affects their perception of this type of food. The quantitative research method was used to collect data. The data from a self-administered survey, which was conducted in South Korea, was analyzed using descriptive analysis, ANOVA, factor analysis, and multiple regression analysis methods. The results of the survey indicate that most respondents may have unknowingly purchased GM food. Further, the respondents reported that they likely had known about or had heard of GM food. In addition, the survey indicated that the amount of knowledge possessed by the respondents regarding GM food greatly affected their perceptions of this type of food. These findings will contribute to the current GM food market by providing the food market with additional information relating to the consumers' perceptions of GM food.

Key Words: GM food, Consumer behavior, Consumer perceptions

I. Introduction

Consumers are interested in a healthy life with longer life expectancy. Food is regarded as the highest priority for a healthy life since the simple fact is that humans need to consume food to stay alive. Hence, consumers want to know about the materials that they eat in everyday life, and the demand for good quality food has increased. For instance, global sales of organic food have grown from 15.2 billion dollars (USD) in 1999 to 81.6 billion dollars (USD) in 2015 (Statista 2015). On the other hand, the beneficiaries of such food are relevantly few since the production of food is limited for various reasons such as the increased demand for biofuel and feedstock production, land degradation, climate change, limited water resources, etc. which leads to the need for genetically modified (GM) food (Zhang et al. 2016). In addition to the growth of organic food sales, the acreage of GM crop production has doubled, and approximately 180 million hectares was planted in 2015 (Statista 2015).

The necessity for GM food has been growing due to a variety of reasons, including the difficulties in meeting the food demands of today and the increase in the world population. The global population is projected to rise to 8.5 billion by 2030 and to 9.7 billion by 2050; however, consumers continue to have negative perceptions of GM food (United Nations 2015). The most realistic solution for increasing food demand to match the growth of the world population is to increase crop yields on cultivated land (Statista 2015). However, land and water resources are not infinite and face heavy stress; therefore, future agriculture production should have a more productive system (Food and Agriculture Organization of the United Nations 2011).

GM food is defined as "food derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g., with the introduction of genes from a different organism" (World Health Organization 2015). Genetically modified organisms (GMOs) can be defined as "organisms (i.e., plants, animals and micro-organisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination" (World Health Organization 2014). In addition, "food produced from or using GMOs are often referred to as GM food" (World Health Organization 2014). Therefore, this study uses the term GM food including GMOs.

The FDA first approved GMOs in 1982, and the first

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GMOs introduced to consumers in grocery stores with FDA approval was Flavr Savr tomatoes that went on sale in 1994 (Woolsey 2012). The GM food now available in grocery stores includes soybeans, potatoes, corn, eggplants, rice, apples, strawberries, carrots, wheat, etc. (Bawa & Anilakumar 2013; ISAAA 2018). Among the 28 countries that grew GM crops in 2014, the Unites States is the lead producer followed by Brazil, Argentina, India, and Canada (Wunderlich & Gatto 2014). South Korea is the second-largest country to import GM food globally; however, there is not sufficient information about GM food for consumers (Daehan Foodservice News 2014). Insufficient information about GM food could cause the perception of risk for consumers and might affect their purchasing behavior. In Korea, the issue of risk related to GM food was raised publicly when the Korea Consumer Agency investigated 22 tofu products to find out whether they were made with GM soybeans and found that 18 products used GM beans (Huh 2003; Korea Consumer Agency 2003). In Korea, a labelling policy for GM food such as soybeans, corn, sprouts and other products started in 2001, and from February 2018, GMO labelling was expanded to all food materials for food products with a font size of 12 points, increased from 10 points previously (Korea Times 2017).

The EU made a policy to add labels if GM food was used in a product in 1998, and Japan started a similar labelling policy in 1999. Previous studies showed that consumers were aware of GM food and requested labelling on products (Huh 2003; Kim 2010). The EU strictly regulates all new GM crops and enforces mandatory labeling, but the United States prohibits use of the term "GMO-free" since there are no tests available for the low-level presence of GM ingredients, and it regulates no mandatory labeling (Wunderlich & Gatto 2015). However, several states have laws that make labels for GM food mandatory even though this is considered unnecessary since no negative health effects have been found (Fernando 2017).

Perceived risks associated with consuming GM food have been found, and they affect consumers' decision-making process. Reviews have shown that consumers are willing to pay more for non-GM food (Lusk et al. 2005; Colson & Rousu 2013; Wunderlich & Gatto 2015). Consumers perceived "genetic modification" negatively, followed by "genetic engineering" and "food biotechnology" (Health Canada 2017). Huh (2003) found that if a consumer has children or risk perception of GM food they do not purchase GM beans. The formation of risk perception was affected by such factors as whether consumers consume bean products, practice a healthy life, and are aware of GM beans (Huh 2003). In a survey by the Harman Group (2014), the respondents were mostly concerned about the possible impact of GM food on their health, followed by being willing to know what ingredients are in the food they eat. Debates about the safety and risks of GM food regarding human health (Domingo & Giné Bordonaba 2011; Bawa & Anilakumar 2013; Hilbeck et al. 2015) and environmental safety (Snow & Palma 1997; Gilbert 2013) have been ongoing. Also, higher risk perception of GM food increases the demand for labeling information on GM food (Huh 2003). Without clearly known health risks, consumers want to know information on the materials they consume regarding specific diseases such as food allergies, nutritional ingredients, expiry dates, or any information regarding food materials (Tonkin et al. 2015). Labelling information regarding GM food is one of the considerations for consumers (Huh 2003; Kim 2010; Wunderlich & Gatto 2015; Zhang et al. 2016; Fernando 2017).

The consumers' level of knowledge about GM food is related to their food behavior. A survey in the U.S. showed that a majority of respondents rated their knowledge as poor, followed by saying they knew very little about GMOs (Hallman et al. 2004; Kim 2010; Hallman et al. 2013; Fernando 2017). Negative perceptions toward GM food was related to a rejection of GM food as well as negative attitudes (Kim 2010; Sorgo et al. 2012). Also, a correlation between higher knowledge and the preference for non-GMO goods was found (Vecchione et al. 2014). However, consumers with higher knowledge of GM food had less negative perception towards GM food (Kim 2010; Mielby et al. 2013; McComas et al. 2014).

GM food has some benefits for agribusiness, not only with plants, but also with animal products. GM technology not only allows a longer shelf life, but also improvement of nutritional value such as vitamins A, C, and E, unsaturated fatty acids, etc. (Shell & Van Montagu 1977). The nutritional valuation of GM food affected consumers' attitudes; they believe that nutrition may help the acceptability of GM food (Lusk et al. 2005; Kim 2010). Research on various crops is underway to see if they are potentially effective against infections such as Escherichia coli toxins, rabies virus, and Helicobacter pylori bacteria (Aggarwal 2012; Nicolia et al. 2014). Another study showed that French consumers were willing to purchase the GM food if it was reasonable (Noussair et al. 2004).

GM food is prevalent, and consumers purchase it with or without their knowledge of it. GM food has been in daily life for longer than consumers realize, yet their response to GM food is limited. Different nations enforce different regulations for GM food, and consumer behavior differs as well. Therefore, in order to provide safe GM food in accordance with regulations and businesses, it is essential to study the perception of GM food. First, this study examined if consumers are aware of GM food in their daily life by measuring their self-reported level of knowledge of GM food. Second, this study measured differences between high and low knowledge of GM food in the perception of GM food. Lastly, the relationship between purchase behavioral intention and perceptions of GM food was investigated.

II. Materials and Methods

1. Sample and procedure

The data were collected in Korea using self-administered surveys on- and off-line for about two weeks from November 19 to December 13. For the on-line survey, a URL address (http://naver.me/5Zwu7eBz) was sent via social networks that started by asking for the respondents' permission to participate. The off-line survey was conducted by one of the authors. The age group for the study was 20 to 29 years old since consumers in this age range will have more opportunities to have GM food in their life compared to other generations. Therefore, this study chose the group to suggest the most valuable recommendations to the food industry. A total of 224 responses were collected, and 13 were excluded due to incompletion or because the age was over 29 years old. Finally, 211 responses were used in the study. The subjects were asked to answer questions that measured their self-reported knowledge about GM food, perceptions of GM food, behavioral intention to purchase GM food, and GM food purchasing behavior. To help understand GM food, a definition was given to the respondents.

2. Questionnaire and data analysis

The questionnaire items were developed from previous studies (Huh 2003; Hallman et al. 2004; Kim 2010; Hallman et al. 2013; Vecchione et al. 2014) and the participants were asked to answer on a five-point Likert scale (1: disagree very much to 5: agree very much). The self-reported knowledge about GM food was measured with five items, perceptions of GM food was measured with 24 items, and behavioral

intention was measured with two items.

The collected data were analyzed were using IBM SPSS (ver. 23.0, IBM Corp, Armonk, NY, USA). The analyses conducted were descriptive statistics, reliability analysis, analysis of variance (ANOVA), factor analysis and multiple regression. Descriptive statistics were conducted on the socio-demographic characteristics. Groups were divided by level of knowledge with GM food (M=2.72, SD=0.955, Cronbach's alpha=0.890), with those who had low knowledge (< or =2.72) coded as "1" and those who had high knowledge (>2.72) coded as "2." ANOVA was computed to measure the mean differences of the high and low knowledge of GM food on perceptions of GM food and behavioral intention. Factor analysis was run to find characterized perceptions of GM food. Finally, multiple linear regression was conducted to test the relationship between perceptions and behavioral intention to purchase GM food.

III. Results and Discussion

1. Profiles of the respondents

Profiles of the respondents are presented in <Table 1>. About 56.4% of the respondents were male and 43.6% were female. Most of the respondents were single (97.6%), while about 2.4% were married. Approximately 94.3% had more than some college education. More than half of the respondents (64.9%) had a monthly household income of less than one million won. The reason for these characteristics is that the sample in this study was individuals in their 20s.

Approximately half of the respondents received information about GM food through SNS (22.3%) or portal sites using the Internet (37.9%). Consumer/environmental organizations (30.8%) were more credible organizations for information about GM food than the government (22.3%). Most respondents agreed that they may have purchased GM food without knowing it (M=3.58. SD=1.072), while others were not for sure if they purchased GM food (M=2.78, SD=1.196) nor if they checked for GMOs in food when making a purchase (M=2.78, SD=1.196).

2. Consumers' knowledge of GM food

<Table 2> shows levels of knowledge about GM food. Most of the respondents thought that they knew or had heard of GM food; however, considered they were unlikely to have the ability or expertise to explain it. To compare consumer

<Table 1> Profile of the Respondents   (n=211)

Characteristics	Frequency	Valid percentage (%)*
Gender		
Male	119	56.4
Female	92	43.6
Marital Status		
Single	206	97.6
Married	5	2.4
Education		
High school diploma	12	5.7
Some college	31	14.7
Bachelor's degree	157	74.4
Graduate degree	11	5.2
Monthly Household Income (thousand won)**		
Less than 1,000	137	64.9
1,000 to 1,999	48	22.7
2,000 to 2,999	17	8.1
3,000 to 3,999	3	1.4
4,000 or above	6	2.8
Sources of GM foods information		
SNS	47	22.3
Internet portal sites	80	37.9
TV	53	25.1
Newspaper	3	1.4
Family or friends	18	8.5
Others	10	4.7
Most credible organization about GM foods		
Government	47	22.3
Consumer/environmental organization	65	30.8
Media	11	5.2
Agricultural/food companies	34	16.1
Experts/scientists	45	21.3
Others	9	4.3

*Percentage may not add to 100 because of rounding.
**One thousand won is about 0.94 US dollar

perceptions and previous purchasing behavior regarding GM food, the participants were divided into two groups, one with high knowledge and the other with low knowledge. Questions about consumers' previous GM food purchase behavior were asked, and three items were compared by

<Table 2> Level of knowledge on GM foods   (n=211)

Specifications	Mean SD
I know about GM foods	3.18±1.188
I have heard of GM foods	3.62±1.179
I can explain about GM foods to others	2.60±1.169
I am expertized on GM foods	2.03±1.030
I know about labelling policy on GM foods	2.20±1.155

level of knowledge of GM food <Table 3>. ANOVA was conducted, and it showed significance for one item of consumers' previous purchasing behavior, which was "I have purchased GM food" (F=5.622, p<0.05). The patterns showed that consumers with high knowledge had higher agreement with purchasing GM food (3.15±1.212), checking if GMOs were in food (2.23±1.018) and with purchasing GM food without their acknowledgement of it (3.81±0.999) than consumers with low knowledge.

3. Perceptions of GM food and behavioral intention

To find out consumers' perception of GM food, 23 items were entered for exploratory factor analysis and four factors were extracted <Table 4>. The maximum likelihood method combined with Varimax with Kaiser normalization was used. Of 24 items measuring perceptions of GM food, one item was excluded since it was not in any of the factors extracted. The four factors were "future-oriented," "negative," "healthful," and "solving current issues."

All of the items in the factors were compared by level of knowledge using ANOVA <Table 5>. The results showed that most items in "future-oriented" showed significance. Respondents with higher knowledge agreed more that GM food helps hungry nations (F=10.615, p<0.01), helps future needs (F=9.027, p<0.01), helps with food scarcity (F=14.238, p<0.001), helps shortages of food materials (F=8.907, p<0.05), has benefits (F=5.467, p<0.05), is good for related businesses (F=10.902, p<0.01), and that GM food research is needed (F=8.028, p<0.01). In addition, two items under "healthful" under levels of knowledge showed significance.

<Table 3> GM foods purchase behaviors of the respondents   (n=211)

Specifications	Knowledge (n=211)	Low knowledge (n=98)	High knowledge (n=113)	F
	Mean SD			
I have purchased GM foods	2.78±1.19	2.35±1.02	3.15±1.21	5.622*
I check if GMOs are in the food product when I make a purchase	2.07±0.96	1.89±0.87	2.23±1.01	3.449
I may have purchased GM foods previously without acknowledgement	3.58±1.07	3.33±1.10	3.81±0.99	2.535

*p<0.05

<Table 4> Results of factor analysis of the measurement items

Factor	Measurement items	Factor loadings	Variance (Eigen value)	a
Futureoriented	GM food is good for its price	0.688	25.017 (5.754)	0.921
	GM food has good quality	0.533		
	GM food helps hungry nations	0.719		
	GM food helps agriculture and food business	0.729		
	GM food helps future needs	0.733		
	GM food helps with food scarcity	0.793		
	GM food helps shortage of food materials	0.680		
	GM food has benefits	0.658		
	GM food is good for related businesses	0.753		
	GM food research is needed	0.712		
Negative	I have negative opinions towards GM food	0.788	17.378 (3.997)	0.890
	GM food is bad for health	0.854		
	GM food contains toxic elements for human	0.863		
	GM food is worse than chemical supplements	0.659		
	GM food affects negative side to environments	0.833		
	GM food changes a food chain system	0.718		
Healthful	I have positive opinions towards GM food	0.711	13.497 (3.104)	0.844
	GM food is safe	0.765		
	GM food helps health	0.784		
	GM food helps prevent allergies or diseases	0.659		
Solving current issues	GM food helps protect our environment	0.787	10.657 (2.451)	0.822
	GM food helps prevent incurable diseases	0.736		
	GM food helps longer life span	0.701		

Respondents with higher knowledge were more positive toward GM food (F=12.768, p<0.001), and safety (F=8.262, p<0.01). Interestingly, one item under "behavioral intention" showed significance ("I will purchase GM food," F=14.302, p<0.001). Items under "negative" and "solving current issues" did not differ in level of knowledge. However, patterns showed that high knowledge had slightly higher agreement throughout the question items in the questionnaire.

Multiple regression was run to measure the effect of factors on behavioral intention <Table 6>. Four factors of perceptions and knowledge were regressed on purchase behavioral intention. All factors influenced purchase behavioral intention. Future-oriented (B=0.336, SE=0.074, p<0.001), negative (B=−0.249, SE=0.054, p<0.001), healthful (B=0.373, SE=0.070, p<0.001), and solving current issues (B=0.145, SE=0.061, p<0.05). However, knowledge (B=0.054, SE=0.043, p>0.05) did not influence the purchase behavioral intention of GM food.

The results of this study suggested insights into consumers' perception of GM food. Consumers with high knowledge of GM food showed significant positivity towards GM food compared to consumers with low knowledge (Kim 2010). This study found that knowledgeable

consumers tend not to purchase it, which was aligned with the findings of previous studies (Huh 2003; Vecchione et al. 2014). Responses on level of knowledge showed that consumers did not strongly believe that they knew about GM food as in findings from previous studies (Huh 2003; Hallman et al. 2004; Hallman et al. 2013; Kim 2016; Health Canada 2017) which suggest that there are opportunities for intervention with knowledge of GM food to increase the positive perceptions of consumers. Still, many consumers do not know about GM food and negativity towards GM food exists. Comparisons between high and low negativity towards GM food did not show any significance, which indicates that negativity cannot be persuaded by level of knowledge or education. Educating consumers may increase their positive perceptions of GM food but may not affect negative perceptions. If this is the case, then facts that make consumers consider GM food negatively should be presented with opposing facts. The history of GM food is relatively short, and more research is needed along with more time. Providing information with facts that are either positive or negative towards GM food, should be done before making GM food attractive to consumers.

The results of this study did not show any effects of

<Table 5> Comparisons of specific features toward GM food

Features	Specification of features	Knowledge (n=211)	Low knowledge (n=98)	High knowledge (n=113)	F
		Mean±SD			
Futureoriented	GM food is good for its price	3.45±1.03	3.32±1.01	3.56±1.05	2.861
	GM food has good quality	3.05±0.92	2.95±0.88	3.14±0.95	2.280
	GM food helps hungry nations	3.62±1.10	3.36±1.09	3.84±1.05	10.615**
	GM food helps agriculture and food business	3.57±1.03	3.44±1.06	3.69±1.00	3.121
	GM food helps future needs	3.39±0.86	3.20±0.74	3.56±0.93	9.027**
	GM food helps with food scarcity	3.78±0.91	3.53±0.92	3.99±0.85	14.238***
	GM food helps shortage of food materials	3.61±0.91	3.41±0.91	3.78±0.88	8.907**
	GM food has benefits	3.29±0.97	3.12±0.95	3.43±0.97	5.467*
	GM food is good for related businesses	3.75±0.87	3.54±0.89	3.93±0.81	10.902**
	GM food research is needed	3.69±0.90	3.50±0.86	3.85±0.91	8.029**
Negative	I have negative opinions towards GM food	2.76±0.98	2.80±0.95	2.73±1.01	0.203
	GM food is bad for health	2.95±0.94	2.97±0.90	2.94±0.97	0.058
	GM food contains toxic elements for human	3.02±0.94	3.03±0.95	3.02±0.94	0.010
	GM food is worse than chemical supplements	2.50±0.92	2.49±0.82	2.50±1.01	0.013
	GM food affects negative side to environments	3.02±0.95	3.04±0.93	3.01±0.98	0.058
	GM food changes a food chain system	3.49±0.99	3.46±0.98	3.51±1.00	0.155
Healthful	I have positive opinions towards GM food	2.96±0.86	2.73±0.81	3.15±0.86	12.768***
	GM food is safe	2.74±0.85	2.56±0.78	2.89±0.88	8.262**
	GM food helps health	2.65±0.91	2.53±0.86	2.76±0.94	3.368
	GM food helps prevent allergies or diseases	2.77±0.94	2.72±0.89	2.81±0.99	0.467
Solving current issues	GM food helps protect our environment	2.98±0.95	2.86±0.86	3.09±1.02	3.104
	GM food helps prevent incurable diseases	2.96±0.93	2.84±0.88	3.07±0.97	3.323
	GM food helps longer life span	2.90±0.94	2.85±0.88	2.95±0.99	0.582
Behavioral intention	I will recommend GM food to others	2.76±0.84	2.68±0.86	2.83±0.82	1.617
	I will purchase GM food	3.13±0.99	2.86±0.97	3.36±0.96	14.302***

*p<0.05, **p<0.01, ***p<0.001

<Table 6> Multiple regression results of consumers' behavioral intention

Predictors	B	SE	t
Constant	0.889	0.289	3.074**
Future-oriented	0.336	0.074	4.557***
Negative	-0.249	0.054	-4.646***
Healthful	0.373	0.070	5.344***
Solving current issues	0.145	0.061	2.375*
Knowledge	0.054	0.043	1.275

F=62.799***, R^2=0.605, Adjusted R^2=0.595
*p<0.05, **p<0.01, ***p<0.001.

knowledge when it comes to purchasing GM food. Positivity and negativity towards GM food affected consumers' purchasing behavioral intention, but knowledge did not. However, knowledge showed significance when levels of knowledge were compared to perceptions which affected purchasing behavioral intention. Therefore, knowledge has a role in creating consumers' perception of GM food and should not be ignored.

The most valuable finding of this study is that there are many areas of improvement for creating positive perceptions of GM food that influence purchasing behavioral intention. As consumers consider GM food to be more helpful for a better life, for instance, and future-oriented, healthful, and solving current issues. Hence, manufacturers should provide consumers with a guide to the necessity of GM food. What GM food is and why we need it, and all strategies should be based on the safety of GM food. Of perceptions of GM food, negativity existed, which negatively affected purchase behavioral intentions (Sorgo 2012). Negativity did not differ by level of knowledge, so negativity may not be removed by providing information about GM food to build consumers' knowledge. The best practice to reduce negativity might be research showing no influence on human health as well as on nature. Research about GM food should continue and better ways to present research results should be developed to make a more positive consumer perception of GM food.

In addition, uncertainty about potential effects on human

health might be an obstacle for consumers' perceived negativity toward GM food. The results of this study showed that providing benefits from several angles, which are consumers themselves or even environmental issues, should be based on no harmful influence on humans or nature. Consumers trusted consumer/environmental organizations over governments, which might be the result of insufficient information about GM food. The media was not trusted in the results of the study (Jurkiewicz et al. 2014). However, consumers considered that most knowledge about GM food was available on the Internet (Aleksejeva 2014). For example, most of the respondents in this study did not check for GMOs in food and did not know about labeling policies for GM food. The results of this study suggested that consumers' perceptions and purchase behavior were similar to almost a decade ago (Huh 2003; Hallman et al. 2004; Wunderlich & Gatto 2015). In other words, policies and information about GM food may have to be updated to cope with consumers' requests; however, at the same time, consumers' knowledge and perceptions may have increased in parallel with the growth of GM food production.

In the beginning of the nutritional labelling system, many consumers might be confused and misunderstand terms such as "fat free," "organic," "no sugar," "trans-fat," etc. This labelling may still need to be explained to consumers; however, information regarding GM food should be used to educate consumers as well as the companies that produce GM food.

Some parts of this study need to be improved for further research. First, this study was conducted with consumers in their 20s in South Korea. These consumers may have had opportunities to have GM food for a longer time, which was the reason for choosing this study sample, but their perceptions of GM food may differ from those in other age ranges. In addition, geographical limitations may affect the generality of the findings of this study. Hence, future studies should be conducted in different nations with different generations.

IV. Summary and Conclusion

The necessity for GM food has been growing due to a variety of reasons; however, consumers continue to have negative perceptions of GM food. The purpose of this study is to measure consumers' perceptions of GM food and to provide the findings to the GM food market to help them increase their sales and find ways to improve potential

consumers' perceptions of GM food. The results suggested that if consumers were better educated regarding the production of GM foods, their positive perceptions of GM food may increase; however, the additional knowledge may not affect their negative perceptions. The intervening effect of increased knowledge on consumers' perceptions of GM food may be further explained at a later stage of the research. While the consumers' knowledge did not impact their behavior, the results of the survey suggest that the consumers' perceptions of GM food did affect their behavioral intentions. Furthermore, these findings will help to increase the understanding of consumers' behaviors when they are deciding whether to purchase GM food.

GM food have been part of our daily consumption during these past decades, with or without consumer recognition. Now, we need to cope with GM food in our lives and need to know what consumers' perceptions about GM food are and how we can develop products without the concerns that consumers might have. There are many more GM food areas to be researched by scientists. Higher knowledge of GM food may affect both positive and negative perceptions of GM food. The best way to deliver the message of GM food safety is to present facts that can oppose the negative aspects of GM food that consumers believe.

감사의 글

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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