Asymmetry of Visual Perception When Choosing Products: Methods and Algorithms of Neuromarketing

Natalia Kalkova, Olga Yarosh, Ella Mitina, Vyacheslav Khokhlov

Abstract: ***Consumer behavior is a complex and multi-step process. It is necessary to study consumer choice with different alternatives and choice parameters, which will allow us to identify behavioral characteristics in different demographic groups. The article deals with theoretical and practical issues of consumer behavior when choosing food. The article uses classical marketing methods and neuromarketing approaches. Based on this comprehensive approach, an assessment of the structure of food consumption was carried out, as well as a pilot study of the characteristics of consumer choice depending on gender characteristics.The study of statistical data showed that the decline in real incomes of the population in Russia affected the structure of food consumption. There is a decrease in the volume of demand for meat, vegetables, and fruits, which is associated with a decrease in the population's ability to pay and an increase in the level of poverty.Gender characteristics in the consumer's preferred and actually purchased products were identified using the neuromarketing research methodology. Thus, it was determined that the speed of decision-making when choosing products is higher for women than for men, since women are more frequent buyers. The high speed of decision-making by women is most likely a result of emotional choice of products. Using visual advertising signals can increase attention to incentives and increase motivation. It was also found that in the absence of external restrictions: the number of products chosen and sufficient financial resources, women consumers are strongly influenced by internal restrictions, but men tend to take risks. Women try to be Thrifty, choosing a standard set of products that make up their diet, men in conditions of unlimited financial resources tend to buy expensive goods without thinking about the costs. The study of consumer choice between those products that were visually noticed and those that were selected as a result of the survey showed that there is a significant asymmetry between what is desired and what is chosen. To assess the level of asymmetry of visual attention, we proposed a method for assessing the asymmetry of consumer preferences, the use of which allows us to assess the gap between the desired and purchased goods. Based on the coefficient of asymmetry of consumer preferences, it is possible to assess the level of consumer imbalance and timely prevent social and economic dissatisfaction in different gender groups. The possibility of changing consumer choice under the influence of various stimulating factors is proved.***

The results obtained can be used in the practical activities of food retailers and food manufacturers when promoting their products with gender differences in mind. The results also need to be taken into account when developing government strategies for developing the food market and supporting healthy lifestyles and changing consumer culture.

Keywords: consumer, consumer behavior, consumer choice, neuromarketing, asymmetry

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I. INTRODUCTION

One of the main tasks for the successful functioning of enterprises in a turbulent market environment and increased competition in the commodity market is to study the behavior of end consumers, which means to identify their needs, preferences, tastes, etc. This allows food producers to better understand the needs of potential customers, be able to quickly respond to their requirements and receive information on the actions of competitors in time. It becomes extremely relevant to study the possibilities and effective use of various forms and methods of selling goods, analyze the requests of various population groups, and improve the image of retail. Analysis of demand for a particular product along with the factors affecting its formation is a prerequisite for the effective functioning of enterprises aimed at developing business and profit maximization. The basis for the formation of consumption, as well as its structure, volume, and other indications is the population, which is characterized by a number of processes (demographic, ethnocultural, religious, etc.) that significantly affect the quality and lifestyle of individuals. The combined impact of these factors contributes to the development of the level and living conditions of society, significantly affects the needs of consumers and provides a mechanism for the formation of effective demand for food products, determines the nature of consumption.

II. LITERATURE REVIEW

Demand for food products depends on a wide range of factors that affect consumer behavior in different ways, leading as an alternative to the selection of certain foods and the rejection of others. It depends on the consumer choice what kind of nutrients the human body will receive. Therefore, food products are vital. However, in the current context, consumers choose food products based not only on their biological needs.

Their choice, as noted by scientists Conner M and Hermitage S., is also influenced by many psychological and emotional factors [1], as a result of which the problem of choosing food products has the multidisciplinary nature of the study, because this process considers economic, sociological, psychological, biological, cultural and other relationships. In this regard, the choice of food products should be evaluated as a complex human behavior, which is considered by Russian and foreign scientists from the point of view of individual aspects that affect behavior: psychological [2, 3], sociological [4], medical [5] and economic [6]. Studies more often demonstrate that a significant part of consumer decision-making takes place outside of conscious awareness or under the influence of factors not recognized by the decision maker. Thus, consumer decisions consist of a combination of conscious and unconscious processes, while the degree of influence of unconscious processes on the consumer choice process, according to scientists D. Kahneman, D. Ariel, is much greater than previously thought. A study of consumer behavior is alternatively called a study of motivation or a study of buying motives, as it studies the behavior of consumers or their reactions to a particular brand, product or quality, as well as the circumstances leading to such behavioral patterns.

The main difficulties associated with conducting research on consumer behavior, in our opinion, are:

– the consumer may have several incentives for the purchase and cannot express his main motive, as a result of which the research task of determining the main incentive for the purchase is complicated;

– the consumer may hesitate in explaining his motive for the purchase or give an incorrect idea of his motive, as a result of which the research task of identifying the real motive for the purchase is complicated.

– systematic research is required due to the variability of the consumer's personality, behavioral attitudes, beliefs, values and motives, and changes in the socio-economic structure;

– the methods used when studying consumer behavior are empirical in nature and are not accurate, therefore it is necessary to use a comprehensive approach to improve the accuracy of the results, including classical statistical analysis of the structure of consumption and experimental neuromarketing study of the characteristics of consumer choice.

III. MAIN PART

Analysis of statistical data of the Republic of Crimea revealed the structure and actual volume of consumption of certain food products in the region. Table-I shows the dynamics of food consumption on the peninsula.

Table-I: Dynamics of the actual consumption of food products in the Republic of Crimea for the period from 2015 to 2018

Product name	Consumption volume by year, in million Russian rubles							
	2015	%	2016	%	2017	%	2018	%
Bakery products	2619,7	5,3	3606,3	5,2	3631,2	5,2	3962,9	5,8
Potatoes	1018,6	2,0	1908,3	2,8	1895,7	2,7	2389,7	3,5
Vegetables and gourds	2721,4	5,5	6702,2	9,7	8087,7	11,5	7176,1	10,6
Fresh fruit	4827,6	9,7	6963,6	10,1	7295,0	10,4	10341,2	15,3
Sugar and confectionery	4370,7	8,8	6631,7	9,6	6663,9	9,5	5983,6	8,8
Meat products	14767,8	29,7	20011,5	29,1	19839,2	28,2	17207,9	25,4
Fish products	4356,4	8,8	5910,5	8,6	5450,6	7,7	4510,3	6,7
Milk and dairy products	9685,6	19,5	11070,4	16,1	11154,2	15,8	9783,6	14,4
Eggs	1371,0	2,8	1273,7	1,9	1374,2	2,0	1257,7	1,9
Vegetable oil, margarine, fats	1725,5	3,5	1971,7	2,9	2389,0	3,4	2433,1	3,6
Other products (salt, tea, spices)	2278,2	4,4	2712,4	4,1	2615,0	3,6	2709,6	4,0
Total	49742,5	100	68762,3	100	70395,7	100	67755,7	100

Source: Calculated by the authors on the basis of [7]

The table shows that the largest consumption of food products falls on 2017 and amounts to 70395.7 million rubles. In 2016, it increased by 19019.8 million rubles compared to 2015, while in 2018 it decreased by 2,640 million rubles compared to 2017, which is explained by a decrease in real incomes of the population and, as a result, a decrease in expenses, including for food products. The dynamics of the actual consumption of some food products is presented in Fig. 1.

Regardless of the year, the largest consumption falls on the meat products, which amounted to 29.7%, 29.1%, 28.2%, 25,4% in the overall structure in 2015-2018 respectively. Demand for milk and dairy products during 2015-2017 was quite stable, accounting for 19.5%, 16.1%, 15.8% respectively. However, in 2018, consumption of milk and dairy products fell sharply by 1.4%. Stability can be seen in such groups of products as "Vegetable oil, margarine, fats", "Bakery products", whereas the proportion of "other goods" accounts for about 4%.

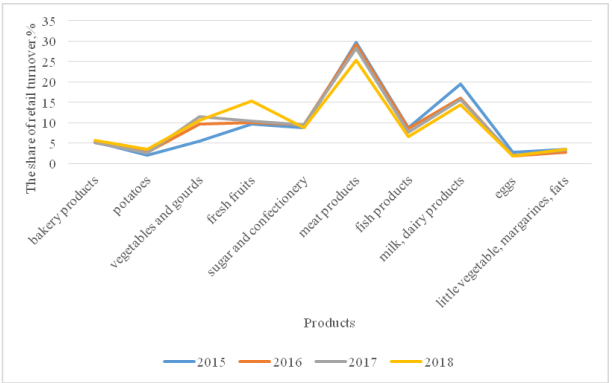


Fig. 1. Consumption of food products in the Republic of Crimea from 2015 to 2018

Based on the volumes of consumption, there has been compiled a ranking of consumer goods in dynamics (Table 2).

The rank of a certain product corresponds to a larger proportion of its actual consumption by the population of the region in the overall structure.

The leader in consumption, regardless of the year, is meat products. Despite the stable demand for milk and dairy products in 2015-2017, a significant increase in the percentage of fresh fruit consumption in the overall structure by almost 5% replaced them to 3rd position. The fourth place in the ranking in 2018 was taken by Vegetables and melons, which accounted for 10.6%. Sustainable demand for sugar and confectionery is fairly clearly traced. Despite a decrease in the percentage of consumption of fish products to 6.7%, this group consistently takes 6th place in the food rating. The consumption of bakery products, which account for about 5.5%, remained almost unchanged. Consistency is also evident in the consumption of less-rated goods.

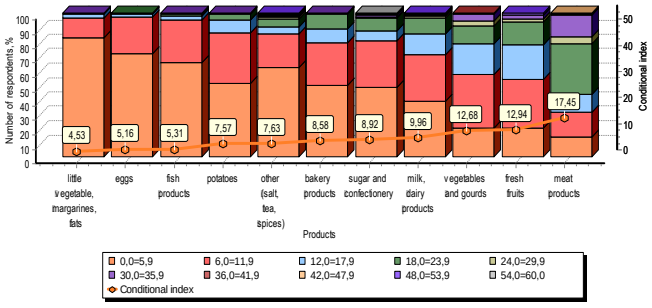
Table-II: Ranking of actual consumption of food products in the Republic of Crimea from 2015 to 2018

Place in the ranking	The proportion of goods consumption by year, %							
	2015	%	2016	%	2017	%	2018	%
1	Meat products	29,7	Meat products	29,1	Meat products	28,2	Meat products	25,4
2	Milk and dairy products	19,5	Milk and dairy products	16,1	Milk and dairy products	15,8	Fresh fruit	15,3
3	Fresh fruit	9,7	Fresh fruit	10,1	Vegetables and gourds	11,5	Milk and dairy products	14,4
4	Sugar and confectionery	8,8	Vegetables and gourds	9,7	Fresh fruit	10,4	Vegetables and gourds	10,6
5	Fish products	8,8	Sugar and confectionery	9,6	Sugar and confectionery	9,5	Sugar and confectionery	8,8
6	Vegetables and gourds	5,5	Fish products	8,6	Fish products	7,7	Fish products	6,7
7	Bakery products	5,3	Bakery products	5,2	Bakery products	5,2	Bakery products	5,8
8	Other products	4,4	Other products	4,1	Other products	3,6	Other products	4
9	Vegetable oil, margarine, fats	3,5	Vegetable oil, margarine, fats	2,9	Vegetable oil, margarine, fats	3,4	Vegetable oil, margarine, fats	3,6
10	Eggs	2,8	Potatoes	2,8	Potatoes	2,7	Potatoes	3,5
11	Potatoes	2,0	Eggs	1,9	Eggs	2	Eggs	1,9
Total		100		100		100		100

Source: Calculated by the authors on the basis of [7]

IV. MARKETING RESEARCH RESULTS

In order to identify the economic volume of food consumption, we conducted a marketing research surveying 400 residents of the region. The survey involved various age and gender groups, different marital status, occupation, levels of education and income. The main objective was determining the distribution of expenses for the consumption of products included in the list of the consumer basket of the Republic of Crimea in 2020. The results of the research are presented in Fig. 2.



Source: Compiled by the authors on the basis of conducted research

Fig. 2. Economic consumption of food products by group in the Republic of Crimea

The figure shows that meat products account for the largest percentage of economic consumption (17.45%). The percentage of fresh fruits in the total structure is 12.94%, the purchase of vegetables and melons by the population is slightly inferior (12.68%). The proportion of consumption of the product groups “milk and dairy products”, “sugar and confectionery”, “bakery products”, “other products”, “potatoes”, “fish products”, “eggs”, “vegetable oil, margarine, fats” is 9.96%, 8.92%, 8.58%, 7.63%, 7.57%, 5.31%, 5.16%, 4.53%, respectively.

Fig. 2 shows that the asymmetric consumption did not affect “meat products”, “fresh fruits”, “milk and dairy products”, “vegetables and melons”, “sugar and confectionery” in the ranking. It more affected the products at the lower positions. For instance, the proportion of actual consumption of fish products accounts for 6.7%, while economic consumption is 5.31%. Despite the fact that the proportion of economic consumption of bakery products is higher than the actual by 2.78%, this group is at the sixth position. The consumption of “other products”, “potatoes”, “eggs”, vegetable oil, margarine, fats” is also different, while the differences are 3.63%, 4.07%, 3.7%, 0,93%, respectively.

Table-III shows the ranking asymmetry of food consumption in the Republic of Crimea.

Table-III: Ranking asymmetry of actual and economic consumption of food products in the Republic of Crimea

Place in the ranking	The proportion of goods consumption, %			
	Product group	Actual consumption, %	Product group	Economic consumption, %
1	Meat products	25,4	Meat products	17,45
2	Fresh fruit	15,3	Fresh fruit	12,94
3	Milk and dairy products	14,4	Vegetables and gourds	12,68
4	Vegetables and gourds	10,6	Milk and dairy products	9,96
5	Sugar and confectionary	8,8	Sugar and confectionary	8,92
6	Fish products	6,7	Bakery products	8,58

7	Bakery products	5,8	Other products	7,63
8	Other products	4	Potatoes	7,57
9	Vegetable oil, margarine, fats	3,6	Fish products	5,31
10	Potatoes	3,5	Eggs	5,16
11	Eggs	1,9	Vegetable oil, margarine, fats	4,53
Total		100		100

To confirm the results of asymmetric consumption of food products, we carried out a neuromarketing study, the purpose of which was to study visual attention on products displayed on a virtual shelf and select specific products in conditions of unlimited resources.

V. METHODS OF NEUROMARKETING RESEARCH

A comprehensive neuromarketing experiment was conducted to study visual attention and interest in products on a virtual shelf using a stationary eye tracker VT 3mini with EventID software. The obtained data consisted of recording the position of the pupil (fixation) and eye movement (saccade), as well as measuring visual attention on the proposed stimulus material [8]. The emergence of advanced sophisticated methodologies, such as eye tracking, allows you to more fully understand processes such as perception, visual attention, and decision making. Tracking eye movements does not require large sample sizes so that its results are considered reliable, therefore tracking tests and experiments can be performed even with a small sample size, and the results can be used for planning purposes. This leads to a more economical and efficient way of researching consumer behavior and developing customer profiles.

Eye movements, according to scientists M. Vedel, R. Peters, are an essential part of the analysis, because they allow you to measure visual interest, corresponding to higher cognitive processes [9, 10]. According to scientists Castelano M., Musk M., Henderson J., human vision is an active, dynamic process during which the viewer searches for a specific visual element necessary to maintain current cognitive and behavioral activity [11].

Since eye tracking cameras only record eye movements, additional measurements must be used to understand the results of eye tracking. Thus, the results of a neuromarketing experiment can be expressed in the number of fixations, which, as noted by the scientist A. Duchowski [12], are characterized by focusing the eyes on a specific object by stabilizing the retina focus on it, i.e. these are pauses in movement between saccades, which indicate interest and attention to the selected object. Scientific studies show that they are most informative because they are associated with higher order cognitive processes. In addition, eye tracking provides objective, unbiased and accurate data by providing real-time results by measuring the response or behavior of clients at the very moment they occur. However, the results of evaluating the number and duration of fixations should be interpreted based on the objectives of the study. For example, if the number and duration of fixations when searching for product A is higher and longer than searching for product B, this may mean that the physical positioning of product B and its perception was less convenient for the consumer in the task of searching for this product on a virtual shelf , or in the desire to choose product A than product B, in the task of choosing a priority product. It is noteworthy that consumers tend to behave in accordance with a certain pattern, which is a negative factor when using classical instrumental methods, however, the tracking method allows you to evaluate their attention, reactions, choices based on natural, subconscious and familiar behavior. One of the main disadvantages of the eye movement recording technology is that not all eyes can be tracked. Contact lenses, glasses, and pupil color can affect the ability of the eye-tracking camera to record eye movements; therefore, not all (usually 10–20% of the sample) consumers can participate in eye-tracking research [13].

VI. RESULTS AND DISCUSSION

The oculomotor behaviors of 23 test subjects were recorded in an array of 966 data sets. The experiment involved two gender groups: men - 13 people and women - 10 people, aged 18 to 40, who had normal, uncorrected vision. Participants were warned that their eye movements would be controlled during the experiment.

Visual stimuli were projected onto a 24-inch monitor with a resolution of 1920x1080 pixels. Eye tracker was located at a distance of 600 mm from the test subject. The correction angle did not exceed 0.5°, which corresponds to an error of 5 mm.

The detection algorithm for finding the center of the pupil has a reliability of 98% with an accuracy of determining the zone of ± 1 mm. The results were processed using economic-mathematical and statistical analysis methods implemented in the SPSS environment and author's calculations. Data received from the eye tracker were transcoded into maps of visual significance using OGAMA program.

During the experiment, in order to determine the number of fixations in areas of interest (goods of interest), the subjects were offered 21 visual stimulus materials of virtual shelves, which were alternately projected onto the screen for certain product groups: vegetables, fruit, canned water, meat and meat products, sausages, fish, bread and bakery products. The products on the presented virtual counters were available in various arrangements and price categories, so that the most suitable one for the test subjects could be chosen. The stimulus material was made on the basis of real counters of various retail chains in Simferopol (Fig. 3).

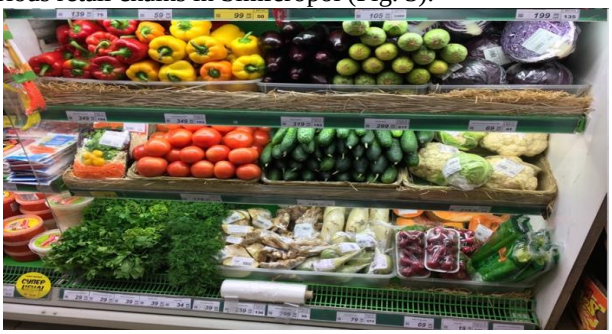


Fig. 3. Example of stimulus material of a virtual shelf with vegetable products

The experiment took place in several stages.

At the first stage, the test subjects, for an unlimited time period, studied the stimulus material proposed alternately. The experiment participants were informed that their choice of virtual goods is unlimited, as well as the virtual financial resources.

The results obtained in the course of the study indicate that, on average, female consumers spend less time studying the counters than male consumers, which can be explained by their activity and constant choice of products in supermarkets, as a result of which the decision-making speed of women is higher than of men (Table-IV).

Table-IV: The average time spent by consumers to study the virtual counters, ms; the average number of fixations on the slide by men and women

Stimulus material number	Males		Females	
	Average fixation time per slide, ms	Average number of fixations per slide	Average fixation time per slide, ms	Average number of fixations per slide
1	25735,2	83	19462,9	60
2	12142,8	40	10432	36
3	23169,9	77	15869,4	55
4	12901,6	41	12550,8	40
5	12896,1	40	10395,7	29
6	5933,6	16	5415,2	17
7	10712,8	31	7355,4	24
8	15497,9	47	10133,0	30
9	9907,1	32	6464,7	20
10	11586,7	38	10616	30
11	6864,6	16	5043,3	13
12	8787,4	26	8596,3	25
13	11882,3	37	10749,2	34
14	5424,2	14	5356,9	15
15	9607,9	29	6232,9	18
16	6856,6	19	2864,1	8
17	12415,8	37	6037,8	18
18	17376,9	56	7938,4	19
19	12530,0	39	11105,2	35
20	9945,0	32	7249,1	20
21	13951,5	43	10260,5	31

The data obtained indicate that when studying any of the 21 virtual counters, women spend less time choosing goods than men, because the average fixation time on the slide, as well as the average number of fixations for female test subjects are less than for male test subjects. This is confirmed by the study of the scientist S. Bakshi [14], who indicates that the behavior of men and women in the process of making a purchasing decision is different, starting with the recognition of needs through the assessment of alternative behaviors before and after the purchase, as a result of which men and women work differently with different types of incentives and rating options. As the scientist notes, of all the factors affecting consumer behavior when making decisions, gender is one of the main factors. This applies to social roles and responsibilities of men and women, expectations related to the characteristics, inclinations and likely behavior of both women and men (femininity and masculinity), which are studied and changed over time within and between cultures [4]. During the experiment, men and women differently approached the solution of the task - the choice of goods on a virtual shelf in the conditions of unlimited resources. Women chose products they often bought, as a result of which their decision-making speed was high. Men, by contrast, have a completely different approach to buying than women. For most men, solving the problem is an opportunity to demonstrate their competence, the strength of determination and commitment to relationships, as a result of which more time was spent studying the virtual counters. Although the amount of time that the eyes remain fixed in a specific area of the scene is an important component of eye movement behavior, the fixation position is an equally important component. Eye movement control models that focus on duration but ignore location lead, according to Henderson J., to incomplete accounting and may even lead to erroneous conclusions about the nature of eye movement control [15].

Therefore, at the second stage of the experiment, it was of practical interest to compare the conscious choice of goods made by men and women and their subconscious interest in the presented products, by comparing the number of fixations in the selected zones of interest.

During the study, maps with highlighted areas of interest for the desired products and products that were consciously selected by the test subjects were analyzed. As scientists Castelano M., Henderson J. note, the average duration of fixation on the stimulus material, as well as the total duration of sequential fixations on a specific area of interest are associated with current perceptual and cognitive activity [16].

An example of stimulus material is shown in Fig. 4.

a) b)

Fig. 4. Total fixation time of men (a) and women (b) in the zones of interest of the desired goods

The results of the comparison of the desired products identified on the basis of the largest fixations in the zone of interest, and selected consciously presented in Table-V.

Table-V: Comparison of products of interest and actually selected products

Stimulus material number	Males			Females		
	Product from zone of interest, ms	Actually selected product	Did not choose anything, people	Product from zone of interest, ms	Actually selected product	Did not choose anything, people
1	Red pepper – 591 ms	Pomelo, oranges, lemons, kiwi, pomegranate, tangerines	-	Red cabbage – 403 ms	Oranges, tangerines, kiwi, pineapple, bell pepper	2
2	Ginger – 205 ms	Tomatoes, cucumbers, herbs, cabbage	1	Cucumbers – 389 ms	Cucumbers, tomatoes, herbs, bell pepper	3
3	Lecho jar – 280 ms	Pears, tangerines, canned corn, canned peas, olives, cabbage	1	Tangerines – 963 ms	Pears, apples, canned corn, olives, cabbage	3
4	Avocado – 226 ms	Apples, mushrooms, cucumbers, avocado, coconut	4	Red pepper – 350 ms	Napa cabbage, dragon fruit, apples, banana	4
5	Bottled water 0,5L – 399 ms	Sparkling, still water 1.5L, banana	-	Bottled water, 5L – 367 ms	Sparkling, still water 1.5L, apples, banana	3
6	Apples "Champion" –217 ms	Apples "Champion", golden	10	Apples "Champion" – 189 ms	Apples "Champion", golden	6
7	Chicken drumstick – 404 ms	Chicken fillet, chicken drumstick, beef	4	Chicken thighs - 417 ms.	Chicken fillet, chicken wings, pork	4
8	Whole chicken – 400 ms	Fried sausages, chicken fillet	3	Whole chicken – 288 ms	Chicken fillet, chicken wings, nuggets, whole chicken	4
9	Minced pork – 221 ms.	Minced meat, chicken sausages	7	Minced pork and beef – 413 ms	Minced chicken	8
10	Smoked chicken fillet – 233 ms	Smoked sausage, salami	5	Raw smoked sausage – 588 ms	Cooked sausage, smoked sausage	6
11	Chicken sausages – 340 ms	Chicken sausages	11	Chicken sausages – 904 ms	Chicken sausages	9
12	Dehydrated sausage – 299 мс.	Cooked sausage, sausages	10	Smoked sausage – 235 ms	Ham, smoked sausage slices	6
13	Salami sausage discounted – 384 ms	Cooked sausage, cervelat	7	Salami sausage discounted – 869 ms	Cooked sausage	5
14	Sausages «Kazackie» – 254 ms	Sausages, cooked sausage	10	Sausages– 275 ms	-	10
15	Frozen herring -326 ms	Red caviar, salmon steak, fresh mackerel	5	Red caviar – 285 ms	Salmon steak, fresh mackerel, red caviar	5
16	Frozen squid – 272 ms	Frozen squid	11	Hake fillet – 198 ms	-	10
17	Ketchup “tender” – 278 ms	Ketchup, frozen mackerel, frozen hake	4	Ketchup “tender” – 255 ms	Ketchup for children, tomato ketchup	6
18	Smoked mackerel – 229 ms	Preserves, red fish, crab sticks, smoked mackerel, mussels, shrimp	2	Crab sticks – 435 ms	Crab sticks, smoked horse mackerel	4
19	Rolls with poppy seeds – 326 ms	Regular loaf, bran loaf	3	Buns – 191 ms	Regular loaf, pita	-
20	Bread “Brick”– 253 ms	Sliced long loaf, bun with poppy seeds, nutella	4	Buns with raisins – 279 ms	Nutella, sliced long loaf	6
21	Beer –415 ms Garlic bread – 376 ms	Garlic bread, chips, crackers, pita	6	Dietary crispbread – 436 ms	Pita, black bread, crispbread	5

Each subject, regardless of gender, preferred one, a maximum of two products from those offered on the virtual shelf, despite the fact that their choice was not limited by both financial resources and the objectives of the experiment. Female test subjects, onslide s 14 and 16, showed a significant number of fixations on sausages (14) and frozen hake fillet (16), however, none of them decided to choose any product from this virtual counter. Also, it is interesting that men and women, when choosing products on slide 13 (sausages), spent the most time studying discounted sausages, as evidenced by the largest number of fixations in this zone of interest, however, the subjects made an actual choice in favor of cooked sausage. The results confirm that the use of visual signals can increase attention to stimuli, and increase the motivation or bias of the consumer choice of goods in favor of a programmed, in this case, a specific brand of sausage, i.e. there is a chance of making an irrational decision

under the influence of various stimuli. The authors agree with the opinion of scientists who indicate that "the rationality of the consumer is, firstly, limited – depending on both his objective limitations of perception and processing of information, and subjective attitudes and prejudices. Secondly, consumer rationality is selective and depends on the degree of his involvement in the process of consumer choice" [6, p. 31], which is confirmed by the results of the conducted experimental study.

Interestingly, most of the test subjects did not make a real choice of goods from the virtual shelves 6, 9, 11, 12, 14, 16, although they were actively fixed on certain products.

Notably, the location of consumer goods on virtual shelves does not play a significant role in purchasing behavior, since consumers were fixed on the desired products located in different areas on the stimulus material, both in the foreground and in the background, or behind the main goods.

The results presented in Table 5 indicate that there is an asymmetry in the desired and actually selected products by consumers. We propose to calculate the gap between the level of the desired and the acquired by the formula (1):

$$R_{ij} = \frac{f_i}{f_j} \to 1 \quad (1)$$

where R_{ij} – the coefficient of asymmetry of consumer preferences;

f_i – total number of fixations on an actually selected product, ms;

f_j – total number of fixations on the desired product, ms.

The proposed method allows to determine the difference between the desired and purchased goods, while if the calculated indicator is in the range of 0.75-1.0, then the consumer acquires what he wants, however, we assume that if $R_{ij} < 0.5$, then there is a significant gap between desired and purchased goods. If the coefficient of asymmetry of consumer preference is within $0.5 < R_{ij} < 0.75$, then this indicates that the consumer can decide to change the product in favor of the desired under the influence of various external stimuli and internal motivational factors (for example, a product is expensive, but it is tasty and good quality, or, for instance, there are people buying red caviar for the New Year because it is a tradition, though it is more expensive than herring). The results of the assessment of fixations and the calculation of the indicator R_{ij} are presented in Table-VI.

Table-VI: The results of the calculation of the coefficient of asymmetry of consumer preferences (R_{ij}) of men and women by group of products

Slide	The total number of fixations on the desired product, f_j, ms	The total number of fixations on an actually selected product, f_i, ms	Coefficient of asymmetry of consumer preferences, R_{ij}	Slide	The total number of fixations on the desired product, f_j, ms	The total number of fixations on an actually selected product, f_i, ms	Coefficient of asymmetry of consumer preferences, R_{ij}
Males							
1	591	177	0,30	12	299	227	0,76
2	205	205	1,00	13	384	186	0,48
3	280	217	0,78	14	254	212	0,83
4	226	198	0,88	15	326	242	0,74
5	399	190	0,48	16	272	252	0,93
6	217	150	0,69	17	278	278	1,00
7	404	245	0,61	18	229	179	0,78
8	400	243	0,61	19	326	171	0,50
9	221	221	1,00	20	253	197	0,78
10	233	219	0,94	21	376	376	1,00
11	340	304	0,89				
Females							
1	403	367	0,91	12	235	202	0,86
2	389	389	1,00	13	869	253	0,29
3	963	206	0,21	14	275	0	0,00
4	350	219	0,63	15	285	173	0,61
5	367	259	0,71	16	198	0	0,00
6	189	157	0,83	17	255	255	1,00
7	417	152	0,36	18	435	200	0,46
8	288	182	0,63	19	191	181	0,95
9	413	320	0,77	20	279	278	1,00
10	588	358	0,61	21	436	175	0,40
11	904	600	0,66				

According to Table 6, for men, 13 out of 21 products are the same in terms of desired and actually selected, while for women – only 8 out of 21. A significant number of gaps between desired and purchased goods among females (7 out of 21 products) is explained by their greater propensity for thrift and economy, while Rij value <0.5 for males is determined for only 4 products. When any factors change, men are ready to change their consumer preferences for 3 products, while women can change their minds regarding 6 products.At the third stage, based on the calculated coefficient of consumer preference asymmetry, it is possible to determine the level of consumer imbalance between the consumer's desires and the actual purchased goods. So, we assume that if the number of items with factor 0,75<Rij<1.0, and up to 30% the level of imbalance is optimal if the number of products with 0.5<Rij<0,75 there is a 30%- 60%, the level of imbalance is acceptable if the number of products with 0.5<Rij ranges from 60% to 100%, the critical level of imbalance, there is a social and economic dissatisfaction in the gender group. Thus, in our study, the level of consumer imbalance is average (Table VII).

Table-VII: The level of consumer imbalance by product groups of men and women

Consumer preference asymmetry coefficient, Rij	Limit level of consumer imbalance	Males	Females
		Amount of goods, %	Amount of goods, %
$0,75<R_{ij}<1,0$	60%-100%	61,9	38,1
$0,5<R_{ij}<0,75$	30%-60%	23,8	28,6
$0,5<R_{ij}$	<30%	14,3	33,3

The results of the study showed a critical level of consumer imbalance in women, which indicates their financial insecurity, unstable position in society, and lack of confidence in sustainable long-term social prospects. Men, on the contrary, are quite confident in their social status, since their level of consumer imbalance is optimal.

Thus, gender plays an important role in consumer behavior. However, in our opinion, it is not a key role, because there are differences between men and women in terms of perspective, desire, need, lifestyle and external or internal factors that influence decision making. Indeed, the behavioral aspects of men and women are largely due to their psychological and physiological differences.

The research was aimed at elucidating the desired and actually selected consumer goods based on the study of oculographic parameters that could predict the choice of the consumer. The stimulus material options were not different between men and women, as we tried to present a real shopping scenario. The scientist Shimoho S. et al. [17] found out that people focus more on the object that they are likely to buy. However, our experimental study showed that manipulating a variable factor, such as financial resources, changes the preference for the object even it receives more attention. The results confirm the conclusions of the scientists Reiner K. [18] and Russo J. [19] about experimental manipulations of consumer attention. As a result of the experiment, it was revealed that the number of fixations and the total duration of fixation significantly correlated with the desired choice, however, the product was not actually chosen by the consumer. At the same time, the total duration of fixation was a guideline for gender differences in the speed of decision-making.

VII. RESULT AND DISCUSSION

Based on the research, the following conclusions can be drawn.

1. The results of statistical analysis showed that, despite the expansion of the product range structure, the consumer market has a tendency to reduce consumer activity. Most of the consumption in Russia is accounted for by meat products, followed by the consumption of fruits and vegetables. The dynamics of consumption shows a decline in demand for these products in recent years, due to a decrease of the solvency of the population and increasing levels of poverty.

2. The results of the neuromarketing experiment showed that when having unlimited resources (external constraints if limited), female subjects are still guided by internal limitations, choosing the standard set of products that make up their diet, while male subjects give preference to more expensive products under the same conditions. For example, men often chose red caviar among fresh seafood, and women, despite the fact that they focused on red caviar, made a choice in favor of fresh mackerel and salmon.

This is explained, in our opinion, by the fact that women consumers, when purchasing goods for family, tend to consider purchase as a long-term solution to their needs, while men make choices based on their current needs.

3. A study of the visual attention of men and women when they choose products on virtual shelves showed that women spend less attention on studying visual objects in the store. Women's high decision-making speed is most likely a result of emotional product choices. Using visual advertising signals can increase attention to incentives and increase motivation. In this case, there is a shift in consumer choice of the product in favor of the one that is actively advertised in the store.

4. The study of consumer choice between those products that were visually noticed and those that were noted as a result of the survey showed that there is a significant asymmetry between what is desired and what is chosen. The desired product was evaluated based on the number of visual fixations, since their duration is directly related to the possible product selection. To assess the level of asymmetry of visual attention, a method was proposed for calculating the coefficient of asymmetry of consumer preferences, which can be used to assess the level of consumer imbalance and identify social disparities in the selection of products.

5. The significance of the identified asymmetry should be considered when promoting goods for different gender groups of consumers. It is also important that the nature and structure of women's consumption will change only if they are confident in their financial stability in the long run, which indirectly confirms the lower social protection of women than men.

6. To change consumer preferences and change habitual behavior, sufficient time and financial resources are required, as well as active propaganda and advertising by manufacturers and retailers. This will allow changing stereotypes in consumer behavior and the structure of selected consumer goods.

VIII. CONCLUSION

The study of consumer behavior is quite important, because in the conditions of increasing competition and expanding the range of products, it is necessary to take into account the motives of behavior and factors that affect consumer choice, especially food. However, consumer behavior is a multi-step process that requires constant study. Therefore, a comprehensive approach using new research methods is required. Neuromarketing research with high accuracy allows you to evaluate the consumer's choice, to investigate the level of dissatisfaction with their choice. The research results can be used to develop strategic alternatives by retailers, manufacturers, and the government.

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