




IMPLEMENTING ARTIFICIAL INTELLIGENCE IN THE PACKAGING DESIGN FOR THE TASTE IMPRESSION

Gojko Vladić , Dejana Jovanović, Gordana Bošnjaković , Teodora Gvoka 
University of Novi Sad, Faculty of Technical Sciences,
Department of Graphic Engineering and Design, Novi Sad, Serbia

Abstract: *This study examines the ability of the artificial intelligence (AI) generator to create packaging with taste impression. Influence of packaging design on taste impressions is well researched and achieved through transfer effects of symbolic associations from the visually perceived packaging to the products taste. The experiment was conducted by generating packaging designs with gradation in the strength of taste by AI image generator. This was done for sweet, sour, bitter, salty taste and feeling of hotness for spicy food. Afterwards participants were asked to grade packaging designs on their perception of the presumed product taste. Results indicate that AI image generator was able to generate packaging designs with recognizable strength of taste, although limited, as fine gradation of the presumed taste perception was not achieved.*

Key words: Packaging design, artificial intelligence, perceived taste

1. INTRODUCTION

Visual appearance of the product is one of the most important factors for purchasing decision of the food products (Crilly et al., 2004; Fenko et al., 2010). In the category of the food products packaging is often conveying the characteristics of the product. So packaging, rather than the product itself, can steer purchasing decision through its design (Creusen et al., 2005; Febrianti et al., 2023; Van Rompay et al., 2009), furthermore packaging can in some cases influence food product experience (Schifferstein et al., 1999). Taste of the food product is most important characteristic, followed by the smell and packaging should present those characteristics by its shape, colour, typography and other design elements. Stating the previous it must be mentioned that not all consumers pay equal attention to the packaging design and are not equally affected by it (Bloch et al., 2003).

Artificial Intelligence (AI) is affecting all industries and packaging industry is no exception. There are many applications of AI in the packaging industry, but graphic design of the packaging is perhaps most impacted by introduction of AI. New tools and techniques in graphic design are being developed based on the ability of the image generating AI to analyze and interpret huge data bases while learning and adapting. Generating designs based on learning data and user preferences is changing the way the packaging design is created and interpreted. Graphic designers have already few decades of experience of using AI, first applications were limited to automation of repetitive tasks, such as image manipulation, typography, and layout (Bahaa, 2023). This freed time for designers to focus on more creative aspects of their work. Advancements in the field of deep learning and neural networks led to the development of AI-based design tools that can generate designs based on data and user preferences. Ability to create designs that are tailored to specific demographics, browsing history, and purchase history improves consumer engagement and loyalty (Bahaa, 2023). The use of AI has its advantages and disadvantages. Advantages are increased efficiency and productivity, while the loss of human touch and creativity is one of the main concerns. There is debate focus on the fundamental difference between humans and machines, whether AI solutions are “killing creativity” and “replacing designers” by creating products much faster and cheaper than humans. (Anantrasirichai et al., 2022; Tomić et al., 2023).

Having in mind popularity of AI technologies and function of packaging design to communicate clearly products characteristics there is a need to examine how successful AI image generators are at creating comprehensive visual representation of the products taste. In order to determine are the designs proposed by AI image generator perceived in the intended way by human observers experiment was conducted by generating packaging designs with gradation in the strength of taste by AI image generator. This was done for sweet, sour, bitter, salty taste and feeling of hotness for spicy food. Afterwards participants were asked to grade packaging designs on their perception of the presumed product taste.

2. METHODS

The experiment was conducted in order to examine the ability of the AI image generator to create packaging with taste impression. First task was creation of the prompt instructions for the AI image generator. Prompts were refined additionally with adjectives for each taste in order to get desired results, and eliminate as much visual noise which could later influence participants judgment of the perceived product taste. Getimg.ai platform for generating images from text was used. For each taste (sweet, sour, bitter, salty taste and feeling of hotness for spicy food) three different designs were created for every level of taste intensity, four levels of intensity were used. Basically, after refinement of the prompts twelve images of the designs were created for each taste. Images were randomized and numbered in order to be identified. This collage of twelve images was used as stimuli in the online survey conducted by Google forms. Figure 1 shows the example collage of twelve images used as stimuli for bitter taste, as an example.



Figure 1: Collage of twelve images used as stimuli for bitter taste

Survey was sent to 100 participants, 62 of them have taken part in the survey. There were 53 females and 27 males, in the wide range of ages 13 to 54 and wide range of professions and education. Participants were asked to grade perceived taste intensity of the product shown in each of the images in the collage. Each of the images could receive one unique grade, so the result would be clear gradation of the products perceived taste intensity. Besides judgment of the taste intensity participants were asked to give their comments on the design presented and write suggestions on which element could, in their opinion, help improve communication of a taste.

3. RESULTS

Results shown in the Tables 1 - 4 are an example for bitter taste, with prompt used, image of the design, graph and descriptive statistics. Graph in the table is showing received grade and number of the participants giving the grade. Descriptive statistics for all other tastes are shown in Table 5, without images of the design and graphs.

Table 1: Results for three different designs in the lowest taste intensity category for bitter taste


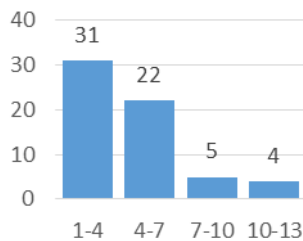

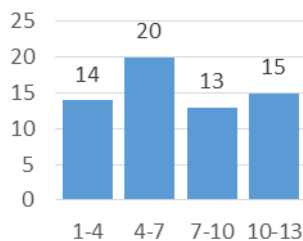

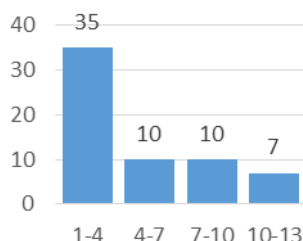
Prompt: Design a packaging that exudes a subtle and inviting aroma of coffee. Incorporate warm tones and soft imagery that evoke comfort and relaxation. Consider using a gentle gradient background with a single coffee bean illustration to represent the mild bitterness level.													
	 <table><thead><tr><th>Category</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>31</td></tr><tr><td>4-7</td><td>22</td></tr><tr><td>7-10</td><td>5</td></tr><tr><td>10-13</td><td>4</td></tr></tbody></table>	Category	Frequency	1-4	31	4-7	22	7-10	5	10-13	4	Mean	4.03226
		Category	Frequency										
		1-4	31										
		4-7	22										
7-10	5												
10-13	4												
St. dev.	2.57967												
Skewness	0.98156												
Kurtosis	0.3606												
	 <table><thead><tr><th>Category</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>14</td></tr><tr><td>4-7</td><td>20</td></tr><tr><td>7-10</td><td>13</td></tr><tr><td>10-13</td><td>15</td></tr></tbody></table>	Category	Frequency	1-4	14	4-7	20	7-10	13	10-13	15	Mean	6.59677
		Category	Frequency										
		1-4	14										
		4-7	20										
7-10	13												
10-13	15												
St. dev.	3.39459												
Skewness	0.21106												
Kurtosis	-1.07631												
	 <table><thead><tr><th>Category</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>35</td></tr><tr><td>4-7</td><td>10</td></tr><tr><td>7-10</td><td>10</td></tr><tr><td>10-13</td><td>7</td></tr></tbody></table>	Category	Frequency	1-4	35	4-7	10	7-10	10	10-13	7	Mean	3.93548
		Category	Frequency										
		1-4	35										
		4-7	10										
7-10	10												
10-13	7												
St. dev.	3.62537												
Skewness	0.94111												
Kurtosis	-0.47939												

Table 2 (part 1): Results for three different designs in the second in strength taste intensity category for bitter taste


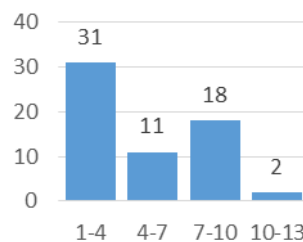

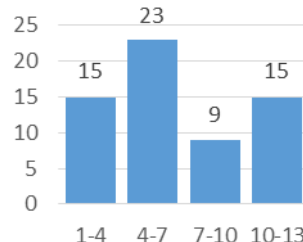
<p>Prompt: Craft a packaging design that balances sophistication with a hint of robustness. Integrate deeper shades of brown and burgundy to convey richness and depth. On the label, utilize imagery such as a steaming cup of coffee or a swirling aroma to signify the medium level of bitterness. Add a touch of elegance with minimalistic typography.</p>														
	 <table><thead><tr><th>Category</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>31</td></tr><tr><td>4-7</td><td>11</td></tr><tr><td>7-10</td><td>18</td></tr><tr><td>10-13</td><td>2</td></tr></tbody></table>	Category	Frequency	1-4	31	4-7	11	7-10	18	10-13	2	Mean	4.74194	
		Category	Frequency											
		1-4	31											
		4-7	11											
7-10	18													
10-13	2													
St. dev.	2.88544													
Skewness	0.59673													
Kurtosis	-0.78443													
	 <table><thead><tr><th>Category</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>15</td></tr><tr><td>4-7</td><td>23</td></tr><tr><td>7-10</td><td>9</td></tr><tr><td>10-13</td><td>15</td></tr></tbody></table>	Category	Frequency	1-4	15	4-7	23	7-10	9	10-13	15	Mean	5.96774	
		Category	Frequency											
		1-4	15											
		4-7	23											
7-10	9													
10-13	15													
St. dev.	3.21863													
Skewness	0.35926													
Kurtosis	-1.18357													

Table 2 (part 2): Results for three different designs in the second in strength taste intensity category for bitter taste


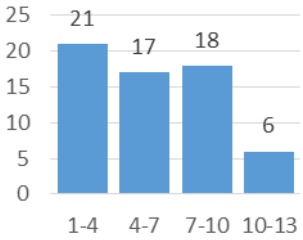
		Mean	5.32258
		St. dev.	2.82712
		Skewness	0.28046
		Kurtosis	-0.89885

Table 3: Results for three different designs in the third strength taste intensity category for bitter taste


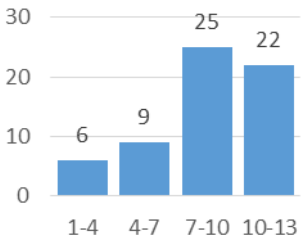

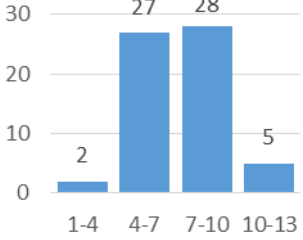

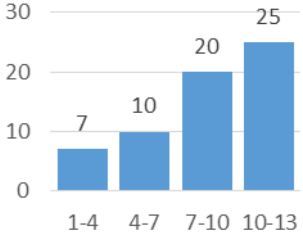
Prompt: Develop a packaging in the shape of a bag that commands attention and intensity. On the label, employ bold colours like dark espresso brown or charcoal grey to reflect the strength of the coffee. Incorporate imagery such as cracked coffee beans or a rugged landscape to symbolize the bold flavour profile. Utilize sharp and angular typography to convey the robustness of the product.			
		Mean	8.1129
		St. dev.	2.66799
		Skewness	-0.9064
		Kurtosis	0.24686
		Mean	6.79032
		St. dev.	2.12816
		Skewness	0.22031
		Kurtosis	0.95159
		Mean	8.29032
		St. dev.	3.41831
		Skewness	-0.60492
		Kurtosis	-0.66255

Table 4: Results for three different designs in the highest taste intensity category for bitter taste


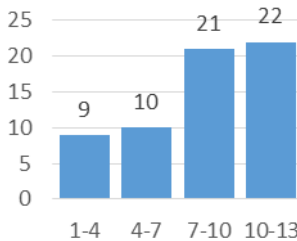

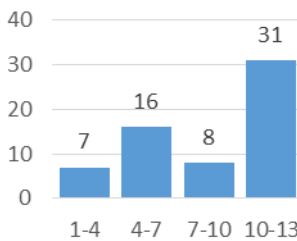

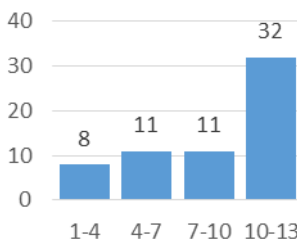
Prompt: Create a packaging design in the shape of a coffee bag that exudes power and boldness. On the label, opt for a striking contrast of colours, such as black and fiery red, to evoke a sense of intensity. Incorporate imagery like a thunderous storm or a roaring flame to represent the extreme bitterness level. Use dynamic typography with jagged edges to convey the electrifying taste experience.														
	 <table border="1"><thead><tr><th>Intensity Range</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>9</td></tr><tr><td>4-7</td><td>10</td></tr><tr><td>7-10</td><td>21</td></tr><tr><td>10-13</td><td>22</td></tr></tbody></table>		Intensity Range	Frequency	1-4	9	4-7	10	7-10	21	10-13	22	Mean	7.59677
			Intensity Range	Frequency										
			1-4	9										
			4-7	10										
7-10	21													
10-13	22													
St. dev.	3.14908													
Skewness	-0.62012													
Kurtosis	-0.79766													
	 <table border="1"><thead><tr><th>Intensity Range</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>7</td></tr><tr><td>4-7</td><td>16</td></tr><tr><td>7-10</td><td>8</td></tr><tr><td>10-13</td><td>31</td></tr></tbody></table>		Intensity Range	Frequency	1-4	7	4-7	16	7-10	8	10-13	31	Mean	8.25806
			Intensity Range	Frequency										
			1-4	7										
			4-7	16										
7-10	8													
10-13	31													
St. dev.	3.42094													
Skewness	-0.56773													
Kurtosis	-0.97977													
	 <table border="1"><thead><tr><th>Intensity Range</th><th>Frequency</th></tr></thead><tbody><tr><td>1-4</td><td>8</td></tr><tr><td>4-7</td><td>11</td></tr><tr><td>7-10</td><td>11</td></tr><tr><td>10-13</td><td>32</td></tr></tbody></table>		Intensity Range	Frequency	1-4	8	4-7	11	7-10	11	10-13	32	Mean	8.35484
			Intensity Range	Frequency										
			1-4	8										
			4-7	11										
7-10	11													
10-13	32													
St. dev.	3.28981													
Skewness	-0.70488													
Kurtosis	-0.83283													

Table 5 (part 1): Results for three different designs in four categories of taste intensity for sweet, sour, salty taste and feeling of hotness for spicy food. 1-lowest taste intensity, 4 highest taste intensity

Taste/intensity		Sweet/1	Sweet/2	Sweet/3	Sweet/4	Sour/1	Sour/2	Sour/3	Sour/4
1	Mean	5.75806	6.6129	6.17742	7.66129	3.45161	5.1129	4.70968	8.06452
	St. dev.	3.0282	2.89349	2.621	3.78497	2.93468	1.9342	3.37001	2.70925
	Skewness	-0.0318	-0.17854	0.31952	-0.26261	1.41588	0.57967	0.605	-0.70932
	Kurtosis	-1.13913	-0.90519	-0.35505	-1.55923	0.93196	1.05423	-0.56642	-0.2715
2	Mean	7.91935	5.96774	6.96774	7.82258	3.96774	7.8871	8.06452	9.40323
	St. dev.	4.04604	2.52832	2.75781	3.75707	2.61125	2.78818	3.11459	3.03779
	Skewness	-0.51339	-0.02543	-0.01381	-0.68112	1.45209	-0.5645	-0.85589	-1.35238
	Kurtosis	-1.28237	-0.32724	-0.15046	-1.18131	1.78069	-0.15297	0.2441	1.0004
3	Mean	4.40323	4.54839	7.8871	6.27419	5.45161	5.0	8.12903	8.75806
	St. dev.	3.41386	2.3447	2.97589	4.40257	2.88397	2.73412	2.77272	3.05515
	Skewness	0.70293	0.83589	-0.81243	0.03398	0.41166	0.78572	-0.8866	-0.91771
	Kurtosis	-0.8917	-0.06281	-0.14749	-1.72121	-0.1863	-0.48877	0.29226	0.09664
Taste/intensity		Salty/1	Salty/2	Salty/3	Salty/4	Hot/1	Hot/2	Hot/3	Hot/4
1	Mean	3.54839	4.14516	8.56452	8.40323	5.75806	7.82258	6.27419	7.72581
	St. dev.	1.90493	2.97997	2.66502	2.67017	3.62453	2.28699	1.90056	4.20448
	Skewness	0.79794	0.76491	-0.53329	-0.94068	0.21684	-0.23344	-0.18636	-0.55217
	Kurtosis	0.43564	-0.15664	-0.06671	0.78215	-1.45077	-0.70972	0.37919	-1.41187

Table 5 (part 2): Results for three different designs in four categories of taste intensity for sweet, sour, salty taste and feeling of hotness for spicy food. 1-lowest taste intensity, 4 highest taste intensity

2	Mean	5.77419	6.29032	8.83871	4.16129	4.16129	9.01613	4.16129	9.69355
	St. dev.	4.3473	2.41842	3.03636	2.82955	2.29178	2.82548	2.74724	3.27729
	Skewness	0.16447	0.43083	-0.46935	1.17205	0.49638	-0.9677	0.64949	-1.68767
	Kurtosis	-1.63897	0.59847	-1.21518	0.49424	-0.37819	0.13126	-0.56306	1.79901
3	Mean	6.17742	7.54839	8.83871	5.70968	3.54839	6.54839	5.66129	7.62903
	St. dev.	2.6459	3.3175	2.77101	3.05355	2.64065	2.62196	2.986	2.94893
	Skewness	0.03233	-0.50697	-1.31772	0.42773	1.23829	0.1634	0.18711	-0.47526
	Kurtosis	-0.926	-0.90654	1.03653	-1.17754	0.56761	-0.93418	-0.88212	-0.48304

4. DISCUSSION

Results shown in previous section indicate limited ability of AI image generator to produce good results in visual representation of the packaging taking in to consideration the taste of the product. For some of the tastes and some of the designs, for example sour taste, there is noticeable gradation of the grades given by the participants in the relation to the intensity of the taste. It must be emphasized that gradation is not linear which suggest that fine differences in the neighbouring intestines were not recognized by all of the participants. On the other hand results for designs of salty taste were not consistent, which indicates that participants had trouble recognizing taste intensity gradation of the presented designs. Means of taste intensity levels two and three especially do not give clear results, presumably as the differences are small and participants personal subjective opinion prevailed.

Participants gave their free comments and suggestions how the taste could be better presented. Images of fire in the fourth level of bitterness were deemed as unsuitable for bitter taste and more suitable for spicy hot taste, while AI image generator used the illustration of the flames in all three suggested designs. Usage of the blue colour for salty taste was also frequent comment, while AI image generator used blue colour sporadically in three out of twelve designs.

Participants suggestions are welcomed, with the caveat that not all of them are experienced in the field of graphic design. Those more experienced, based on their occupation noticed influence of the background on their judgment. Minimization of the background variations was attempted in the prompts writing, but it was rather unsuccessful as AI image generator always created the image with background as a part of the design.

5. CONCLUSIONS

AI image generator tools such as Getimg.ai platform used in this study are becoming ever more popular as a tool for designer to get inspired and come up with greater number of ideas and approaches to the packaging design solution. Although very effective in producing great number of designs in a short time, study shows potential for the visual representation of the product taste, but that potential is limited to greater steps in taste perception gradation as subtle differences in the neighbouring intestines of the taste were not recognized by the human observers. Usage of colour and illustration elements in the AI generated designs were also deemed as unsuitable by the humans. This study could benefit from larger number of participants and clear division in groups based on the graphic design experience, which leaves room for further studies to be conducted in the future.

6. ACKNOWLEDGMENTS

This research has been supported by the Ministry of Science, Technological Development and Innovation (Contract No. 451-03-65/2024-03/200156) and the Faculty of Technical Sciences, University of Novi Sad through project "Scientific and Artistic Research Work of Researchers in Teaching and Associate Positions at the Faculty of Technical Sciences, University of Novi Sad" (No. 01-3394/1).

7. REFERENCES

- Anantrasirichai, N. & Bull, D. (2022) Artificial intelligence in the creative industries: a review. *Artificial Intelligence Review*. 55, 589-656. Available from: doi: 10.1007/s10462-021-10039-7
- Bloch, P. H., Brunel, F. H. & Arnold, T. J. (2003) Individual differences in the centrality of visual product aesthetics: Concept and measurement. *Journal of Consumer Research*. 29, 551-565. Available from: doi: 10.1086/346250
- Bahaa, M. (2023) The Impact of Artificial Intelligence on the Graphic Design Industry. *Arts and Design Studies*. 104, 1-9. Available from: doi: 10.7176/ADS/104-01
- Creusen, M. E. H. & Schoormans, J. P. L. (2005) The different roles of product appearance in consumer choice. *Journal of Product Innovation Management*. 22, 63–81. Available from: doi: 10.1111/j.0737-6782.2005.00103.x
- Crilly, N., Moultrie, J. & Clarkson, P. J. (2004) Seeing things: Consumer response to the visual domain in product design. *Design Studies*. 25, 547577. Available from: doi: 10.1016/j.destud.2004.03.001
- Febrianti, I. A., Slamet, A. & Faizin, W. A. (2023) The effectiveness of Canned Coffee packaging's graphic design elements in consumers' decision-making process. *Journal of Graphic Engineering and Design*. 14 (4), 5-12. Available from: doi: 10.24867/JGED-2023-4-005
- Fenko, A., Schifferstein, H. N. J. & Hekkert, P. (2010) Shifts in sensory dominance between various stages of user-product interactions. *Applied Ergonomics*. 41, 34-40. Available from: doi: 10.1016/j.apergo.2009.03.007
- Schifferstein, H. N. J., Kole, A. P. W. & Mojet, J. (1999) Asymmetry in the disconfirmation of expectations for natural yogurt. *Appetite*. 32, 307-325. Available from: doi.org/10.1006/appe.1998.0208
- Tomić, I., Jurić, I., Dedijer, & Adamovic, S. (2023) Artificial Intelligence in Graphic Design. In: *54th Annual Scientific Conference of the International Circle Circle of Educational Institutes of Graphic-Media Technology and Management Wuppertal, Germany. The Hellenic Union of Graphic Arts and Media Technology Engineers Athens, Greece*. pp. 85-93.
- Van Rompay, T. J. L., Pruyn, A. T. H. & Tieke, P. (2009) Symbolic meaning integration in design and its influence on product and brand evaluation. *International Journal of Design*. 3, 19–26.

