Food product packaging adapted for visually impaired and elderly people

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ABSTRACT *Most of food product packaging is unsuitable for elderly and visually impaired people. Food information, such as ingredients, nutritional values, allergens and date of use are printed in small letter size and illegible. Due to reduced motor skills, visually impaired people often have problems with handling packaging, i.e. opening and closing products. In this paper, we propose a redesign of the packaging of food products in order to make it easier to use (ergonomically adapted) and to make the typography, color and contrast, more noticeable (visually adapted). For the purposes of this study, we conducted a survey on elderly and visually impaired people in the city of Zagreb: in the "Vinko Bek" Center for Education, several homes for the elderly and one visually impaired person's household. Thirteen visually impaired people participated in the study. Based on the obtained results, the font type had the least impact, while the contrast between the color of the letters and the background had the greatest impact on readability. The most noticeable colors were red, yellow and magenta. It is important that packaging materials are unbreakable, like plastic or cardboard, and it is preferable that they are colored (for better visibility).*

KEY WORDS visually impaired, food product packaging, material, typography, color

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1. INTRODUCTION

Low vision or amblyopia is the loss of a certain degree of visual function, such as acuity, contrast sensitivity and peripheral vision. Based on studies by the World Health Organization [1] it is estimated that there are 285 million visually impaired people worldwide (65% are over 50 years old). 246 million of them are partially sighted (63%), and around 39 million are blind (82%). Functional limitations increase with age and the most frequent include visual disorders or weakening and blurring of vision, age-related macular degeneration (AMD), cataracts and glaucoma. Impairment to the visual system affects the subjective assessment of life quality due to impossibilities of performing daily activities [2].

Impairment of visual acuity, the peripheral visual field and the chromatic sensitivity affects the loss of chromatic sensitivity in the RG (red/green) or YB (yellow/blue) area, which causes a decrease in the ability to read text information on a colored background [3], [4], [5]. Reading speed for people with macular degeneration (AMD) depends on the print size, and text contrast [6]. Fonts designed for people with macular degeneration (AMD) improve the readability of smaller letters, but have no additional benefits over standard fonts, e.g. Courier [7], [8]. Previous research related to the readability of information for visually impaired people proposed guidelines for the design of printed media adapted for the visually impaired [9], [10], but practical application is often lacking [11].

Apart from difficulties in reading and understanding the information on product packaging [12], visually impaired people also face ergonomic usability problems. Due to reduced motor skills, there are often problems with handling the packaging, or opening and closing the product. Glass packaging, challenging ways of opening and closing packaging, use of scissors and knives, represent only some of the problems that make daily functioning difficult. In order to reduce frustrations and difficulties related to the use of product packaging, recent research [13], [14] proposes an inclusive design methodology to enable the elderly and visually impaired to use the products more easily.

In order to contribute to this topic, the purpose of this study is to expand the design area of visually and ergonomically adapted packaging for the elderly and visually impaired. The research was conducted through the collection of data based on the experiences of people with reduced visual abilities related to difficulties when using packaging. A design solution for the packaging of four food products and a logo representing that category of users will be proposed based on the obtained results.

2. METHODOLOGY

The research was conducted in the "Vinko Bek" Center for Education and the homes for the elderly in the jurisdiction of the city of Zagreb - Maksimir, Dubrava, Lašćina and Park. Data were collected through interviews according to structured questions from a questionnaire. Participation was anonymous and voluntary, and the participants were able to withdraw at any time. Before the research began, the participants were introduced to the subject through their social workers (from the homes for the elderly) and rehabilitators ("Vinko Bek" Education Center). Due to possible fatigue related to the participant's age, the interviews were limited to 10 - 15 minutes.

2.1. PARTICIPANTS

Thirteen people with visual disorders participated in this study (twelve visually impaired and

one blind). Three of them were male (63 - 87 years old) and ten were female (48 - 92 years old).

2.2. SAMPLES

Product packaging samples were used for ergonomic evaluation. The evaluation of the packaging visual design was based on three tests: readability of typography with regard to letter size; recognition and perceptibility of individual colors; and readability assessment based on the color contrast between the text and the background.

Packaging samples - Three samples with different ways of opening and closing were used so that the participants could evaluate their usability; Sample 1 - Cylindrical cinnamon cardboard packaging with a detachable lid which is large enough to be grasped with fingers; Sample 2 - Cardboard packaging for cocoa with a plastic lid that needs to be lifted and separated from the packaging; Sample 3 - Plastic packaging of body lotion with a cap that opens and closes with the pressure of a finger, and has the possibility of dosing through the opening (Figure 1).
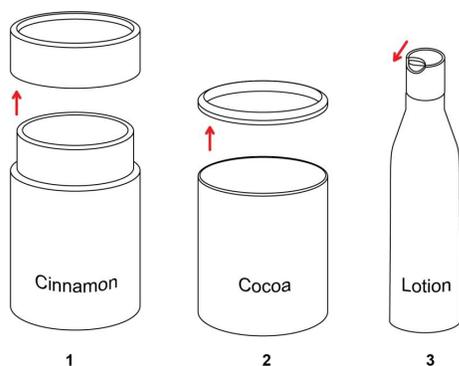

Figure 1. Product packaging samples

Typography samples **-** Three fonts were used for the evaluation of readability: Nunito, Hack and APH (regular and bold). APH [15] was created by the American Printing House for the Blind (APH), and for the purposes of this research, diacritical marks - š, č, ć, ž, Š, Č, Ć, Ž were added. The font sizes used were 14, 16, 18, 20 and 55 pt. Nunito and APH are classified as proportional fonts (each letter character has a different width), while Hack is classified as a monospaced font (the characters have the same letter width) (Figure 2.).

Figure 2. Typography samples

Samples with different text/background color combinations - The readability assessment included samples of text and background in different colors. The samples used background colors that were intended to present the entire spectrum of colors. Product names were displayed in different colors, fonts and sizes, with sufficient contrast between the background and text (minimum 60% difference in brightness) for the readability of the textual information (Figure 3.).

3. RESEARCH RESULTS

Descriptive characteristics of the participants are presented in Table 1. Key data were compiled on the participants' experiences with the product packaging, and on the results of opening and closing of the samples of cinnamon, cocoa and body lotion based on the data collected during the interviews (Table 2.).

Figure 3. Samples with different text/background color combinations

Table 1. Characteristics of participants

Mean age in years (range)	75.85 (48-92) SD = 15.87
Gender	
Female	77%
Male	23%
Diagnosis	
Cataracts	29,2%
Retinitis pigmentosa	16,7%
Blind person	8,3%
Short sightedness	8,3%
Consequence of a stroke	8,3%
Macular degeneration	8,3%
Glaucoma	8,3%
Myopia	7,0%
Strabismus	2,8%
Astigmatism	2,8%
Employment	
Employed	15%
Invalidity Retired	15%
Retired	70%

Table 2. Results of the evaluation of the packaging usability (cinnamon, cocoa and lotion)

Participant	Gender	Age	Diagnosis of low vision	The results of the packaging of food products evaluation
Participant 1	Female	52	Retinitis pigmentosa	Problems with foodstuffs like coffee, vinegar, oil and pasta. Transfers the coffee from the original packaging to a metal one due to spillage. In the case of plastic containers for oil and vinegar that do not have a dispenser, she has to hold the opening with a finger in order to determine the right dose of oil and vinegar. For pasta, she doesn't prefer cellophane packaging because of using scissors, which increase the likelihood of injury. As for materials, mostly uses plastic and paper-cardboard packaging, while she doesn't use glass packaging due to fear of falling and breaking. The participant can open and close the packaging of all samples without any difficulty.
Participant 2	Female	48	Blind person	Food packaging must be plastic, cardboard, or metal. The biggest problems are caused by sugar and salt. She isn't sure which product it is until she tastes them. She also lists problems with opening cans and jars and therefore rarely uses them. The participant can open and close the packaging of Sample 1 (cinnamon) and Sample 3 (lotion) without any difficulty, she has difficulty opening Sample 2 (cocoa) because the groove of the lid is too shallow for her fingers.
Participant 3	Female	54	Short sightedness	She uses an electronic magnifier for the visually impaired. She reports problems with food packaging when opening cans, flour, sugar, and salt. Because of the impractical packaging, she is forced to transfer them into familiar containers, usually metal ones. The participant can open and close the packaging of all samples without any difficulty.
Participant 4	Male	79	Strabismus, Myopia, Astigmatism	Uses glasses as aids. There are problems with food packaging such as cans, oil, and vinegar. The participant can open and close the packaging of all samples without any difficulty.
Participant 5	Female	69	Cataracts, Myopia	Problems with smooth surfaces and prefers rougher packaging surfaces. Motor skills are quite good, has no problems with opening and closing packaging or the weight of existing food products. The participant can open and close the packaging of all samples without any difficulty.
Participant 6	Female	92	Cataracts	Problems with opening twist-on packaging which is hard to open. The participant can open and close the packaging of all samples without any difficulty.

Participant 7	Female	89	Consequence of a stroke	The participant can open and close the packaging of all samples without any difficulty.
Participant 8	Male	87	Unknown	The participant can open and close the packaging of all samples without any difficulty.
Participant 9	Female	92	Macular degeneration	Has problems opening bottles (juice, water) and solves them using a nut crusher. She has a problem with opening packaging that requires strength in her hands (valves in oil and vinegar packaging). The participant can open and close the packaging of all samples without any difficulty.
Participant 10	Male	63	Retinitis pigmentosa	Has difficulties opening plastic packaging (vinegar) because he has to cut the aperture. He transfers foodstuff such as salt, sugar, coffee, and spices into containers that are easier to handle. He highlights the problem of pasta packaging (cellophane), which tears easily, and this often causes the food waste. For milk, he chooses larger packaging (1.75 l) and likes the "ribbed" plastic on such packaging. The participant can open and close the packaging of all samples without any difficulty.
Participant 11	Female	89	Cataracts	Her only problem with food product packaging is using scissors or knives to open them. The participant can open and close the packaging of all samples without any difficulty.
Participant 12	Female	90	Cataracts	Has problems opening bottles and jams, i.e., products that are hermetically sealed. The participant can open and close the packaging of all samples without any difficulty.
Participant 13	Female	82	Glaucoma	Has problems opening paper packaging and foil (coffee packaging). She transfers such products into metal or plastic containers. The participant can open and close the packaging of all samples without any difficulty.

The analysis of the readability of different letter sizes (Table 3.) has shown that three participants could not see or read the text at all. Seven participants could read the text in all the sizes. One participant could read the text in lager letter sizes (20 pt and 55 pt), and two participants were able to read the text with letter size of 55 pt.

The results of the recognition and perceptibility of individual colors are shown in Table 4. The participants had a harder time recognising and identifying orange, tones of blue, lighter tones of green and tones of brown (54.54%). They mentioned lighter purple, dark green and beige colors (63.63%) and cyan blue (72.72%) as more noticeable colors.

A large number of respondents recognized yellow and red (81.81%) while magenta turned out to be the most noticeable color (100%).

The results of the readability assessment based on the color contrast between the text and the background are shown in Table 5. In samples with a higher color contrast between the text and the background (Pasta 1, Coffee 1, Milk 1, Flour 1 and Sunflower oil 1), 90% of respondents successfully read the text.

Table 3. Readability of typography with regard to letter size

Participant	14 pt	16 pt	18 pt	20 pt	55 pt	Diagnosis of low vision
Participant 1				x	x	Retinitis pigmentosa
Participant 2	Participant cannot see or read					Blind person
Participant 3	x	x	x	x	x	Short sightedness
Participant 4	x	x	x	x	x	Strabismus, Myopia, Astigmatism
Participant 5	Participant cannot see or read					Cataracts, Myopia
Participant 6	x	x	x	x	x	Cataracts
Participant 7	Participant cannot see or read					Consequence of a stroke
Participant 8					x	Unknown
Participant 9					x	Macular degeneration
Participant 10	x	x	x	x	x	Retinitis pigmentosa
Participant 11	x	x	x	x	x	Cataracts
Participant 12	x	x	x	x	x	Cataracts
Participant 13	x	x	x	x	x	Glaucoma

Table 4. Recognition and perceptibility of individual colors

Participant																	Diagnosis of low vision
Participant 1			x	x		x										x	Retinitis pigmentosa
Participant 2	Participant cannot distinguish colors																Blind person
Participant 3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Short sightedness
Participant 4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Strabismus, Myopia, Astigmatism
Participant 5	Participant cannot distinguish colors																Cataracts, Myopia
Participant 6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Cataracts
Participant 7	x			x	x												Consequence of a stroke
Participant 8				x	x												Unknown
Participant 9	x			x	x	x											Macular degeneration
Participant 10	x			x			x										Retinitis pigmentosa
Participant 11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Cataracts
Participant 12	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Cataracts
Participant 13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Glaucoma

Table 5. Readability based on the color contrast between the text and the background

Participant	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	Diagnosis of low vision
Participant 1	X			X					X					X				X				Retinitis pigmentosa
Participant 2																						Blind person
Participant 3		X			X				X						X						X	Short sightedness
Participant 4	X			X					X					X				X				Strabismus, Myopia, Astigmatism
Participant 5																						Cataracts, Myopia
Participant 6	X			X					X					X				X				Cataracts
Participant 7																						Consequence of a stroke
Participant 8	X		X	X	X				X					X				X	X			Unknown
Participant 9	X			X	X				X					X	X			X	X			Macular degeneration
Participant 10	X			X	X	X	X		X		X			X				X	X			Retinitis pigmentosa
Participant 11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Cataracts
Participant 12	X			X					X					X				X				Cataracts
Participant 13	X			X					X					X				X				Glaucoma

4. RESULTS AND DISCUSSION

Due to reduced motor skills, the elderly and visually impaired people often have problems opening packaging and tend to use sharp objects like scissors or knives as little as possible. The results have shown that a simpler way of opening/closing (removing the lid, clicking the lid) can reduce the use of sharp objects, and facilitate the process of opening and closing the packaging. Materials such as glass should be replaced with plastic, metal or cardboard, which reduces the possibility of breakage and potential injuries. The packaging slipping out of the hands due to the smooth surface of the packaging can be avoided by using rough packaging materials (cardboard, paper) or plastic packaging with a ribbed surface. Visually impaired people cannot see transparent plastic packaging in a space, so it is preferable to use solid colored plastic packaging.

The participants did not notice any differences between the three types of letters displayed (Nunito, Hack, APH). According to the guidelines, the APH font, designed for the visually impaired by American typographers, was used in this research, but its advantage over the other two fonts was not found. Readability was affected by letter size. By increasing the letter size to 14 pt, regardless of font type, the nutrition information became more legible. Nevertheless, the color contrast between the text and the background was shown to have the greatest influence on the readability of textual information. More than 60% of the participants recognized red, light blue, magenta, purple, yellow, dark

green and beige as the most noticeable colors. The participants pointed out that it is almost impossible to find two visually impaired people who function equally well, but in regards to the color contrast between the text and the background, almost all of the participants agreed that darker backgrounds with light text suit them better. The best readability was achieved by the combination of white text and dark brown or dark blue background. The worst readability was between bright background (grey, yellow, blue, and orange) independently of text color (white or black). When it comes to the white background, they pointed out that the "glare" of the paper, may be a distraction from the text.

5. DESIGN PROCESS OF FOOD PACKAGING ADAPTED FOR PEOPLE WITH LOW VISION

Food products such as milk, oil, coffee and pasta are used daily in households. Food packaging is often unsuitable for the elderly and visually impaired, so there is a need to make information about food (contents, list of nutritional values, allergens, shelf life) more visible and readable for this group of users as well. The materials and shapes of the existing food packaging are also unsatisfactory: transparent glass, transparent protective films around the food, and smooth surfaces of the materials make it difficult to use the product. The shape, usability and information about the product should be adapted for people with limited motor and visual abilities for the effective use of the product.

By choosing liquid (milk and oil), powdered (coffee) and solid (pasta) foods, we tried to include the packaging of food in different aggregate conditions. The chosen materials for product packaging were plastic and cardboard, mainly for the safety of use. Materials such as glass are not acceptable for use by visually impaired people, due to breakage and possible injuries. Plastic is a material with a smooth surface, and as such it can be impractical to handle, but that can be prevented by the ribbed structure of the material. The cardboard packaging has a rough structure, which makes it very suitable for use because it reduces the possibility of slipping during use. It is not watertight, so it is used for packing solid and powdered food, while plastic is the material in which liquid foods are stored. Due to the lack of strength and motor skills of the elderly, the packaging should be equipped with a simple solution for opening and closing the product with minimal use of fingers and hand strength.

The process of designing packaging suitable for the visually impaired was based on the conceptual solution for a fictitious logomark, choice of packaging material, customized font size and color contrasts between the text and the background.

5.1. Conceptual solution of a fictitious logomark

The conceptual design of the logo (Figure 4.) is represented by an illustration of an eye, which was intendeᴅ to be associated with the target group of users, i.e. visually impaired people. The illustration consists of two circles and 24 graduated elements that symbolize the iris of the eye. Visual acuity of up to 40% of normal vision is classified as low vision. Therefore, we used the number 40 (converted into degrees) to represent the residual part of the vision metaphorically. The element is shown as an angle of 40° and highlighted in a magenta color, as the most noticeable color based on the obtained research results, while the remaining part is in a grey color, which symbolizes lost vision. The logo is applied to all food product packaging design solutions shown below.
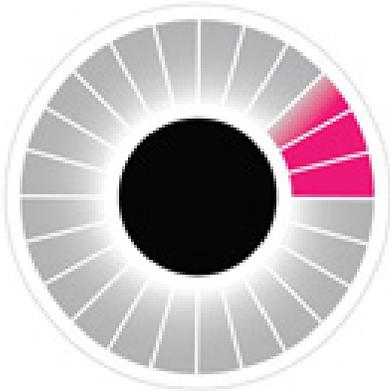
Figure 4. Conceptual solution of a fictitious logomark

5.2. Milk - packaging design solution

White opaque plastic was chosen for the packaging material in order to reduce light transmission to the product and increase visibility. The side surface of the cap is magenta for greater visibility, while the top of the cap is dark blue with the date of use printed in white letters/numbers. Under the lid there is an aluminum foil (milk protection) which has a larger flap than usual for pulling/removing. This way, a greater coverage of the fingers is made possible in order to facilitate the removal of the protective film. The label of the dairy product is in a pronounced contrast of dark blue and white.

For textual information, Nunito Regular was used, in sizes 12 - 38 pt. The font size is adapted to the importance of the information. Nunito Bold was used to highlight important textual information. The label design contains an illustration of three white drops (Figure 5.)

5.3. Sunflower oil - packaging design solution

The packaging is made of plastic lid-cap material on the principle of opening-closing with the pressure of a finger (ease of use and dosing of the product). The cap is yellow, with date of use, printed on the side. Transparent packaging is not recommended for visually impaired people because they cannot see it in the environment. Therefore, the oil packaging is light green in order to be more noticeable. The packaging has a magenta label that is pasted over the bottle and cap, in order to prevent unnecessary opening of the product before purchase. The sunflower oil label is in high contrast, i.e. dark brown background with white text information. Nunito Regular was chosen for the letters in sizes 12 - 56 pt. The font size of the text information depends on the importance of the information to users. Textual information such as nutritional values (carbohydrates, sugars, fibres, proteins and salt) are presented through a single

Figure 5. Conceptual solution for the food product packaging - milk

Figure 6. Conceptual solution for food product packaging - sunflower oil

value, thus simplifying the description and shortening a large amount of text. Nunito Bold was used for textual information that should be highlighted. The label design contains a simple line illustration of a sunflower in a light shade of brown (Figure 6.).

5.4. Coffee - packaging design solution

Cardboard was chosen as a packaging material and it is opened/closed by pulling out or removing the lid of the packaging. It has a cylindrical shape, which makes it easier to hold, and the roughness of the surface reduces the possibility of it slipping out of the hand. The side surface of the lid is without textual and pictorial information. The top of the lid is burgundy to make it more noticeable in the home, and the date of use is printed on it in white letters/ numbers. The coffee label is in marked contrast with the burgundy background and the white text. Nunito Regular was used, in sizes 12 - 60 pt, depending on the importance of the information. Uppercase letters were used for textual information on how to store and preserve the product, and the Nunito Bold typeface was used for highlights. The label design

Figure 7. Conceptual solution for food product packaging - coffee

contains a linear silhouette of a cup with a coffee bean symbol in a light shade of brown (Figure 7.)

5.5. Pasta - packaging design solution

Cardboard was used for the packaging material. The outer shell of the packaging is in marked contrast, a dark brown background with white text information. Between the two colors; brown and magenta, there is a yellow flap that is wrapped around the entire packaging and by removing it, the packaging opens (perforated flap). The part of the sheath that magenta colored, is the lid of the packaging. Using two colors, the "head" (magenta) and "body" (brown) of the packaging are highlighted. The sides are in dark brown and contain the date of use for the product. Nunito Regular was used for the text information, in sizes 13 - 37 pt, depending on the information hierarchy, and Nunito Bold was used for the highlighted information. The label design contains a simple line illustration of pasta in yellow (Figure 8.).

5.6. Design guidelines for food product packaging adapted for the visually impaired

In the design of food product packaging, foodstuffs in liquid, solid and powder conditions are included. Depending on their structure and product protection, different packaging materials such as paper, cardboard and plastic should be used. The lids should be in a different color than the packaging itself, in order to stand out and be more noticeable. The packaging for oil and milk should be made of colored plastic material in order to be easily recognizable and noticeable in the space, and transparent plastic packaging should be avoided.

The text information should be printed in larger font sizes on cylindrical packaging (milk, oil, coffee) to facilitate legibility, while on a flat surface (i.e. pasta) it can be in smaller sizes. The packaging design should be minimalistic with the important information about the product highlighted.

Design unification of the food product packaging for the visually impaired is shown in Figure 9. The visual identity is mostly based on the perceptibility and legibility of the textual content in the negative (on a contrasting background) with an illustration of the product positioned in the lower part of the packaging. The entire content on the cylindrical packaging is centrally positioned for easier visibility, while on the flat packaging it is positioned on the left side to provide space for product display.

The logo indicates the target group for these products, which are visually impaired people. The position of the logo is placed above the name of the product, highlighted by its position and size, in order to provide good visibility and recognition to the target group [16].

Figure 8. Conceptual solution for food product packaging - pasta

Figure 9. Packaging of food products adapted for visually impaired people

6. CONCLUSION

Most of the product packaging is visually and ergonomically unsuited for visually impaired people, which makes it difficult to use the products and read the information on them, especially for the elderly. Previous research on this issue has proposed guidelines for increasing the readability of information, and adapting the packaging design methodology to the visually impaired and elderly. In order to contribute to the mentioned problem, the focus of this study was on the packaging design for food products. According to our guidelines for the visual and ergonomic adaptation of packaging design for the visually impaired and elderly, designers and marketers should use simplified product description, omit redundant information, create a minimalist design with simplified illustrations, design a colored packaging which is easy to open/ close without the use of additional aids. Additional guidelines based on the results of this study suggest the use of light textual information on a dark background (the contrast between text and background should have at least 80% difference in color brightness).

The proposed guidelines can assist packaging designers in adjusting their packaging designs for the visually impaired population of product users. However, the causes of low vision are various and affect the users' perception differently. Several limitations of the current study and possibilities for future research can be taken into consideration. Firstly, more focus on individual diagnoses of visual impairment and the adaptation of packaging design related to the most common causes of visual impairment is needed. Secondly, future studies should include a larger number of respondents to obtain alternative recommendations for different deficiencies.

By making the community aware of the problems faced by the visually impaired, blind and elderly, and by increasing empathy towards their needs, we support their independence and protect this population of our social community to which we will all belong at some point in our own lives.

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