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The Influence of Age and Color on E-Commerce: Issues for Seniors and the Visually Impaired

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Abstract: Global e-commerce sales have experienced significant growth over the past five years. Although online shopping is often thought to be reserved for younger consumers, statistics show that older consumers are increasingly purchasing large quantities via e-commerce. However, visual impairment affects the ability to use online shopping, and aging is often accompanied by various types of impairments. Visual differentiation, such as compliance with color standards, is beneficial for certain product categories by helping people with vision problems. Thus, this research work aligns with a netnography study to determine how consumers with declining or limited vision can access e-commerce product information. Then, to determine whether age moderates the effect of color on information retention when using an e-commerce website. The results of this research allowed us to propose a conceptual model synthesizing the factors to consider for seniors and the visually impaired on an e-commerce website.

Keywords: E-commerce; Seniors; Perceptual deficit; Contrast; Netnography.

I. INTRODUCTION

Internet use and higher levels of internet purchasing by the middle-aged population suggest that older consumers will increasingly purchase large quantities via e-commerce [4].

However, visual impairment affects the ability to use online shopping, and aging is often accompanied by various types of impairments [10]; [11]. It is estimated that 95% of e-commerce websites are inaccessible to people with visual impairments [26]. Therefore, some users may choose not to use e-commerce because the navigation process may be too arduous or a promotional offer may be too difficult to view [20]. These difficulties may also affect those who attempt to purchase but leave an e-commerce site before completing a transaction. Visual differentiation is beneficial for some product categories, helping people with vision problems, such as compliance with color standards [19].

Following the reasoning outlined by [24] and [25], we believe that the use of color can also benefit online product sales. The use of color may be essential for the expansion of e-commerce if its strategic positioning can improve the customer interface for people with visual difficulties. It has also been suggested that color can affect memory. Thus, this research aims to determine how consumers with declining or limited vision can access e-commerce product information. Then, to determine whether age moderates the effect of color on information retention when using an e-commerce website.

II. LITERATURE REVIEW

A. Seniors in e-commerce

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E-commerce is defined as the exchange of goods and services between usually independent organizations and/or individuals, supported by the comprehensive use of powerful information and communication technology (ICT) systems and a globally standardized network infrastructure [31]. Seniors are driving the growth of e-commerce. According to the Federation of E-commerce and Distance Selling [33], online sales increased by 14%, or €12.1 billion. While e-commerce growth is slower, it remains promising for businesses, from mass retail to fashion, cultural goods, high-tech, and travel, which generate a growing share of their revenue. Giants like Amazon and C-discount continue to dominate the top e-commerce sites in France. However, many smaller players, or those from traditional retail, are launching online every day [28].

According to Nielsen [34], "Tomorrow's most powerful consumers are those who lean much higher towards digital purchases. As the population ages, more and more consumers will be connected and online visibility will continue to grow. Building trust from the start is the basis for maintaining lifelong loyalty among buyers." New customers are getting involved, especially among seniors, or "Silver Surfers," as web professionals gallantly call them. "One might have feared that the increase in purchases among those aged 65 and over would be affected by the crisis," he explains. "This has not been the case. On the contrary, there have been many of them, which makes this age group a good source of growth" [35]. The number of online buyers over 65 increased by 27% in the first quarter. CSPs and 25-49 year-olds remain in the majority, but the number of over-50s shopping online has grown twice as fast over the past four years as that of online shoppers of all ages. Online shopping behavior is changing. The average basket per transaction reached a historically low level in the first quarter, at €85, down 4% year-on-year. This decline is not necessarily a reflection of consumer tensions [28].

Distance selling has also pushed seniors to e-commerce; they appreciate distance selling. Distance selling among this age group has grown significantly because it compensates for the absence of a portion of local distribution channels, which has exploded, particularly in terms of loyalty and reliability. They appreciate the ability to plan their purchases, and selecting them from a varied assortment of products and services offers practical advantages. A former international director of Damart established five broad categories of catalogs that target the over-50s, either exclusively, primarily, or among other segments [28]. "Problem/solution" catalogs, designed to make life easier for older people and solve problems related to age-related disabilities: incontinence, loss of visual or hearing acuity, etc.

In the case of older people residing in long-term care facilities, a study highlighted a series of obstacles to continued Internet use: physical and cognitive factors; individual differences; hardware and software problems; scheduling conflicts; and uncomfortable computer lab conditions [22]. Indeed, the phenomenon of cognitive aging explains the causes of the deficits that older people encounter with advancing age, which often prevent them from using e-commerce sites that do not take into account the visual deficits of this age group, such as in the use of colors and/or input characters.

B. Cognitive Aging: Perceptual Deficits in Older Adults

According to Fontaine, cognitive aging is: "a differential process (very variable from one individual to another) which is based on both objective data (physical deterioration, downward trend in perceptive and memory performance, etc.). But also subjective data which are in fact the representation that the person has of their own aging" [11]. A general deterioration of the main functions of the human body: "On a physiological level, the evolution of cells results in a degeneration of tissues which causes a deterioration of the different bodily systems (muscular, nervous, cardiovascular, etc.). This results in a reduction in the body's ability to adapt to the various

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demands of the environment (living conditions, accidents) and, consequently, an increased vulnerability to illness" [12]. Indeed, seniors have great difficulty navigating the Web and rely on search engines to guide them [14]. They represent the age group most affected by the problems of advancing age, they experience difficulties in perception due to sensory losses, particularly visual. This can complicate the task of older people in using e-commerce. Marketing stimuli often appeal to visual performance, particularly visual acuity and contrast perception, which are subject to an age effect:

- ✓ Visual acuity: The visual acuity of seniors deteriorates progressively with age, as highlighted by the longitudinal study of [27] and [5]. Thus, at 75 years of age, only 40% of individuals retain perfect vision in both eyes, compared to approximately 60% at 65 years of age and 90% at 25 years of age (estimates from the American Department of Health cited in [11]).

  - Near visual acuity: corresponds to the ability to discern the details and contours of objects located close to the observer, begins to decline around the age of 50 but remains normal until the age of 70. Beyond the age of 70, visual impairment becomes felt in daily life as a real problem after the age of 80 [2]; [5].

  - Distance visual acuity: also seems to decrease with age. It begins to decrease gradually around the age of 30, accelerating around the age of 70. As a result, people under the age of 70 retain perfectly normal distance vision. Beyond this age, this threshold, elderly people experience difficulty discerning, depending on their size, typographic characters on packaging or printed advertisements, and the visual deficit in distant situations becomes slightly felt at the age of 80 [32].

Wearing glasses can restore normal visual acuity for individuals. However, according to Stults, individuals wearing glasses or contact lenses do not receive sufficient vision correction. This means that older people, even with visual aids, experience some difficulty performing certain activities such as reading [30].

- ✓ The perception of contrasts : Cross-sectional and longitudinal studies show that older people have significantly more difficulty than younger people in perceiving contrasts [23]; [13]. Contrasts allow readers to distinguish letters from the background of the page. Poor contrast perception impairs reading speed and attention paid to a message. This factor is very important and must be taken into consideration by marketing agents when transmitting information to older people. This category has more difficulty perceiving contrasts and risks becoming tired and taking longer to better understand. This decline phenomenon is particularly accentuated in the case of low-contrast, colorful, and high spatial frequency elements (fine details) [8]; [6]; [9]. The level of contrast perception is maintained until approximately 65 years of age, then becomes much more noticeable beyond this pivotal age [13].

C. Color perception by seniors

- ✓ Blue light from screens

Perceptual deficits caused by aging are relative; not all seniors are affected by these deficits. But even those with perfect vision are exposed to the side effects of blue light from screens when shopping online. The adverse health effects of blue light emitted by our laptops, mobile devices, and other digital screens are well known. Tech's favorite color inhibits the body's production of melatonin and prevents us from sleeping, interrupting our sleep cycles. In addition to causing severe eye strain, it also increases the risk of obesity and certain types of cancer, which may explain the recent popularity of glasses designed solely to filter blue light [36].

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The toxicity generated by blue light on the retina is universal. It can kill any type of cell. New findings could lead to the development of a preventative remedy, such as eye drops. In the meantime, he echoes previous suggestions to try UV- and blue-filtering glasses and to reduce screen time in the evening. Indeed, computers are the widely preferred device for browsing and shopping online, with mobile phones coming in second place for respondents in the Middle East/Africa and gaining importance in Asia-Pacific and Latin America. In developing markets, mobile is often the primary device for accessing the internet. Tablets, which have become increasingly popular since the introduction of Apple's iPad in 2010, are used by nearly a third (31%) of global respondents for online shopping. While tablets are currently less popular than other devices for online shopping, their portability and large-screen capabilities are conducive to e-commerce. As the penetration of these devices continues to grow, so too does their use for online shopping. [37].

✓ Color and Contrast: Hue, Lightness and Saturation

Partial vision, aging, and congenital color deficiencies all cause perceptual changes that reduce the visual effectiveness of certain color combinations. Two colors that contrast strongly to a person with normal vision may be much less distinct to a person with a visual impairment. Lighter colors should be made and darker colors should be made to increase the visual accessibility of the design. Dark colors with hues from the lower half of the circle versus light colors from the upper half of the circle should be avoided [38]:

- Contrast the light colors in the lower half with the dark colors in the upper half.
- Contrast the hues of adjacent parts of the hue circle, especially if the colors do not contrast sharply in brightness.

For most people with partial vision and/or congenital color defects, the brightness values of colors in the lower half of the hue circle tend to be reduced. Color defects associated with partial vision and congenital defects make it difficult to distinguish between colors of similar hue.

Indeed, hue, lightness, and saturation are the three perceptual attributes of color; they can be thought of as a solid. Hue varies around the solid, while lightness varies from top to bottom, and saturation corresponds to distance from the center. Hue is the perceptual attribute associated with elementary color names. Hue allows us to identify basic colors, such as blue, green, yellow, red, and violet. People with normal color vision report that hues follow a natural sequence based on their similarity. With most color deficiencies, the ability to discriminate colors based on hue is impaired. 6 Thus, lightness is the amount of light that appears to be reflected from a surface relative to neighboring surfaces. Lightness, like hue, is a perceptual attribute that cannot be calculated from physical measurements alone. It is the most important attribute for making contrast more effective. With color deficiencies, the ability to discriminate colors based on lightness is reduced.

Saturation is the degree of color intensity associated with how differently a color is perceived compared to white, black, or gray of the same brightness. Slate blue is an example of an unsaturated color because it resembles gray. A deep blue, even if it has the same lightness as a slate blue, has a higher saturation. Congenital and acquired color deficiencies generally make it difficult to distinguish between colors based on saturation. For a person with color-deficient partial vision, the panel on the left may look similar to the panel on the right for a person with normal color vision. With color deficiencies, the ability to discriminate colors based on all three attributes (hue, lightness, and saturation) is reduced. Designers can help compensate for these deficits by making colors differ more dramatically in all three attributes.

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E-commerce marketers must take into account these specific forms and the perception deficits generated by aging. Indeed, according to a recent analysis of e-commerce data by Internet Retailer and historical data from the U.S. Department of Commerce, online consumers spent $517.36 billion with U.S. merchants in 2018. This figure is up 15.0% from $449.88 billion spent in 2017. This is a slight slowdown from 2017, when online sales increased by 15.6% year over year.

III. RESEARCH METHODOLOGY

The research problem of this study is two-dimensional, we are interested in discovering the relationship between age and color in e-commerce. For this study, we used a case study approach of netnography. The term was coined by [16] as an ethnographic adaptation in the contemporary digital world. In order to designate the contingencies of online communities and cultures that use digital marketing research techniques to provide useful information. Indeed, netnography is a qualitative survey method that uses the Internet as a data source by relying on virtual communities. It analyzes the communication acts of these communities, seeking to give them meaning. According to [18], netnography is ideal for researching phenomena of the digital world, having a digital aspect such is the case of this study which tends to explore the traditional notions of nethnography through the observation of technologically mediated interactions within networks and digital platforms. In this research, the case study with nethnography is most appropriate, as few subjects met our objective of exploring the perception of images and posters in e-commerce by older adults and the visually impaired. Therefore, this study is structured around a thematic content analysis, carried out using a qualitative research method. It attempts to present a semantic analysis of comments on posters of different colors and formats from e-commerce sites using Nvivo 11 software. We published these posters on a Facebook group of older adults of different nationalities, consisting of more than 3,150 members. This sample was exposed to these posters, viewed, and analyzed using the analytical model of [1], with specific reference to the linguistic message, the uncoded iconic message, and the coded iconic message.

To constitute the corpus for this study, we selected three posters. Each one comes from an online platform in e-commerce but differs in terms of colors and volume of information. However, the published posters are in French, and to collect the maximum amount of information in comments we animated them with a description to explain the context of this publication, while commenting above the poster "which one do you choose and why". Indeed, we will base ourselves on the criteria prescribed by [17]: high level of social interactions (comments, views and links) and rich self-presentation data (especially visual material such as images, logos and drawings).

IV. RESULTS

The aim of this research is to determine how consumers with declining or limited vision can access information about e-commerce products. Then, to determine whether age moderates the effect of color on information retention when using an e-commerce website. Website posters posted in a Facebook group for older adults generated 525 comments. These comments represent the corpus that was analyzed using Nvivo 11 software. This analysis revealed perspectives that revolve around color and the volume of information.

A. The Effect of Color on Seniors in E-Commerce

The website's poster, which featured darker colors, was less appreciated by the older members of this group. According to these people, the colors were poorly chosen and inharmonious:

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“Why put these colors?”; “If it was on a simple white background, it would be better”; “Should I focus on the colors or on what is written in these colors.”

These people suggested lighter colors compared to those used in the chosen website poster. Therefore, it is important to exaggerate the brightness differences between foreground and background colors and avoid using adjacent colors of similar brightness, even if they differ in saturation or hue. The perceived lightness will be the same as the lightness perceived by people with color deficiencies. They will see less contrast between colors than those with normal vision. For example, if we lighten light colors and dark colors, we will increase the visual accessibility of our design.

In fact, we should choose dark colors with hues in the lower half of the hue circle versus light colors in the upper half of the circle. Therefore, avoid contrasting light colors in the lower half with dark colors in the upper half (Arditi, 2002). For most people with partial vision impairment and/or congenital color blindness, the brightness values of colors in the lower half of the hue circle tend to be reduced. For this reason, it is necessary to avoid contrasting hues from adjacent parts of the hue circle, especially if the colors do not contrast strongly in terms of brightness (Arditi, 2002). Color deficiencies associated with partial vision and congenital deficiencies make it difficult to distinguish between colors of similar hue. This refers to what we have developed in terms of hue, lightness and saturation, these are the three perceptual attributes of color, and which can be considered as a solid [24]; [25]. The use of color is essential in e-commerce platforms to the extent that good strategic positioning is achieved, which can improve the customer interface for people with visual difficulties.

B. The Information Volume Effect for Seniors in E-Commerce

The poster that contained more information than the others was not appreciated by the seniors in the group. We found comments such as: "*There is a lot of information, which makes it difficult for me to read"; "I don't want to read too much so as not to tire my eyes"; "It would be more interesting in brief and with images."*

This age group does not appreciate a high volume of information, as this affects their ability to perceive and pay attention. Indeed, without conscious or unconscious perception, and the lower the level of attention, the individual can neither process nor understand the information, and subsequently, they are not convinced by the importance or usefulness of the product. [29] explains this behavior as a consequence of a reduced working memory, which makes it difficult for them to process multiple data and information. More specifically, in the real estate and automotive sectors, these results were drawn from studies conducted by [15]; [3]. Recent findings from [7] show that as people age, they seek fewer options and tend to consider familiar options during decision-making processes, providing opportunities for referrals. This indicates that consumers may consider fewer options in order to limit information due to declining cognitive abilities. The findings suggest the possibility that a decline in cognitive memory may lead to the tendency to consider familiar options, which leads to repeatedly visiting only a few restaurants. It is evident that older consumers are more likely to rely on heuristics to make a decision without intensive research or evaluation [7]. The poster that received unanimous consent from the members of the senior Facebook group was the one with more light colors and less information. This confirms that older consumers or seniors with declining or limited vision do not appreciate large amounts of information. Obviously, age moderates the effect of color on information retention when using an e-commerce website.

The results of this research, corroborated with findings from the literature, led us to conclude this conceptual proposition, summarized in the following figure:

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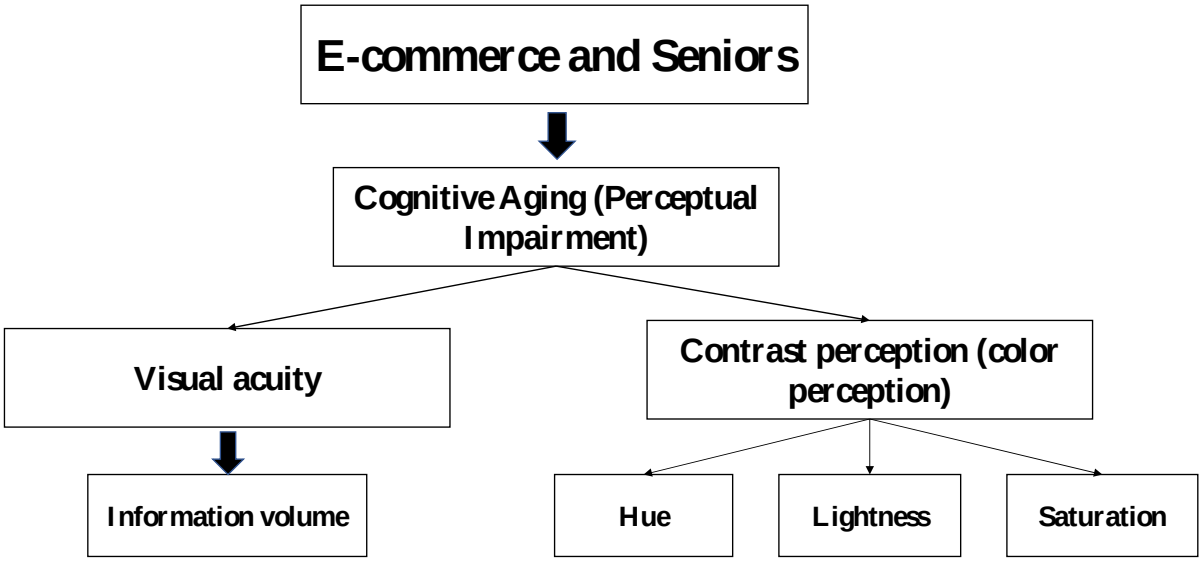

Fig. 1 Factors influencing Seniors and visually impaired in e-commerce

Indeed, this model shows the factors to be taken into account for seniors or the visually impaired in e-commerce. Cognitive aging is the main trigger for deficits, particularly in perception, which has an effect on visual acuity, which has an effect on the volume of information and the perception of contrasts. This perception affects hue, lightness, and saturation, which are the three attributes of color perception.

V. CONCLUSION

E-commerce continues to attract more and more consumers, including seniors, who have turned to this type of commerce in recent years for ease of access and choice. Indeed, this population can encounter difficulties in perceiving the posters and information published on online platforms, which prevents them from completing the purchasing process. Thus, these companies may miss out on this consumer if they do not consider the factors that can impair the perception of seniors and/or the visually impaired. Our use of literature allowed us to develop the causes of these deficits and how to overcome them. Seniors may experience deficits due to cognitive aging in terms of perception, including visual acuity and the perception of contrasts and colors. Two colors that contrast strongly with a person with normal vision may be much less distinct for a person with a visual impairment. Therefore, light colors should be brightened and dark colors darkened to increase the visual accessibility of the design. In order to synthesize everything we have developed in the literature and what we have learned from our study, a proposal has emerged through a conceptual model in Figure 1. This model links the factors to be taken into account in e-commerce for seniors and the visually impaired. Cognitive aging is the main trigger for deficits, particularly in perception, having an effect on visual acuity, which has an effect on the volume of information and the perception of contrasts. This perception affects hue, lightness and saturation, which are the three attributes of

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color perception. The size of this population is quite significant given its potential in terms of demographic and economic weight, which deserves more attention from marketing agents working in the field of e-commerce. More particularly in the choice of colors and information in this type of commerce [21].

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