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Effects of Visual Complexity of Banner Ads on Website Users' Perceptions

Nejc Bočaj and Jure Ahtik *

Faculty of Natural Sciences and Engineering, University of Ljubljana, 1000 Ljubljana, Slovenia; nejc.bocaj@gmail.com
* Correspondence: jure.ahtik@ntf.uni-lj.si; Tel.: +386-1-20-03-286

Abstract: Design plays a major role in online advertising. While specific aspects such as color or animation have been extensively studied, there is a surprising lack of comprehensive research on the overall impact of visual design and aesthetics. This study delved into the effects of varying levels of visual complexity in banner ads using the eye-tracking method. Out of 108 participants browsing test webpages with specially designed banners, data from 90 adequately measured data sets were used in the study. Notably, ads with a low level of visual complexity outperformed ads with a high level of visual complexity. While users noticed complex ads slightly faster (by 0.84%), they fixated on them significantly less (by 9.09%) and looked at them less frequently (by 4.79%). An implemented survey questionnaire examining the user perception of the banners reinforced the superiority of simple ads, as they were perceived as 4.40% more appealing in comparison. The study further delved into the correlation between objectively and subjectively evaluated data, exploring the credibility of subjective methods in the process. Considering our results and findings from other studies, it was evident that visually complex ads demanded more cognitive effort, could be more distracting, negatively impacted attention, could contribute to banner blindness and were perceived as less appealing.

Keywords: visual complexity; online advertising; banner ads; user perception; eye tracking; design impact; subjective vs. objective correlation; data evaluation

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1. Introduction

With online advertising space being increasingly saturated, advertisers strive to find out what characteristics make ads more effective. One of the important factors is the design of the ads. Surprisingly, the effect of holistic visual design and aesthetics is not well researched. Researchers have mostly focused on understanding specific components of ads, such as ad shape [1], animation [2], visual images [3], text size [4], color [5], typeface figuration [6], etc., but not on the visual design of the ads in general. In ideal conditions, the impact of each individual component can be predicted, but this does not guarantee that the ad achieves the desired effect in a real environment. In fact, the success of a piece of advertisement depends on many dependent factors that need to be harmonically coordinated with one another [7].

The impact of design and visual aesthetics on the consumer is becoming an increasingly important factor for market competitiveness in advertisement [8]. To achieve an aesthetically appealing ad, designers can opt for a visually simple or complex design. While visual complexity (VC) is relatively clearly defined for websites [9,10], the interpretations of what VC stands for in advertisement are not uniform [11]. There are different approaches to defining VC, some are based on subjective and some on objective methods of research. Objective methods are computational methods used for the quantification of VC. They are considered to be the most reliable and unbiased, but are inherently flawed since they are unable to take into account various human factors. Computers see images as binary representations of visual information, while humans subjectively look at and

evaluate them [12]. People have different opinions, we react to stimuli and information in different ways and we can be influenced by several noncomputable factors, such as familiarity with the subject [13]. Consequently, in research that studies the impact of aesthetics or design creativity, objective methods are usually used only as a secondary indicator or for comparison with the main research method of defining VC. Due to our study focusing on the effects of design complexity and visual aesthetics, we selected a subjective method to define VC. The best-defined and structured method for the subjective determination of VC was provided by Pieters et al. [14]. Based on their analysis of 249 advertisements in consumer magazines that were tested with eye-tracking, they identified six general principles that determined design complexity: quantity of objects, irregularity of objects, dissimilarity of objects, detail of objects, asymmetry of object arrangement and irregularity of object arrangement. As Pieters et al. [14] stated, it is possible to obtain an overall index of design complexity by summing the six principles, since each principle independently raises complexity. It is important to note that VC is not to be confused with the comprehensibility of ads, as the visual design can be simple or complex regardless of the advertising message's comprehensibility.

After we understand what VC is, we can examine its effect in advertising. There has been a long ongoing debate about whether it is better to use a visually simple or complex design. Opinions and research results are mixed [11]. It is impossible to look into all the existing research referring to the usage of various levels of design complexity, because this is a very active, dynamic and, due to constant improvements in technology, an always current topic. As a result, a lot of research is being conducted in the field of advertising, which is yielding new results and can sometimes undermine some beliefs or even completely refute the findings of past studies. Nevertheless, we listed some prevailing opinions. On the one hand, visually simple ads should perform better because they require less cognitive effort to process them [15], have a better impact on consumers' attention [16], achieve better clickthrough rates [17] and have a bigger impact on raising brand awareness [18]. On the other hand, visually complex ads should perform better because people look at them longer [19], they have a greater perceived emotional value [18] and are more user friendly [14]. After reviewing the existing literature, it is apparent that there is no clear common opinion on the impact of VC of ads on consumer perception. We were even able to observe completely contradictory research findings. The impact of VC is, thus, a gray area, which, in our opinion, is due to two major factors. The first factor that proves to be a problem in researching the effect of VC on consumer perception is that there is no standardized definition and research method. To a certain extent, researchers themselves regulate how and which aspect of VC they study. The second factor is the fact that the field of VC is highly exposed to the subjectivity of individuals. Psychological factors specific to individual users arise from their preferences, interests and needs [20]. They have different personalities and numerous opinions, both on a conscious and subconscious level. Certain factors that greatly affect the objectivity of results in VC research are extremely difficult to isolate and mitigate, let alone eliminate completely.

Due to these and many other reasons, in one way or another, a large proportion of researchers in the field of advertising utilize eye tracking as the main method to obtain results. It is a very resilient and flexible method for gathering objectively quantified data, regardless of the obstacles it may face. One of the biggest problems in online advertising and web browsing in general is the lack of visual attention. Users are often overwhelmed with too much information and the presence of advertisements only exacerbates the issue. Therefore, understanding consumer behavior and observing what they devote the most attention to while browsing websites is crucial for examining online advertising effectiveness [21]. Even if a certain ad attracts the consumer's attention while using the internet, it does not yet mean that it persuaded them to invest in a purchase. The individual must mentally process it and decide what their next action may be. However, in the occurrence that the ad on the website goes unnoticed, there is no chance whatsoever that the next action of the user results in a purchase or any other type of action the ad is persuading

the user to take. Consequently, the more attention an ad receives, the higher the chance it achieves its purpose [22].

As we know, eye movements and visual attention are correlated [23], while attention is crucial as a fundamental prerequisite for perception [24]. Eye tracking is of great importance in online advertising because it enables us to carefully examine the viewing priority and the individual's focus on elements on websites. Self-observation, questionnaires, oral research, computational methods and reports are not entirely reliable. Among other factors, advertisements can affect people only on a subconscious level, without having to consciously focus on them and later mentally process them. Even unnoticed ads that users are not aware of or remember can affect the consumer's attitude towards the ad and the brand it represents. Consumers often unknowingly include the advertised product in their selection when determining decisions when shopping, even though they did not consciously focus on the advertisement and its content [25]. Eye tracking can be used to predict user behavior to a certain extent, since we can often determine users' interests and intentions by observing eye movement data [26].

The aim of this study was to research the effects of the visual complexity of banner ads on website users' perceptions. We focused specifically on the impact of design complexity and visual aesthetics on online banner effectiveness. We did not focus on the potential marketing outcome of advertisements (e.g., checking the clickthrough rate and purchasing decisions) and did not address the impact of ads on brand awareness. We hypothesized that website users notice visually complex ads faster, that they look at visually complex ads longer and that visually simple ads are less distracting. First, we reviewed previous research papers in the field of online advertising and the effect of visual complexity. Based on the review, we designed 12 web banners, replicating real-world designs divided into two distinct groups. They were then placed on purposely prepared test websites. The primary and crucial method utilized in the study was eye movement tracking. In addition, we conducted a subjective evaluation through a survey questionnaire employing a semantic differential model to illustrate the subjective perception of users. The goal was not necessarily to prioritize the subjective results, but to establish a comparison between objectively and subjectively evaluated data. The aim was to examine the correlation between the two and determine if subjective methods could be deemed credible when researching the effects of visual complexity in banner ads on the perception of website users.

2. Materials and Methods

2.1. Banner Ad Design

For the purpose of the study, the first step was to design advertisements that differed in the degree of VC. We decided to design static banners in a standard size of 336 × 280 pixels. This ad format is robust and allows for good control over the conditions using the eye-tracking method. Before designing our own, we reviewed existing web banners. Our aim was to create ads that emulated real-life banners, ensuring practicality rather than just theoretical suitability. This led us to include a call-to-action element and brand logo in half of the banners. This was to minimize the impact of these elements, as they were not of direct interest to us in our research. For the same reason, we decided not to include animation, since it would be more difficult to unify and compare the ads. We also avoided depicting prices of products or services. The price is not a design factor, but it usually has a strong influence on consumer decisions, which could potentially have a negative impact on the credibility of the results.

To create the designs for the banners, we first had to define the criteria for determining VC based on design complexity. Through research, we discovered that the best definition of VC for the needs of our study was provided by Pieters et al. [14]. In their study, they identified six general principles of design complexity, as listed in the introduction. Based on these principles we designed six pairs of test banners. Each pair consisted of a visually more complex and a visually simpler banner, as shown in Figure 1. When designing the ads,

we were careful that the ads within a pair were as similar as possible in terms of content and all design criteria, except for the one directly related to one of the six principles.

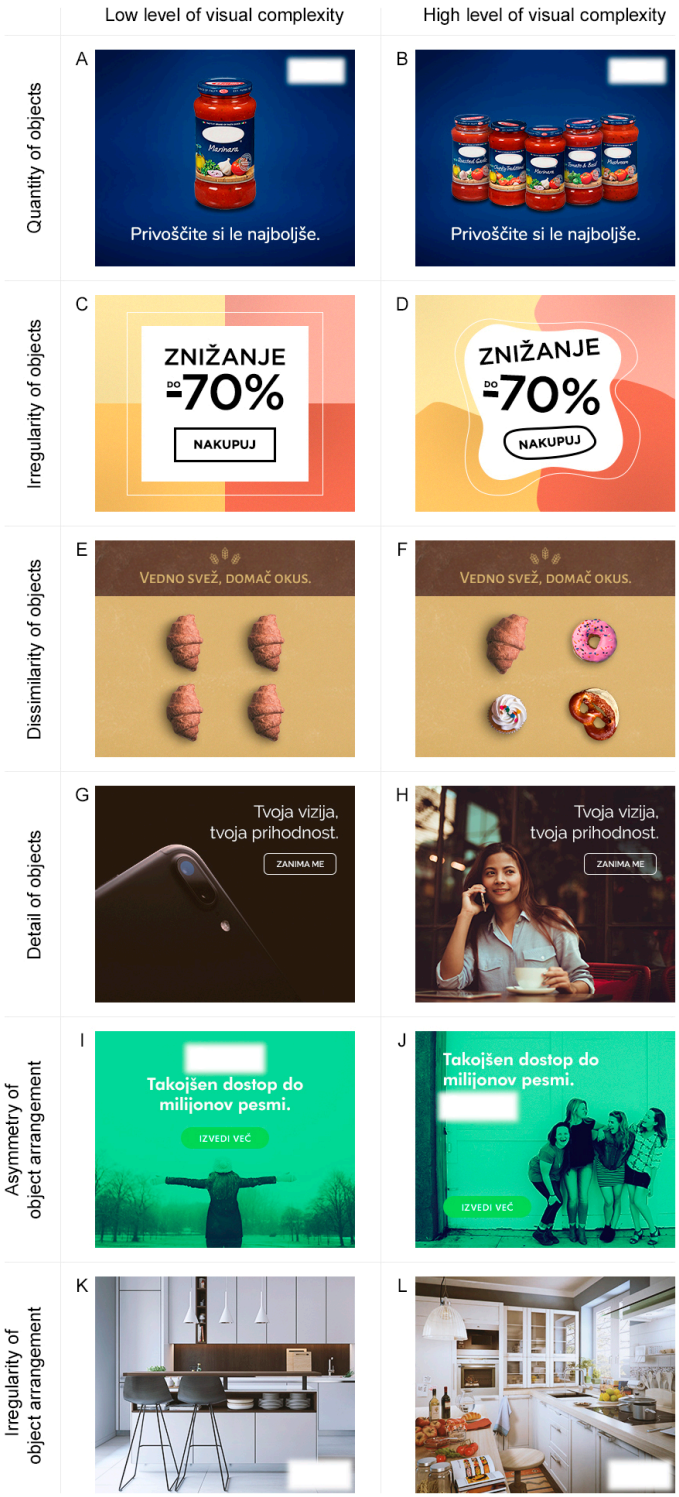

Figure 1. Banner pairs designed based on the six general principles of design complexity and varying between the level of complexity. They were individually labeled with letters (**A**–**L**) to facilitate result interpretation in Section 3. Depicted logos were concealed for the purpose of this publication. The statements on the banners are in Slovenian and serve as mere components of the banner design, intended to emulate real-world banners. They lack any substantial meaning or impact for full comprehension within the context of this article.

2.2. Obtaining Objectively Evaluated Data Using the Eye-Tracking Method

2.2.1. Test Webpage Setup

To be able to measure the effects of the VC of banner ads on website users' perceptions, we had to place the 12 designed banners on webpages. To conduct the experiment, we chose three of the most visited websites in Slovenia at the time, from three different fields of interest: the news site https://www.24ur.com (accessed on 17 March 2022), the web portal and forum https://med.over.net/ (accessed on 17 March 2022) and the online marketplace https://www.bolha.com/ (accessed on 17 March 2022). Three different samples of each website were prepared by taking screen captures of an entire page in a browser. While taking the captures, we used a browser plug-in to block ads, because their presence would affect the perception of the test banners. Using Adobe Photoshop CC, we edited the screen captures and placed the designed test banners in positions within the page where they would normally be located (the position varied depending on the individual content of each page). Each of the 12 web banners was placed on one screen capture for each website for a total of 36 different test pages, with 3 representative examples shown in Figure 2. We placed them in such a way that both ads within a pair were always displayed in the exact same position of the same webpage capture and were, therefore, directly comparable, eliminating the effect of different banner positioning on the website. The preparation of the final test websites with advertisements was time-consuming and complicated, but it enabled us to achieve accurately measurable and comparable conditions that perfectly simulated a real experience of using websites in a web browser.

The test websites were divided into six sets of six pages. In each set, only one ad from each pair was displayed to each individual test participant. This meant that by using a smaller set, we lowered the possibility of respondent fatigue, and that no participant was exposed to both ads based on the same general principle of design complexity, resulting in a higher data quality. The test banner on each test page defined the region of interest. We measured the time to first fixation, total fixation duration and fixation count, as these metrics aligned with previous research works, where the number of fixations and fixation time were most commonly employed to measure visual attention [27].

2.2.2. Procedure

The participants were required to sit down in front of a 24-inch LCD screen at a 60–65 cm viewing distance and instructed to adjust the height of the seat so that their line of sight was perpendicular to the surface of the screen. The Tobii X120 eye tracker was used to record the participants' eye movements. Testing was performed in a dedicated testing room in a neutral gray RAL 7037 color with constant lighting.

Before running the experiment, each participant underwent the calibration and validation procedure. For each trial, the participants were presented with one of the six sets of test webpages. Throughout the process, we distributed them evenly so that we were able to achieve the same number of samples for each ad. The participants were asked to use the browser and scroll through the pages as they normally would (using a mouse and a keyboard). We did not disclose what we were testing until the very end of the test, because it might have affected their browsing behavior. Each of the webpages was displayed for 20 s before automatically switching to the next one.

2.2.3. Participants in Eye-Tracking Testing

In total, 108 volunteers participated in the experiment, the majority of whom were students of the faculty of natural sciences and engineering. In total, 27% of the participants were male and 73% were female aged 18–26 years. All had normal or corrected-to-normal (glasses or lenses) visual acuity. A total of 18 data sets were excluded due to inadequate measurements, leaving us with 90 appropriate data sets.

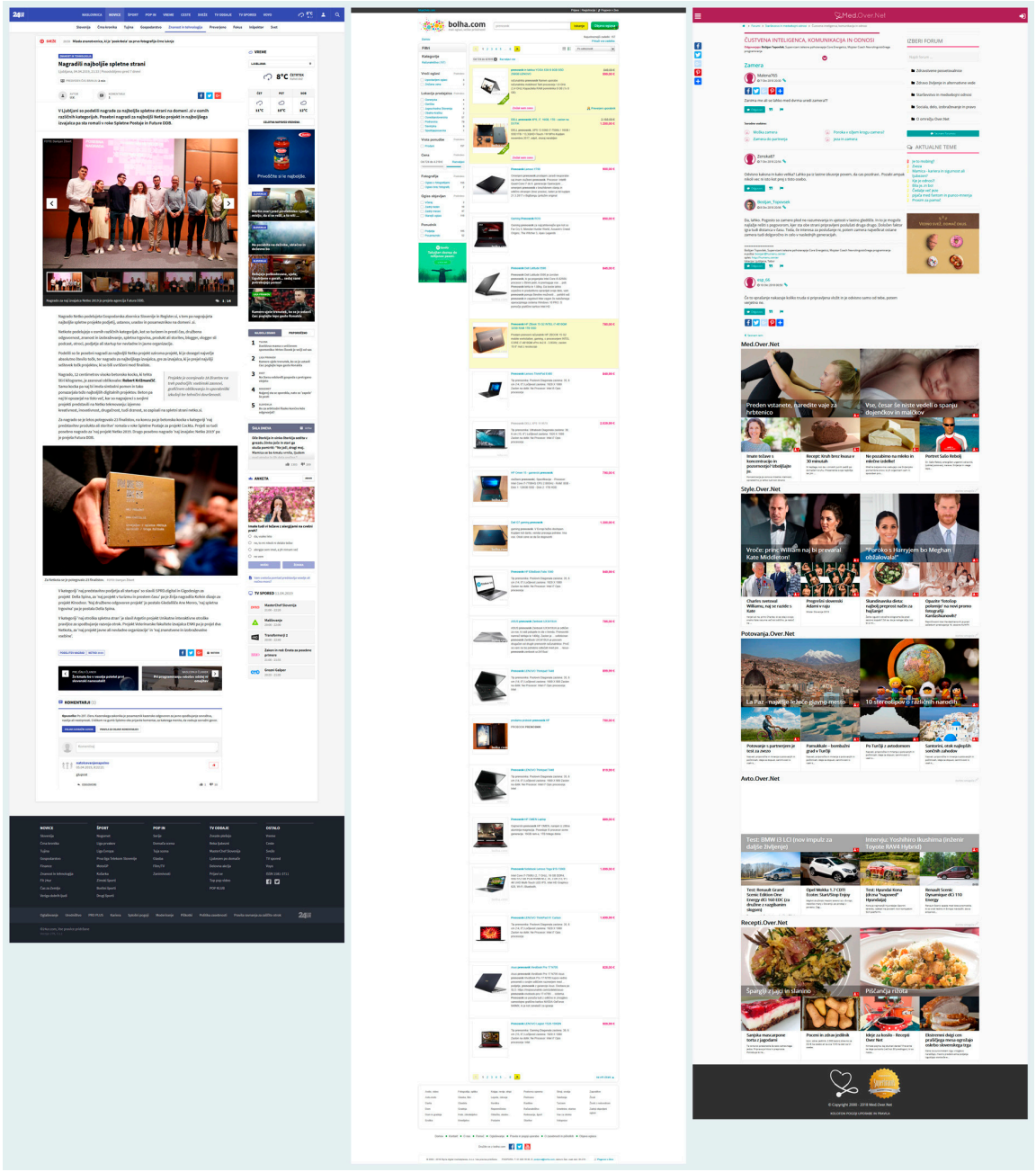

Figure 2. A total of 3 examples from the 36 prepared test webpages, 1 from each source website.

2.3. Obtaining Subjectively Evaluated Data with an Online Survey Questionnaire

2.3.1. Questionnaire Design

The questionnaire was based on the AttrakDiff model developed by Hassenzahl, Burmester and Koller [28]. The model outlines the impact of pragmatic and hedonic qualities on the subjective perception of attractiveness. It allowed us to evaluate how users perceived products (in our case, web banners) using a semantic differential. It is a bipolar rating scale with two opposing adjectives on each pole, where one has a positive while the other a negative connotation (e.g., dull–captivating, ugly–attractive and cheap–premium). A total of 28 pairs of adjectives were included for each tested product. For easier interpretation of results, they were divided into four segments: pragmatic quality, hedonic quality–identity, hedonic quality–stimulation and attractiveness. Due to the semantic differential scale presenting highly contrasting adjectives at either end

of the spectrum, it enabled a more precise and comprehensive expression of opinions than in questionnaires with open-ended question types, Likert scales, etc. Due to the research indicating that humans may not be optimal judges due to various subjective factors highlighted in the introduction, in an effort to further mitigate the impact of these factors, we took an additional step. We modified the model and used a two-point bipolar scale instead of the original seven-point scale. When taking the survey, only the adjective that better described the banner within the pair could be selected, without any gradations or levels between them. This approach compelled users to determine a distinct choice and prevented them from offering neutral or slightly opinionated responses. In our study, where we directly compared two groups of ads, definitive answers contributed more insights. A questionnaire designed in this way, therefore, reduced response bias, allowing us to obtain more valuable data.

2.3.2. Implementation

We chose to conduct the questionnaire online using the 1KA EnKlikAnketa web application, providing a convenient option to reach a large user audience. To prevent respondent fatigue, we limited each participant to rating one web banner. The setup ensured that respondents always had a direct view of the ad in question. The questionnaire was structured to present the twelve ads in a randomized order, guaranteeing a balanced distribution of responses across all of them.

2.3.3. Participants in the Survey Questionnaire

The survey questionnaire was completed by a total of 171 people; however, 64 surveys were inadequately filled out and were, consequently, excluded. This left us with 107 valid responses. On average, the respondents were 25.8 years old, with 34% being male and 66% female.

3. Results

In the following section, we used the phrase "simple ads" to refer to the banners designed with a low level of VC and "complex ads" to refer to the banners designed with a high level of VC, where A, C, E, G, I and K are simple ads and B, D, F, H, J and L are complex ads.

3.1. Eye-Tracking Results

As seen in Figure 3, the difference in the average time to first fixation between simple and complex ads was minor. The average time to first fixation for simple ads was 10.85 s (SD = 3.95) and for complex ads was 10.76 s (SD = 4.44). The t-value between simple and complex ads was 0.61, with a corresponding *p*-value of 0.27. Participants spent an average of 0.84% or 0.09 s more time before the first fixation on websites with simple banners. In terms of visibility, complex ads were more effective, because people noticed them faster while browsing.

When it comes to the averages of the total fixation duration, the variance between simple and complex ads was greater (Figure 4). On average, the total fixation duration for simple ads was 0.84 s (SD = 0.60) and 0.77 s (SD = 0.47) for complex ads. The t-value between simple and complex ads was 0.21, with a corresponding *p*-value of 0.42. In contrast to the results of the average time to first fixation, we saw that even though the absolute difference between the duration was small (0.07 s), the percentage difference was significant. On average, the volunteers fixated on simple ads for 9.09% longer. Since it was better if users looked at ads on websites longer, simple ads had a greater effect according to this parameter.

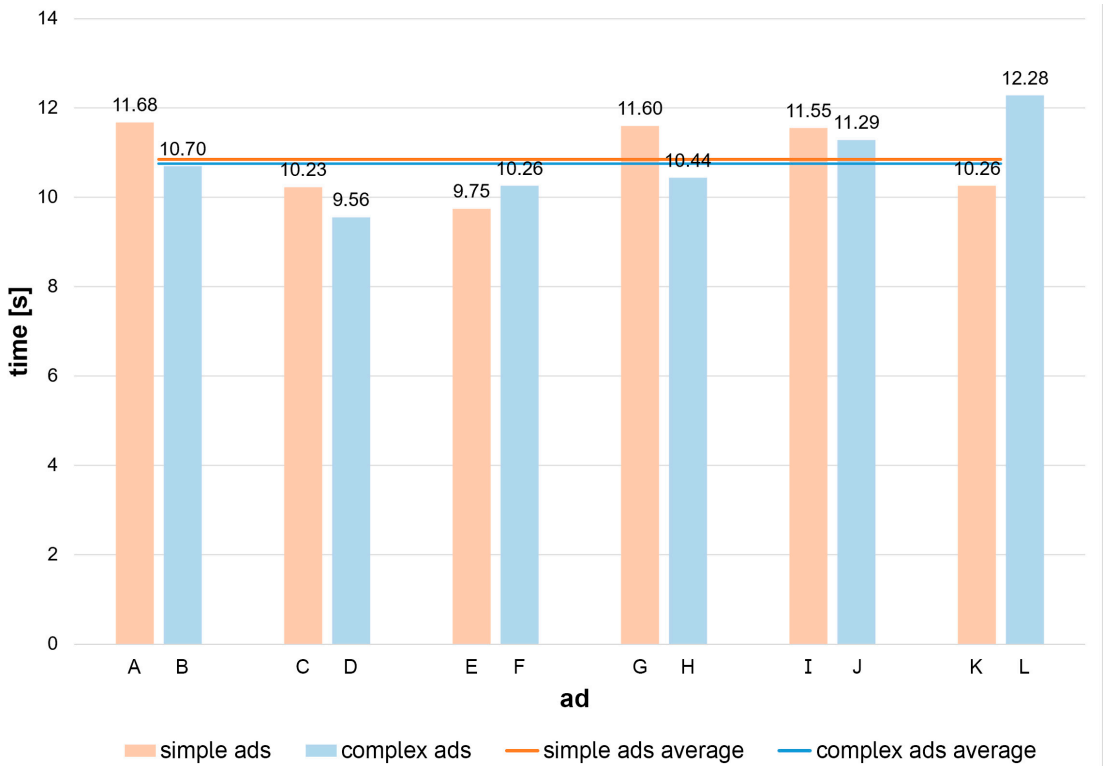

Figure 3. Time to first fixation on the banner ads, including individual values and averages.

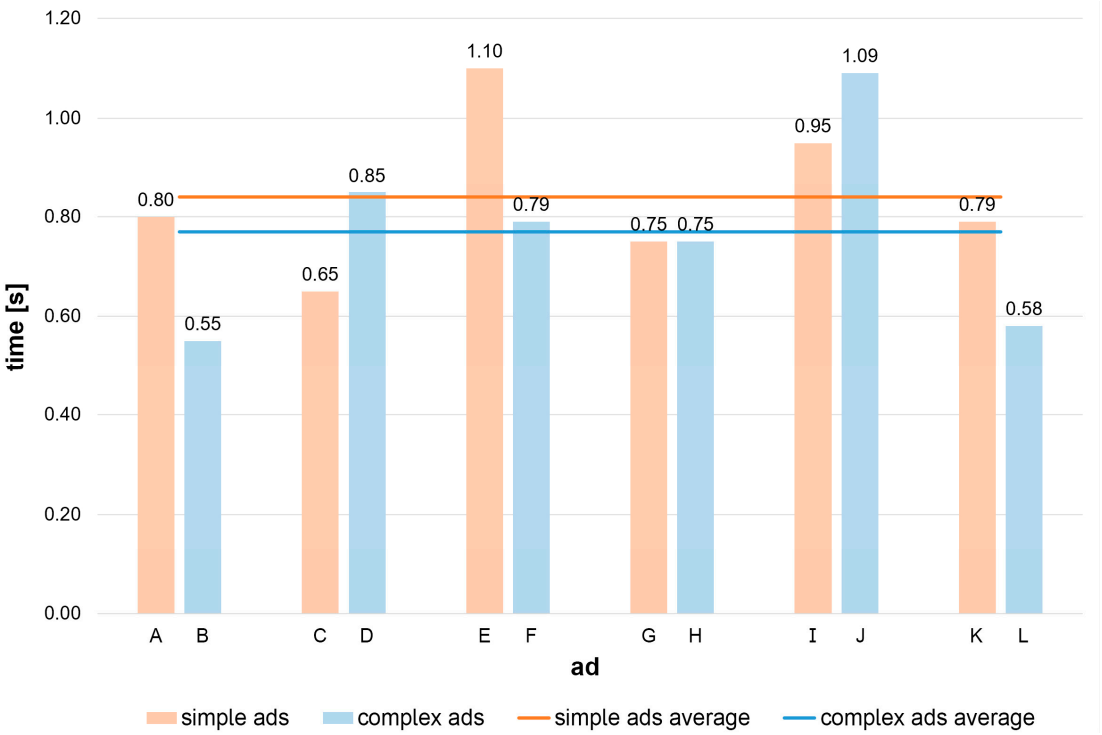

Figure 4. Total fixation duration on the banner ads, including individual values and averages.

Given that the average for the total fixation duration was higher for simple ads, it was not surprising that the average fixation count was also higher. It was compared in Figure 5. On average, the participants fixed their gaze 3.50 times on simple ads (SD = 2.37) and 3.34 times on complex ads (SD = 2.16). The t-value between simple and complex ads was 1.08, with a corresponding *p*-value of 0.15. The percentage difference in this case was slightly smaller, as the fixation count for simple ads was 4.79% higher than for complex ones. A smaller fixation count for complex web banners meant poorer performance.

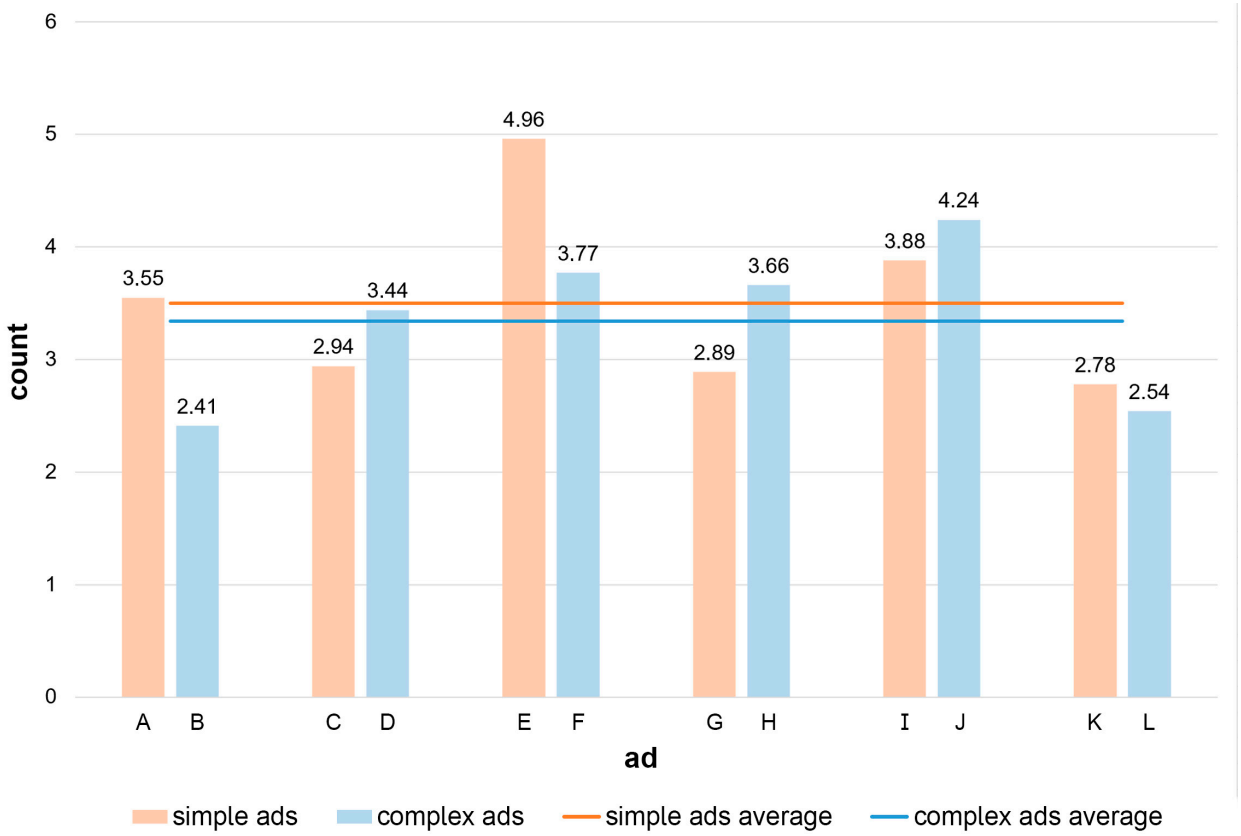

Figure 5. Fixation count on the banner ads, including individual values and averages.

3.2. Survey Questionnaire Results

The questionnaire results indicated that users preferred the simple ads, contrary to our initial expectations. On average, simple ads were considered superior by 4.4%. They also outperformed the complex ads in every single one of the four segments: by 1.8% in pragmatic quality, 4.8% in hedonic quality–identity, 2.7% in hedonic quality–stimulation and an outstanding 8.4% in attractiveness. The model we used enabled us to visualize the data, facilitating a simultaneous comparison of the results for each individual pair of adjectives, for each segment and for the overall contrast between simple and complex adverts. Refer to Figure 6 for a comprehensive breakdown.

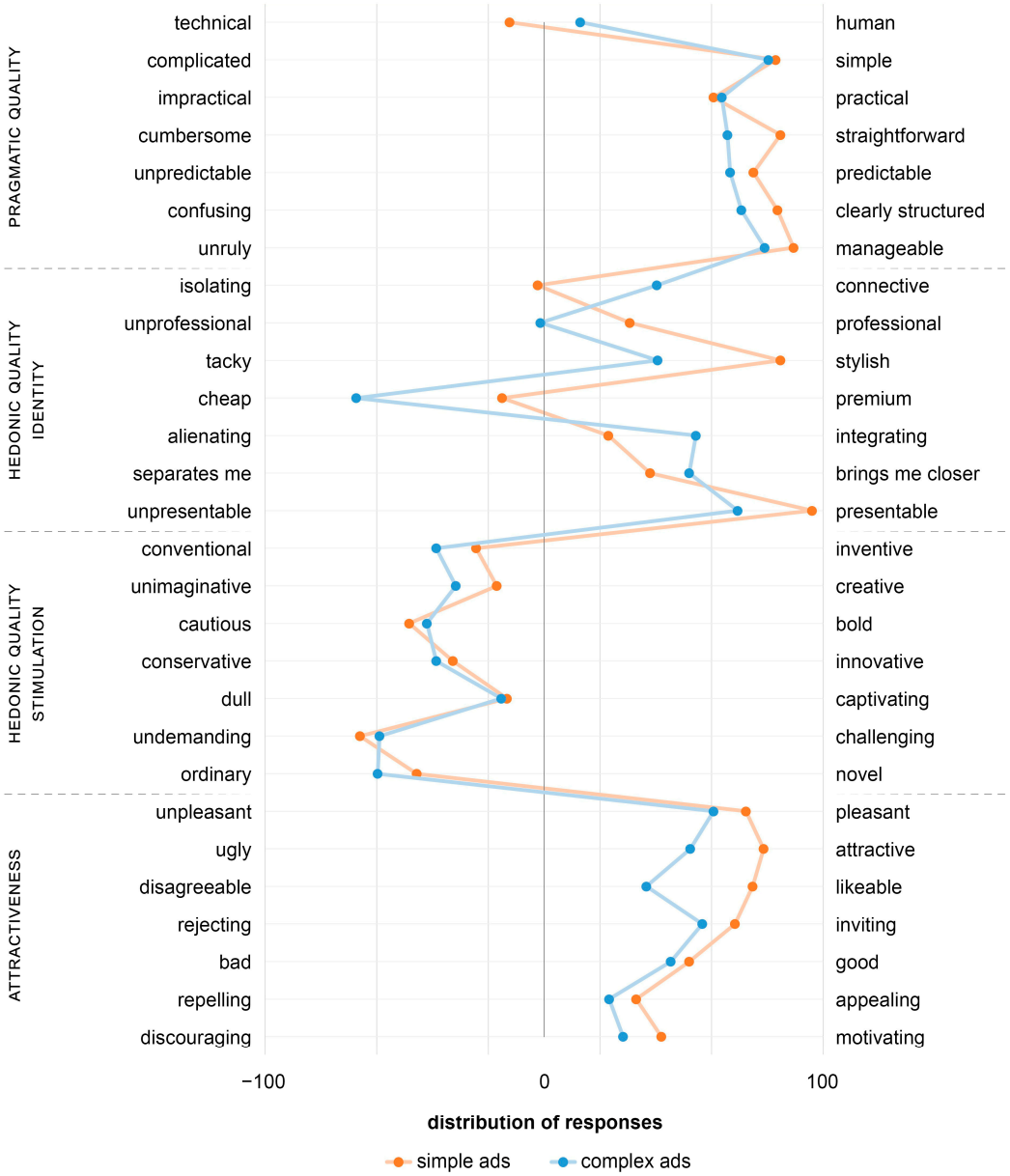

Figure 6. Distribution of responses in the survey questionnaire displayed according to the AttrakDiff model.

4. Discussion

Through performing an analysis of the results as a whole, we discovered that based on the degree of visual complexity of the design, simple ads had a better effect on website users' perceptions. Prior to the experiment, we did not expect that simple ads would outperform the complex ads by such a margin, as they were significantly better in two of the three parameters of the eye-tracking testing and were perceived as more appealing in the survey questionnaire.

While the results regarding the better performance of complex ads when it came to the average time to first fixation did not surprise us, it was relatively surprising that the difference was so minor. We expected users to notice complex ads sooner because they were more saturated in design and stood out more. Elements on the website that stand out more tend to grab a user's attention faster. As Lee and Ahn [22] also argued, the visual attention of users when browsing websites affects the effectiveness of advertisements. One way to grab users' attention slightly faster according to our study was to design the ads

with a higher degree of VC. Converse to the other banner pairs, simple ads outperformed the complex ones only when it came to the principles of the dissimilarity of objects and the irregularity of the object arrangement. This may have been attributed to a more pronounced contrast in the depicted colors and a more organized composition within these two pairs, suggesting that excessive complexity could have had a negative impact.

The longer the total fixation duration on the ad, the greater the possibility of further mental processing and memorization of information on it is. Based on reviewing the existing research works beforehand, we expected users to look at complex banners for longer periods of time, as Morrison and Dainoff [19] discovered in their study. We anticipated that such ads would be more interesting to users and, consequently, they would look at them longer. However, that study was dated and was not performed in a modern environment. Prior to looking at that article, we did not take into consideration a study on the impact of cognitive effort in graphic design conducted by Trogu [15]. Namely, complex ads require more cognitive effort required to process them. Simple ads, on the other hand, require less effort from users and, consequently, they avoid them less. We could, therefore, agree with the research of Bakar et al. [16], who found that simple ads had a better impact on consumer attention. Differing from the remaining banner pairs in our study, complex ads demonstrated better performance to their simpler counterparts in terms of the principles of the irregularity of objects and the asymmetry of the object arrangement. We contended that these two simple banners might have been perceived as excessively mundane and overly precise, potentially failing to capture the users' interest.

The data regarding the average fixation count was in line with our expectations. We correctly assumed that simple ads were less annoying and participants, therefore, fixated their gaze on them more often. The required amount of cognitive effort also affected the number of fixations. If an ad requires more mental processing, it is expected that a website user looks at it less often. There may also be a correlation between banner blindness and the level of complexity of the ads. Higgins et al. [29] found out that the probability of banner blindness increased with lower user interest levels. Website users are, in general, not particularly interested in ads, so we could assume that because of a greater amount of cognitive effort required to process complex ads, their interest only decreased more.

Even when considering subjectively evaluated data from the questionnaire results, it was evident that users generally perceived simple ads more favorably. While the difference in terms of perceived pragmatic quality was slight, the variance in hedonic quality was not negligible. Moreover, the difference in attractiveness, which could be deemed as the most crucial segment for our research, was substantial. Wu et al. [11] found in their study that complex ads attracted people more towards evaluating the visual content. Although they attracted people's attention more, they were less liked by them according to the results of the questionnaire. From our perspective, this could result in a negative effect, as such ads may draw people to view content that is less appealing to them. The advertising strategy in designing online banners is, therefore, of great importance, as it needs to strike a balance between noticeability and likeability. By comparing the response rates and considering the research by Pileliene and Grigaliūnaitė [18], an intriguing question emerged regarding the impact of emotional value. Despite the expectation that complex advertisements should hold more emotional value in the eyes of consumers, our survey revealed that respondents predominantly perceived them as more unprofessional, tacky, cheap and disagreeable compared to simple ads. This suggested that even if complex ads carried more emotional value, it tended to be negative emotional value. Such associations are undesirable for advertisers, as they may lead website users to link their products with negative emotions.

After analyzing and interpreting all the results, we discovered that the visually complex ads were a better choice, solely if the main goal of the ad is to be noticed as soon as possible. Simpler ads were more appealing to users, less distracting and, above all, better affected their attention while browsing the websites. However, we along with most researchers agree that to fully comprehend the effectiveness of online banner ads, researching just the VC of ad design is not enough. When assessing ad campaigns, advertisers are

interested in the performance of the ads themselves as well as overall visitor behavior on the website [30]. There are numerous important factors to consider, such as brand awareness [18,31], the position and relation of the ad in regard to other elements on the website [32], presence of celebrities' photos [16,33], etc. One of the major influences in researching the effect of advertisements is the familiarity with either the entire ad or just the brand present in the ad. A large share of advertisements on the market have a marketing strategy based on whether or not consumers already know the brand featured in the ad. In such cases, researchers may determine a test group composed only of participants who have sincerely judged that they meet the study condition (not being familiar with the brand present in it) but may in fact only meet it on a conscious level. It turns out that, because of this, humans are not best suited to subjectively determine the impact of VC on their own, as Forsythe agrees [13]. Consequently, research studies that acquire data through objective methods, carefully designed under controlled conditions, such as our eye-tracking study, tend to hold greater significance in the field of advertising. Subjectively evaluated data, such as that acquired through questionnaires, is often considered less reliable due to challenges like self-definition, interdependence of answers and susceptibility to current emotional states. However, in our study testing the impact of VC of ads on web users, we found that survey questionnaire results could be trusted. This was attributed, in large part, to utilizing a questionnaire based on a model like ours, which minimized classic human biases in the evaluation. Our research indicated a clear correlation between objective and subjective evaluation methods with consistent and complementary results. While objective methods provide quantifiable and precise data, they may be raw and challenging to interpret. When aligned with results from subjective methods, they enhance interpretation and offer an additional perspective on the overall situation. It is worth acknowledging that, in practical terms, conducting advanced technical research in the advertising industry is frequently unrealistic for most advertisers due to resource limitations. Despite this challenge, we emphasize the importance of not depending solely on a questionnaire. However, it remains a valuable tool for obtaining feedback on the perceived design complexity of web banner ads.

5. Conclusions

The results of our study were consistent with the findings of some existing research works, which stated that, when it comes to designing banner ads, strategy is extremely important. Before we start using ads on the market, it is necessary to have a direction at least to a certain extent and be aware of the goals of the ads. Advertisers, especially those with less available marketing resources, often do not have a strategy in place and want to achieve too many different goals with just one ad. Based on our findings from testing 336 × 280 static banners without displaying the price, we could recommend ads designed with a lower degree of VC for usage in such cases, as well as for general usage. Namely, simple ads outperformed complex ads by a significant margin. Users did notice complex ads slightly faster, but they required more cognitive effort to process, were more distracting, had a worse impact on attention, were perceived as less appealing and potentially raised the probability of banner blindness. Therefore, when it comes to the effect of the visual complexity of banner ads on website users' perceptions, ads designed with a lower degree of VC are a better choice.

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