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Attention Allocation of Dynamic Icons on Mobile App Interfaces

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Abstract: The interface serves as the primary channel for interaction between users and mobile apps, making interface design critical for a successful user experience. To enhance the design language of app interfaces, motion graphics have been used due to their unique appeal. However, mobile usage patterns and interface sizes pose challenges in transmitting information effectively. Thus, the question of how to effectively apply motion graphics to meet users' needs and reflect design value remains a pressing concern for interface designers. To address this, this study focuses on the research of dynamic icons in app interfaces and employs the user's cognitive mechanism as a theoretical basis to explore the influence boundary of dynamic icons' core feature. Specifically, an eye-tracking experiment was conducted to study the impact of dynamic icon attention under various experimental conditions. Through the analysis of the distribution characteristics of user attention, it was found that the influence of dynamic icons on user attention varied with changes in the number of dynamic icons. Moreover, the number of dynamic icons played a significant role in regulating changes in a user's information processing mode. These changes ultimately affect the attention of dynamic icons. This research provides a crucial point of reference for future motion graphics interface design and implementation, as well as a more efficient way to enhance user experiences in mobile app user interfaces.

Keywords: APP user interface; attention; dynamic icon; eye-tracking; usability

1 INTRODUCTION

With the increasing expectations and requirements of users, the technology core development mode that only focused on product functions in the past can no longer meet the experience needs of users. In the Experience Economy era [1], where the functionalities of smartphone items and services are similar, users place more value on their interactions with products and services. Thus, the advantages and disadvantages of interface design elements will have a significant impact on the use frequency and preferences of users [2]. However, the interface design of ordinary products is not sufficient to meet the increasing needs of users [3]. The graphical user interface (UI) of smartphones has rich visual expression forms, and in the graphic interface design of mobile app, users' desire for experience is becoming more demanding. Visual requirements have changed from static to dynamic. Based on this demand structure, a new form of expression has emerged in the field of smartphone user interface design, namely, dynamic icons. Given the limitation of the smartphone display screen, animated graphics are a powerful way to explain the relationship between things. The use of animated graphics displays rich information on the interface, providing an important means for smartphone interface design.

1.1 Attention Allocation in Interface Design

In the information processing process, attention plays a crucial role in guiding information processing. Attention refers to the degree of attraction or focus given to a specific stimulus [4]. Designers, in general, utilize techniques that induce greater deformation and contrast than other elements in order to highlight certain elements in the interface. This design approach emphasizes performance modeling characteristics, thereby attracting the user's attention [5]. Attention can be induced through different methods, including color, shape, deformation, contrast, and others. For the navigation buttons of the APP interface, a series of icons is commonly used. However, due to the pursuit of consistent design, the size, color, location, and shape of these icons tend to be very similar. This creates a challenge in giving priority to vital information disclosure and system-recommended information. Attention is closely related to eye movements. Accurate tracking of eye movement can help to understand how visual objects guide the attention of the line of sight [6]. Instinctively, eye movements represent active or passive allocation of attention resources, and selection of more useful and attractive information. Therefore, eye-tracking technology is commonly used to study attention. Studies on web page attention have revealed that most readers unconsciously view the page in an "F" shape mode. This reading habit creates an "F" shape of attention on the page [7]. Research on mobile APP interfaces has shown that highly nonlinear path exploration is characterized by the back-and-forth movement of the line of sight, which jumps between different elements. Hot spot distribution is related to the graphic and text layout structure, and it no longer follows the F-shaped browsing rule. This suggests that the F-shape is a visual mode that appears without effective guidance on the page. To improve the usability of the interface, it is necessary to optimize the design to highlight important information and guide users to view certain content in combination with the principles of attention.

1.2 Relevance and Importance of the Research

Based on the previous discussion, it is essential to conduct a comprehensive study on the impact of dynamic icons on user attention allocation in mobile app user interfaces. Dynamic icons have emerged as a new form of expression in the field of smartphone user interface design, to meet the increasing demand for an enhanced user experience.

Attention, as a critical stage in information processing, is often attracted through various design means, such as color, shape, deformation, and contrast. Eye-tracking technology is a widely used method for studying attention, as it accurately tracks eye movements, which are indicative of attention allocation. Recent research on mobile app interfaces has demonstrated that the distribution of attention hot spots is no longer confined to the F-shaped browsing rule. Instead, the highly nonlinear path exploration is characterized by the back-and-forth movement of the line of sight between different elements.

Therefore, it is necessary to conduct a study on the attention allocation of dynamic icons on mobile app interfaces to optimize the design and guide users to view important content effectively. The proposed research will provide insights into how dynamic icons influence user attention and facilitate the design of interfaces that offer a better user experience.

2 RELATED WORKS

Human attention orientation is manifested through eye movements [9-11]. It has been found that the duration of gaze, also known as fixation duration, is indicative of a person's level of interest in the object they are looking at. The existing research has proved that eye movement is the main behavior that occurs when users view the interface and interact with the APP, reflecting the cognitive process and emotional changes of users [12, 13]. Eye-tracking technology has been established as an effective means of studying visual exploration and search strategies [14]. The use of eye-tracking data to gain insights into human attention and intention has been applied to various research studies. For instance, a study used an eye tracker to investigate the preferred reading regions of a desktop computer screen [15]. Results showed that university students paid more attention to the middle portion of the screen with some expansion to the upper and lower edges of the left side of this region. In another study, visual usability of children's websites was examined by tracking their viewing behavior and visual attention using eye-movement tracking and the SUS usability scale [16]. A different study evaluated interfaces and found that well-organized interfaces resulted in more efficient search outcomes, as evidenced by shorter scan-paths and a smaller covered area [17]. Other researchers have explored various topics in this field, such as the optimal navigation design scheme of the WeChat APP [18] and improving the visual competitiveness and download of game apps in the application market by tracking the user's visual cognition and interface interaction [19].

Eye-tracking is a quantitative and reliable method of evaluating human attention allocation in app interfaces, making it an ideal tool for research [17]. In this study, we utilized eye-tracking technology to investigate participant attention during target-less app browsing sessions. Visual perception is influenced by various cognitive factors, such as emotion and expectation, and attention is guided by both top-down cognitive control and bottom-up visual stimuli [20][21]. While the literature has examined these factors, to the best of our knowledge, the allocation of attention during target-less app browsing on a smartphone containing dynamic icons has not been studied. Therefore, we designed an experiment to examine the role of dynamic icons in attention allocation. We first verified the objective effectiveness of mobile app interface dynamic icons attention by setting the icon status as the unique variable and comparing the browsing characteristics of different design schemes of the same interface (UI with only one dynamic icon and UI with only a static icon). We then examined whether the number of dynamic icons simultaneously distracts users, since the main design elements in the interface are static. As such, if the number of dynamic icons in the interface changes, the user's cognitive environment will change fundamentally. If dynamic icons continue to increase, users' attention will be distracted, and the attention of dynamic icons will also change. Our study, therefore, investigates the relationship between the number of dynamic icons and user browsing characteristics using typical cases, and it addresses the number of dynamic icons that can effectively retain attention.

3 METHODOLOGY

The previous chapter has discussed the interface features that are inherent in the design of dynamic icons in smartphone applications, which include dots, lines, surfaces, and dynamic features. The use of color is an important aspect of interface design as it aids in distinguishing features, highlighting design characteristics, and capturing the attention of users. In interface design, colors are classified based on their purity, and bright colors have visual priority, which guides users to focus their attention [22]. Given that layout and color are the two features that are most closely associated with human attention, this study posits that the use of dynamic icons in the interface of mobile applications can significantly affect these features. Therefore, eye-tracking experiments were conducted to examine the impact of dynamic icons on these features.

The aim of this study was to evaluate the effectiveness of dynamic icons in attracting user attention and to determine if the focus on a dynamic icon remains consistent when multiple dynamic icons are present on the interface. This was achieved by conducting a comparative analysis of two design schemes, namely, dynamic icons and static icons. Specifically, this study aimed to assess the impact of multiple dynamic icons on user attention, as the simultaneous appearance of such icons could potentially divide the user's attention.

The research object of this experiment is the dynamic icon, and the experimental subject is the free exploration of the interface. To create the experimental stimulus materials, the APP interface containing only static icons was designed after processing dynamic icons through static means. The experiment comprises five stages, namely, sampling, experiment design, experiment implementation, data sorting, and data analysis.

With regard to smartphones, users' information processing of digital interfaces is generally closely related to their background knowledge [23]. The user's background knowledge refers to the external manifestation of the APP interface, which affects the formation of the user's initial experience of the design. Therefore, this study selected participants with similar knowledge backgrounds for the experiment.

3.1 Experiment Preparation

3.1.1 APP Interfaces

To comprehensively investigate the presence of dynamic icons in mobile app user interfaces within application malls, a significant number of interfaces were selected for the experiment. To obtain a more comprehensive research conclusion, the test results of different interface types were compared and analyzed. A strategy of simplifying the complexity of the object group was employed by eliminating visual styles and similar interface elements. After considering the limitations imposed by the experimental time frame, 100 user interfaces containing dynamic icons, as shown in Fig. 1, were selected as the ultimate experimental test samples. As per the experimental design, 100 UIs featuring dynamic icons were designated as the Group A experimental material, while the 100 UIs devoid of dynamic icons were designated as the Group B experimental material. Following the pre-processing phase, 100 UIs lacking dynamic icons were derived from the UI that incorporated dynamic icons. The experiment entailed the visual perception of 200 interfaces, and users were not required to engage in any interaction with the UI during the experiment. All interfaces were presented in the same size on a Huawei Mate40 Pro device.

Figure 1 Experimental objects

3.1.2 Eye-Tracking System

The current study utilized a smartphone running on the Android operating system (OS) and an eye tracker for data collection. The sampling frequency was set at Hz, and the Dikablis Glasses3 manufactured by Ergoners, Germany were employed for this purpose. The large head movement range of Dikablis Glasses3 participants minimized the limitations of experimental instruments that interfere with the experimental process. The computer used in the study was equipped with the D-lab software, which was compatible with the eye tracker and recorded the experimental process data. Moreover, Dikablis Glasses3 could also be used as glasses. The device boasts high accuracy, with a precision of 0.1 under ideal conditions and 0.1-0.3 under all conditions. It is non-invasive, lightweight, and minimally disruptive to participants. Furthermore, both eye cameras and field of view cameras were adjustable, and the latter recorded the interaction behavior of the experimental process from the first-person perspective.

3.1.3 Task Selection

The information that is presented in the user's brain regarding interface elements includes color, intensity, direction, and other raw physical features of an external stimulus that are transmitted through the visual pathway. Based on the bottom-up attention mechanism, which is led by external environmental information, the present experiment was designed as a free exploration task in which participants were asked to explore the interface according to their usual mobile application usage habits. This task was modeled after the state in which users search aimlessly in real-life situations and is similar to the passive search task studied by Touch [24]. The task involved the perceptual processing of the mobile phone screen interface by the subjects and is considered to be the best method for reproducing the user's actual search behaviour [25]. The present experiment is, therefore, a realistic representation of the user's interaction with mobile interfaces in their daily lives.

3.2 Experimental Design

3.2.1 Participants and Evaluation Indicators

Due to the relatively restricted area of interest in the interface and limitations of data collection precision of existing instruments, relevant indicators for exploration were selected in this experiment. Glance pertains to exploring the area of interest (hereafter referred to as AOI), fixating on the AOI, and conducting an exploration until leaving. This experiment employs a variety of application software as the material. In order to eliminate data deviation caused by products and operations, the eye movement indicators of AOI attention ratio, mean glance duration, number of glances, time to first glance, total glance time, and other ratios, average values, and maximum values were chosen.

AOI attention ratio refers to the fixation rate of AOI, i.e., the ratio of the time spent focusing on an AOI to the total experimental time. Mean glance duration denotes the average exploration time, which is determined by dividing the entire exploration time by the total number of explorations. Number of glances refers to the frequency of browsing an AOI. Time to first glance refers to the initial moment of visual contact with an AOI. Total glance time pertains to the complete browsing duration of an AOI, which is utilized for data comparison. The dynamic icon area is defined as the AOI of this experiment, and the eye movements of users are extracted based on AOI. The experiment classifies dynamic icons into icons, texts, and advertisements based on their characteristics. AOI is displayed according to the type and frequency of dynamic icons.

For this experiment, 22 men and 24 women aged 21 ± 1.3 years were recruited, amounting to a total of 46 participants. All participants were in good health in the week before the experiment and had normal or corrected vision, no color blindness, and were right-handed. Middle-aged and young people are the most prevalent groups that use smartphones, and the corresponding age groups of the sample population are most suitable for this study. All participants were Chinese university students who had used smartphones for over one year, and the average time spent browsing or using APPs was more than one hour every day.

3.2.2 Experimental Process

In the current experiment, a single factor (UI) with two dimensions (dynamic icon and static icon) was designed to investigate the visual paths of participants when viewing different UIs. To control for the order effects of UI presentation and potential gender influences on experimental results, the two UI types were randomly presented to participants as stimuli. All UIs were divided into two groups, with each group comprising four sessions, and each session displaying 50 interfaces, with each interface presented for 3.5 seconds. Before the formal experiment, participants were provided with experimental instructions and a practice session. At the start of the experiment, a fixation point appeared at the center of the screen. The experiment would only commence once the participant's gaze was fixated on the center. Group A was assigned to the dynamic icon specimen group, while group B was assigned to the static icon specimen group capturing dynamic icons. Participants were required to browse the interface content presented and press the Home button to end the experiment. After each experiment, a central fixation point would appear immediately, and the next experiment would commence. This process was repeated four times, as illustrated in Fig. 2.

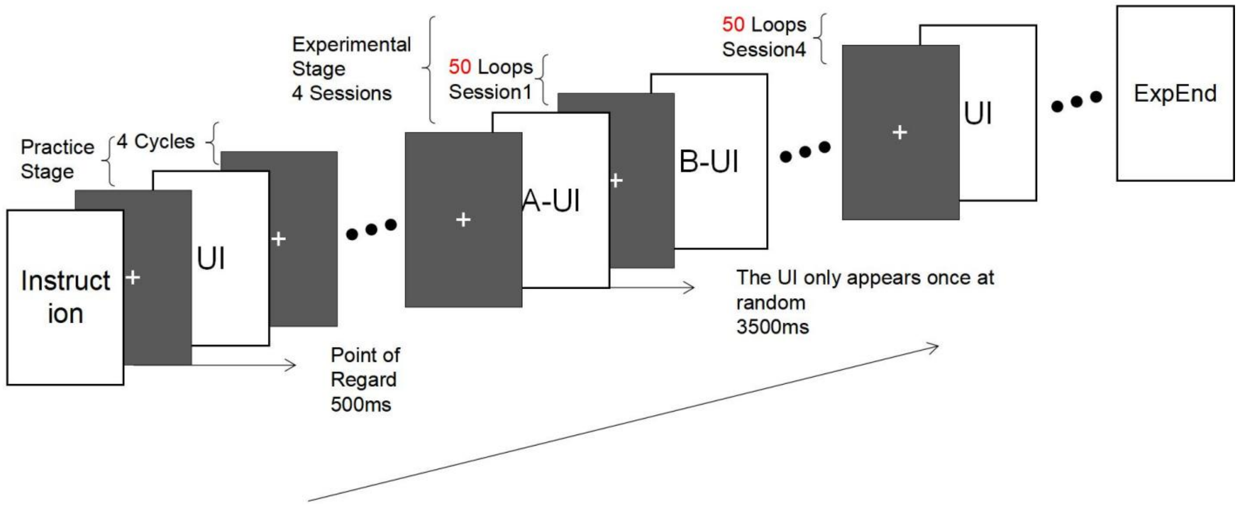

Figure 2 Experimental process

The experiment was conducted in a quiet and uniformly lit laboratory environment and lasted for approximately 20 minutes.

4 EXPERIMENTAL RESULTS

The present study employed both quantitative and qualitative data analysis to explore the effects of variables in the study of single-factor variables. Specifically, the analysis involved a summary evaluation and a classification evaluation. The former focused on evaluating eye movement data of all participants as a whole, whereas the latter focused on the evaluation of the experimental results of one, two, and three dynamic icons in the UI, respectively. To this end, the stimulation data were displayed using Huawei Mate40Pro, while eye movements were recorded with Dikablis3 and D-Lab. The statistical analysis involved a t-test using GraphPad 5.0, and the bilateral test analysis method was utilized. The results showed that the p-value was less than 0.05, indicating a statistically significant difference between the two groups.

4.1 Overall Evaluation

The experimental findings presented herein demonstrate consistency with those reported in Fig. 3. The dynamic group is denoted as A, while the static group is denoted as B.

The dependent variables Attention Ratio (AR), Mean Glance Duration (MGD), Number of Glance (NG), Time to First Glance (TFG), and Total Glance Time (TGT) of an Area of Interest (AOI) were subjected to t-tests, and the results were consistent with those presented in Fig. 3a-e. The statistical analysis demonstrated that the influence of dynamic icons on participants' MGD was significant ($p = 0.011 < 0.05$), as was the effect on TFG ($p = 0.030 < 0.05$). Dynamic icons were found to increase TGT by increasing AR, but the difference was not statistically significant. Dynamic icons had no effect on NG (see Tab. 1).

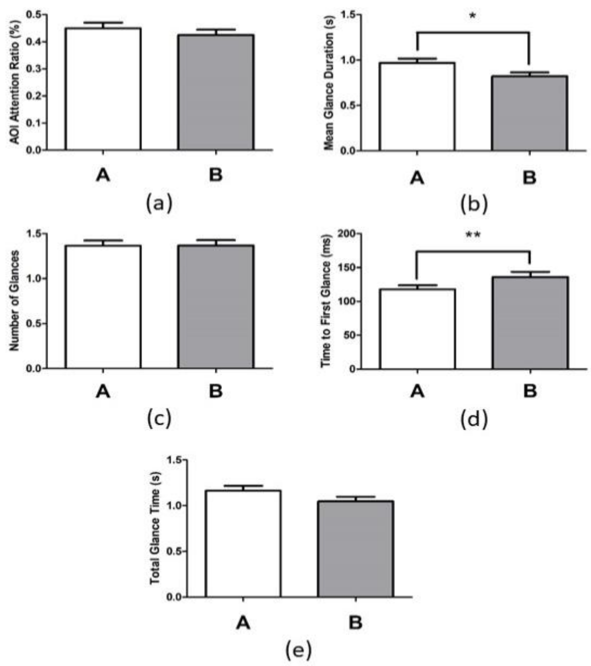

Figure 3 Overall evaluation results

Table 1 Overall evaluation results

Item	Mean ± SEM (N = 46)		p value
	A	B	
AOI Attention Ratio / %	0.45 ± 0.02	0.42 ± 0.02	0.197
Mean Glance Duration / s	0.97 ± 0.05	0.82 ± 0.04	**0.011**
Number of lances (counts)	1.37 ± 0.06	1.37 ± 0.06	0.981
Time to First Glance / ms	118.00 ± 5.80	136.1 ± 7.6	**0.030**
Total Glance Time / s	1.16 ± 0.05	1.05 ± 0.05	0.056

4.2 Evaluation of One Dynamic Icon

This research designates an experimental object containing only one dynamic icon in the UI as "one dynamic icon", with group A and group B being used to represent the dynamic and static groups, respectively. The experimental data were obtained from the identical set of participants, and the results are depicted in Fig. 4.

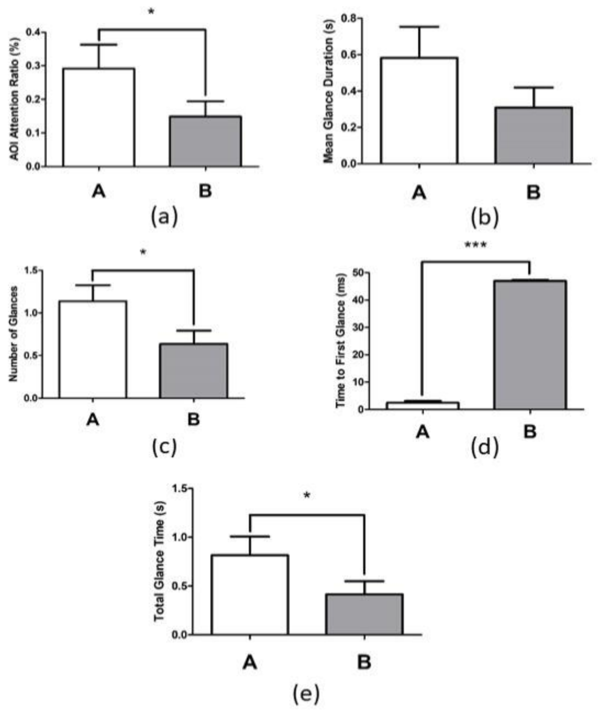

Figure 4 One dynamic icon evaluation results

The t-test results for AR, MGD, NG, TFG, and TGT are consistent with those presented in Fig. 4a-e. Statistical analyses revealed significant differences in the results of AR ($p = 0.050 < 0.05$), NG ($p = 0.048 < 0.05$), TFG ($p < 0.0001$), and TGT ($p = 0.048 < 0.05$). Specifically, the mean scores of the dynamic group were higher for AR, NG, and TGT, while the mean score for TFG was lower. Dynamic icons increased the average browsing time, but the difference was not significant. Thus, under the experimental condition of using only one dynamic icon, it was observed that the dynamic icon had a higher fixation rate and can successfully capture users' attention. These results are summarized in Tab. 2.

Table 2 Research results of one dynamic icon

Item	Mean ± SEM ($N = 46$)		p value
	A	B	
AOI Attention Ratio / %	0.29 ± 0.07	0.15 ± 0.05	**0.050**
Mean Glance Duration / s	0.58 ± 0.17	0.31 ± 0.11	0.095
Number of lances (counts)	1.14 ± 0.19	0.63 ± 0.15	**0.047**
Time to First Glance / ms	2.53 ± 0.64	47.00 ± 0.31	**< 0.0001**
Total Glance Time / s	0.82 ± 0.19	0.42 ± 0.13	**0.048**

The heat map and scan path of the experimental results in dynamic group A are consistent with those presented in Fig. 5.

Fig. 5a illustrates the experimental object of Group A, with the dynamic icon area marked in red. As demonstrated in Fig. 5b, the red region is primarily distributed between the dynamic icon and the UI. The term "hot spot" refers to the area where participants concentrate for extended periods. The results indicate that dynamic icons can attract users' attention for prolonged periods under experimental conditions. The gaze plot of the dynamic group can be observed in Fig. 5c. The subjects in the dynamic group browsed the UI from the top to the bottom, first focusing on the dynamic icon, then on the middle of the UI, and finally on the bottom of the UI. Participants looked at the dynamic icon for the longest duration of 2084 milliseconds. These results suggest that under experimental conditions, dynamic icons can attract users' attention initially and for the longest time. The experimental outcomes of the static group B are analogous to those in Fig. 6.

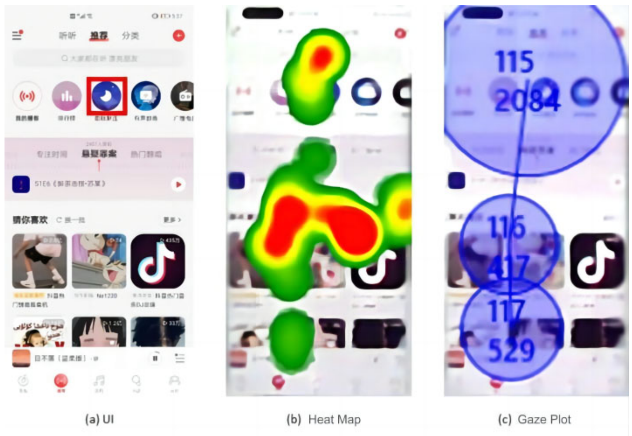

Figure 5 Dynamic grouping experimental results of one dynamic icon study

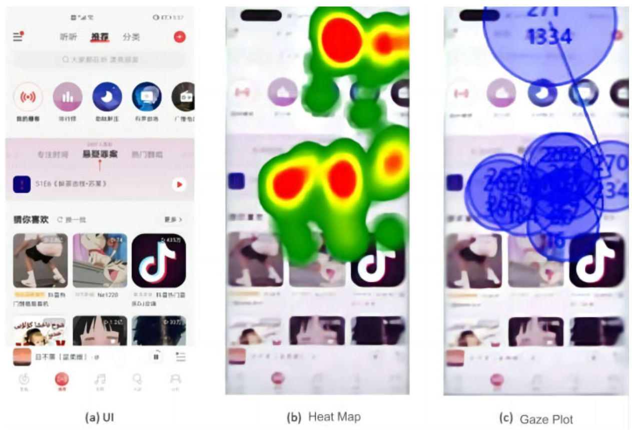

Figure 6 Static grouping experimental results of one dynamic icon study

Fig. 6a displays the experimental object for group B, in which the dynamic icons were excluded. The heat map generated from the experimental data (Fig. 6b) reveals that participants' attention was mostly focused on the top and middle regions of the UI. The red areas, indicating high attention, were primarily distributed above and in the middle of the UI, while the dynamic icon area was represented in green, indicating weak attention. The heat map shows that in the absence of dynamic icons, participants' attention was mainly attracted to the text area in the middle and top of the UI. The gaze plot (Fig. 6c) demonstrates that participants started exploring from the middle of the UI, moved from left to right, and finally focused on the top region. Hence, the experimental findings suggest that in the absence of dynamic icons, the texts in the middle and top regions of the UI are the most attention-grabbing elements for users.

4.3 Evaluation of Two Dynamic Icons

In the present study, two types of UI were used in the experiments, one with dynamic icons and the other without. The former was assigned to the experimental group A, while the latter was assigned to the control group B. The same set of participants completed both experimental conditions. The results of the experiment are summarized in Fig. 7.

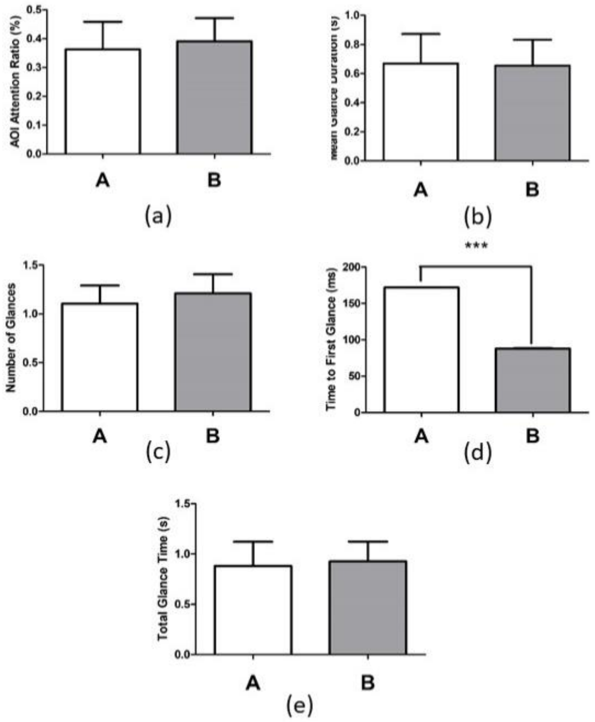

Figure 7 Two dynamic icons evaluation results

The statistical analysis of AR, MGD, NG, TFG, and TGT is presented in Fig. 7a-e. Among them, TFG ($p < 0.0001$) was found to be statistically significant. A higher mean score in TFG for the dynamic group suggested that the participants took longer to explore the UI in the first attempt. However, no significant differences were observed in AR, MGD, NG, and TGT when comparing the two experimental conditions, even though the dynamic icons reduced the exploration rate of AOI, the number of explorations, and the total exploration duration. The findings suggest that the two dynamic icons did not attract users' attention under the experimental conditions. The relevant statistics are presented in Tab. 3.

Table 3 Research results of two dynamic icons

Item	Mean ± SEM (N = 46)		p value
	A	B	
AOI Attention Ratio / %	0.36 ± 0.10	0.39 ± 0.08	**0.413**
Mean Glance Duration / s	0.67 ± 0.20	0.65 ± 0.18	**0.478**
Number of lances (counts)	1.10 ± 0.19	1.21 ± 0.20	0.699
Time to First Glance / ms	171.90 ± 0.29	87.84 ± 0.82	**< 0.0001**
Total Glance Time / s	0.88 ± 0.24	0.93 ± 0.20	**0.443**

The experimental results of dynamic group A are the same as those in Fig. 8.

Fig. 8a is the experimental object of group A. It can be seen from Fig. 8b that hot spots are mainly distributed between dynamic icons and UI. Under two dynamic icons experimental conditions, it shows that dynamic icons can attract users' attention for a long time. The gaze plot can be known through Fig. 8c. The subject browsed the UI from top to bottom. First look at the top of the UI, then at the middle of the UI, and finally at the bottom of the UI. The participants looked at the dynamic icon for a long time. Under two experimental conditions of dynamic icons, it is shown that dynamic icons can attract users' attention the most. The experimental results of static group B are the same as those in Fig. 9.

Figure 8 Dynamic grouping experimental results of two dynamic icons study

Figure 9 Static grouping experimental results of two dynamic icons study

Fig. 9a depicts the experimental object under consideration. As evident from Fig. 9b, participants' gaze was predominantly focused on the top and middle regions of the UI, with hotspots primarily distributed in these areas. Notably, the dynamic icon area of group A was not attended to in group B. Further, the heat map's red portion was primarily concentrated in the text area, indicating that the text in the middle and top of the UI was the most attention-grabbing during the experiment without dynamic icons. Gaze plots, as depicted in Fig. 9c, reveal that participants initially explored the middle-top portion of the UI, with their fixation points oscillating back and forth. It was found that in the absence of dynamic icons, users tend to focus on the text in the middle of the UI.

4.4 Evaluation of Three Dynamic Icons

This study investigated the effects of three dynamic icons on user attention in a UI. The experimental design included two groups: a dynamic group (Group A) and a static group (Group B), with the experimental data collected from the same participants. The results of the experiment are presented in Fig. 10.

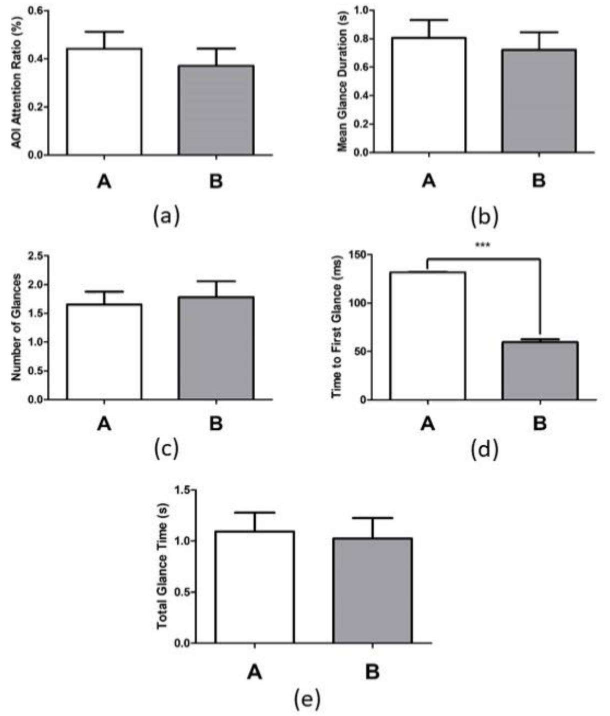

Figure 10 Three dynamic icons evaluation results

AR, MGD, NG, TFG, and TGT are shown in Fig. 10a-e. TFG (p < 0.0001) has a statistically significant difference. The high average score of the TFG dynamic group means that the initial search time is long. However, dynamic icons do not affect AR, MGD, NG, and TGT. Dynamic icons reduce the number of searches, increase the AOI search rate, and increase the average search time and the overall search time, but there is no significant difference. This shows that under the experimental conditions of three dynamic icons, dynamic icons do not attract the user's attention noticeably (Tab. 4).

Table 4 Research results of three dynamic icons

Item	Mean ± SEM (N = 46)		p value
	A	B	
AOI Attention Ratio / %	0.44 ± 0.07	0.37 ± 0.07	0.243
Mean Glance Duration / s	0.80 ± 0.12	0.72 ± 0.12	0.315
Number of lances (counts)	1.65 ± 0.22	1.78 ± 0.27	0.714
Time to First Glance / ms	131.80 ± 0.32	59.64 ± 2.87	**< 0.0001**
Total Glance Time / s	1.09 ± 0.18	1.02 ± 0.20	0.400

The experimental results of dynamic group A are the same as those in Fig. 11.

Fig. 11a is the experimental object. It can be seen from Fig. 11b that hot spots are mainly distributed between dynamic icons and UI. Under the experimental conditions of three dynamic icons, dynamic icons can attract users' attention for a long time, but the hot spot area of the ads in the middle and the icons at the bottom is significantly smaller than that of the icons at the top. The gaze plot can be known through Fig. 11c. The subject browsed the UI from the middle up in the following order, and then moved his gaze back and forth between the dynamic icons. The participants looked at the dynamic icon for a long time. Under the experimental conditions of three dynamic icons, dynamic icons can attract users' attention for a long time, but the participants actively avoid the dynamic icons in the middle. The experimental results of static group B are the same as those in Fig. 12.

Figure 11 Dynamic grouping experimental results of three dynamic icons study

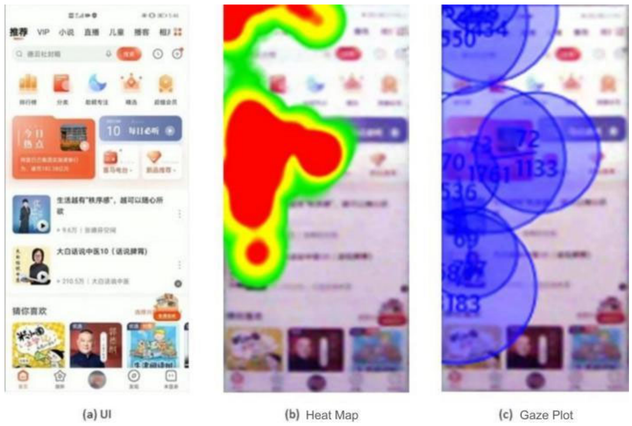

Figure 12 Static grouping experimental results of three dynamic icons study

The experimental data regarding AR, MGD, NG, TFG, and TGT are presented in Fig. 10a-e. It is noted that TFG (p < 0.0001) has significant statistical differences. The TFG dynamic group presents a high mean score, indicating that the first search takes a considerable amount of time. Nevertheless, it was found that dynamic icons have no impact on AR, MGD, NG, and TGT. Even though dynamic icons lower the AOI exploration rate, the number of explorations, and the total exploration duration, no difference was observed in their use. Thus, it can be inferred that under the experimental conditions of three dynamic icons, dynamic icons have no noticeable effect in attracting the user's attention (Tab. 4).

5 DISCUSSION

In this study, our results demonstrate that the presence of dynamic icons can have a significant impact on user navigation habits and attention distribution features under various experimental conditions. Specifically, our findings suggest that one dynamic icon can attract users' attention first and for the longest duration. With two dynamic icons, we observed a clear alteration in users' navigation habits and attention distribution features, as users tended to repeatedly switch their attention between the two dynamic icons, guided by their mutually attractive and mutually exclusive relationship.

However, under three dynamic icons experimental conditions, our findings reveal that although dynamic icons can attract users' attention for a long duration, the dynamic icon in the middle of the interface is deliberately avoided by users. This avoidance behavior is likely due to an increased cognitive load resulting from the presence of multiple dynamic icons. Furthermore, our results suggest that the traditional mechanism, in which users' attention is first attracted by the larger point and then maintains a certain degree of continuity, does not hold true under these experimental conditions. The lack of attention to the larger dynamic icon may be attributed to the dynamic characteristics of the elements.

Overall, our findings suggest that there is a cognitive saturation of dynamic elements in interface design, such that an excessive number of dynamic icons can distract users' attention and hinder the overall user experience. Furthermore, our research indicates that users tend to ignore dynamic icons that are perceived as advertisements, which has significant implications for designers. Notably, we also found that the number of dynamic elements can significantly affect users' information processing type. Additionally, our findings suggest that animated text is not effective in attracting users' attention, and that dynamic icons and background shading can significantly impact users' attention distribution.

6 CONCLUSION

This study sheds light on the impact of dynamic icons on attention allocation and browsing habits of users from a feature analysis perspective. Our experimental results demonstrated that attention to dynamic icons can significantly affect the attention allocation characteristics of the user interface, however, this effect has limitations. Specifically, the influence of dynamic icons on users' attention decreases as the number of dynamic icons increases. Therefore, it is crucial to evaluate the usability of dynamic icons in a mobile app interface to determine if they can guide users to make choices effectively. To maximize the attention drawn by dynamic icons and reduce the impact of top-down mechanisms, our findings suggest that interface designers should use one dynamic icon in their designs, which is considered the optimal solution. Overall, this research provides valuable insights for the development of effective mobile app interface design, and future studies could extend this research by investigating the effects of dynamic icons on user behavior in other contexts.

Acknowledgments

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