Guidelines for the Visual Design of Mobile Application Icons Based on Visual Properties

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Abstract. The design of the icon of a mobile application can have a major impact on its success, by attracting users' attention and perhaps persuading them to install it on their devices. In the case of the continued use of an application, its icon also has an important role to play in terms of its recognition. In this paper, we take a qualitative approach in identifying different roles that the visual design properties of complexity, concreteness and familiarity play in contributing to the appeal and performance of an application icon during different phases of its use – from first exposure to assurance and continued use. We also discuss several theories which we consider relevant to this research, using case studies of the icons of three mobile applications. We then conclude by proposing that the design of an application icon should take into account the maturity level of the application, and the specific phases of its use for which its icon should be optimized.

Keywords: Visual design, visual design properties, icon design, user interface design, mobile application, icon use, user journey, consumer journey.

1   Introduction

Application icons have become an integral part of almost all visual user interfaces. Individual icons represent their particular applications in, for instance, an online application marketplace, or on the home screen of a mobile device. Yet, despite their importance, there is not enough existing research focusing on what makes icons appealing to their users [1]. Most of existing research related to icon design has mainly focused on creating classification methods for different types of icons [2, 3, 4, 5, 6, 7, 8, 9], and a few have focused on factors contributing to icon appeal and performance [10, 1]. Several guidelines have also been proposed for the selection of appropriate metaphors for user interface icons, and how the cultural background of the end users may affect the usability of icons [11]. For instance, Jylhä and Hamari [12] have explored which types of icons increase the likelihood of users interacting, downloading, and purchasing their corresponding applications.

In the field of semiotics, as Peirce [13] notes, signs can be classified into icons, symbols and indexes based on each sign's relation to its referent. According to this, the term "icon" only refers to a representation in which the sign resembles its referent object, an "index" carries an actual connection to its referent object (e.g., a telephone sign on the door of a phone booth), and a "symbol" in contrast has no visual connection to its referent object and is basically an abstract sign that can only be understood through learning its meaning.

However, in the field of user interface design, the term "icon" is generally used for any visual presentation of an application, without any particular reference to different semiotic types of visual signs. Yet, an application icon is also often similar to a product logo, which can be interpreted as a sign from the semiotics point of view. A product logo is a visual representation of its company brand, and serves as a means for helping consumers to consistently recognize its associated brand [14], and as such, carries certain semiotic meaning.

Therefore, while in this paper our focus is on icon design from the perspective of user interface design – with its associated meaning of the term "icon" – it is useful to refer to existing literature in the well-established field of brand and logo design, which has also attempted to address many of the same questions and challenges facing icon designers. For example, research in this area has shown that affective and cognitive components influence consumer attitudes towards a brand and its logo [15]. Furthermore, different design strategies have proposed different guidelines for the design of logos [16]. Due to the similarities between the roles that icons and logos play – at least in terms of recognition and brand loyalty – much of the consumer theories and design strategies proposed for logo design could equally apply to visual design of application icons. Similarly, Honeywill [17] has also suggested that principles of print design and architectural sign design can be used to guide the design of user interface icons.

Furthermore, based on the similarities between a mobile application and other consumer products, existing theories about customer journey – as developed in the field of service design [18] – can be used to analyze customers' needs and actions throughout the lifespan of a mobile application. The customer journey, or customer journey map, is a method often used to describe the touch points between a customer and a product or service [18].

The origin of the customer journey as a method of analysis can not be traced to a single source, but it emerged in the 1990s. For instance, Carbone and Haeckel [19] introduced a similar concept called "experience blueprint", and later Shaw and Ivens [20] developed a similar concept called "moment mapping". As such, different phases of the customer journey are not well-defined, and it can be considered as a design method that can be customized depending on its use for a specific purpose. In this paper, we adopt the consumer journey as a method of analysis, and propose that a user's interactions with a mobile application can be divided into three main phases, which impact the design of its icon in different ways. These three phases are: 1) first

exposure, 2) assurance, and 3) continued use. This division into three phases is similar to that of the customer journey suggested by Lemon and Verhoef [21], which consists of the prepurchase, purchase and postpurchase phases. The first exposure could be considered as part of the prepurchase phase, while assurance leads to purchase, and continued use takes place during the postpurchase phase. However, since in a mobile application context there is often no clear point-of-sale, the concepts of purchase or pre- and postpurchase seem less meaningful. The first time a user is presented with an application icon, the context is most likely to be, for instance, an app store, a desktop or an applications folder, in which there are often several – or many – different icons competing for the user's visual attention. The icon is often the consumer's first point of contact with an application, and its design can therefore be crucial for its commercial success [12]. While the initial role of an icon is to attract the user's attention during the first exposure phase, once the attention has been caught, the user needs to be assured of the suitability of the application for their intended use – i.e., future tasks to be performed using the application. In the context of many application icons being present – e.g., in an app store – the visual design of the icon can also be a pivotal deciding factor between installing an app instead of another competing one [12] – this is referred to as the assurance phase. Once the application has been installed, it enters the third phase – i.e., continued use. In this phase, although the user already knows what the application icon looks like, the challenge lies in quickly recognizing the icon on a busy home screen or desktop of a device, or multiple devices, that the user may be accessing the application from repeatedly over extended periods of times – or perhaps only once in a while. In addition to these usability factors, the visual design of an icon acts like that of a product logo and plays an important role in building brand loyalty, particularly for applications that are used frequently.

As mentioned, most of the related research – regardless of their focus on application icons or logos – mainly deal with either icon or logo design in general or aim to propose different methods of classification. As such, more research is still needed to focus on the application use and its implications for icon design. More specifically, further research is needed on how the visual and perceptual qualities of icons affect their usability performance and effectiveness throughout their lifespan across the three main phases of users' interactions with them – from first exposure to assurance and continued use. Additionally, there is very little research on strategies for visual design of application icons, and how such strategies can serve the three different phases of icon use, as well as their related functions in terms of the user's interactions with an application icon.

The visual design of icons offers many potential design properties that could be examined in the context of this research. In this paper, we identify the fundamental visual design properties of **complexity, concreteness,** and **familiarity,** which have all been extensively researched and are proven to affect an icon's usability performance [22, 23, 24, 10]. However, since these factors have not been studied in the context of

mobile application icons, in this paper, we describe how these factors contribute to the appeal and usability performance of a mobile application icon during each of the three phases of users' interactions with it.

Based on our analysis, we propose that the maturity level of an application should be considered as a guiding factor in the design, and redesign, of an application icon. Maturity in this context does not refer to the readiness of an application in terms of its functionality or its available features, but instead to the maturity of the application brand and how well-recognized it is to its potential users – e.g., how long the application has been in wide-spread use. A low-maturity level application is an application that is new and unknown to most of its potential users. In this case, the users are typically looking for an application for a specific purpose and comparing various competing alternatives. As such, the application icon needs to catch users' attention and assure them sufficiently enough to install it. A high-maturity level application, on the other hand, would be a well-established application that consumers are familiar with beforehand, and often search for it directly by its name.

To examine the validity of these different theories that we have adopted, in this paper, we also discuss three case studies we have carried out to evaluate the initial designs, and subsequent redesigns of Basecamp© [25], Airbnb© [26] and Instagram© [27] mobile application icons. These case studies aim to identify which visual design properties of the application icons have changed over time, and how these changes have affected the qualities of the icons in relation to the aforementioned three phases of users' interactions with them.

2   Visual Design of Icons

Application icons have a very specific function compared to other user interface icons in general – e.g., a folder or trash can icon. While application icons sometimes serve an important role as product brand elements, they must at the same time adhere to basic user interface usability principles. The role of an application icon often strongly overlaps with that of the company logo, and sometimes they are indeed one and the same visually. The practice of designing logos and visual trademarks can arguably be traced back over 5000 years to the branding of livestock [28]. More recently, during the last two centuries, there has been an ever-increasing growth in the volume of logos that have been created. As such, there is a wide-spread understanding of the importance of logo design, where it is not uncommon for major corporations to spend millions of dollars on logo design [29].

In the corporate sector, the level of recognition of a logo, and the positive associations it delivers, are its main success criteria from a visual design point of view. Recognition is often relative to the brand's maturity, and the amount of money the brand company spends on its exposure through advertising. Despite this,

sometimes even high-investment logo designs may simply fail to be recognizable, or even have a negative impact on the brand [30].This is because the logo is a visual representation of a brand, and serves as a tool for helping consumers to consistently recognize the brand [13]. The logo is also a tool of communication, as it mediates the company's identity to its consumers, employees and business partners, as well as its competitors. As such, the role of an application icon is in many ways similar to that of a logo, but more specific to the digital medium of a graphical user interface. Furthermore, in the case of applications developed by well-known software companies – e.g. Twitter© or Instagram© – the application icons and company logos may even become virtually indistinguishable. However, the research on brand logos and their design has a much longer tradition than that of icon design, and encompasses a wider scope and greater volume. Fortunately, much of this research can also be applied to, and further developed, in the context of icon design.

As mentioned earlier, a user's first encounter with an application icon is likely to be in an app store or a user interface environment with many different icons competing for the user's attention. Since the first role of the icon is to attract the user's attention, it is important for its designers to identify the type of visual elements which could be used to make its design stand out and attract attention. As a comparison, a similar challenge for a logo design would be, for instance, to make it stand out visually on a supermarket shelf, where each product is competing with numerous similar products from other brands.

In addition, it is also important to consider whether an icon has been designed for continued use, and in what way this intent is manifested through its visual design elements. The previous comparison of an application icon to a product logo on a supermarket shelf is not completely accurate in this respect. A traditional product, like a box of cereal, is likely to be bought over and over again by the same consumer. An application, on the other hand, is often only acquired once, and after that it just needs to compete for attention in the context of the user's interface environment – e.g., on their mobile home screen – with other mostly unrelated applications. Therefore, as an important visual design factor, the designers must consider the long-term use of an application icon for fostering brand loyalty through its experiential and communicative visual design properties.

In this section, we will introduce the three visual design properties of **complexity, concreteness,** and **familiarity,** which we will then use in the following section to describe the usability performance of icons.

2.1 Complexity

The visual complexity of an icon can be evaluated according to the amount of visual detail or intricacy in it [10]. Research suggests that simple icons, identifiable by a few features, can increase usability performance in visual search tasks [22]. Simplicity

and aesthetic perception are also interrelated to processing fluency [31]. Additionally, a visually simple user interface can be easier to process, and this can lead to a positive aesthetic evaluation. For instance, in evaluating visual aesthetics of mobile interfaces, Choi and Lee [31] propose that the clean, modern, and balanced arrangement of graphic and textual items leads to a perception of simplicity.

However, simplicity versus complexity can be discussed at different levels. At the most primitive level, comparisons can be made in performance between targets and distractors that are either differentiated by a single visual property – e.g., a pink rectangle target, with brown and purple rectangles as distractors – or a conjunction of properties – e.g., a pink rectangle target, with brown and purple triangles as distractors [32, 33]. On a slightly higher level of abstraction, complexity can be considered as the number of surface propositions – i.e., perceivable elements of a design – which is a factor in measuring a design's propositional density [34]. Consider the Whatsapp© [35] icon shown in Figure 1. In this icon, there are two surface propositions: a speech bubble, and an old fashion telephone handle. In this case, the relevant deep propositions would be conversations and telephone calls. Therefore, the propositional density of this particular icon is 2/2, which equals one. Propositional densities of logos and icons can be higher, with values up to three and beyond. In the best case scenarios the propositional density of an icon should not be less than one – that is, there should be no visual elements that do not relay a meaning.

Fig. 1. Whatsapp© [35] application icon with propositional density of 1.

2.2 Concreteness

The concreteness of visual signs such as user interface icons can be described in various ways. While the underlying concept is generally the same, there is some room for interpretation. For instance, Wang et al. [9] describe concrete icons as consisting only of real-world objects. Blattner et al. [8], on the other hand, use the term "representational" for roughly the same purpose – to describe icons that show pictures of familiar objects or operations. Similarly, García et al. [36] define concrete icons as those that represent the constructs at an operational level, whereas abstract icons

represent the constructs at a higher conceptual level. In the field of trademark design, Mollerup [28] uses a similar term of "figurative marks" to classify trademarks that depict an object.

Sometimes the visual representation of a concrete object can become stylistically so abstract over time, that people start to perceive it as an abstract symbol [37]. Arrows are one example of this phenomenon, where a visual sign can not be unambiguously classified as concrete or abstract. On the other hand, some of these types of visual symbols may be referred to as universal symbols, or "conventionally accepted abstract symbols" [38]. In these cases, although the visual appearance is totally abstract, an existing strong convention allows the symbol to work as effectively as a concrete image – e.g., the use of a rectangle to signify stop in video playback applications and devices.

However, users are generally faster at deciphering the meaning or function of a symbol when they are presented with a real-world object rather than an abstract image. Concrete symbols can also be remembered more easily, since they can be verbalized and stored in declarative – or explicit – long-term memory. Knowledge in declarative memory can, at least in part, be consciously or explicitly recollected [39]. This in turn, can make the visual task of searching for a specific application icon easier – e.g., when searching for an app that the user has used previously.

2.3 Familiarity

In an attempt to measure consumers' response to visual brand identity (VBI), Phillips et al. [14] propose the two theoretical concepts of familiarity and congruence. Familiarity refers to the positive feeling, or the experience of fluency, that is triggered by the ease of processing familiar brand elements. Familiarity, or subjective familiarity, can be a tricky term to define, since it can either mean previous exposure to a visual element, or similarity between elements that have been seen in other contexts [16].

It is important to note that concreteness and familiarity are often closely connected, and the impression of familiarity is more likely to occur when dealing with concrete visual elements rather than with totally abstract ones. Familiarity has been shown to improve the speed and accuracy with which icons can be identified [1].

Congruence, on the other hand, is a term used to describe a more general sense of familiarity. It is defined as the recognition of elements and styles, which are expected from the brands of a certain industry or a product category – e.g., what the logo of a prototypical law firm is supposed to look like. Congruence also plays a key role in communicating a brand's values [40].

3 Usability Performance of Icons

The effectiveness and performance of application icons can be considered in terms of their overall experiential or specific usability qualities. One of the important experiential qualities to consider is affect. Affect in the context of this research can be described as spontaneous – positive or negative – feelings of value towards something that the user is exposed to. Affect can be further analyzed along the three dimensions of pleasure, arousal and dominance [15, 41]. Jun et al. [15] examine the affective and cognitive dimensions of consumers' attitudes towards brands and brand logos. The perceived logo design elements that lead to positive affect can, for instance, be their high-quality, distinctiveness, and their level of being interesting. In addition, slightly more elaborate and natural-looking designs have traditionally been considered to improve affect [16]. Similarly, according to ISO 9241-220 [42] satisfaction is described as positive attitudes, emotions and/or comfort resulting from the use of a system, product or service. Satisfaction is one of the four criteria that can be used to evaluate a system's usability with the other three being effectiveness, efficiency and freedom from risk [42].

Usability itself, on the other hand, can be described and evaluated along several different dimensions. Butler [43], for instance, states that usability in empirical testing can be measured through efficiency and success of users' task performance with a system. Butler also identifies a number of variables, including time spent on tasks, likeliness of errors, and patterns of interactions, which can affect the user's productivity and ability to learn to use the system [43]. Similar variables have been used to measure users' performance with interface icons [10]. The ability to learn to use a system, or learnability of the functionality of a system, is not so relevant in the context of measuring the performance of mobile application icons, because every icon launches an app in the same way regardless of its visual design. However, even though they are clearly interrelated, performance can be considered as a more general term than usability when evaluating user interfaces. While the usability of an application icon is more concerned with the aforementioned factors like task speed and accuracy, due to the similar role of application icons and brand logos, performance measurements and brand goals of logo design can also be applied to application icons. These goals include the likelihood to purchase a product and the ability of the logo's design to support its associated brand. The performance measures can be further divided into for example distinctiveness, positive affect, correct recognition, brand recognition and consumer loyalty. Each of these can then be evaluated accordingly.

Rather than taking a functionality-based approach to evaluating usability of application icons, in this paper, we take an experientially-based approach to considering the usability performance of application icons during different phases of a customer/user journey with an icon. Examining users' interaction with an application

icon by dividing the interactions into three consecutive phases of first exposure, assurance, and continued use offers a user-centric approach that is similar to the high-level phases of the customer journey map.

As mentioned earlier, the customer journey map is often used in the field of service design, with the aim of better designing customer experiences [18]. The customer journey map describes the touch points between a customer and a product or service. It consists of four components: phases, goals, tasks, and routines. The structure and phases of a customer journey map can vary depending on its use cases, and the designers creating them. Usually, three or more phases are used to divide the customer journey to before, during, and after a service engagement [18]. Alternatively, the phases may be divided into pre-purchase, purchase, and post-purchase [21], which is similar to the approach we adopt here.

We would argue that the customer journey map is a suitable method for analyzing the visual design properties of application icons, because it can be used to deconstruct the customers' needs and actions throughout an application product's lifespan. Using this method, it is possible to take a more strategic approach to icon design. This method would also enable the designer of an icon to take into account the maturity level of its associated application in terms of its functionality and popularity, and the specific phases of the icon use for which it should be optimized.

3.1 First Exposure

The distinction between the first exposure and assurance phases – as discussed later – is not always entirely clear. What is clear however is that the first exposure is not just about catching the user's attention with a visual stimulus. For instance, unconscious affective responses can already arise during the first exposure, and processing fluency is one factor that can lead to affect [1]. However, if we were to consider first exposure more literally here, then the user's motivation in this scenario would be to find a suitable application for a specific use, and in that case, the user may not have any prior knowledge of the available applications.

3.1.1 Complexity During First Exposure

During the first exposure, the visual complexity of an icon can have an effect on the probability of the icon catching the user's attention. According to Treisman and Gormican [33], a so-called "pop-out" effect occurs when visual elements are discovered through preattentive search. In such cases, the visual elements are seen in a single eye fixation – or even without localized attention – and processed in less than a tenth of a second. In these cases, the visual search is believed to happen often in parallel. The focus of attention in a visual query can vary from wide to narrow, and the size of the target conversely affects the accuracy of the detection of an object's visual features and its localization. In preattentive search the attention is distributed

over a large area – when attention is narrowed down, it arguably becomes serially directed to one target, or a group of targets, at a time. When pop-out does not occur, the visual search is considerably slower, due to the fact that this type of search is serial rather than parallel [33]. Conversely, Desimone and Duncan [44] suggest that attention in fact consists of a series of slow competing interactions taking place simultaneously, rather than as a sequence of serial processes. Either way, strong contrasts in low-level (primary) properties of visual images – e.g., color, shape, size, texture, motion, orientation, and stereoscopic depth – are likely to catch the user's attention [45]. This would suggest that less complex visual designs are more optimal for first exposure. Consider the Microsoft Teams© [46] and Zoom© [47] application icons shown in Figure 2. In this case the Zoom© application icon has a lower level of complexity, and as such should be more likely to attract a potential user's attention during first exposure. While these two applications are similar, naturally, the differences in the design of their icons are also due to the fact that Microsoft Teams© encompasses a much wider toolset than Zoom©, and as such its icon is visually more complex.

Fig. 2. Microsoft Teams© [46] application icon (left) has a higher level of complexity than the Zoom© [47] application icon (right).

3.1.2 Concreteness During First Exposure

As previously mentioned, concreteness can affect the speed and accuracy of an icon's recognition. Users are faster at deciphering the meaning or functions of the application associated with a new icon when they are presented with a real-world object that offers them affordances and hints as to what it might be used for. For instance, if we compare the application icons of the two competing restaurant food delivery service apps, Foodora© [48] and Wolt© [49] as shown in Figure 3, the Foodora© icon is better suited for first exposure in terms of its concreteness. The concrete illustration of a hand – perhaps that of a waiter – carrying a food tray is a stronger metaphor that better describes – at least in some cultures – the nature of the service provided by this application more accurately.

Participants in user studies have also been shown to have a strong tendency towards attempting to concretize even abstract concepts [38]. That being said, many

concepts in digital applications are so abstract that they are virtually impossible to signify with a concrete concept. However, as mentioned earlier, in such cases "conventionally accepted abstract symbols" [38] may in fact act as concrete objects in user interface icons.

Fig. 3. Foodora© [48] application icon (left) is more concrete than the Wolt© [49] application icon (right).

3.1.3 Familiarity During First Exposure

In the case of first exposure, familiarity is considered mainly as the similarity of visual elements with what the user has seen in another context. As such, congruence would actually be the more accurate term to use here. For instance, if a user is looking for a video conferencing app, then an imagery more commonly associated with this function is more likely to catch the user's attention. The Microsoft Teams© and Zoom© application icons as shown in Figure 2, offer a good example here as well. In this example, the Zoom© icon is more congruent representation for a video conferencing application, thus making it better suited for first exposure in terms of familiarity. However, if the user is instead looking for a meeting support application, then perhaps the Microsoft Teams© icon is more representative of a meeting application.

It should also be noted here that research from the field of branding shows that consumers' attitudes towards a brand and its logo can be divided into affective and cognitive dimensions [15]. Although the cognitive dimension seems more logical and involves conscious thinking and deconstruction of the visual elements, during the first exposure to a brand logo, the affective dimension seems to be even more powerful than the cognitive dimension [15]. However, familiarity or congruence can support the positive effects of cognitive processing by incorporating visual elements that represent familiar meanings through the use of symbolism or a metaphor.

3.2 Assurance

The assurance phase is usually the moment that makes an app a hit or a miss. When a user's attention has been caught by an icon, the visual elements of the icon need to somehow persuade the user to take the desired action – i.e., to download and install the app. Cognition can shape consumers' attitude over time, and evoking thinking or stimulating cognition can, in general, result in positive attitudes towards a brand [15]. Creating a positive association with an application is essential in luring the user to install it. Even when familiarity, concreteness, and visual complexity play their desired role during the first exposure, it is likely that the more complex aspects of these properties would have a more dominant role to play during assurance.

3.2.1 Complexity During Assurance

While the positive effects that a simple design has during a visual search task are still relevant during assurance, in this phase the importance of visual simplicity is reduced. However, it is important to note that users might not immediately move on to the assurance phase after they see an application icon for the first time, but instead they are more likely to browse through icons of a set of potential applications available to them first, and then return to an application icon they remember seeing previously. As such, the simple but strong visual elements of an icon can still be useful in this return-and-find task.

Once the user starts to examine an application in more detail – to consider its suitability for the desired task – the visual design of its icon can act as a means to communicate its functionality. A more refined and detailed visual design can be used to convince the user that the icon's associated application itself is also well-designed, or is of high quality, with the same level of attention to detail in terms of its functionality. For example, the Messenger© [46], WhatsApp© [35], and Line© [50] applications are all used for similar instant messaging purposes. The icons of these three applications shown in Figure 4 consist of very similar visual elements. Yet, the Messenger© icon seems the most refined of the three, with its intricate gradient coloring. The WhatsApp© icon, on the other hand, visually seems a little simpler with its monochrome green gradient, and the Line© icon comes across as the most basic of them all.

Fig. 4. Messenger© [46] application icon (left) seems more refined, Whatsapp© [35] application icon (center) is a little simpler, and Line© [50] application icon (right) is the most basic of the three.

Despite the inherent added value of visual complexity, an optimal visual design should also strive for the type of minimalism in which each visual element has a purpose. This quality can be evaluated by the propositional density of an icon, which is based on the number of deep propositions it has relative to the number of its surface propositions. As mentioned earlier, deep propositions are the underlying meanings of elements, whereas surface propositions are the perceivable elements of a design. The higher this density, the more interesting a design would seem to be [34]. While this concept is often applied to logo design, it is also equally applicable to icon design. Balancing the number of surface propositions and visual details is an important consideration in icon design. During the assurance phase, in particular, moderate levels of complexity with an appropriate level of propositional density can have more positive effects than during first exposure.

3.2.2 Concreteness During Assurance

Existing research on logo design suggests that the perceivable visual elements of a design, and their intended meanings, need to be interpreted in a consistent manner by its intended audience – that is to say, a design should evoke the same meaning across its audience group [16]. Concreteness increases the likelihood of invoking familiar meanings, since it relies more on cognition rather than convention.

However, designing a unique concrete visual concept for a logo can be a challenge, and as such, large companies tend to choose more abstract visual designs for their logos. This, in turn, can even lead to unintended, and sometimes unfortunate, misrepresentations – as is the case with the logo of the luxury car brand Infiniti© [51] shown in Figure 5, which can be interpreted as a pizza with a slice missing [30].

Fig. 5. Company logo of Infiniti© [51], which may visually seem like a pizza with a missing slice.

For application icon design, the prevalent choice these days seems to be the use of natural visual concepts, with the exception of applications that repeat their corresponding company logo, or others that provide such abstract functions which are impossible to depict using a concrete visual concept. However, even in this latter case, well-known companies often still retain some properties of their logo in their application icons. For instance, Google© uses the same colors in its various application icons as those used in its company logo – e.g., the Chrome© web browser and Google Drive© [52] application icons shown in Figure 6.

Fig. 6. Google Chrome© (left) and Google Drive© (right) application icons use the same colors as the Google company logo [52].

3.2.3 Familiarity During Assurance

The visual property of familiarity is where the first exposure and assurance phases clearly tend to overlap. Familiarity during assurance is not only about congruence or recognition of elements that have been seen in another context, but also any previous exposure to the same visual element.

In order for an icon to be recognized, users must both remember seeing it, and also remember its associated application, brand, or company. The key factor for recall is a design that is memorable. At times, false recognition may also occur, resulting in users falsely believing that they have seen a design before [16]. False recognition can

indeed be relied upon as a conscious strategy for an icon or a logo design. For instance, a new game application icon might be designed to resemble that of a popular game, in order to lure users' attention and persuade them to install its app instead of the genuine app. For example, the success of the Angry Birds© [53] franchise spawned a whole genre of "bird" games with varying originality in their gameplay, or their icon design (see Figure 7). A similar strategy can be seen in the case of "Low-investment" company logos.
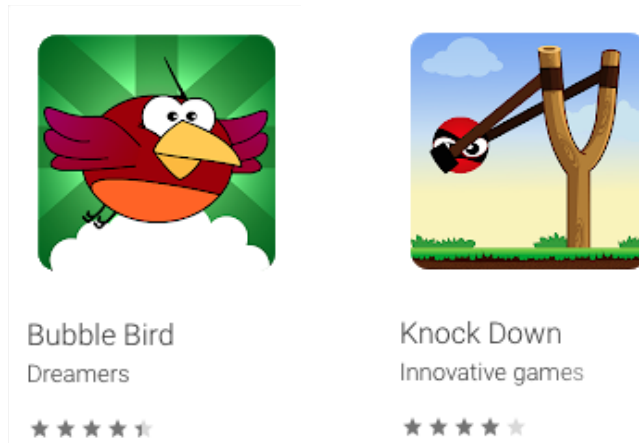

Fig. 7. Two examples of icons for Angry Birds© [53] lookalike games shown in Google Play Store.

Correct recognition is supported by familiar meaning, repeated elements, moderate levels of harmony [16], and the naturalness of a visual design [30]. For an application that is part of a strong brand, repeating those familiar brand elements can be a good strategy – as discussed in the previous section. For a relatively unknown application, on the other hand, familiarity must be first built on congruence or repetition of elements that have been seen in another context – e.g., other competing applications or brands.

3.3 Continued Use

In the case of regular and continued use of an application, the user is likely to have previous knowledge of the visual properties of its icon. Be it the green speech bubble of the WhatsApp© icon, or the red, green and yellow circle of the Chrome© browser icon, the user is primed to find a certain visual stimulus. This type of visual search for a previously seen – and used – icon is a top-down process, where the user's conscious mind drives low-level perception to find the visual target. During continued use, the icon also inevitably becomes part of the brand communication of its application

company. Repeated exposure to the icon builds consumers' familiarity with the brand and the values it attempts to communicate to its users.

3.3.1 Complexity During Continued Use

Simplicity can enhance the usability performance of an application icon during continued use by making it easier to locate and distinguish the icon in an array of other icons – which is often the case, for instance, in a crowded home screen of a mobile device. Contents of the visual working memory can enhance biasing for a visual cue starting already from the non-conscious stages of visual processing [54]. In the case of an application icon, the visual properties of the target image are retrieved from the long-term memory to the visual working memory and then are searched for visually. It is known that while the long-term memory is virtually limitless, the visual working memory is very limited in its capacity [55]. When humans first observe a visual representation, they can typically differentiate only three to four simple objects at once. The process of retrieving an object's visual properties is similar to first perception. More detailed information can be acquired through additional iterations of retrieval from the long-term memory [55]. Low-level visual properties are key in this process. As such, for visual design purposes, it can be effective to incorporate easily distinguishable primitive visual properties into the design of an icon.

3.3.2 Concreteness During Continued Use

As mentioned, one major limitation of human cognition is the capacity of the visual working memory [45, 55]. This is one of the reasons as to why humans learn to rely on external aid. Visual working memory holds about three or four low-level visual elements at a time, and they might remain there for just a few seconds. The patterns formed by these visual elements are recognized as objects and concepts – such as the lines, colors, and curves which form the image of, for example, an apple. Such concepts can then be labeled, given a verbal form, and may become a part of a person's internal monologue and thinking [45]. Verbalized concepts can then be stored in declarative – or explicit – long-term memory. Knowledge in declarative memory can, at least in part, be consciously or explicitly recollected [51]. In this way, concreteness during first exposure can build a foundation for usability performance in the assurance and continued use phases, making the visual task of searching for a specific application icon easier. The previous example of Foodora© and Wolt© application icons (see Figure 3) can be used here as well. The Foodora© application icon can be more effective in search tasks during continued use due to its concrete nature, which is more likely to make it easier to remember.

The incorporation of "ownable" visual elements in a company's visual brand identity is seen as a hallmark of a successful brand design [56]. Such ownable, recognizable, and unique elements can also often be found in the company logo. Ownable visual elements can best be described as recognizable, and yet unique and

distinguishable from other competing brands. Ownable visual elements are not necessarily concrete – at least not initially – but may become so over time. For example, consider how the Nike© [57] Swoosh has over time changed from an abstract sign to an "almost" concrete object. However, establishing abstract shapes as ownable elements can require financial investments in heavy public exposure through advertising. Even in such cases, a concrete visual element – e.g., a mascot character – can be easier to establish as a recognized brand element than an abstract sign.

3.3.3 Familiarity During Continued Use

As previously discussed, familiarity can support the speed and accuracy with which icons are identified [1]. In addition, familiarity during continued use is also about brand recognition and building consumer loyalty to the brand. In fact, the question is not just about whether the repetition of familiar visual elements is beneficial for the usability performance of an individual application icon during its continued use. Instead, continued use is also about creating brand experience, and the repetition of ownable, familiar visual elements is an essential part of this process. Familiarity and congruence have been proven to contribute to consumers' positive attitudes towards visual brand elements [14]. The visual elements – such as logos, colors, shapes, typefaces, characters, and styles – that create and identify a brand are the characteristics that the associated company aspires to maintain through repeated exposure, in order to build brand personality and create relationships with its consumers [56]. The Google© application icons offer a good example here. All the icons shown in Figure 6 share a strong repetition of the Google© brand colors, along with the highly recognizable and characteristic geometric shapes used by Google©.

4 Case Studies

In this section, we present three case studies analyzing the redesign of Basecamp©[25], Airbnb© [26], and Instagram© [27] mobile application icons. The aim is to investigate how different visual elements of these icons have changed through several iterations from their original designs to their current forms in terms of the three aforementioned visual design characteristics – complexity, concreteness, and familiarity. In addition, the usability performance of each described icon throughout its user journey – from the first exposure to assurance and continued use – is analyzed in terms of these visual design properties. These three applications have been selected for the case studies because different versions of their icons exhibit changes in the visual design characteristics that are being studied here. In addition, the designs of these specific icons have been publicly documented by their designers, thus offering valuable insights into their designers' intentions behind the changes.

It is also important to note that re-inventing a company's logo or application icon is always a risky task. If the changes are unexpected or radical, they can provoke strong negative reactions, and even weaken the perceived congruence between the brand and its new logo or icon [40]. While surprise in itself is not necessarily a negative thing, it must be kept in mind that surprise is a powerful emotion that is subsequently transformed into a positive or negative experience [3]. Managing this type of consumer experience can be tricky, and therefore, it can be safer to mitigate its effects by managing consumers' expectations through a well-planned launch strategy. Consumers' familiarity with a brand can also affect their attitudes towards a new brand logo or icon, and loyal existing consumers can often be even more critical of such changes [40].

It is also important to note here that the design of new icons or the redesign of existing icons can also be influenced by the current visual design trends. For instance, skeuomorphism – making icons resemble their real-world counterparts – was a popular user interface icon design style a decade ago. Such dominant visual styles can naturally affect the level of concreteness and complexity the application icons exhibited during their corresponding time period.

4.1   Case Study: Basecamp©

Basecamp© [25] is a popular project management tool developed by 37signals© [55]. The original application icon featured a green mountain inside a light blue snowglobe (see Figure 8, left). The icon has since been redesigned twice, first in 2014 and then in 2019. In its first redesign, the icon essentially remained the same, but a smiling face was added to it (see Figure 8, middle). This was a byproduct of the company's marketing campaign, during which they first created a limited edition toy, called "Happy Sherpa", which later on evolved into the Happy Camper character [58]. A few years later, the icon went through a more drastic redesign, when the globe and the mountain inside it were replaced with a single stroke of black line showing the outline of the shapes in the original version (see Figure 8, right). The friendly face from the first redesign was removed in the second redesign, and the black line was presented on a strong yellow background, the shape of which can vary depending on the application platform.

4.1.1   The Original Icon

Although the original icon features dominantly concrete visual elements, these elements do not represent the functionality of the application in a direct manner. Rather, the metaphor being used is more subtle, and as such, the design is not optimal for the purpose of first exposure. However, the elements are distinctive and can be verbalized, which make the icon potentially easier to remember later on during the

assurance phase. The signature shape of the hills is also a strong, ownable brand element that functions as a building block for brand recognition during continued use.

While the original icon can be described as relatively simple, the color contrasts in its visual elements are not very strong. They neither effectively support attracting attention during first exposure, nor recognition during assurance or continued use. As we previously stated, a highly detailed and refined visual design can convince the potential users that the application itself is also well-designed, or is of high quality, with the same level of attention to detail in terms of its application functionality. However, the style of the original Basecamp© [25] icon is so minimalistic that basing judgements about the quality of the application on its design would seem questionable.

Also as previously discussed, familiarity and congruence may have a lesser role to play during first exposure – being mostly limited to supporting the positive effects of cognitive processing, by incorporating visual elements that represent familiar meanings through symbolism or metaphor. The imagery of the original icon is not clearly connected with the functionality of the application – i.e., project management – and does not utilize congruence in this fashion. By its nature, the Basecamp© [25] mobile application is an extension of its online project management tool, and therefore, first exposure to the tool is more likely to happen online in a web browser environment, rather than in a mobile application marketplace. Familiarity in this regard is manifested in the unmodified repetition of the software logo in the mobile application icon, which also ensures rapid recognition of the associated software tool during the assurance phase and continued use.

Fig. 8. The original Basecamp© icon (left), first redesign in 2014 (center), and second redesign in 2019 (right).

4.1.2 The First Redesign: Happy Camper

The changes from the original to the first redesign of the icon are related to the use of color, contrast, level of detail, and embedded meanings. The added surface propositions include two dots and a curved line. These can be interpreted as either two eyes and a mouth, or as two map markers and a connecting path. This addition affects the communicative aspects of the icon, and the black emoji-style face also

creates a strong contrast in color with the green hills in the background. It is interesting to note how the inclusion of a simple visual element can have manifold positive effects on the quality of the icon.

This redesigned version is slightly more complex than the original icon. The design still remains rather simple, and the added details support attracting attention during first exposure. The addition of these elements does not clarify the purpose – i.e., functionality – of the application any more than the original icon, and therefore, does not support its usability performance during first exposure. However, the new elements may produce a phenomenon called face pareidolia, which causes the viewer to perceive features of a human face in an inanimate object [59, 60, 61, 62]. The representation of a face can also be very abstract, since the brain is highly tolerant to variations in the type of visual objects and elements it is processing [61]. An image with even a remote likeness can result in the perception of a face [59]. This can benefit first exposure and attract viewers' attention. Whether the smiley face should be considered a universal symbol or a concrete visual sign is not of great importance, in the sense that the strong convention allows the symbol to work as effectively as a concrete image.

Although the inclusion of the smiley face is not congruent with the functionality of the application, it may support the effects of cognitive processing and produce positive attitudes towards the icon. These effects can benefit the usability performance of the icon – starting already from first exposure, but most importantly during assurance – by incorporating visual elements that represent familiar meanings through symbolism or metaphor. Repetition of elements that have been seen in another context supports familiar meaning, which, in turn, aids processing fluency, thus leading to appeal and the likelihood of purchasing or installing the application.

The smiley face makes the icon potentially easier to store in the user's long-term memory and supports search tasks during assurance and continued use. The inclusion of concrete and simple visual details with strong contrast also supports rapid recognition in visual search tasks. The redesigned icon repeats the familiar brand elements and is similar enough to the original icon to be recognizable to existing users of the application.

4.1.3 The Second Redesign: Black and Yellow

The drastic change in color in the second redesign of the Basecamp© [25] icon is very interesting, and seems deliberate. The physiology of the eye makes it difficult to differentiate certain kinds of color combinations. The capabilities of the middle- and long-wavelength-sensitive color cone cells are overlapping, and the same hue of yellow can affect both. For this reason, yellow appears as the lightest of all hues, and makes it difficult to see on a white background [45]. The yellow of the Basecamp© icon compensates for this by being sufficiently dark and saturated to work on a white background. In addition, this yellow still produces a very high contrast when paired

with the black line stroke of the new icon, which can be attributed to the multi-channel activation of yellow-blue and black-white color cone cells in the eyes of the viewer.

The black and yellow icon is very simple, even compared to the two previous versions. The simplicity of its design, in combination with its strong color contrasts, improve the usability performance of this icon during first exposure, making it more likely to stand out among other visually competing application icons. Its choice of colors is also likely to assist with the continued use of the application by providing strong and simple visual cues that can be biased for – e.g., while looking for the application on the user's device home screen. For example, Figure 9 shows the effectiveness of this version of the icon in comparison to the original version on the home screen of a mobile device. The new design clearly also works more effectively as a small-sized icon.
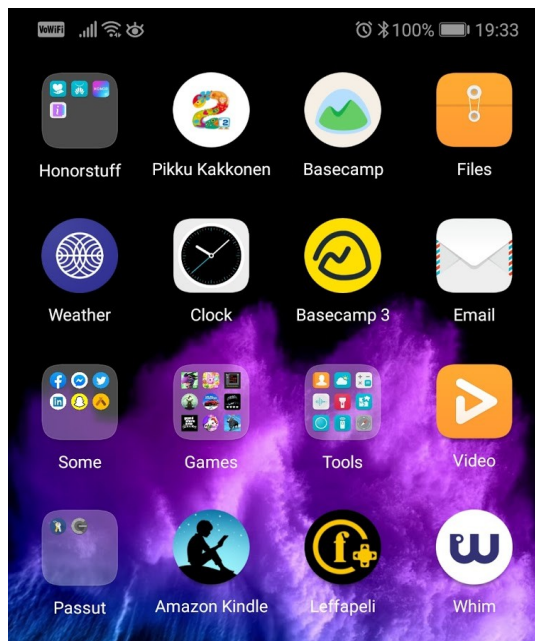

Fig. 9. The original (top row) and the latest (second row from top) versions of the Basecamp© [25] icon on the home screen of a mobile device.

However, the new icon is less natural than the earlier versions, and the deep propositions of the image have become so abstract that they might be impossible to decipher without previous knowledge of the icon or the application. Despite this, the new icon is now more open to interpretation, and its black line can even be seen as an upward line graph. Consequently, what is gained in terms of first exposure and

continued use might be lost in the assurance phase due to the lower level of naturalness. Furthermore, the reduced number of cognitive triggers in the new icon may affect users' attitudes towards it negatively. The low level of familiarity in relation to the previous two icons, and brand identity in general, is likely to confuse existing users of the application upon first exposure to the new design. This may temporarily affect visual search tasks negatively during assurance and continued use. In addition, since the new icon certainly looks more formal, perhaps the intent of the redesign was to make sure that the icon – and its associated application – is taken more seriously.

4.2 Case Study: Airbnb©

Airbnb© [26] is a global online accommodation rental marketplace that was founded in 2008. Up until 2014, the company was using its original logo, as well as the application icon derived from it. The original design was created by one of the company's founders – Joe Gebbia. In a video discussion between the Airbnb© [26] CEO Brian Chesky and DesignStudio© CEO Paul Stafford [63], Brian Chesky states that the original design was always meant to be temporary. Although at the time they felt that the blue logo identity was good enough, later on they realized that the business, and its community of users, no longer matched with the original visual brand. Therefore, in 2014, Airbnb© [26] launched its new brand identity, and introduced the "Bélo" logo and icon concept. However, the new logo initially received strong reactions online and in social media, with the most vociferous ones being negative [64]. The criticism subdued over time, and the logo redesign later received recognition, including the Bronze Clio Award [65].

4.2.1 The Original Icon

It is important to note that the original Airbnb© [26] icon (Figure 10, center) is actually an extension of the company logo (Figure 10, left) rather than having its own design. The original company logo is a lettermark design set in a thick, blue script style typeface with a strong white stroke. The design is simple and casual, and perhaps even rather too modest. The application icon itself – the focus of our case study – simply features the first letter of the logo, a lowercase 'a'.

Fig. 10. The original Airbnb© [26] logo (left), original application icon (center), and first redesign in 2014 (right).

Although the design of the original icon is simple in terms of its number of elements, it still contains several visual details as part of the design of the used font and its stroke and shading. These elements combined with their low level of visual contrast are not sufficient enough to attract users' attention during first exposure. The same problem also exists in terms of visual search tasks during continued use. The small number of elements and their levels of detail, as well as the inordinately obvious choice to use the first letter of the company name as the only visual element, do not communicate that this is the icon of a well-designed and high-quality application – and its corresponding service.

Furthermore, since the design of the original icon is completely abstract, it does not really communicate the intended use of the application during first exposure. The use of the blue color in logos and application icons has often been a typical choice for many Internet-based tools and services – e.g., Facebook©, Dropbox©, LinkedIn©, Twitter©. Similarly, the use of the first letter of the company name in the icon is rather common, and not very imaginative. In that sense, the original Airbnb© [26] icon is congruent, even though the abstract nature of the visual design might otherwise hamper congruence and familiarity. However, the original design does not exhibit anything that might be considered familiar upon first exposure, so it is unlikely to catch attention. This type of general congruence in visual design does nothing in particular that might affect user appeal, either positively or negatively. The letter "a", and the distinctive font that it is set in, may however be easy to remember. This compensates for the lack of concreteness, which could negatively impact performance in visual search tasks during continued use. The design of the original icon is also aligned with the overall visual brand of the company, and contributes to its brand experience.

4.2.2 The First Redesign: "Bélo"

The new application icon of Airbnb© [26] is very different from its original icon. In fact, the only similarity between them is the use of the letter "A" – now set in capital – which is still recognizable in the new design. The new company logo and application icon (Figure 10, right) are essentially the same, with the only difference

being that the company name is usually present in the logo along with the visual "Bélo" symbol, whereas in the application icon the symbol stands alone, and the name of the application is in the text label which is dependent on the mobile device platform. The aim of the new design has been to transcend language and create "a simple icon that could be drawn by anyone, worked across every touchpoint, and became a symbol of belonging." [63]. The "Bélo" symbol is made up of four individual elements: people, places, love, and the letter "A" for Airbnb© [26] (see Figure 11). The dominating and traditional blue color in the original company logo and application icon has been replaced with a trendy coral-pink color in the new design.
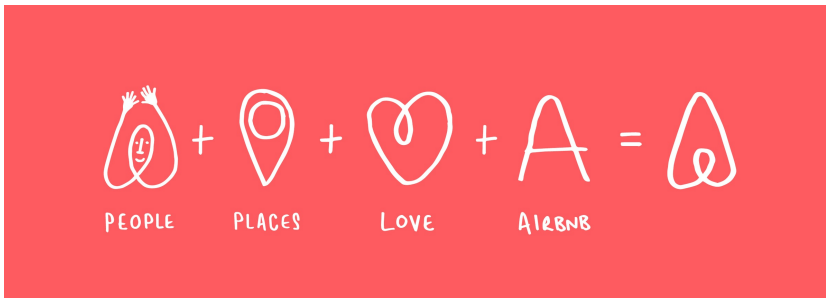

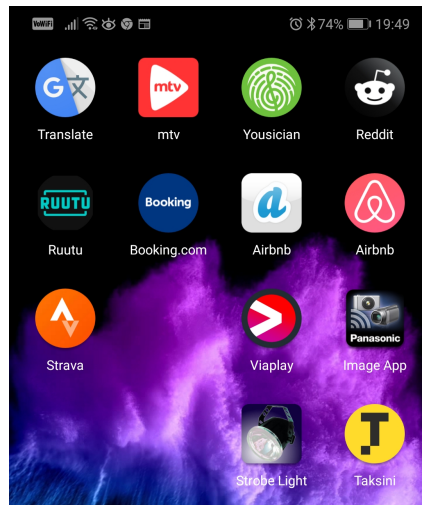**Fig. 11.** The four elements of the Airbnb© [26] Bélo symbol [63].

Fig. 12. The original (second row from top), and new Airbnb© [26] icons on the home screen of a mobile device.

The new icon is deceptively simple in its visual design. The saturated pink color, together with the white-lined shape of the "Bélo" symbol, create a relatively strong contrast on the home screen of a mobile device (see Figure 12). Despite its simplicity, the visual design of the new icon is sufficiently engaging and refined to communicate high-quality design. In this regard, it is suitable for assuring the users of the quality of the mobile application and its associated company service. The contrasting visual elements and the simple, yet unique, visual design result in an icon which is also effective in visual search tasks during continued use.

While the visual style of the new icon might be best described as abstract – as discussed above and shown in Figure 11 – it incorporates concrete symbolism through embedded deep propositions. The two most dominant visual elements that are relatively easy to recognize are the capital letter "A" and the upside-down heart shape. In addition to the intended embedded deep propositions, the initial reaction of many online users was that the icon resembled various parts of the human anatomy – which in turn resulted in the mixed and strong reactions towards the new design. The concreteness of the visual design of the new icon is so remote that it is unlikely that many users would be able to decipher the intended use of the application solely by looking at its icon. For the same reason, the icon is neither effective for mediating familiar meaning – which might be useful during the assurance phase – nor does it support visual search tasks during continued use through concrete, memorable visual design elements. The concreteness of the icon is probably relevant, and of value, mainly to the fraction of users who have somehow become aware of the underlying meaning associated with the new "Bélo" design.

Overall, the new icon does not benefit from the positive effects that either congruence or familiarity can have during first exposure and assurance. However, the new icon is likely to have good usability performance during continued use. Furthermore, the "Bélo" symbol is unique and ownable, and builds up the Airbnb© [26] brand experience and supports visual search tasks. Based on the case study presented by DesignStudio© [63], the design of the logo was not concerned with optimizing the usability performance of the new icon. Therefore, the resulting effects on the usability performance of the new icon are rather coincidental than intentional. Although the new icon is, in many ways, better than the original, it is not reasonable to say that it has been optimized for any specific phase of the customer journey.

4.3 Case Study: Instagram©

The Instagram© [27] application was launched in 2010 along with its original icon. The icon included an illustration of a Polaroid© OneStep [67] camera with its lens, flash and other small details, plus a rainbow colored stripe passing through its middle (Figure 13, left). This icon was only kept for a short period, and was replaced with the first redesigned icon in less than a year. The original realistic-looking camera was

replaced by a slightly more abstract and playful version of a camera in the new design by Cole Rise (Figure 13, center). Then in 2016, the Instagram© [27] icon went through a much more drastic redesign, during which it was simplified to the mere outlines of a camera (Figure 13, right). In this version, the colors of the rainbow were reduced, and represented only in the form of color gradients on the background. The change of the icon for this very popular application initially received a lot of negative public reactions, which have since largely been forgotten.

Fig. 13. The original Instagram© [27] icon showing a detailed Polaroid OneStep camera (left), first redesign showing a simplified front and rear view of a camera (center), the second redesign showing an abstract camera design (right).

4.3.1 The Original Icon

The original icon was actually more of a pictogram than a typical user interface icon (Figure 13, left). Since the visual design of this icon is skeuomorphic and almost photorealistic, it has a large amount of small details that results in low levels of visual contrast. For this reason the icon does not perform well during first exposure, since it does not really attract attention, especially when shown as a small icon. This lack of contrast that negatively impacts first exposure, can also interfere with rapid recognition in visual search tasks during continued use. However, the high level of details in the visual design can be effective in conveying the professional design quality of the application. Arguably, a slightly lesser amount of detail, and a more apparent attention given to stylization might be even more effective for this purpose.

The concrete nature of the original icon makes it apparent to the user upon first exposure that the application is somehow closely related to photography – unless the icon is too small for its details to be identifiable. This level of concreteness also supports memorability during assurance and continued use. In addition to supporting visual search tasks through concrete memorable objects, brand recognition during the continued use phase can also be easier to establish through concrete images than abstract shapes.

The camera as a visual element is congruent for the original purpose of the application, which in this case is that of sharing photographs and short videos – although the real Polaroid© OneStep [67] camera did not support recording of videos. This type of familiarity increases the positive effects of cognitive processing both during first exposure and assurance. The fact that the depicted camera is in fact a

retro-styled Polaroid© OneStep instant camera, makes it less familiar to younger users and partially limits the benefits of congruence only to older users – i.e., old enough to remember the original cameras. Assuming that the icon is correctly recognized as a camera, it can function well in visual search tasks during continued use. Additionally, the design is unique and ownable, and by these means it can be functional in building brand recognition and familiarity through repetition during continued use.

4.3.2 The First Redesign: The Pictogram Becomes an Icon

The first redesign of the icon reduced the original realistic camera illustration (Figure 13, left) to a rounded rectangle with comparatively fewer details (Figure 13, center). Yet, inside the rounded rectangle shape, the second design still maintained the material and natural appearance of an almost real-looking camera. The icon featured in Figure 13 (center) is actually the more polished final form of this version of the icon, which was released with Instagram© 2.0 application. A slightly different – flatter and less realistic – version was briefly featured with the initial launch of the second generation application. In the version shown here, it is possible to distinguish the textures and three-dimensional shapes of the various components of the camera. For instance, the glass of the lens and the viewfinder reflect the light from a room with a window, and the two-toned body of the camera has a pleasant tangible feel, with a brown leather imitation on the top part, and a bone white granular surface on the bottom part. The rainbow stripe has also been made more prominent. As a quirky detail, there was also a design for the backside of the camera. The main reason for the new design was the fact that the original logo intentionally resembled a Polaroid© OneStep instant camera, but the Apple App Store rules prohibit the use of a trademarked design in this fashion [66]. Another practical outcome of the redesign was that the new version was easier to reproduce in smaller icon sizes.

This first redesign was not very radical, as it retained the main features of the original icon. However, the reduced level of visual details and number of elements of the icon helped to emphasize some of the main features of the depicted camera, making it stand out better during first exposure. The stronger visual shapes also make the icon more recognizable, which has a positive impact for the assurance and continued use phases, by making it easier to bias for in a visual search. However, as mentioned, visual realism and more visual details do not necessarily lead to a perception of higher quality when realism is used excessively – as was the case with the original icon. In comparison, the design quality of the icon in this case is perhaps more apparent in the level of execution of the details of the redesigned icon.

The level of concreteness in the second version of the icon is of course slightly reduced when compared to the original icon. Despite this, the icon is still realistic enough to benefit from the positive effects of concreteness and realism. For the first-time users, the visual design effectively communicates that the application is centered

around personal photography. While the word "Insta" shown on the icon gives a hint of the idea of "instant" photography associated with a Polaroid© OneStep camera, the illustrated camera is more generic in the redesigned icon, and it is no longer recognizable as a Polaroid© OneStep camera. Moving away from the Polaroid© OneStep camera is a sensible choice, making the icon more easily acceptable to younger users. As such, the retro-styled camera can effectively create positive associations during the assurance phase, since the realism works in unison with familiarity, thus stimulating cognition and supporting processing fluency.

The new design repeats some of the visual elements of the original icon, such as its rainbow stripe. While the playful visual design of the second version of the icon is similar to the first version, yet the two designs are very different, and it is difficult to imagine that an existing user would immediately recognize the resemblance and realize that this is a new version of the same application.

4.3.3 The Second Redesign: A Flat Design
The second major redesign of the Instagram© [27] icon resulted in something visually completely different (Figure 13, right). In this version, the realism of the previous two versions has been replaced with extreme minimalism. This design clearly follows the trend of the flat design paradigm that has dominated graphical user interface design over the past decade. In this version of the icon, only the most essential features of a camera – perhaps a digital camera rather than a film camera – have been retained. A thick rounded rectangle follows the outline of the camera, and inside it are the two circles representing the lens and the flash. The strong white lines heavily contrast with the background, which itself is made of a gradient color-fill with a hint of a reference to the rainbow stripe of the previous icons.

The abstract design is only remotely recognizable as a camera, and no longer represents the purpose of the application clearly during first exposure. Yet, the simple design with strong contrasts and thick lines is very effective in attracting users' attention during first exposure, while also making it equally easy to remember and look for during continued use.

The simplicity and lack of details in the second redesign – compared to the previous designs – can, on the other hand, be a hindrance during the assurance phase. The icon is less intricate and does not communicate the same level of attention to detail as before. However, the Instagram© [27] application has of course become so well-established these days that assurance is perhaps not a major concern for its owner company anymore.

The camera as a visual element is still congruent for the functionality of this application. This can support the usability performance of the icon during first exposure and assurance – if the user is able to recognize its visual element as a camera. The close connectedness of complexity, concreteness, and familiarity is apparent in this dilemma. Familiarity is more likely to be achieved through concrete

imagery, and concreteness also requires a certain amount of complexity, a premise also recognized by García et al. [36]. As with the redesign of Airbnb© [26], the radical change in visual design of the new icon does not attempt to build on familiarity with the previous visual brand identity. Instead, the redesign is a complete visual brand identity renewal, which perhaps only very well-known brands can afford to undertake.

Since its initial release in 2010, the Instagram© [27] app has become hugely popular with around one billion regular users worldwide. This has made it possible for Instagram© [27] to radically change the visual design of its application icon. The first two versions of the icon can be best described as high-image icons, concerned more with creating positive affect rather than recognition, and attempting to persuade new users to choose this application in the first place. For the latest version, on the other hand, the strategy has shifted more towards creating a high-recognition icon and trademark for an already well-established and known application.

5   Guidelines for the Visual Design of Icons

The three phases of users' journey are not always clearly separated, and they can overlap, affect each other, and be defined in varying ways. For instance, first exposure and assurance can in some cases refer to the actual first time a user sees an application icon and considers installing it, without any previous knowledge of the application. In some other cases, such as that of Basecamp©, the user might however be looking for a mobile application they have not used before, but they are already familiar with the software from another context or platform. Although one might question whether true first exposure and assurance phases actually exist in this example scenario, nevertheless, the icon design strategy can be completely different in targeting users in this particular scenario.

The three visual properties that have been proposed and used here – complexity, concreteness, and familiarity – are strongly connected to one another as well, and therefore, they are not meant to be considered entirely separately either. For instance, familiarity is more likely to occur when concrete visual elements are used rather than totally abstract ones. Similarly, concreteness may also require a certain amount of complexity.

While keeping these points in mind, in this section we propose a set of guidelines for considering these visual properties in design of application icons, with the aim of supporting the three phases of consumers' journey. Table 1 provides a summary of our proposed visual design guidelines for icons, which are then discussed below.

Table 1. A summary of the proposed guidelines for visual design of application icons.

	First Exposure	**Assurance**	**Continued Use**
Complexity	Attract attention through strong contrast in simple visual design elements.	Communicate a sense of high-quality through details in visual design.	Support rapid recognition in visual search tasks through strong contrast in simple visual design elements.
Concreteness	Communicate the intended use of the application through concrete visual design elements.	Increase the probability of invoking familiar meanings through concrete visual design elements.	Support visual search tasks through memorable visual design elements.
Familiarity	Attract attention through congruence and recognizable visual design elements.	Support processing fluency by repeating familiar or congruent visual design elements.	Support visual search tasks, and create brand experience through the repetition of ownable, familiar visual design elements.

5.1 Complexity

A lower level of visual complexity can be effective during first exposure, when the minimalism in visual design supports attracting attention through strong contrast in low-level primary visual properties. The aim is to catch users' attention during the preattentive visual search phases. The same benefits of minimalistic visual design, which relate to visual search tasks during first exposure, can be important for assurance as well. However, a more complex icon can be beneficial during the assurance phase, if complexity is used to communicate a sense of high-quality through details in visual design. For continued use, the focus of the visual design should primarily be on supporting rapid recognition in visual search tasks. This can

also be achieved through strong contrasts in simple visual design elements and low-level primary properties.

5.2 Concreteness

Concrete visual design elements are beneficial for the usability performance of an icon in all the three phases of consumers' journey. During first exposure, concreteness can be used to communicate the intended use of the application. The interplay between concreteness and familiarity has an important role to play during assurance, since concrete visual design elements have a better chance of invoking familiar meaning, which, in turn, supports processing fluency, leading to appeal and likeliness to purchase – i.e., to install an application. Concrete images can arguably have a better chance of entering a user's long-term memory. In this way, concreteness can also support visual search tasks during continued use. In addition, brand recognition, which is established through ownable visual design elements, can be easier to achieve through the use of more concrete imagery rather than simple abstract shapes, particularly for less known brands.

5.3 Familiarity

Familiarity and congruence clearly affect all the three phases of consumers' journey as well. Congruent and recognizable visual design elements can be used to attract users' attention during first exposure. Familiarity during assurance, on the other hand, can support the positive effects of cognitive processing, by incorporating visual design elements that represent familiar meanings through symbolism or the use of metaphors. This can contribute to processing fluency, thereby, leading to appeal and likeliness to purchase. Familiarity during continued use is a valuable means of creating brand experience through the repetition of ownable familiar visual design elements. In addition, familiar visual design elements can also support visual search tasks during continued use.

6 Conclusions

In this paper, we have discussed the process of a consumer's journey from first exposure to assurance and continued use of an application icon. We have also presented the three visual design properties of an icon, in terms of its complexity, concreteness, and familiarity. Based on these properties, through three case studies, we have analyzed the usability performance of the visual design of the original icons of three different mobile applications, as well their redesigned icons.

There are of course some limitations in terms of how clearly the phases of a customer's journey can be separated from one another. Furthermore, one should also note that the effects of the visual design properties of complexity, concreteness, and familiarity are strongly interrelated to each other. However, our example case studies indicate that it is possible to evaluate and predict the usability performance of a mobile application icon by evaluating how these three properties can be manipulated in the visual design of icons to make them more effective for different phases of the consumers' journey. While the limited number of case studies included here makes it difficult to generalize all our findings, yet these findings provide a starting point for further validation through future research.

Furthermore, it is evident that the effects of these visual design properties are dependent on the different phases of customers' journey. A lower level of visual complexity can be effective during first exposure, assurance and continued use by attracting users' attention and supporting recognition in visual search tasks. However, complexity can also be a means for communicating high design quality during assurance. During first exposure concreteness can be used to communicate the intended use of the application. During assurance, on the other hand, concreteness can increase the chance of invoking familiar meanings. In addition, during continued use concreteness can support visual search tasks by making an application icon easier to remember. Familiar and congruent visual design elements can attract attention during first exposure, increasing the positive effects of cognitive processing during assurance, and support visual search tasks during continued use and act as a means for creating brand experience.

It should also be noted that the maturity of an application, in terms of its functionality and market use, is a key factor in deciding on the visual design properties of its icon which are best suited for its use. For example, a well-established application like Instagram© [27] may no longer require an icon that is optimized for first exposure and assurance, but instead, its icon can be designed with more focus on continued use, brand recognition and brand experience. For a new or a relatively unknown application, on the other hand, much more emphasis must be placed on catching potential users' attention during first exposure in a crowded online app store, and persuading them to install the application during the assurance phase, rather than just aiming for better usability during continued use.

Finally, while we have proposed some guidelines for better targeting each of the three phases of consumers' journey using the three visual design properties of mobile application icons, these guidelines are mainly based on existing research from other fields such as logo design and branding. Although the analysis of our example cases studies shows the potential value of these guidelines, it is still necessary to formally evaluate their validity and practical value. We are currently planning to undertake such an evaluation, particularly to see if these guidelines make sense to visual designers who are tasked with the design of mobile application icons.

References

1. McDougall S., Reppa I, Kulik J et al : What makes icons appealing? The role of processing fluency in predicting icon appeal in different task contexts. Applied Ergonomics 55 pp.156-172. doi:https://doi.org/10.1016/j.apergo.2016.02.006 (2016).
2. Nakamura C., Zeng-Treitler Q : A taxonomy of representation strategies in iconic communication. International Journal of Human-Computer Studies 70(8) pp.535-551. doi:https://doi.org/10.1016/j.ijhcs.2012.02.009 (2012).
3. Lodding K.N. : Iconic Interfacing. IEEE Computer Graphics and Applications 3(2) pp. 11-20. doi:https://doi.org/10.1109/MCG.1983.262982 (1983).
4. Webb J.M., Sorenson PF, Lyons NP : An Empirical Approach to the Evaluation of Icons. SIGCHI Bull. 21(1) pp.87-90. doi:https://doi.org/10.1145/67880.67894 (1989).
5. Rogers Y. : Icons at the interface: their usefulness. Interacting with Computers 1(1) pp. 105-117 (1989).
6. Purchase H. : Defining multimedia. IEEE MultiMedia 5(1) pp.8-15. doi:https://doi.org/ 10.1109/93.664737 (1998).
7. Gaver W.W. : Auditory Icons: Using Sound in Computer Interfaces. Human–Computer Interaction 2(2) pp.167-177. doi:https://doi.org/10.1207/s15327051hci0202_3 (1986).
8. Blattner M.M., Sumikawa DA, Greenberg RM : Earcons and Icons: Their Structure and Common Design Principles (Abstract Only). SIGCHI Bull. 21(1) pp.123-124. doi:https:// doi.org/10.1145/67880.1046599 (1989).
9. Wang H., Hung S, Liao C : A survey of icon taxonomy used in the interface design. In: Anonymous ACM, pp. 203-206 (Aug 28, 2007).
10. McDougall S.J.P., Reppa I : Why do I like It? the Relationships between Icon Characteristics, user Performance and Aesthetic Appeal. Proceedings of the Human Factors and Ergonomics Society Annual Meeting 52(18) pp.1257-1261. doi:https://doi.org/ 10.1177/154193120805201822 (2008).
11. Rizvanoğlu K. : Generating guidelines for choosing appropriate metaphors in GUIs through the analysis of cross-cultural understanding of metaphorical icons: an explorative study with French and Turkish users on an e-learning site. Digital Creativity 21(3). doi:https://doi.org/10.1080/14626268.2010.483686 (2010).
12. Jylhä H., Hamari J : An icon that everyone wants to click: How perceived aesthetic qualities predict app icon successfulness. International Journal of Human-Computer Studies 130 pp.73-85. doi:https://doi.org/10.1016/j.ijhcs.2019.04.004 (2019).
13. Abdullah, R., Hübner, R.: Pictograms, Icons and Signs. Thames & Hudson Ltd., London (2006).
14. Phillips, Barbara J. ; Mcquarrie, Edward F. ; Griffin, W. Glenn : How Visual Brand Identity Shapes Consumer Response. Psychology & Marketing 31(3) pp.225-236. doi:https://doi.org/10.1002/mar.20689 (2014).
15. Jun J.W., Cho C, Kwon H.J. : The role of affect and cognition in consumer evaluations of corporate visual identity: Perspectives from the United States and Korea. Journal of Brand Management 15(6) pp.382-398. doi:https://doi.org/10.1057/bm.2008.11 (2008).
16. Henderson P.W., Cote J.A. : Guidelines for Selecting or Modifying Logos. Journal of Marketing 62(2) pp.14. doi:https://doi.org/10.2307/1252158 (1998).
17. Honeywill P. : Designing Icons for the Graphical User Interface. Digital Creativity 10(2). doi:https://doi.org/10.1076/digc.10.2.67.3254 (1999).
18. Moon H., Han S, Chun J et al : A Design Process for a Customer Journey Map: A Case Study on Mobile Services: A Design Process for a Customer Journey Map. Human Factors

and Ergonomics in Manufacturing & Service Industries 26. doi:https://doi.org/10.1002/hfm.20673 (2016).

19. Carbone L., Haeckel S : Engineering Customer Experiences. Marketing Management 3 (1994).

20. Shaw C., Ivens J : Building great customer experiences. Palgrave Macmillan, New York (2002).

21. Lemon K.N., Verhoef PC : Understanding Customer Experience Throughout the Customer Journey. Journal of Marketing 80(6) pp.69-96. doi:https://doi.org/10.1509/jm.15.0420 (2016).

22. Byrne M.D. : Using icons to find documents: simplicity is critical. In: Anonymous Association for Computing Machinery, New York, NY, USA (1993).

23. Stotts D.B. : The usefulness of icons on the computer interface: Effect of graphical abstraction and functional representation on experienced and voice users. Proceedings of the Human Factors and Ergonomics Society Annual Meeting 1 pp.453 (1998).

24. Isherwood S.J., McDougall SJP, Curry MB : Icon Identification in Context: The Changing Role of Icon Characteristics With User Experience. Human Factors: The Journal of the Human Factors and Ergonomics Society 49(3). doi:https://doi.org/10.1518/001872007X200102 (2007a).

25. Basecamp : Basecamp: Project Management & Team Communication Software. https://basecamp.com/. October 2022.

26. Airbnb : Vacation Rentals, Homes, Experiences & Places - Airbnb. https://www.airbnb.com/. Accessed October 2022.

27. Instagram : Instagram. https://www.Instagram.com/. Accessed October 2022.

28. Mollerup P. : Marks of Excellence. Phaidon Press Limited, London (1997).

29. Fajardo, Tatiana ; Zhang, Jiao ; Tsiros, Michael : The Contingent Nature of the Symbolic Associations of Visual Design Elements: The Case of Brand Logo Frames. Journal of Consumer Research 43(4) pp.549. doi:https://doi.org/10.1093/jcr/ucw048 (2016).

30. Bird L. : Advertising: Eye-catching logos all too often leave fuzzy images in minds of consumers. Wall Street Journal (1991).

31. Choi J.H., Lee HJ : Facets of simplicity for the smartphone interface: A structural model. International Journal of Human Computer Studies 70(2). doi:https://doi.org/10.1016/j.ijhcs.2011.09.002 (2012).

32. Treisman A.M., Gelade G : A feature-integration theory of attention. Cognitive Psychology 12(1) pp.97-136. doi:https://doi.org/10.1016/0010-0285(80)90005-5 (1980).

33. Treisman A., Gormican S : Feature analysis in early vision: Evidence from search asymmetries. Psychological Review 95(1) pp.15-48. doi:https://doi.org/10.1037/0033-295X.95.1.15 (1988).

34. Lidwell W., Holden K, Butler J : Universal Principles of Design. Rockport Publishers, Massachusetts (2003).

35. Whatsapp : Whatsapp. https://www.whatsapp.com. Accessed October 2022.

36. García M., Badre AN, Stasko JT : Development and validation of icons varying in their abstractness. Interacting with Computers 6(2) pp.191-211. doi:https://doi.org/10.1016/0953-5438(94)90024-8 (1994).

37. Korpilahti T. : Approaches to Interface Icon Classification. In: Kurosu M (ed), Human-Computer Interaction. Theories, Methods, and Human Issues - 20th International Conference, {HCI} International 2018, vol 10901. Springer, pp. 126-137 (2018).

38. Rogers Y., Oborne DJ : Pictorial communication of abstract verbs in relation to human–computer interaction. British Journal of Psychology 78(1) pp.99-112. doi:https://doi.org/10.1111/j.2044-8295.1987.tb02229.x (1987).

39. Ullman M.T. : Contributions of memory circuits to language: the declarative/procedural model. Cognition 92(1-2) pp.231-270. doi:https://doi:10.1016/j.cognition.2003.10.008 (2004).
40. Grobert J., Cuny C, Fornerino M : Surprise! We changed the logo. Journal of Product & Brand Management 25(3) pp.239-246. doi:https://doi.org/10.1108/JPBM-06-2015-0895 (2016).
41. Mehrabian A., Russell JA : An approach to environmental psychology. MIT Press (1974).
42. ISO 9241-210 : Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems. International Standard, 2. (2019).
43. Butler K.A. : Usability Engineering Turns 10. Interactions 3(1) pp.58-75. doi:https://doi.org/10.1145/223500.223513 (1996).
44. Desimone R., Duncan J : Neural Mechanisms of Selective Visual Attention. Annual review of neuroscience 18 pp.193-222. doi:https://doi.org/10.1146/annurev.ne.18.030195.001205 (1995).
45. Ware C. : Visual Thinking for Design, 1st edn. Morgan Kaufmann Publishers, Burlington (2008).
46. Microsoft : Microsoft. https://www.microsoft.com/. Accessed October 2022.
47. Zoom : Zoom. https://zoom.us/. Accessed October 2022.
48. Foodora : Foodora. https://www.foodora.fi/. Accessed October 2022.
49. Wolt : Wolt. https://wolt.com/. Accessed October 2022.
50. Line : Line. https://line.me/. Accessed October 2022.
51. Infiniti : Infiniti. https://www.infinitiusa.com/. Accessed October 2022.
52. Google : Google. https://about.google/products/. Accessed October 2022.
53. Angry Birds : Angry Birds. https://www.angrybirds.com/. Accessed October 2022.
54. Pan Y., Lin B, Zhao Y et al : Working memory biasing of visual perception without awareness. Attention, Perception, & Psychophysics 76(7) pp.2051-2062. doi:https://doi.org/10.3758/s13414-013-0566-2 (2014).
55. Fukuda K., Woodman GF : Visual working memory buffers information retrieved from visual long-term memory. Proceedings of the National Academy of Sciences of the United States of America 114(20) pp.5306-5311. doi:https://doi.org/10.1073/pnas.1617874114 (2017).
56. Phillips B.J., McQuarrie EF, Griffin WG : The Face of the Brand: How Art Directors Understand Visual Brand Identity. Journal of Advertising 43(4) pp.318-332. doi:https://doi.org/10.1080/00913367.2013.867824 (2014).
57. Nike : Nike. https://www.nike.com/. Accessed October 2022.
58. Dihiansan J. : Connecting the dots: How we put a smile on the Basecamp logo. – Signal v. Noise. https://signalvnoise.com/posts/3965-connecting-the-dots-how-we- put-a-smile-on-the-basecamp-logo (2015).
59. Liu J., Li J, Feng L et al : Seeing Jesus in toast: Neural and behavioral correlates of face pareidolia. Cortex 53 pp.60-77. doi:https://doi.org/10.1016/j.cortex.2014.01.013 (2014).
60. Rolls E.T. : Neurons in the cortex of the temporal lobe and in the amygdala of the monkey with responses selective for faces. Human neurobiology 3(4) pp.209-222. (1984).
61. Taubert J., Wardle SG, Flessert M et al : Face Pareidolia in the Rhesus Monkey. Current Biology 27(16) pp.2505-2509.e2. doi:https://doi.org/10.1016/j.cub.2017.06.075 (2017).
62. Tsao D.Y. : A Cortical Region Consisting Entirely of Face-Selective Cells. Science 311(5761) pp.670-674. doi:https://doi.org/10.1126/science.1119983 (2006).
63. DesignStudio : Airbnb - Belong anywhere | DesignStudio. https://design.studio/work/airbnb. Accessed October 2022.

64. Digiday : The best (and filthiest) tweets about Airbnb's new logo - Digiday. https://digiday.com/marketing/10-best-reactions-airbnbs-revamped-logo/. Accessed October 2022.
65. Clio Awards : Airbnb - Airbnb Rebrand | Clios. https://clios.com/awards/winner/design/airbnb/airbnb-rebrand-394. Accessed October 2022.
66. Pachal P. : What the designer of the old Instagram icon thinks of the new one. https://mashable.com/2016/05/11/instagram-old-icon-designer/?europe=true (2016). Accessed October 2022.
67. Langenfeld N. : History of the Polaroid Camera https://www.sutori.com/en/story/history-of-the-polaroid-camera--Ag1tvQmMVmHZPffv5fweFDcs. October 2022.