On the Understandability of Public Domain Icons: Effects of Gender and Age

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Abstract. Icons and symbols are often deployed in graphical user interfaces. It is commonly believed that icons add to the user friendliness of products. Developers have great trust in icon libraries and they are likely to use icons they understand themselves without verifying users' understanding. Interfaces relying on icons that are misinterpreted can lead to erroneous operation. In this study a set of icons in the public domain was interpreted by 64 participants to assess how well general icons are understood. Of the 105 icons included only 67 were correctly identified by all the raters. The results confirm that some basic icons are universally known. However, nearly half of the icons where not identified by all. Recognition correlated with gender, as males were more likely to identify icons connected to masculine concepts and females were more likely to recognize icons connected to feminine concepts. Moreover, a positive correlation was found between the age of the participants and icons depicting ideas from the past versus timeless icons. The results thus support the practice of user testing of icons rather than relying on assumptions.

Keywords: Icons · Recognition · Gender · Age

1 Introduction

Icons are commonly used in graphical user interfaces. Attempts have even been made at making complete icon-only based interfaces [1], as icons are believed to consume less real-estate on mobile handsets with small displays. Icons have been applied in a vast range of domains including translation tasks where texts and icons are used in parallel to aid translation [2].

There is a general belief that icons improve user friendliness of user interfaces. However, unlike text which is read, icons are recognized. Consequently, icons must be learned in order to be correctly interpreted as it is impossible to recognize an icon of a concept unknown to the viewer. Many icons, however, rely on the users' general

knowledge about the world and items and notions in the real world that can be considered universal – concepts and notions that most of us have learned, such as the Isotype diagrams for man and woman. These universal symbols are thus frequently used in both the physical and digital domain.

Humans decode simple symbols more rapidly than complex and detailed symbols. This is the reason why traffic signs are simple – many of which are impossible to understand without training. Driving licenses ensures that the driver has gone through sufficient training and has knowledge of all these traffic signs.

Icons are also known to be connected to the users' context and culture, as icons that are meaningful in one cultural setting may be difficult to understand in another cultural setting [3–5]. A study of Taiwanese students' understanding of icons showed that icon recognition was linked to the students' English proficiency, but mostly to their computer literacy [6]. The effect of culture and context is strong because icons are learned. To study how children perceive icons is therefore particularly relevant as they are less affected by the context and experience compared to older users [7].

The challenge of designing icons that users understand is well known. Several voices argue for the user testing of icons during development [8] and more detailed test methodologies have been proposed such as lexical analysis, semiotic analysis, long distance visibility testing [9], icon intuitiveness testing [10] and magnetic resonance imaging [11]. However, others argue for better icon design methodologies [12].

Attempts have also been made at improving icon recognition performance. In one study the researchers relied on the users' visual memory and ability to memorize locations and hence make associations between automatically generated landmark icons [13]. Research has also found that larger icon spacing leads to shorter icon recognition times [14]. Other approaches use multiple modalities such as visual icons and audio to improve recognition [15]. The issue of how many icons users can relate to before reducing recognition performance has also been addressed [16]. In a study of icons intended for a music application rules based on a model of emotions were used in the design [17]. Other studies of performance related to icons have addressed effects of physical constraints such as few or no colors, limited pixel resolution and size [18].

Despite the vast literature on icons and attempts at organizing icons into taxonomies [19], icons are still often employed on the basis of assumptions that users are familiar with universal shapes. Thus the motivation of this study was to shed light on the understandability of general icons.

2   Method

2.1   Participants

A total of 64 students participated as icon raters of which 76.6 % were female and 23.4 % were men. Their mean age was 27.8 years. All the participants were first year students in library and information science at Oslo and Akershus University College of Applied Sciences.

2.2 Stimuli

A total of 105 icons were selected from the Noun Project (http://thenounproject.com/) and are all released into the public domain under a Creative Commons license. The Noun collection is too large to be included in its entirety in this study for practical reasons. The icons investigated were thus prescreened and selected according to the principal investigators subjective impression of clarity and understandability. Unclear and obscure icons where discarded.

A paper based questionnaire was created with the icon on left and a line for writing the name of the icon on the right.

2.3 Procedure

The questionnaires were distributed in class. Students were asked to write down a word (noun) to describe what they thought the icons represented. The primary investigator personally administered the questionnaire session. The questionnaires were collected after 20 min when all of the students appeared to have completed the questionnaires.

2.4 Analysis

Four of the questionnaires were discarded as outliers as too many of the fields were not completed. The remaining 60 questionnaires were included in the analysis. Each reply was tallied if the response matched the intended meaning of the icon or using a description which was sufficiently similar.
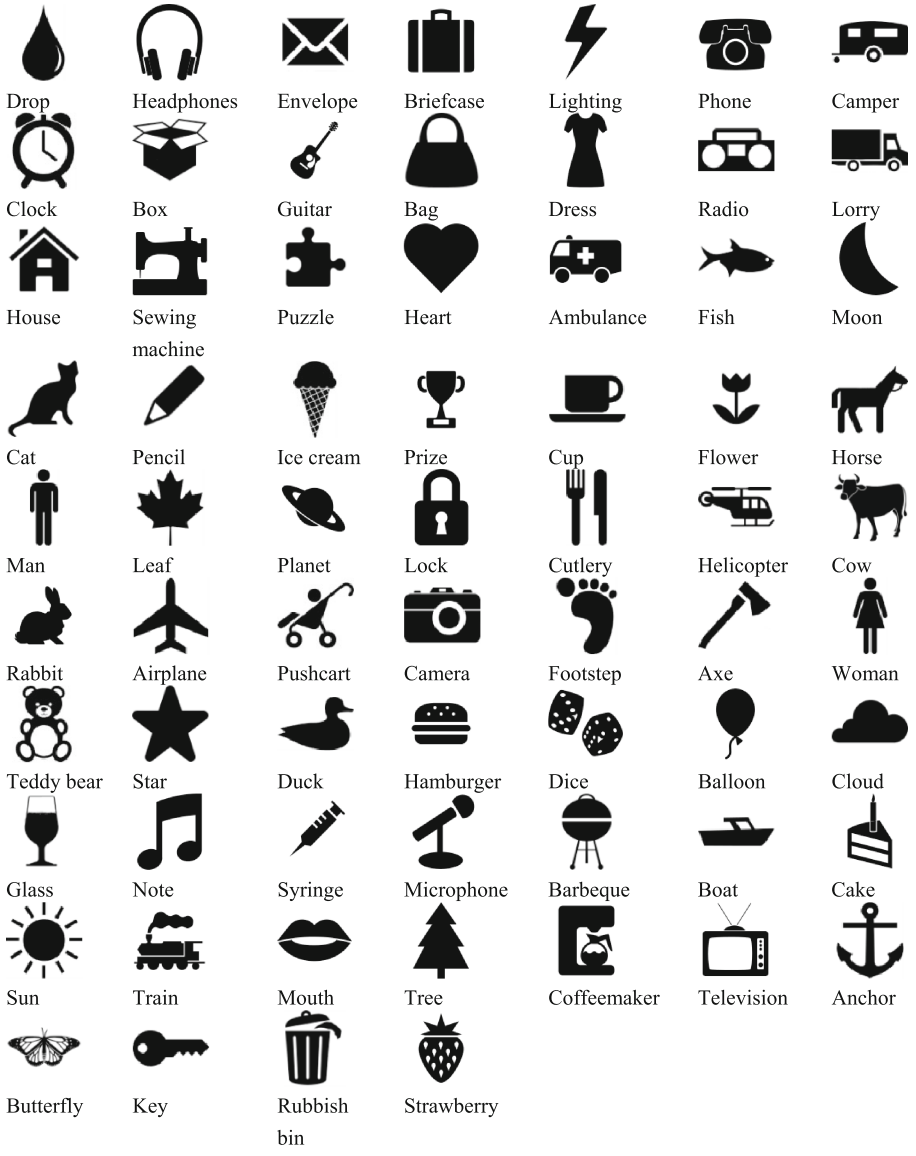
3 Results

Most of the icons were identified by all the participants, that is, a total of 67 icons. These are shown in Fig. 1 and are not discussed any further herein. Next, 22 icons were recognized by between 97 % and 98 % of the subjects (see Fig. 2). This is close to a rater agreement of 100 % since only one or two individuals failed to recognize the icons.

Consequently, these icons are considered understandable as the error rate is less than 5 % and the misinterpretation is more likely to be caused by individual ad hoc factors.

The remaining items incurred error rates of 5 % of more and are considered significantly challenging to interpret. Of these a total of 10 icons where identified by 90–95 % of the participants (see Fig. 3) and are thus the easiest to recognize among the set of icons that were not successfully identified by all the participants. These were ghost, factory, hand, pot, calculator, scooter, cannon, ant, bathtub and spool of thread.
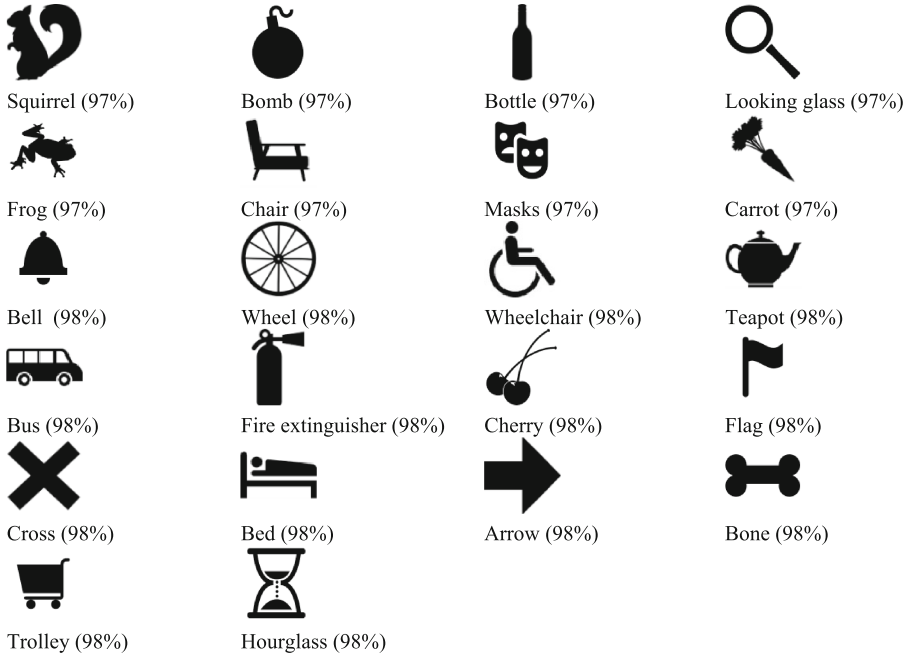
One possible explanation may be that the ghost was printed in black on a white background, while stereotypical ghosts usually are white on a dark background representing night. The calculator could be interpreted as a mobile phone. Two decades ago there were few mobile phones and calculators where common, while today mobile phones are more common and even used as calculators. The bathtub visualization includes a shower which perhaps is confusing. One may speculate whether the misidentification of the bathtub could

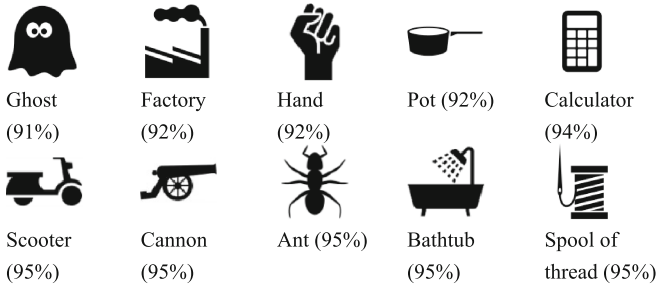|						
Drop	Headphones	Envelope	Briefcase	Lighting	Phone	Camper
Clock	Box	Guitar	Bag	Dress	Radio	Lorry
House	Sewing machine	Puzzle	Heart	Ambulance	Fish	Moon
Cat	Pencil	Ice cream	Prize	Cup	Flower	Horse
Man	Leaf	Planet	Lock	Cutlery	Helicopter	Cow
Rabbit	Airplane	Pushcart	Camera	Footstep	Axe	Woman
Teddy bear	Star	Duck	Hamburger	Dice	Balloon	Cloud
Glass	Note	Syringe	Microphone	Barbeque	Boat	Cake
Sun	Train	Mouth	Tree	Coffeemaker	Television	Anchor
Butterfly	Key	Rubbish bin	Strawberry			

Fig. 1. Icons successfully identified by all the participants (100 % recognition rate)

be connected to the trend that more Norwegian homes are fitted with showers than bath-tubs compared to three decades ago.

Next, Fig. 4 shows four icons recognized by 69–81 % of the subjects, namely wind-surfing board, parking meter, hammer and floppy disk. Possible explanations could be that there was a windsurfing craze a few decades ago, while it is not as popular today. The parking meter icon depicts a coin operated mechanical device, while current day parking meters often are larger wall mounted self-service terminals offering credit card

Squirrel (97%)   Bomb (97%)   Bottle (97%)   Looking glass (97%)

Frog (97%)   Chair (97%)   Masks (97%)   Carrot (97%)

Bell (98%)   Wheel (98%)   Wheelchair (98%)   Teapot (98%)

Bus (98%)   Fire extinguisher (98%)   Cherry (98%)   Flag (98%)

Cross (98%)   Bed (98%)   Arrow (98%)   Bone (98%)

Trolley (98%)   Hourglass (98%)

Fig. 2. Icons recognized by 97 % and 98 % of the participants

Ghost   Factory   Hand   Pot (92%)   Calculator
(91%)   (92%)   (92%)   (94%)

Scooter   Cannon   Ant (95%)   Bathtub   Spool of
(95%)   (95%)   (95%)   thread (95%)

Fig. 3. Icons recognized by 90–95 % of the participants

Windsurfing board   Parking meter   Hammer (75%)   Floppy disk
(69%)   (70%)   (81%)
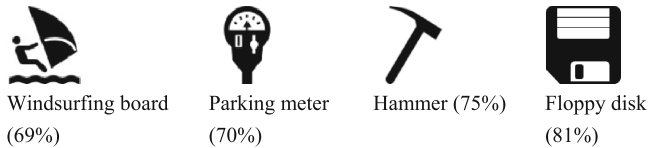
Fig. 4. Icons recognized by 69–81 % of the participants

or mobile payment via text messaging. Moreover, the floppy disk is obsolete and it is possible that younger individuals do not have the same relation to the floppy disk as older individuals.

The hammer is still a current object, however, it can be considered masculine. One may speculate that the large female group comprising three quarters of participants show signs of a more distant relationship to the hammer compared to the smaller group comprising one quarter of men. Another possible explanation is that the icon resembles a pick. The error rates for these four icons are significantly high as one in five individuals misinterpreted the icons. One may argue that such icons are not suitable for general user interfaces where the users are not subjected to training.

The two icons with the lowest recognition rates were the depictions of a parachute and a wrench with recognition rates of only 47 % and 52 % (see Fig. 5). A wrench is a tool which may be associated with masculinity and the results show that the ratio of men that successfully identified the wrench (66.9 %) was larger than the ratio of women (46.7 %). The same pattern could be observed for the parachute, which may also be considered a masculine symbol, although the differences are smaller, with a success rate of 53.3 % for males and 44.8 % for women.
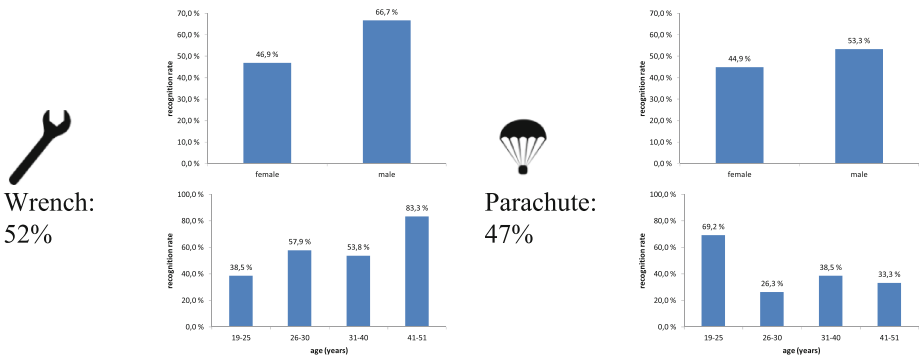
Fig. 5. The wrench and parachute icons recognized by only approximately half of the subjects with recognition rates according to gender and age

To further explore the effect of age the participants were organized into four age groups: participants 25 years old or younger, participants aged 26–30, participants aged 31–40 and those aged 41 or older. The results show that age has an effect in both cases as the participants 40 years or older had a recognition rate of 83.3 % while only 38.8 % the participants 25 years or younger recognized the wrench. Cleary, the mature subjects demonstrated a familiarity with the wrench while the younger participants demonstrated less familiarity with the wrench.

Surprisingly, this pattern was somewhat reversed for the parachute icon where 69.2 % of the participants of 25 years or younger recognized the parachute, while the recognition rates were less than 40 % for all the other age groups. If this is due to parachutes being part of younger individuals' lives or whether they have more imagination in interpreting the icons is only a speculation.

Next, to explore the hypothesis that icon recognition is related to gender the icons were subjectively classified as masculine, feminine and neutral (see Table 1).

Masculine icons were related to war such as bomb, parachute and cannon, and typical male dominated professions such as factory work, or work involving tools such as hammer and wrench.

Table 1. Gender icon categories

Gender	Icons
Masculine	Bomb, cannon, factory, floppy disk, hammer, parking meter, wind-surfing board, wrench, parachute
Feminine	Teapot, squirrel, spool of thread, pan, ghost
Neutral	Remaining icons

Feminine icons were related to household items such as teapot, pan and spool of thread, as well as cute animals such as squirrel – assuming squirrel décor is more common on girls' toys. The ghost was also categorized as feminine as the depicted ghost is cute and based on a weak assumption that females are generally more interested in spirituality than men.

Next the ratio of successfully recognized icons in each category according to males and females were counted and the results are shown in Fig. 6. The results confirm the hypothesis that icons can be connected to gender as more females (97.1 %) recognized feminine icons than males (86.7 %). Moreover, more males (84.4 %) successfully recognized masculine icons compared to females (72.6 %), while the recognition ratios where more even for the neutral icons with 96.9 % and 98.3 %, respectively. One may conclude that it is advisable to use gender neutral icons unless the user interface is specifically intended for a specific group of individuals.
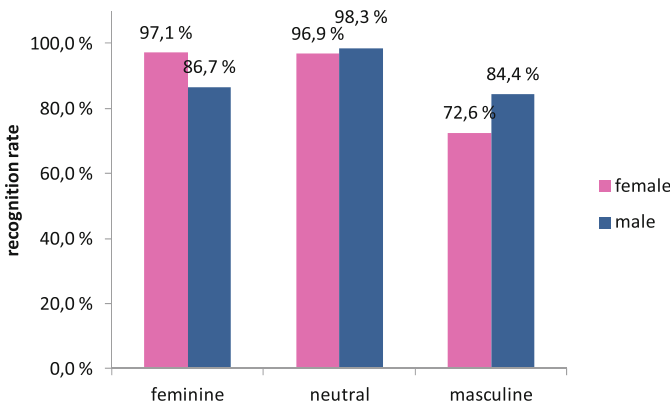

Fig. 6. Recognition of feminine, masculine and neutral icons as a function of gender

Finally, to explore the hypothesis that certain icons are outdated and thus more easily recognized by older and more experienced participants, the icons where subjectively classified into aged and timeless icons as shown in Table 2. Aged icons are those depicting items no longer in use such as the hour glass, floppy disk and coin operated parking meters. Factory was classified as aged as there are very few actual factories in Norway since most of the factory industry has moved overseas. The participants were divided into those 25 years or younger, participants in the range of 26–30, 31–40 and those older than 40. The ratio of aged and timeless icons recognized where counted and the results are shown in Fig. 7.

Table 2. Aged versus timeless icons

Category	Icons
Aged	Hour glass, spool of thread, bathtub, cannon, factory, floppy disk, parking meter, windsurfing board, wrench
Timeless	Remaining icons
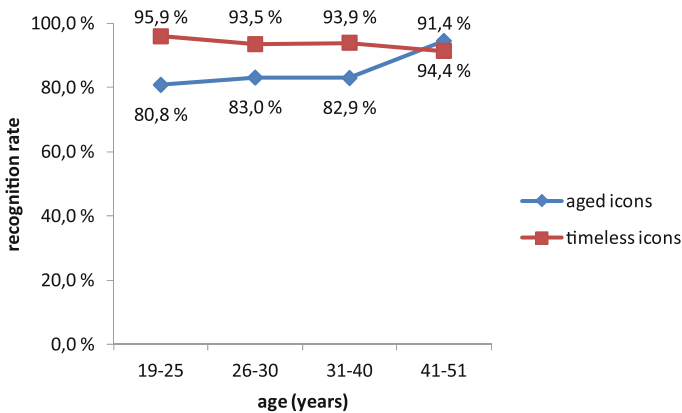
Fig. 7. Icon recognition as a function of age

The results confirm the hypothesis that icon recognition is related to experience and time periods as the timeless icons are identified by more than 91.4 % by all age groups. However, the recognition rate for the aged icons is higher for the older participants (94.4 %) than the youngest participants (80.8 %), with the remaining participants in between. One may conclude from this that it is important to keep in mind that the notion of universal symbols is not constant, but rather in continuous change reflecting our culture and the current objects we surround ourselves with and the activities we are involved in.

4   Conclusions

This study explored the understandability of a set of general icons in the public domain. The results revealed that general icons are not necessarily universally recognized.

The results further suggest that there are effects of gender and age, as the recognition of icons is related to the viewers' context, knowledge and experience and not only the result of the rendering of the icon. Consequences of these findings are that icons should be used with care by avoiding gender specific icons and icons representing outdated concepts. One way to ensure that the icons are understandable is to perform user testing of the icons. Since icons are commonly used in a wide range of products, commercial icon providers should be expected to extend their service beyond being graphical artists by conducting such recognition studies and bundle icon packages together with recognition rates or icon quality certificates. In this way, developers can focus on essence of application development and not superficial visual details.

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