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Analysis of the Pattern for Icon Selection and Relation to Positive/Negative Actions in Desktop Applications

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Abstract

The paper presents an experiment on selecting and identifying an icon in desktop applications. The aim of this work is to get more specific guidelines for improvement in the design of a natural user interface. By conducting an indirect survey and handling different tasks to users, the issues such as what usual patterns for overviewing an icon in desktop applications are, how these patterns change when a user has to make a decision on what icons must be selected, how the pattern for selecting the icon varies and what changes in selection time take place when a task is executed multiple times in a row have been considered. To examine the influence of decision making on icon selection, icon classification into the positive and negative ones has been employed. As users had no guidelines what a positive/negative icon was, the ability to analyze if the colour of the icon and a related type of action influenced the perception of the icon has been developed. The carried out research draws the basic patterns for overviewing the icon in desktop applications and proves that the colour of the icon or the related type of action cannot be used as a single property to indicate icon perception by users.

Keywords: Icon; user interface; desktop applications; human-computer interaction.

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1 Introduction

The user interface (UI) is one of the most important elements in the successful promotion of software among those applying it in practise. The user interface has to implement software functionality, to be easily applied and intuitive for different types of users. The design of a suitable UI is a challenging task and requires knowledge of Human Computer Interaction (HCI) in order to create a successful Natural User Interface (NUI), as every situation can be unique. Therefore, what is suitable for one project can be a failure for another; it requires a wide variety of knowledge to design a successful UI. The user interface designer must be sure that all important properties and psychology of the customer have been taken into account and that technical abilities to implement different elements of the user interface have been properly considered. The complexity of the task for UI design can be highlighted by the fact there is no clear, unambiguous rules of how to design a good user interface. There exist only different guidelines and proposals for how to create a suitable UI or a particular type of software for a certain group of users [1]-[8].

A rapid change in technologies and new HCI methods change the user's perception of UI usability. Therefore, knowledge of the NUI has to be frequently renewed; otherwise, it will lead to a failure rather than successful user interface design. Therefore, even the most useful and functional systems have to be updated in order to meet new UI tendencies and user requirements. The aim of this paper is to get more specific guidelines for improvement in natural user interface design, which will be done analyzing the properties of user's work on icon-based desktop applications thus presenting the situation observed in 2013 – 2014. As new ideas of UI design takes time for spreading worldwide, these guidelines should be helpful in 2015 and in the future if no drastic changes emerge in this area.

2 State of the Art

One of the elements used in the UI is an icon – a sign or representation that stands for something by virtue of a resemblance or analogy to it [9]. It plays an important role in the NUI as one good icon can tell more on its purpose comparing to multiple words or even sentences used for describing the function. Therefore, some researches have been done in this area to get more data on the usage, importance and clustering of the icon. Mack et al. [10] suggested that a particularly meaningful icon in displays could capture our attention, and therefore a meaning had to be added to the icon. McDougall and Curry [11] examined a broader context of interpretation from a cognitive psychological perspective by analyzing the effects of workload and task complexity, user preferences and aesthetics, time for day effects and user skills. The results of these works proposed additional guidelines. However, the relationship between the icon and the function is not determined by a set of well-defined syntactic and phonological rules. Icon interpretation is still ambiguous and no laws are presented to determine the quality or success of the icon among its users. It is important to find as many factors influencing the success of icon usage as possible in order to better understand this area.

The role of relationships can be noted in works by Niemela and Saarinen [12] as well as in those by Richards and McDougall [13]. These authors analysed the importance of icon clustering. According to the obtained results, icon clustering allows more effective icon search as well as quicker identification of icon-function relationships. These findings are useful for designing the UI with the help of multiple icons; however, no data on designing one specific icon are given. Research on specific icon design was done by Hg and Chan [14] who analyzed three visual features (colour, surround shape and icon size) and five cognitive (familiarity, concreteness, complexity, meaningfulness and semantic distance) features of the icon. The results of the conducted research on colour importance do not meet with those obtained by Courtney [15] who proved colour was commonly used for communicating with the meaning – red for danger, green for 'go', etc. Colour conventions appear to have reasonable cross-cultural transferability in Courtney research. Meanwhile, Hg and Chan confirmed the colour of the icon was not the only factor as other properties had to be taken into account to determine icon suitability. They also, among other properties, did not give a quantitative evaluation of icon effectiveness or a factor in colour importance. However, more works state the colour has a big influence on icon usage: Wang et al. [16] found the pictorial-colour was a significant factor in the visual identification of subject performance; Shieh and Huang [17] revealed the pictorial size and circle-slash thickness influenced glance legibility for prohibitive symbols under degraded situations; Duarte et al. [18] indicated the pictorial symbol, colour and shape influenced understanding the symbol.

Understanding the problem of icon usage is very complex. Thus, some researchers analyzed very specific situations: designing a web icon for travel websites [19]; mobile interface icons [20]; context-aware navigation in mobile games [21]; differences in shallow and solid icons [22]; analysis of the icon for specific purposes [23]; etc. Most of researches investigating the properties of icon usage in a specific area received clearer data, tendencies and insights compared to researches where, at the same time, a very wide application area was analyzed. This shows that icon interpretation and usage depends on the type of application (web, mobile, desktop application, etc.). Unfortunately, the existing researches on different types of the UI concentrate on the identification of icon context rather than on the patterns identifying the relation or selection of the icon. Meanwhile, these two properties are important for the NUI as the relation of the icon holds the first expression and unconsciously influences the judgment of the icon and the system; also, the pattern of icon selection can give guidelines on how icons should be ordered to fit natural user behaviour and to increase system usability.

Time for task execution is one of the most important metrics in HCI and NUI. It allows estimating how quickly the user is able to execute a task and how much time s/he has to waste and wait because of input device properties or an improperly designed UI. Fitt's law [24] proposes a formula for calculating time needed to go from one point to the centre of an area of a certain size. This law is still relevant and used; however, additional data are needed to be able to adopt this law for a successful design of the NUI: if we know users and typical UI overview patterns, we can calculate the most probable time for eye movement needed to overview the UI; if we know what icons are the most noticeable, we can predict time for eye movement needed to find a certain icon. Therefore, this paper analyzes icon selection properties in the icon-based desktop environment and seeks for two main goals:

- To get data on icon overview patterns that assist in selecting an icon in the desktop environment.
- To highlight some properties that could indicate whether an icon will be related to positive/negative actions treated as positive/negative.

3 Methodology

As mentioned above, the pattern for selecting the icon is an important factor in the NUI. If we knew the pattern for overviewing and selecting the icon, we would be able to group and place icons according to their importance and the frequency of usage. A typical pattern for overviewing the UI can be identified experimentally. Software usability is usually evaluated by means of different methods, including reviewing standards, user testing, subjective assessments and barrier walkthrough [25],[26].To make sure we will get more realistic results the prospect of indirect survey was chosen. For conducting the experiment, an internet tool has been created to imitate the icon-based desktop environment.

Typically, users have two main eye movement tasks in the UI: the user overviews the whole UI in order to inspect functionality, and the user searches for specific information and the function he needs. Overviewing the UI requires going through all icons while search in the UI requires going through all or some icons in the UI and selecting only the specific ones. Our experiment had to imitate both situations. For the overview, we required to select all icons on the desktop to make sure the user saw the icon. As for the task searching for an icon, we asked the user to select positive/negative icons. This additionally allows estimating properties influencing user opinion on icon positivity/negativity as well as ensures they do not need to remember the icon list we asked to select. If a certain list of icons were given to select, we would have one more unknown parameter in this research – how well the user is capable of remembering what s/he needs to find. Meanwhile, in real life, the user usually decides on what to select by him/her. Tasks to select positive/negative icons should be unusual for all users, and all of them should have no prejudgements what have to be selected. Therefore, we could get data on how selection time changed when a task was given for the first time and repeating it multiple times. This type of the task presents a situation when users make a decision rather than try to remember what have to be selected.

Every experiment involved twenty icons placed in different places of the virtual desktop (Table 1). The icons were chosen to present all main icons, which most of users met working with desktop applications. The biggest part of icons cannot be met directly on the desktop; however, they can be seen in different software or the Windows operating system (Windows operating system is applied, as the major part of Lithuanian people use it because it is known and popular). This allowed us to prevent from prejudice where a specific icon should be in a real desktop environment and to make sure all icons are known to the user that has some experience of working with them.

Also, we assigned the main colour and type of action for each of those icons (Table 1). It was done before the main experiment using a separate group of 26 persons. Each of them had to identify what the main colour (only one colour) of the icon was. All persons were asked to select whether the icon was associated with creation, destruction or neither of these actions. This allowed us to get preliminary classification of icons. At this stage, we did not want refer to the same users as in the real experiment by seeking a more general estimation of all icons in the main experiment as well as by keeping the properties and purpose of the experiments in secret for all users before the main experiment.

Table 1. List of icons used in the experiment

No.	Icon	Title	Main colour	Action type
1.		Copy	Blue	Create
2.		Paste	Other	Create
3.		Edit	Other	Create
4.		Help	Blue	Other
5.		Search	Black	Other
6.		Save	Blue	Create
7.		Confirm	Green	Create
8.		Delete	Black	Destroy
9.		Recycle	Black	Destroy
10.		Error	Red	Destroy
11.		Cut	Blue	Destroy
12.		Close	Red	Destroy
13.		Warning	Other	Destroy
14.		Shutdown	Red	Destroy
15.		Picture	Blue	Create
16.		PDF document	Red	Create
17.		Email	Other	Create
18.		Search	Blue	Other
19.		Exception	Green	Destroy
20.		Sound	Black	Other

The main experiment involved all users having to execute three different tasks:

1. To choose all icons from the desktop (by clicking on it) in any order they want.
2. To choose all positive icons from the desktop in any order.
3. To choose all negative icons from the desktop in any order.

The early stages of this experiment showed usual, non-disappearing icons that influenced much dissatisfaction from users in Tasks 2 and 3. The users complained they did not remember what they had already selected. Sometimes, even user frustration was noticed, and therefore different solutions were considered for this survey. Solution to disable icon after selection was eliminated as current desktop applications do not use this practice very often and it would be unusual for users. Meanwhile, icon elimination from the working window is common to many systems of design. Therefore, we decided, after clicking on the icon, it would disappear from the desktop. It gives multiple bonuses to this experiment as the user has no chance to click twice on the same icon doing the same task; it is similar to rating a natural object when the user eliminates the chosen element from the list; it helps with tracking what icons have already been selected and to decrease the number of icons to click.

No explanation in which order icons have to be selected or what should be treated as a positive/negative icon has been given to users. It was done in purpose to invoke the user to find his/her way with no predefined requirements or measurements. In addition, the experiment was executed three times randomly changing the place of icons. The repetition of experiments allows us to eliminate anomalies in user actions as well as to examine if these actions change executing the same task multiple times in a row.

137 users took place in this experiment during the period from May 2013 to September 2014. They also had to provide some data on their gender, age group (from 7 to 14; from 15 to 19; from 20 to 29; from 30 to 39; from 40 to 49; from 50 and above), a field of occupation (Economy, Physiology, Psychology, Technical and Technology scope, Law, Management, Other) they belong to and the country of origin. All personal data were used for analysing if it influenced the pattern for selecting an icon or related results and did not require any specific personal data that could be related to a certain person. The survey was open and everyone who knew the address of the study had a chance to participate. Participation was voluntary. The first page of this tool introduced research as the scientific one. A note shown to all users indicated they had to be at least 18 years old or have a permission of their parents or tutors to attend this experiment.

The results of 69 men and 68 women were analyzed. All other categories were distributed not so evenly; however, at least 3 persons were participating in each category considering age and the field of occupation. Also, there were 19 respondents who did not live in Lithuania at the moment of the survey (9 different countries).

During the experiment, we logged on the selected ID of the icon, a location on the desktop, icon classification into positive or negative, icon selection order, icon selection time, task number, repetition number and mouse click/icon position on the desktop. To simplify the randomization of icon position (as no icons can be placed in the same place or too close to each other) and storage in the log, the desktop was divided into 8 columns and 8 rows, which allowed having 64 different cells on the desktop (Fig. 1.).

4 Results and Discussion

All experimental data were carefully analysed from different perspectives. Two main goals have been established in this paper, and the obtained data have been grouped into two subsections each of which will be presented.

Fig. 1. Example of the experimental environment where all icons are placed randomly on the desktop area and black lines indicate to which cell (column and row) the icon belongs to

4.1 Analysis of Icon Selection Properties

One of the most important measures for the UI is the distance the user has to cover from one click to another. The analysis of the experiment shows that the distance of mouse movement between two clicks depends on the age of the user (Fig. 2). The youngest participants (up to 15 years) showed the capability to choose all icons in the shortest path while all other age categories reported similar results – the average distance between two mouse clicks were from 2.21 to 2.24 of cell width. No tendencies how other user properties (gender, occupation, etc) influences the icon selection distance were noticed during the analysis.

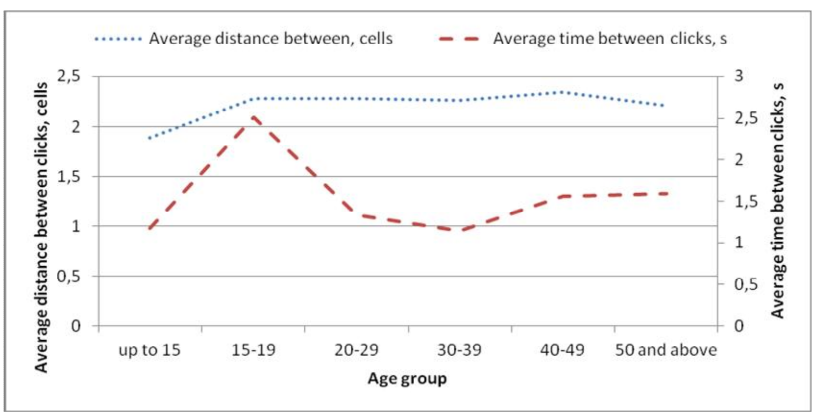

Fig. 2. The average distance of mouse movement and time between two clicks considering the users of different age groups participating in the experiment

Next, distance in cells rather than in pixels is calculated, as the size and resolution of the screen for each user might differ. Also, the distance between cell centres is estimated, as the icon is usually placed in the centre of the cell, and we have logged only the cell rather than an actual mouse position in the screen.

Time is another important measure for the UI. The number of the selected icons might differ considering each user in a different task; therefore, the average time between two mouse clicks was compared and made 1.65 seconds. However, we noticed that the maximum time between two clicks was more than 2 minutes, and 8 times for selecting an icon were found unexpectedly large. This shows these users made some breaks or were disturbed from the task. Therefore, we eliminated all records within the intervals of more than 30 second between mouse clicks and used only the corrected data on time calculation. This allowed obtaining the average time between mouse clicks equal to 1.351 seconds.

The analysis of the average time between two mouse clicks showed interesting results as the age group from 15 to 19 years was slower comparing to other age groups (Fig. 2). The age group from 15 to 19 has the greatest standard variation in time (2.11), which shows the users of this group are very different and unstable as a deeper analysis of data on separate users have showed there are respondents with longer time between mouse clicks as well some users having a wide range of times. In opposite to this group, the age group of up to 15 years showed a very constant speed for all clicks (were executed up to 2 seconds). This also can be related to the distance between mouse clicks – this group had a smallest distance between clicks, and therefore, according to Fitts' law, [27] time should be shorter as well.

To evaluate all events of all age groups or even of the users meeting Fitts' law, this experiment would be not correct. Fitts' law takes into account reaction time and task difficulty, which depends on target distance and width. As regards this experiment, all targets are of the same width, and distance to the target should be the same as that between two mouse clicks; nevertheless, no data on what is the reaction time of the users are available. Meanwhile, reaction time can vary extensively in this experiment, particularly if the user needs time for deciding what a positive/negative icon is. The importance of reaction and decision time can be noticed examining variation in time between two mouse clicks – time to go from one cell to another can be different for the same user in different tasks. The analysis of the average time between mouse clicks during different tasks and repetitions differ (Fig. 3). The first task requires less time for going from one icon to another comparing to Tasks 2 and 3, as the user does not need to think what s/he identifies as a positive/negative icon. It meets with Hiko principle stating that the time it takes to make a decision increases proportionally to the number and complexity of choices [28].

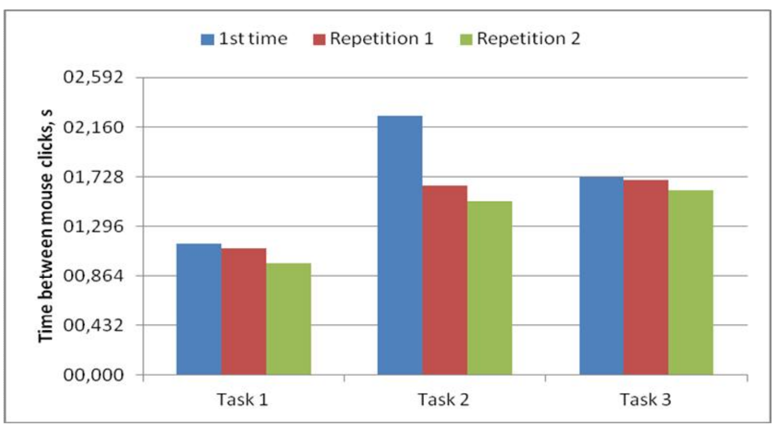

Fig. 3. The average time of mouse movement between two clicks considering different tasks and repetitions

Principles of Gestalt psychology state that the icon is recognized easier if it was selected once before [29],[30]. We also have obtained analogue results, as time between two mouse clicks is decreasing each time the user repeats the task. It shows less time is needed to identify the icon as positive/negative. However, the times of Tasks 2 and 3 do not reach those of Task 1, and this means there is additional thinking in Tasks 2 and 3 (need to decide once again or to remember what to choose) comparing to Task 1.

Also, the difference between tasks can be noticed analyzing the average distance between mouse clicks (Fig. 4). Tasks 2 and 3 have a longer distance between two mouse clicks comparing to Task 1. This can be explained by the fact that the distance between the icons increases as not all icons must be selected. Besides, it is possible the user selects these icons starting from the most positive/negative to the least positive/negative one, and therefore does not try to use the shortest path in contrast to Task 1.

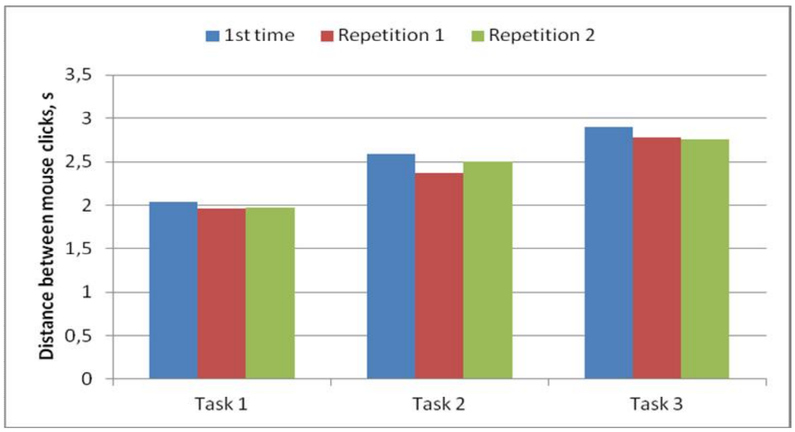

Fig. 4. The average distance of mouse movement between two clicks considering different tasks and repetitions

Fig. 4 shows the distance between two mouse clicks does not vary greatly when the task is repeated. A decrease in the distance between two mouse clicks can be achieved by optimizing the icon selection path; however, it can be difficult to achieve if there are too many icons to remember and to find the shortest path between them. Apparently 20 icons are too many to remember, or the shortest path was optimal at the first attempt in Task 1. Meanwhile, regarding Tasks 2 and 3, a decrease is larger comparing to Task 1. It might indicate some optimizations were done, however it is not as big as it could be.

The analysis of how (in which direction) the user usually chooses icons reveals that the biggest part of users has the same start strategy. Task 1 shows how users start from the left-top corner and go to the right or down. Later, they follow the opposite direction or start from a new column/row. Therefore, the first icons the user chooses in Task 1 are usually in the left-top corner. Fig. 5 suggests that the average icon selection order is the smallest in the top-left corner and increases crosswise at the right-bottom corner. However, a more detailed analysis of icon selection order showed a tendency to go from the left to the right one line by one, which is more frequent than going from the top to the bottom column after column.

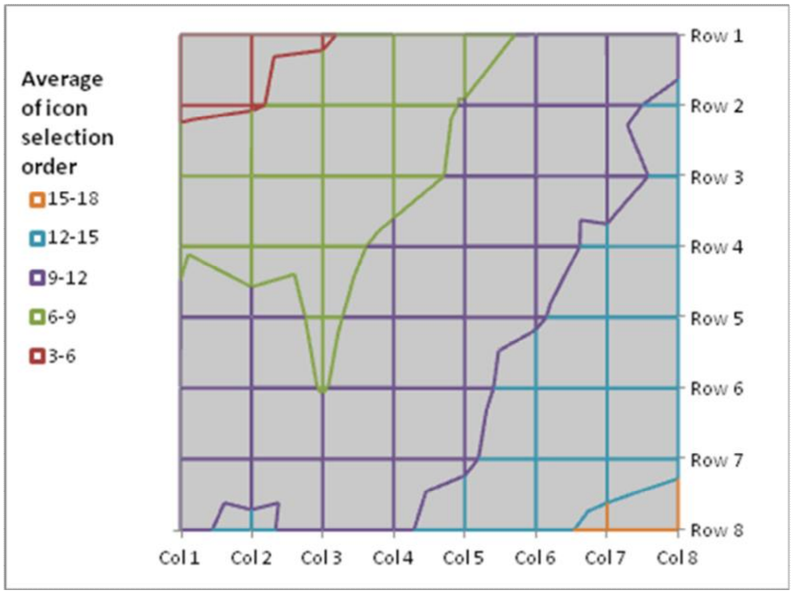

Fig. 5. The average order of the selected icons accordingly to the cell of the desktop

An interesting point is that the same pattern for selecting the icon order applies to Tasks 2 and 3. This shows the same "desktop scanning" method is used not depending on what the user has to choose, as s/he overviews the desktop in the same order. We should add the order might be influenced by a position where the user starts the task as buttons for starting and finishing different tasks are also located on the top of the desktop.

Despites the user starts selecting icons from the left top corner, the smallest distances are in the middle of the desktop (Fig. 6), which indicates a natural situation as the distance from any place on the desktop is shorter to the centre rather than to any other place on the desktop, particularly corners. However, it does not match with data we can see in Fig. 5. Before obtaining results, the user clicks all icons in a grid fashion style (each row or column one by one, rather than randomly). An explanation can be found in Fig. 7 showing how many times the user clicked on each of the cells on the desktop in Task 1 (it applies to all 3 tasks). As users had to choose all icons, this diagram also illustrates how icons were distributed during the experiment. As more icons were placed in the centre, it is natural the distance between two mouse clicks in the centre is smaller than that in the corners where less icons are placed.

The analysis of user age, occupation and other demographical data showed no significant influence on execution metrics of these three tasks.

4.2 Analysis of Icon Classification into Negative/Positive

Data on Tasks 2 and 3, to get information on what the user treats as a positive/negative icon, have been analyzed. These two tasks required to select only the icons the user thought to be positive/ negative. The average number of the icons users chose as positive was 11 out of 20, while that of negative ones – 9 out of 20.

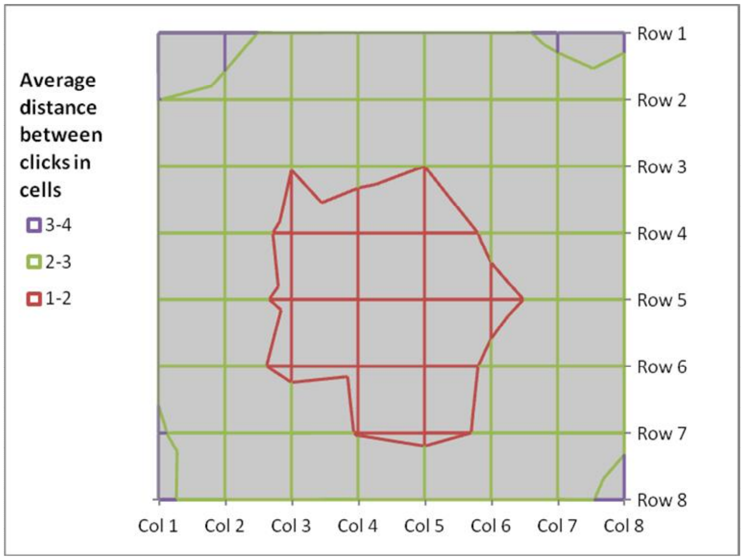

Fig. 6. The average order of the selected icons accordingly to the cell of the desktop

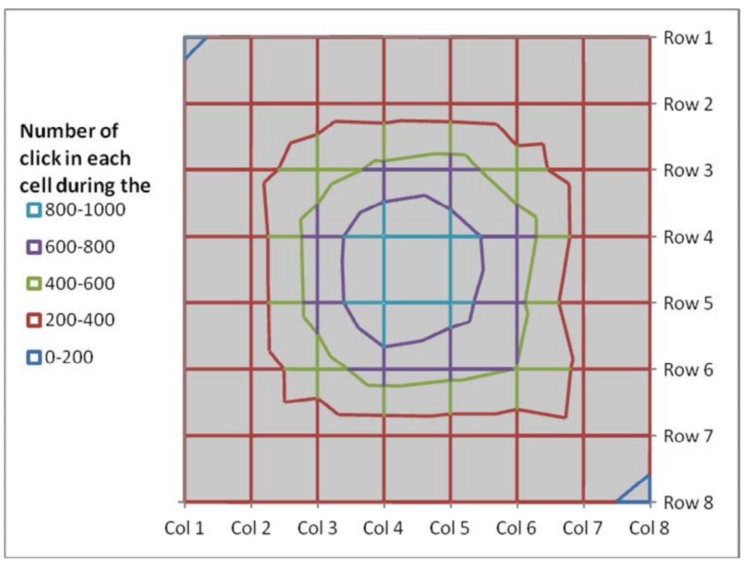

Fig. 7. The average order of the selected icons accordingly to the cell of the desktop

In the beginning of the experiment, we had a hypothesis that the colour of the icon would be one of the most important factors indicating if the user treated it as positive/negative. After data analysis, despites the colour, we had a very similar identification of the icon as positive/negative (Fig. 8). We can notice red icons are found as positive more rarely comparing to other colours, particularly black; however, difference is only 1%. Meanwhile, users more frequently discover red icons as negative comparing to other colours; nevertheless, the difference is also only up to 1%, which is not enough to make some conclusions depending on the colour only.

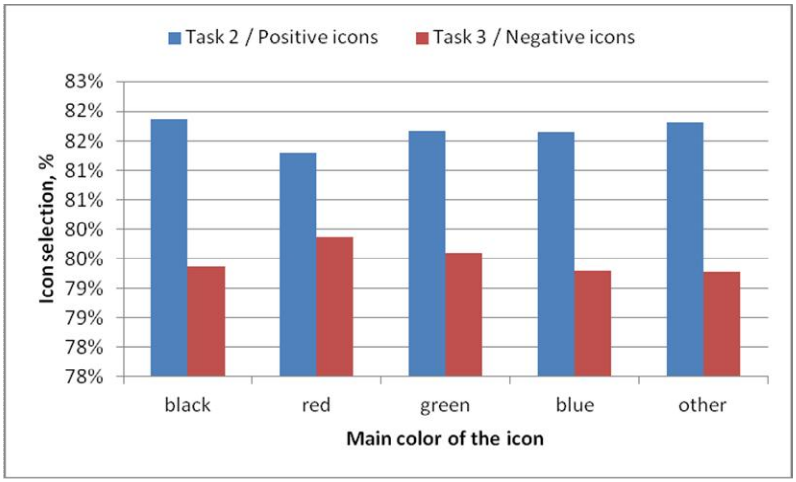

Fig. 8. The distribution of selecting an icon according to different colours

Task 2 shows that users, first of all, choose green icons, while the red ones are the last ones they prefer (Fig. 9). In the meantime, Task 3 indicates the icons of the red colour were selected in the beginning, while the blue ones in the end. This means the colour has an influence on icon classification into positive/negative; however, the colour is not the only property of determining whether the icon is positive or negative.

Analysis if the related type of the action of the icon has an influence on icon identification as positive/negative has been conducted. Similar results as those of the colour have been received – on average the icon of each type of action was selected by 91% of users in Tasks 2 and 3. Still, the order of icon selection gives more data (Fig. 10): as for Task 2, first of all, the icons that mean creation were selected while those related to destruction were selected the last; Task 3 shows that, first of all, the icons that mean destruction were selected while those related to the creative action were selected the last.

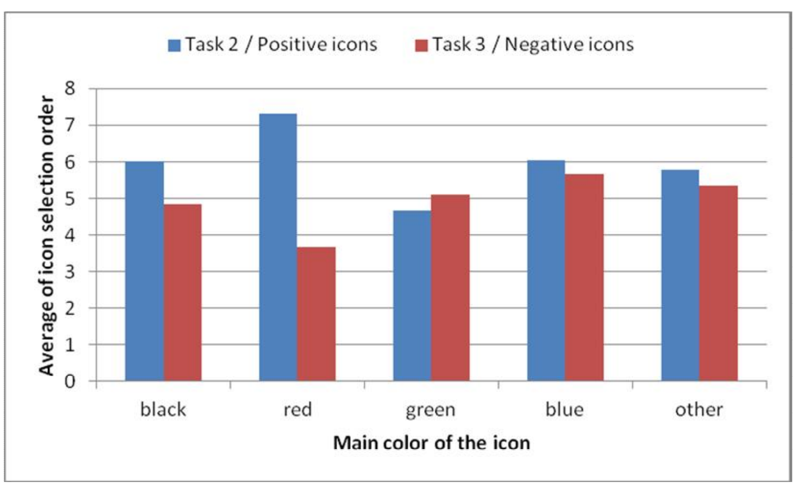

Fig. 9. The distribution of selecting an icon order according to different colours

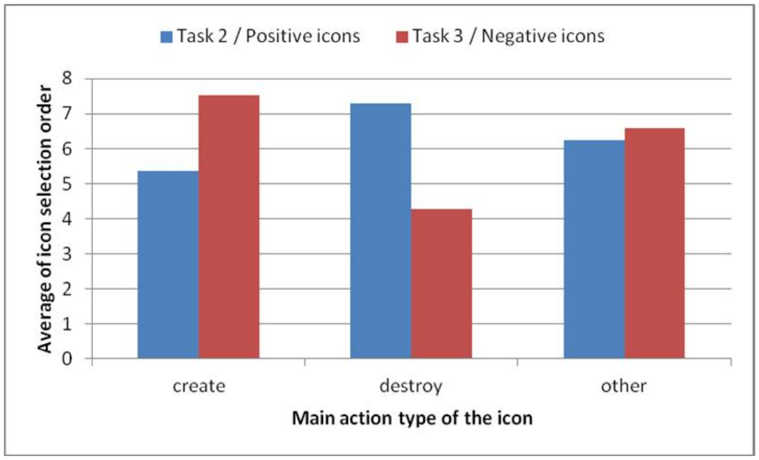

Fig. 10. The distribution of selecting the icon order according to different types of actions

The combination of both properties (icon colour and a related type of action) has an influence on identifying the icon as positive/negative. For example, a green icon that means a creative action was always selected as positive within the first 8 icons as well as the red one that refers to destruction – as negative. However, it seems there are more factors influencing icon classification into positive/negative (personal experience, etc.).

The analysis of how separate icons were classified to positive and negative by the participants of the experiment has also been carried out (Table 2). The obtained results suggest all icons were selected as positive/negative approximately by 79-82% percent of users. This shows there is no strict division into a positive or negative icon.

Table 2. List of the icons used in the experiment

No.	Icon	Percentage of the users who selected the icon		Average of selection order for the icon	
		Task 2 / "Positive"	Task 3 / "Negative"	Task 2 / "Positive"	Task 3 / "Negative"
1.		82%	79%	5.87	8.35
2.		82%	79%	6.02	10.77
3.		82%	79%	5.89	7.86
4.		81%	80%	7.40	5.81
5.		82%	79%	5.81	7.89
6.		82%	79%	5.42	7.73
7.		82%	79%	4.09	7.67
8.		81%	80%	6.89	4.24
9.		81%	80%	7.94	5.15
10.		81%	80%	9.92	3.70
11.		81%	80%	7.38	4.95
12.		81%	80%	6.47	3.58
13.		81%	80%	7.48	4.56
14.		81%	80%	6.64	3.73
15.		82%	79%	5.53	5.48
16.		82%	79%	5.93	7.22
17.		82%	79%	4.74	6.37
18.		81%	79%	6.34	8.58
19.		81%	80%	6.98	4.72
20.		82%	79%	6.12	6.30

As icon colour and related action cannot be used as single criteria for icon classification into positive/negative, we tried to analyze if neighbouring icons influenced icon classification into positive/negative. Therefore, each user of a positive/negative icon selected in Tasks 2 and 3 was related to (depending on a situation up to 8 icons placed in the connecting cell of the desktop) colour and action types of neighbouring icons. As icons were placed randomly on the desktop, there were not enough cases of 9 identical cell combinations to get significant results of the carried out analysis. Meanwhile, the examination of the icon pair (selected icon and its neighbouring icon) had more data. However, the correlation between selecting the positivity/negativity of the icon and a neighbouring colour, action type and positivity/negativity in the same task were too small to exhibit tendencies. This shows the random function was not able to place the icons of similar positivity/negativity level. Besides, it shows that the user analyzes all icons separately to classify them as positive/negative rather than rely on its surrounding.

If we added an additional requirement for selecting a limited number of positive and negative icons, the situation could be slightly different as when analyzing selection order, more obvious results could be noticed. According to the average selection order, the positive icon would be Confirmed, Email, etc., while the negative icon would be Close, Error, Shutdown, Delete, etc.

4.3 Specification of Some Bruce Tognazzini Principles

Bruce Tognazzini made a list of the main principles regarding UI design [31]. It is one of the most combined materials we have to deal with to ensure the UI will be suitable for usage and satisfaction. These principles are not meant for one specific type of application only and used as "must have" in many cases. Most of Tognazzini principles are abstract and have no exact property value or another measurement how to evaluate if something is achieved or not. The same idea exists in almost all best practices in order to present a guideline or an idea rather than measurement, taking into account it might vary in different situations. The obtained results allow specifying some of Tognazzini principles (Table 3).

Table 3. Specification of Tognazzini principles

Tognazzini principle of interaction design	Suggested specification for icon-based desktop applications
"If the user cannot find it, it does not exist"	The most important icons should be placed in the top-left corner as the user usually starts overviewing the desktop from this place.
"Look at the user's productivity, not the computer's"	Related icons should be placed close to each other as the user first overviews the icons close to the current position rather than "jumps" through more than the radius of 2-3 icons out of the current position.
	The same icon or its usage sequence should be similar in order to increase task execution time, as multiple usages of the same task eliminates decision time and speeds up task execution time.
"Do not strip away or overwhelm colour cues in the interface because of a passing graphic-design fad."	The colour is not the main component that forms impression on the icon. The previous experience and associations of the user might be more important rather than the colour only.
"Choose metaphors that will enable users to instantly grasp the finest details of the conceptual model"	Item colour or associated action as single property are not enough to predict icon success among users; there are more unknown factors, and therefore the already known icons should be used or new ones should be examined by the users before real usage.

We also would like to notice that these specifications are for icon-based desktop applications only and apply for the period 2013 – 2015. Hence, these experiments should be repeated time to time to make sure user behaviour has not changed.

5 Conclusion

The executed experiment using an indirect survey has showed the same tendencies towards selecting icons in the desktop environment as Hiko and the Principles Gestalt psychology suggest. However, we did not get any significant data on what influences icon relation to positive/negative, and the principles of the colour theory could not be approved.

Changes in icon selection depends on is icon selected during automatic task or task which requires additional decisions to be made. This is proved numerically as average time for moving a mouse from one icon to another is up to 2 times faster if the user does not need to make any decisions on choosing the icon. Also, our experiment showed none of the users was able to select the icon faster in Task 2 or 3 comparing to Task 1. This demonstrates an additional time is needed to make a decision.

A comparison of selecting the average distances of the icon in Task 1 showed the youngest age group was capable to select all icons within the shortest path where the average distance did not reach 2 cells. This might be an indication the elder persons gain additional experience and can be distracted by some icons that do not allow them to follow a certain strategy for icon selection.

The conducted experiment showed the positive/negative icon cannot be estimated only by its main colour and action type. These two characteristics influence the selection orders of positive/negative icons. However, these two characteristics are not enough to estimate what the user will select as positive/negative. All users have different experience, which additionally may influence how many icons he will treat as positive/negative and what kind of icons they will be. In order to estimate all influencing factors in icon classification into positive/negative, more additional data have to be gathered from individual users (open questions why he chooses an icon as positive or negative, the previous experience of working on the icon, etc.).

Competing Interests

Authors have declared that no competing interests exist.

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