Making Packaging Waste Sorting More Intuitive in Fast Food Restaurant

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Abstract. Consumers are accustomed to classifying garbage in front of recycling stations after finishing their meal at fast food restaurants. However, due to a lack of knowledge about the recyclability of the garbage items, and confusion caused by the weak design of the instruction system provided, many users are not able to complete the sorting task quickly or correctly. The low success rate of the customer's garbage sorting subsequently results in employees having to spend more time and energy in the following rectifying work, which leads to extra and unnecessary costs for the corporation. Therefore, our researchers have attempted to explore the recycling process from a more cognitive perspective, and proposed a new concept for the sorting task, which is more intuitive and less confusing.

Our research was designed into two stages. The first stage is to summarize the criteria of intuitive design with literature reviews, and make adjustments to the current recycling instruction system. The second stage is to conduct simulation experiments to verify the efficiency and correct rate of the new instruction system. Our research is anticipated to verify that an instruction system based on intuitive theory is more efficient, and less confusing to users. The research results will not only be a benefit to the fast food industry, but also to the other recycling instruction systems used in our daily lives.

Keywords: Intuitive · Garbage sorting · Recycling process · Sorting · Cognitive

1 Introduction

1.1 Research Background

It is now commonplace for fast food restaurant patrons to sort the packaging waste from their meal to dispose of into recyclables and trash. More often than not, however, these consumers may experience confusion during sorting sometimes to the point of simply chucking the entirety of their waste into one sorting bin, diminishing the efficacy of waste sorting as restaurant workers will need to commit extra effort into re-sorting the waste, which generates extra cost for businesses. Those responsible for

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coming up with the recycling programs for businesses may believe that adequate instruction has already been provided for the consumer to follow in waste sorting; after all, labels and text instructions are on waste bins as well as symbols and icons on the food packaging enough for the average consumer to figure out what goes where. But is that really the case? Our researchers are intrigued at this everyday occurrence and have taken action to investigate the cause of waste sorting confusion for consumers and whether there is a way to design waste to be more in line with the consumer's cognitive process so that waste sorting efficacy and accuracy can be increased.

1.2 Observation on Current Systems

Our researchers used McDonald's, currently the largest fast food hamburger restaurant chain in Taiwan, as their target of observation. The recycling system of MacDonald's Taiwan (McD's) labels its food packaging into recyclables and non-recyclables so that the restaurant patrons may sort their waste into the proper waste bin according to the labels (Table 1). In order to investigate the problems and potential aspects of confusion consumers may have when faced with a system for recycling, the researchers have come up with a questionnaire of 6 questions and with it surveyed 40 adult consumers, half of each gender, when they had just finished their meals and completed the disposal of their waste. The results of the survey are as illustrated in Table 1.

Table 1. Symbols on McD's food packaging and corresponding recycling symbols

<table>
<tr><th></th><th>Corresponding Symbols on McD's Food Packaging</th><th>Corresponding Symbols at Recycling Station</th></tr>
<tr><td>Recycable waste</td><td></td><td></td></tr>
<tr><td>General Waste</td><td></td><td></td></tr>
</table>

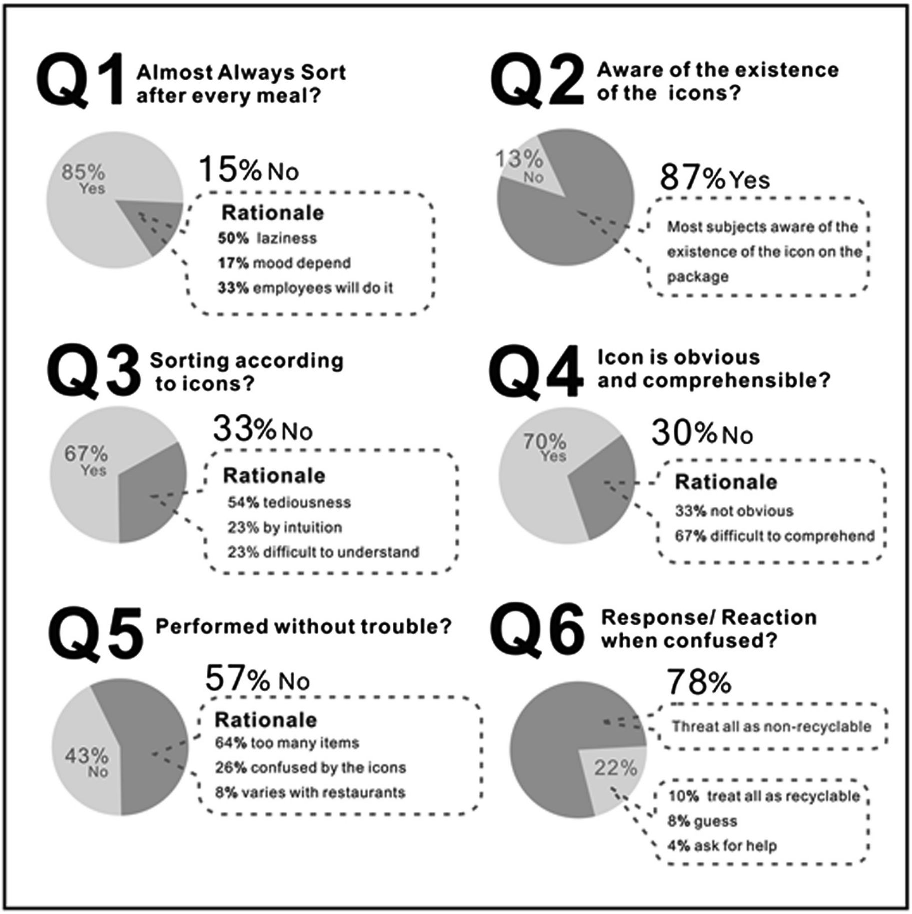

Fig. 1. Results of questionnaire on the use of fast food restaurant's recycling system

From the results of the surveys (Fig. 1), some interesting phenomenon can be seen:

- Although labels are present, users still feel sorting according to labels to be tedious (question 3).
- Many may feel confused seeing the labels to be unclear or too complex (question 4).
- Even with labels, many hesitate over sorting, especially for too many items and confused by the icons (question 5).
- Primary reason for confusion was due to uncertainty or over-variety of waste types (question 5).

From this rudimentary survey that was able ascertain that difficulty with categorizing waste and the labeling are problems associated with sorting, from which the following questions emerge:

1. Why is it that, under labeled instructions, consumers still experience tediousness with sorting according to labels and attempts to categorize through their own cognitive process?
2. Why is it that users are still confused with waste which have been categorized through available labels, and feel that there are too many varieties to sort?
3. What is the problem with the task of waste sorting? Can improving the concept of sorting and the labeling alleviate the problems found above?

2 Reference Discussions

When discussing fast food waste sorting, the current system hopes to achieve one goal: Identify recyclable waste and ordinary waste. This seemingly simple task actually involve complicated identification processes and decision making. Given that fast food recycling systems expect customers to find the labels and sort according to the labels, the customers may in fact find it overly tedious to look for the labels and sometimes one was not even found. Furthermore, even if a label is found, the customer still has to refer to previous knowledge and experience to make the right decision, which is where confusion occurs. For example, something that the customer believes is recyclable is actually considered general waste, such as PLA transparent plastic lids (made from corn starch resin, a biodegradable organic material). A more common occurrence of problem is when the consumer doesn't see the label and is unable to determine the recyclability of certain waste items. What follows is to sort in confusion, or to abandon sorting altogether. In order to gain insight into the questions raised above, this research will focus on the areas below for reference discussion: (1) Knowledge and behavior; (2) Intuition and functional level; (3) Intuitive design; (4) Theories on sorting and symbol recognition.

2.1 Knowledge and Behavior

In one of their research, Spool [23] mentioned that 'Product design' is a process that has to bridge the 'knowledge gap', the gap between Target Knowledge, or the intended amount of knowledge a user should have to operate a product, and Current Knowledge, which is what users currently have in order to recognize the interface provided. When the two levels of knowledge touch or overlap, Instinctive Operation is achieved.

Norman [18] explained the relationship between precise behavior and imprecise behavior through an experiment on the recognition of coins. In the experiment, he provides several similar pictures of American pennies, and only one of them is the correct coin design. Although less than half of all college students tested were able to correctly identify the picture, in truth, it does not affect the usage of the pennies, since all they have to do is to separate them from nickels, dimes, and quarters without having to register the subtleties of the design. Even though the experiment involved American coins, the same principle applies to other domains. We often forget that the design of a product has to minimize the amount of knowledge a user is required to operate it, as most of the time, all the product needs to do is get the job done, ideally without very much user input. For example, when finding a location, all that most people require are certain key landmarks without the details of the streets and alleyways and distances. We often neglect that we are equipped with basic navigational functions and rapid problem solving capabilities; Giving someone too much details in direction would only generate confusion.

Furthermore, Norman believes that behavior is the result of guidance by both outside information and innate knowledge, and people don't have to be aware of precise knowledge of every detail of all knowledge as long as the information is suffice to handle everyday situations. Norman gives four reasons for this: (1) knowledge is present both inside the mind and outside; (2) Highly accurate knowledge is often unnecessary; (3) The world is already full of natural limitations that guide behavior; (4) Cultural limitations as well as social customs often reduce the number of behavioral choices. Taken together, knowledge of the task at hand, and environmental and social limitations, work together to equalize the amount of available knowledge and operational knowledge, which produces correct judgment. On the other hand, when the two knowledge levels have a wide gap, it creates usability issues. Before we ask the user to correctly identify trash, have we examined the level of knowledge and experience required of the task is complete and rudimentary?

2.2 Intuition and Functional Level

From a psychological perspective, Intuition is an ability that accesses knowledge without logic or rationalization. Jung [10] describes it as an irrational function where the process is mostly without conscious thought. In the discussion of user behavior, it is considered an intuitive non-conscious process, as in, it does not enter the thinking process but instead is a result that emerges unconsciously from past knowledge or experience [1, 7]. UI expert Blacker and his research team defines Intuition as the following after discussion with various scholars: Intuition is a type of cognitive processing that utilizes knowledge gained through prior experience (stored experiential knowledge). It is a process that is often fast and is non-conscious, or at least not recallable or verbalizable [2–4].

Raskin [20] also attempted to define Intuition through the example of a computer mouse. Even something as simple as a computer mouse to the modern person could confuse either a Starship engineer from the future [StarTrek VI scene with Chief Engineer Montgomery Scott] or a Literature teacher from 20 years before the invention of personal computers because no such product existed during their time so therefore no past experience could be referenced. Raskin therefore defines Intuition as a behavior modified by familiarity or that which uses readily transferred or existing skills.

In the SRK task model proposed by Rasmussen [21], human function is categorized into three types: (1) Skill based; (2) Rule based, and (3) Knowledge Based. When people are executing a task, they draw from these types interchangeably depending on the situation. Of the three, skill based is function that is based on instinctive reaction and the vast pool of past experience; it is the type that is able to complete a task without thinking it through and therefore accomplished a task the quickest. Furthermore, Newell [17] ordered the reaction time of four different bands of task processing from longest to shortest: (1) social band; (2) rational band; (3) cognitive band; (4) biological band. The reaction time of task processing in the biological band is the shortest, measurable in milliseconds, and the reaction time in the social band is the longest, sometimes from days to months. Once task processing enters the rational band, the required time is measured in 102 s, which still exceeds actions that is measured in minutes. Therefore, Newell suggests that design should be applied to shorten the task processing time in the cognitive band. For example, the cognitive process that connects symbol and functional meaning should belong to the biological band of task processing, and in order to achieve intuitive reaction, the thought process involved for the user should be minimized in order to achieve the task with the easiest of task processing.

2.3 Designing for Intuition

Blacker et al. [3] investigated the relationship between Intuitive design and operational experience through an experiment involving television remote control. They discovered that the ease of operation increased along with experience and concluded that as operating knowledge of the product increased, task processing time relatively decreased. It therefore stands that an intuitively operable product must decrease the likelihood of users employing cognition, and requires no prior instructions for the user to perceive how a product is used. This allows those with less experience to operate a product with the same ease as someone with experience. Complex cognitive thinking consumes a great amount of mental energy, and the more a user is required to think and make decision, the more of that mental energy is consumed, making users unwilling to continue its operation, resulting in a phenomenon known as ego depletion, which is deeply unpleasing to the user and creates a negative experience of use [11, 19]. Active Japanese Designer, Fukasawa Naoto, has also suggested the concept of "Without Thought" design, where a behavioral trend is identified through studying people's unconscious behavior, and applied to the product design. He believes that a great number of products on sale today that is designed to work by stimulating the senses but overstimulation interrupts the unconscious cognitive activity, so the design that best expression of intuitive design is something that works in harmony with the human unconsciously [16]. Blackler et al. [4] proposes three points in designing a product that is intuitively usable:

1. Location of product features: should be easily visible without too much effort from the user
2. Types of features (structure, shape, color, labels): the design of the interface should relate to its function
3. Functions of the features and how it is operated: method of operation should be associated to similar experience in order to make operation more intuitive

If we wish to allow the user to effortlessly operate the product non-cognitively or without thought, we must be mindful of the influence of past experience, since past experience may not necessarily have a positive influence on the current operation [5, 12].

If users now face so much confusion over the process of waste sorting, we can conjecture that past experience is in conflict with the sorting task at hand. How to employ a more intuitive design allowing users to efficaciously complete the sorting task without much cognitive input is a great research challenge.

2.4 Sorting Theory and Symbol Recognition

In theories concerning cognition, the primary purpose of sorting involves the conjecture of features without form, especially for novel stimuli. For example, in a zoological situation we may sort animals into "Tigers" or "Zebras" to indicate whether they are threatening or not. The act of sorting connects the stimulus we experience to what we have previously learned or to information we find relevant. We can therefore interpret the act of sorting as a inference on formless properties. The process of learning to perform sorting is one of great importance, as it relies heavily on all of our cognitive abilities to properly organize, absorb information, and develop new concepts that surpass previous understandings. In addition, sorting often simultaneously involve multiple dimensions or different forms of abstract thinking, which makes learning to sort a great challenge [13]. As apparent from the above definition and discussion on sorting, it is a skill more difficult than it seems. It was thought that the restaurant customers would perform sorting happily and quickly while the inherent difficulty of the task of sorting, as well as the difference of understanding for each individual of the recyclability of each item (or possessed knowledge thereof), were both neglected. This can potentially generate feelings of conflict as well as confusion, since individuals, children and adult alike, would in default perform the most basic kind of sorting, which is sorting through the most fundamental visual properties such as color, orientation, shape, etc [15, 22]. Furthermore, Johansen and Palmeri [9] in their sorting experiments discovered that when learning to sort, people will tend to perform rule-based sorting during the beginning before transitioning to exemplar-based sorting after repetition.

In this research, the factors that influence a user's sorting efficacy, other than the knowledge required for making judgment on relevant items, also include the clarity of symbol, which concerns its color and shape. In design-related issues, the general consensus is that color of the symbol is a stronger emotional trigger than the outline of the symbol [14, 24]. In addition, experiments by Fullera and Carrascoa [6] revealed that when identifying colors, the closer the images are to a primary color, the easier they are to identify, and that designers can utilize the saturation and contrast of a color to increase the efficiency of identification. In terms of the shape, although humans are not as acute as they are with color, just in terms of shapes humans are better with circles than other shapes [8] and during recognition will pay attention to circular items first. Hence, the circle is a more preferred shape when making labels, as they produce a better identification result. In summary, people respond to color as a stimulus quicker than the shape, and so in designing labels the use of color is particularly important. In addition, the design for the label can benefit from adapting a circular contour, and the use of a highly vivid primary color, all of which increase attractiveness and identifiability.

2.5 Reference Summary

Based on the above literature, our researchers have devised directions for tackling the issue of recycling process improvement:

- Reducing the level of thinking needed from within the rational band to the cognitive band, since reducing the level of thinking is how a system achieves intuitive use for the user.
- Imprecise knowledge can nonetheless be guided to achieve the correct behavior, and how to avoid having users of different knowledge and experience background to perform complex judgment of waste categorization, how guidance can be redesigned may be the key to this challenge.
- Rethinking about the past experiences of the user can prevent conflicts between that experience and the sorting design of fast food restaurants.
- Simplification of symbol instructions by introducing ways to make pairing and recognition simper and easier.

The researchers employed a new guidance model that changes the question of "Is this piece of waste recyclable (rational band) into something like "which bin should this piece with this symbol go into?" (cognitive band) in an attempt to apply an adjustment in the decision making process to simplify and raise the accuracy of the waste sorting process. To this end, an interesting experiment will be conducted to test a sorting method that is designed to bypass reasoning and trigger action simply through the matching of pictures to see if this is what it takes to increase sorting efficacy and decrease waste sorting confusion.

3 Research Method

Our researchers used McDonald's hamburger chain restaurant as the object of observation, and believe its waste sorting system has the following problems:

- The symbols are overcomplicated, as it displays body movement, abstract symbols, and both English and Chinese instructions (Fig. 1)
- Even with symbols as guidance the user will nevertheless ponder the properties of the item being sorted, which will lead to conflict with known knowledge of what is and is not recyclable material.
- The level of thinking that this system asks the user to employ still belongs to rationalization, which means the user is required to think about the properties of a waste item which does not produce quick reactions.

Based on the problems discovered, our researchers attempted to shift the thought process of the sorting activity by using a novel conceptual design to minimize the chances of the user thinking about the properties of the waste items, which in turn should also reduce the conflict that may arise between the user's knowledge case and the instructions given on the waste items. The goal will be to simplify the thinking process during sorting, to remove the user from thinking about whether or not an item is recyclable, and focus on matching symbols to the correct sorting bin.

3.1 Experiment Group Design

Our researchers have come up with 3 systems of labels designed to simplify the thinking process. The designs only employ color and circular symbols which are simple triggers of reaction and attention.

Table 2. Label contents of the four testing groups

Testing Groups		Label Contents			
			Packaging	Waste Station	Methods
Reference Label System	A	Recyclable		資源回收 垃圾	Combinational guidance: symbol, and text instructions
		Non-recyclable		一般垃圾	
Experimental Label Systems	B1	Recyclable			Color-guided
		Non-recyclable			
	B2	Recyclable			Symbol-guided
		Non-recyclable			
	B3	Recyclable			Color-and-Symbol -guided
		Non-recyclable			

The three groups are B1: matching colors, B2: matching symbols, and B3, colored symbols. The three systems are designed to bypass the concept of recyclability so that the user will only focus on matching colors and symbols, thus taking away the rational thinking required to judge the recyclability of an item. The original system is labeled 'A', and 'B2', 'B2', and 'B3' makes 4 label systems in total (Table 2).

3.2 Simulated Packaging and Equipment

McDonald's does provide additional receptacles for leftover food and ice, which does not create any sorting issues. Therefore, our researchers focused on those food packagings that do get confused. The researchers picked out five items that are often found in a McDonald's meal: 1. Hamburger packaging; 2. French Fries packaging; 3. Drink cups; 4. Drink lids; and 5. Straws. The only item that is recyclable is the cup, while all other items, due to their being coated in oil and the lid being bio-degradable, all belong to normal (non-recycled) waste. To simplify the experiment, the designs and patterns on the packaging have been removed, and their base color is decidedly white. In these five waste items, other than the drink straw which is unsuitable for printing, all the other items in each group follow the current McDonald's practice of printing labels onto the packaging at the exact same size and place. Furthermore, the recycling stations are made in the same dimensions as the ones that McD's currently uses, but they are simplified to having only two openings, each with their corresponding image of recyclables or general waste. The recycling stations also have white base color (Fig. 2).

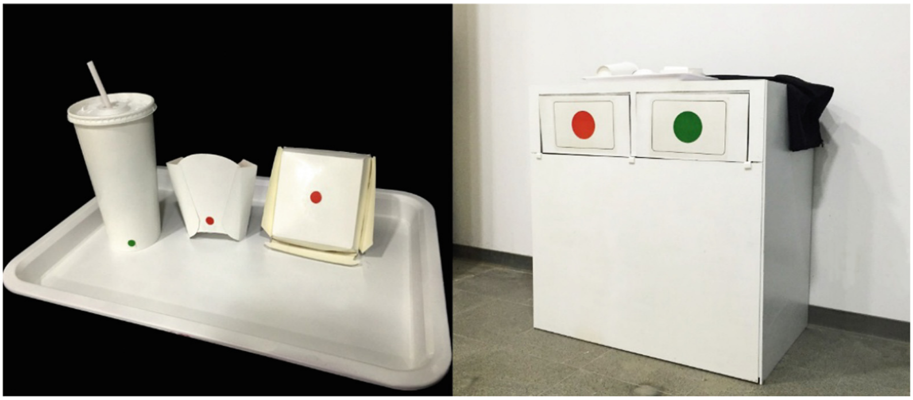

Fig. 2. One example of the simulated packagings and recycling station.

3.3 Subjects and Procedure

The experiment consists of four groups of 30 participants. The participants consists of college and post-graduate students, half of both gender. The experiment was conducted in a well-lit laboratory. For the sorting activity, the operating time, accuracy, and the participant's subjective feedback are recorded. The procedure of the experiment is as follows:

1. Before the experiment, the images on the recycling stations are covered up with a black non-see-through cloth. The participants are asked to hold their trays containing randomly assigned mock food packaging while standing in front of the recycling station.
2. The participants then are informed of the objective of the experiment. They are told that this is an experiment for the observation of the fast food restaurant sorting process. They are asked to sort the food packaging items on their trays according to the labels found. They are not to raise questions or ask for assistance once the experiment commences.

3. The experiment is timed. The time starts when the black cloth is removed revealing the waste sorting image and ends when the participant has completed sorting and pout the tray on top of the recycling station, completing the experiment.
4. The researchers record sorting period time, sorting accuracy, and have the participants fill out a questionnaire that asks the participants for their subjective feedback. The questionnaire is designed to understand if the participants felt the sorting system was easy to use, easy to comprehend, quick decision making, and comfort to use, each evaluation with a score from 1 to 5.

4 Results

4.1 Sorting Time and Error Times

From the sorting time data it is obvious that the three B groups required significantly less time than the control group, requiring less than half the time it took the control group (Fig. 3).

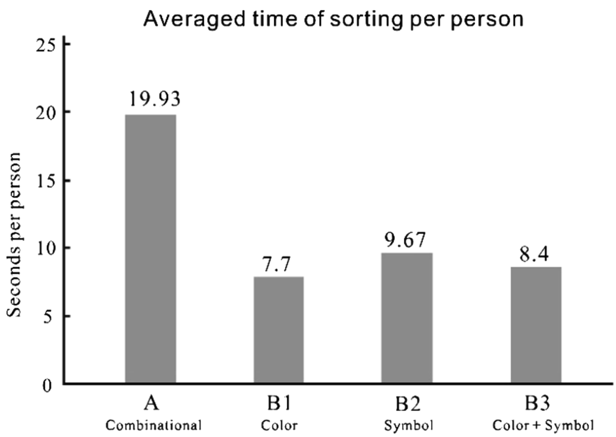

Fig. 3. Averaged sorting time of four testing groups

In terms of accuracy, the A control group with 30 people accumulated a total of 37 mistakes, while the B1 group had 1 mistake, and B2 and B3 group had 3 mistakes each (Fig. 4). In other words, each participant in A control group makes an average of 1.23 mistakes and those in the B1 group makes an average of 0.03 mistakes. And those in B2 and B3 groups made an average of 0.1 mistakes. All the B groups performed vastly more accurately than group A.

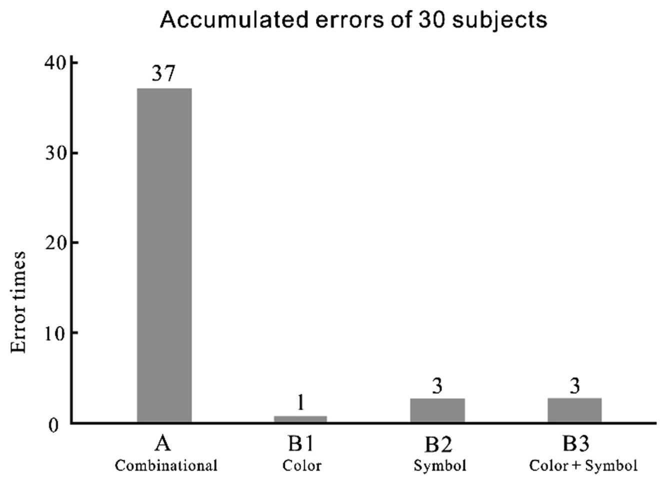

Fig. 4. Accumulated error numbers of four testing groups

ANOVA values were calculated for figures from the four groups, and the results were significant (Table 3). Turkey post hoc tests were conducted to compare the four sets of figures, and the results show that the three new designs were significantly different to the control in terms of sorting time, accuracy, and mistakes made. However, there were no significant differences between the three new designs. Statistical figures are as Table 4.

Table 3. ANOVA test for four guiding systems

	F value	Sig.
Sorting time	50.786	.000*
Error times	34.540	.000*

*The mean difference is significant at 0.05 level.

Table 4. Post hoc test by Tukey for comparing sorting time and error times

	System (I)	System (J)	Mean difference (I − J)	Sig.
Sorting time	**A**/combinational	**B1**/color	12.233*	.000
		B2/symbol	10.267*	.000
		B3/color+symbol	11.533*	.000
	B1/color	**A**/combinational	−12.233*	.000
		B2/symbol	−1.967	.313
		B3/color+symbol	−.700	.927
	B2/symbol	**A**/combinational	−10.267*	.000
		B1/color	1.967	.313
		B3/color+symbol	1.267	.682
	B3/color+symbol	**A**/combinational	−11.533*	.000
		B1/color	.700	.927
		B2/symbol	−1.267	.682

(*continued*)

Table 4. (*continued*)

	System (I)	System (J)	Mean difference (I − J)	Sig.
Error times	**A**/combinational	**B1**/color	1.200*	.000
		B2/symbol	1.133*	.000
		B3/color+symbol	1.133*	.000
	B1/color	**A**/combinational	−1.200*	.000
		B2/symbol	−.067	.964
		B3/color+symbol	−.067	.964
	B2/symbol	A/combinational	−1.133*	.000
		B1/color	.067	.964
		B3/color+symbol	.000	1.000
	B3/color+symbol	**A**/combinational	−1.133*	.000
		B1/color	.067	.964
		B2/symbol	.000	1.000

Note: *The mean difference is significant at 0.05 level.

4.2 Evaluation of Subjective Feedback

Once the participants have completed the sorting task, the researchers gave them four criteria on subjective experience (ease of use, ease of comprehension, quick decision making, and comfort of use) for evaluation with a score of 1 to 5. The average score for the four criteria are distributed as indicated on Fig. 5. It is apparent that the four criteria of the three B groups scored significantly better than those of the A control group, and B1 with color guided method has the best performance in all criteria.

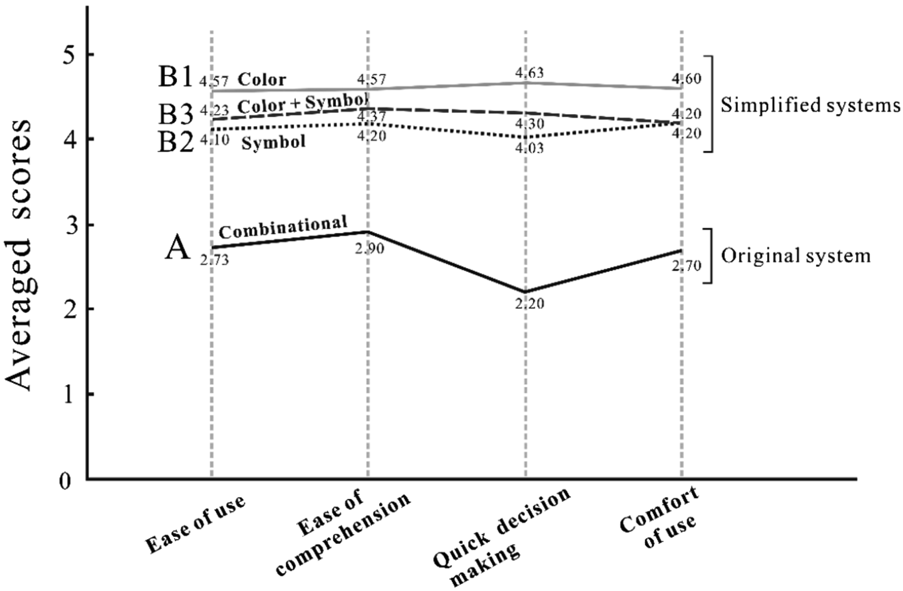

Fig. 5. Averaged score of the subjective evaluation for all testing groups.

5 Discussions

Our experiments show that all 3 designs are superior to the current system that McD's uses in terms of both time saved and increase in accuracy. The subjective feedback parameters such as easy of use and quick decision making are also better than the original recycling system. There are no significant differences of parameters between the three new designs, most likely since the objective of all of them was to reduce the amount of reading of the object the user has to conduct. When the information received and the decision making needed are both simplified, operational efficiency can be dramatically improved as well as the operation itself greatly simplified. The initial results from the experiment confirmed that the simplification of the thinking process can reduce user confusion, making an activity like sorting more efficient as well as more accurate.

In the experiment, the same instructions were given to the four participant groups, which is to simply sort the items according to the labels. However, since the meanings contained in the labels had a fundamental change, the results were drastically different. The original labels permeate our lives and when users see the type of instructions given will habitually activate the thinking process. Yet the user's knowledge base of what constitutes recyclable or non-recyclable waste and the correct knowledge required to sort the way they asked to conduct can be quite different. This means that the user is unable to trust the labels and instructions provided, and this generates confusion.

On the other hand, the original waste sorting system intended to pass on various messages, such as the action of waste disposal, the properties of recycling, and even the nuances of a bilingual text-based instructions. Yet what was not realized is that the majority when sorting waste tend to want to complete the task quickly, and there are increasingly fewer individuals who would take the time out to read the sorting instructions in detail instead of completing the task quickly by applying intuition or experience. The overwhelming amount of information provided had unintentionally confused the users, and this is apparent in the subjective evaluation data. It is worth bringing up that many of the participants of the three new design groups, once they're done with the surveys, would ask the researchers out of curiosity what the meaning of the images provided were. This suggests that while the participants were conducting a sorting task that required them to think less, they are not applying knowledge regarding the recyclability of items to the actions, and are instead completing the task almost without any thinking, which did allow them to complete the sorting task with high accuracy. This confirms that allowing users to sort using intuition and imprecise knowledge is actually a method that achieves high accuracy.

6 Conclusion and Suggestions

From what seems like a simple experiment with a symbol matching activity, this research has demonstrated that the simplification of the thinking process can transform what was once a rational "categorization" task into a simple "matching" task, which has the advantage of greatly enhancing sorting efficiency and task affinity. This confirms that, to achieve a given task accurately, the user doesn't necessarily need the concrete knowledge. Our research provides those who work in recycling related fields a way of redesigning a sorting system to make it more simple. On the other hand due to the limitations in manpower and funding, the study was not able to fully explore all of the details or conduct an investigation on a larger scale. The following are future research suggestions for those who are interested in this topic:

1. The task of waste sorting to achieve recycling involves more than the efficacy of sorting. Reaching a balance between simplifying the task of sorting and allowing the user to be educated on the knowledge related to sorting is what will achieve a waste sorting system design that is the most ideal.
2. This research removed elements of an assortment of color and images design elements on food packaging. The mock items simulating waste food packaging were all white, which means that the participants found the images right away. These items in the real world are usually abundant in colorful and image-filled design elements, which potentially make the task of locating a recycling related image more difficult. Future research can be conducted to investigate where, how, and what size to place recycling related images taking these design elements into account.
3. This research purposefully used images that are extreme abstract for the experiment, and yet in reality the ubiquity of conventional recycling symbols should also be considered. How these symbols can be incorporated into a novel sorting process may provide a challenge in practice.

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