Improvement for New Energy Vehicle within UI—Case Study on Han EV

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Abstract

New energy vehicle (NEV) refers to a vehicle which is fully or partially powered by electricity instead of petrol. Since petrol price grows constantly and people become more environmentally conscious, people have shown their numerous interests on the NEV. A lot of previous studies have paid more attention on vehicle itself, such as the high technology of the in-car assistance systems, and the pros and cons of electricity as a new energy for vehicle. However, the quality of vehicle should not only be limited to these aspects. Therefore, in this study, author focus more on the relationship between the vehicle and users and gives a brief introduction of some user interface problems through investigating one of the top selling types of NEV, Han EV belonging to BYD company, in terms of Standardize symbol, Gestalt grouping principles, Design of Visual display, Working memory and attention. In addition, corresponding improvement advice will also be provided in the later part of this work.

1. Introduction

As Zheng claimed that the total sales of New Energy Vehicle will approach to 5 million in 2022 which is up 47% compared to 2021, NEV has attracted increasing attention recently in China [1]. The NEV refers to a vehicle which is fully or partially powered by electricity instead of petrol. It has also equipped with smarter in-car assistance systems simplifying previous common control panel, which means drivers can control some basic functions and enjoy their in-car lives just via one single screen.

There are already a lot of studies going on around NEV. For instance, one study investigated New Energy Vehicle lightweight technology trying to reduce the weight of the vehicle itself as much as possible with the aim of achieving combination of weight reduction, consumption reduction, environmental protection, and safety [2]. What's more, another study focused more on the relationship between "Internet Plus" and NEV in terms of the obstacles and opportunities of NEV, and the charging pile [3]. These previous studies about NEV have paid a lot of attention on vehicle itself, such as the high technology of the in-car assistance systems, and the pros and cons of the new energy of vehicle, which is the electricity, however, the quality of vehicle should not only be limited to these aspects. The relationship between the vehicle and users should also be under consideration.

Therefore, this study tends to investigate NEV focusing more on the user interface aspect. User interface (UI) serves as a medium referring to support the interaction between a user and the expert system in terms of obtaining solutions to problems, adding to the basis of the system's knowledge, and examining the reasoning processing of the system [4]. Han EV (Figure 1), one type of NEV from BYD company, has been analyzed in this study from some specific cognitive psychology aspects such as standardize symbol, Gestalt grouping principles, design of visual display, working memory and attention, which means this study aims to examine whether the efficiency and convenience of vehicle have been improved as the in-car assistance systems and the interior design of vehicle getting smarter. Moreover, their corresponding brief improvement suggestions will also be mentioned in this study.

2. Problem

2.1. Button for Hanging up the Phone Call

As shown in Figure 2, the words circled in orange mean that if you want to hang up this phone call, you should press the button which is circled in blue in Figure 3. However, people tend to both pick up and hang up a phone call by pressing

Figure 1. New Energy Vehicle—Han EV.

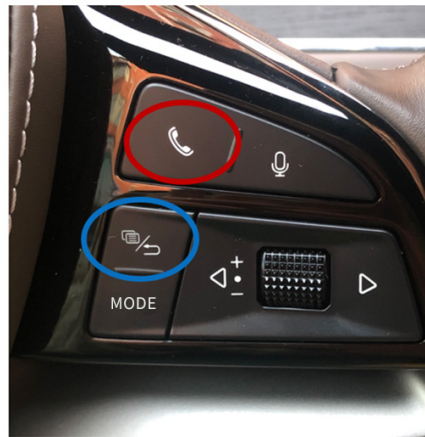Figure 2. The instruction of hanging up the phone on the screen.

Figure 3. The pick-up bottom and the hang-up bottom on the steering wheel.

the button which is circled in red in Figure 3. Nevertheless, there is a high possibility that most people may tend to press the red one more than the blue one. Because the red one is the most common symbol or standardized symbol used to be as a symbol related to the phone.

In order to identify whether this symbol do have some potential design problems, a questionary was made. The main question in this questionary was that suppose you are driving on the road and trying to hang up the phone, which button you prefer more to choose. Two options were that one was the typical phone symbol like the red circle and the other one was the button the Han EV forces to like the blue circle in Figure 3. This questionary was randomly assigned to 80 people. As shown in Figure 4, there are 69 of 80 people chose the typical phone button than the button which the designers of Han EV want drivers to do. It is possible to some extent that this result is due to respondents' lack of driving experiences. Therefore, to check this potential reason which may affect the interpretation of the previous result, an extra questionary was also assigned to respondents, asking respondents about their driving experience. Figure 5 reflects the overall driving experience within those who chose the typical
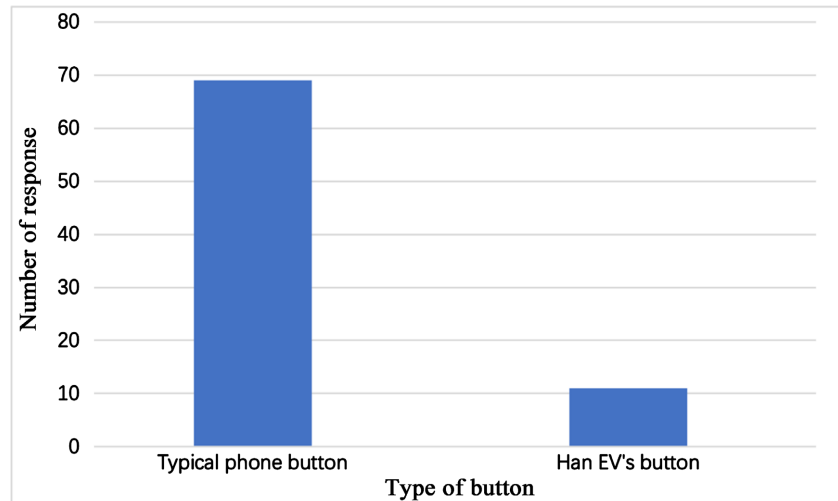
Figure 4. Overall response of the questionary—which button you prefer more to choose.

■ more than 10 years   ■ over 5 years but less than 10 years
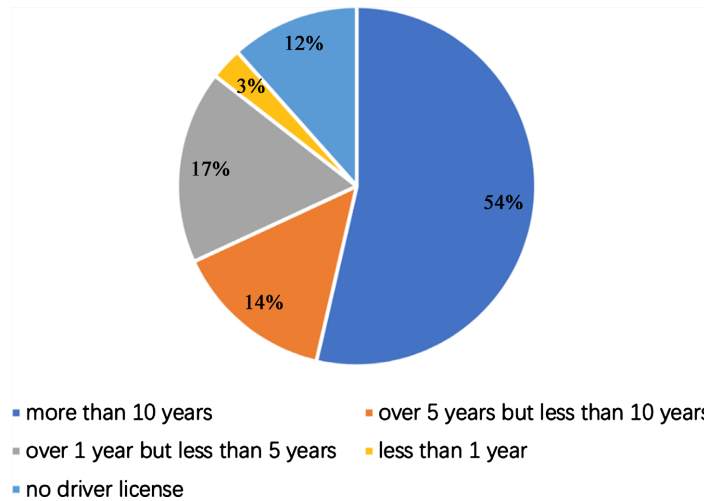■ over 1 year but less than 5 years   ■ less than 1 year
■ no driver license

Figure 5. Driving experience within those who chose the typical phone button in the first questionary.

phone button in the first questionary. According to this, 54% of those who chose the typical phone button have held their driver license more than ten years, which means even though the skilled driver cannot make the right choice under this situation.

This result is generally consistent with standardization which is one of the principles that can increase the effectiveness of visual display. Standardization refers to that designer would better to use standard words and symbols whenever they exist, otherwise it may be confusing to introduce some new symbols [5]. Therefore, the button for hanging up the phone call of Han EV needs to be improved so that drivers can pay less attention to thinking of which button is the correct one while driving.

2.2. The Pros and Cons of the Huge Screen

Han EV has a huge screen for both driver and passengers which is one of selling

points for it. With this huge screen, a driver can look at the navigation more clearly, which means the huge screen can convey more location information. Also, passengers can use this huge screen to watch some movies or dramas during their trips.

At the same time, its huge size may also cause some problems or provide some misinformation. There are a lot of number information conveyed in the box which is in the upper left corner. As shown in Figure 6, except the two circled numbers in this box, the other numbers may not lead to different implications over people because they have totally different meaning dimensions. Although the "34 m" and the "44 m" indeed have the same meaning dimension, they have followed one of the principles that can enhance the effectiveness of visual displays which is Emphasis referring to the most important words or symbols should be highlight [4]. The "34 m" is in bold weight and bigger than the "44 m" in Figure 6.

Nevertheless, the "1 hr 2 min" and the "17:37" convey the same meaning time dimension which is closely placed at the bottom right corner of the box. Many previous studies suggested that the capacity of visual working memory is highly limited which is only about 3 to 4 objects [6] [7] [8]. What's more, according to the Proximity principle, one of the Gestalt grouping principles, people tend to group the elements close together in space during information perception [9]. In addition, as "16:36", the actual current time, is placed in the upper right corner which is relatively far away from the "17:37" on this huge screen and cannot be compared with each other, people may tend to perceive the "17:37" as current time and consequently make a wrong prediction that he may arrive at the destination on "18:39".

2.3. A Brief Auditory Navigation Message

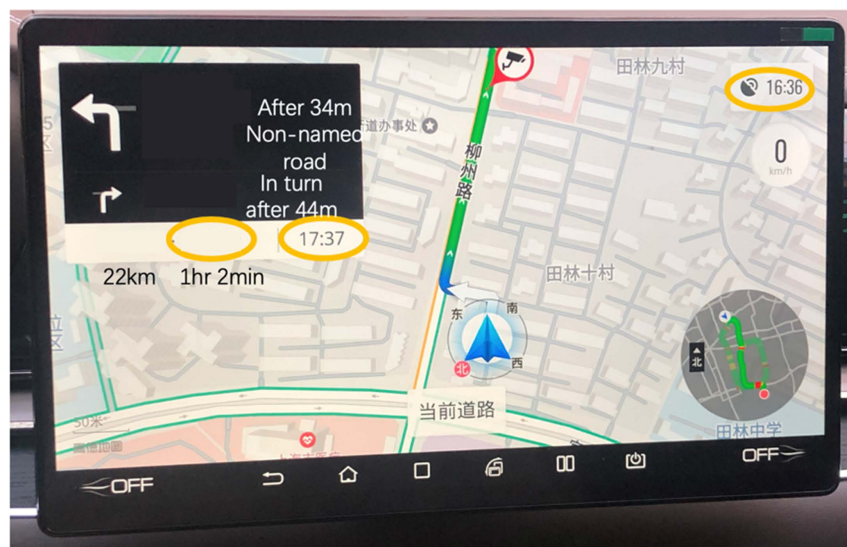A brief auditory navigation message may not be as much useful as it supposed to

Figure 6. Real-time interface of the navigation.

be, even resulting in some horrible car accidents sometimes.

As we all know, working memory plays an essential role in our daily lives. Every information we felt are processed in our working memory and being integrated with those stored in long-term memory, then we response or make a decision based on those integrated information. But the main deficiency of it is its limited capacity referring to only about seven plus or minus two chunks [10]. Besides, without rehearsal, the duration of working memory only can be less than 20 seconds [11]. During driving, a driver needs to remember the current speed limit, what kind of lane he is driving on and a lot of traffic regulations. Some of information may be retrieved from long-term memory and others of them may be the new obtained information from the road signs, but their common ground is that all of them are being stored and processed in the working memory. Therefore, the available memory capacity may be not enough to memorize additional navigation information.

What's more, a brief auditory navigation message may also have some problems in terms of attention. During driving, there are a bunch of things to which a driver must pay attention simultaneously, such as whether the front car tends to stop, whether the car in the left or right lane allows him to change the lane to drive, whether the car behind him has honked or not and whether he is driving exceeding the speed limit or not at the same time. According to the unitary attention resource model, attention is regarded as a single resource that can be allocated to various tasks. When required attention exceeds available attention, performance may suffer [4]. Therefore, due to a lot of things that should be considered at the same time, people may have only few attentional resources to fully process information. According to the multiple attention resource model, only when information required the same attention resource, performance will suffer [12]. The auditory navigation message requires auditory pools, similarly, perceiving honk information also requires auditory pools, which means they use the same attention resource pool and both of them may not be fully processed. Altogether, regardless of what kind of attention resource models, the available attention resource is less enough than the required attention resource by the navigation message.

As a result, the driver may tend to look down to the screen which contains the visual navigation information and is placed beside the steering wheel. However, the driver may lose his sight to the front scene and also pay less attention to other information resulting in a car accident sometimes.

3. Improvement

3.1. Use the Typical Phone Symbol

Using a standardized symbol is very important when the car is more sophisticated. It is difficult to change people's common thought rapidly. In addition, according to the principle of consistency, which is one of the memory principles, display should be designed in a manner which is consistent with other displays

so that people can operate this new display by just using their existing knowledge. Thus, using the typical phone symbol may be the best choice.

3.2. Place the Current Time Closer to the Arrival Time

Based on the Proximity principle, the current time should be arranged closer to the arrival time so that people can perceive this time information as the designers' purpose and can reduce misunderstanding about them. For instance, the current time can be arranged just right below the arrival time.

3.3. Present Both Auditory and Visual Version of Navigation Message

The navigation message is a message which will be referred to later so that a visual presentation will be better than an auditory presentation. Thus, it will be more effectiveness if a visual presentation is also presented. Instead of presenting the visual version of the navigation message with no interval between the auditory version, present them after 2-3 seconds will be appropriate.

Although there indeed provide a visual presentation of the navigation message, it is presented on the screen besides the steering wheel. As mentioned before, this may distract driver and lead to some horrible consequence. In terms of link analysis of display arrangements, the most frequently used and important displays should be located in close proximity in the central view field [13]. So, it will be better to arrange the visual presentation closer to the central viewing sights. For instance, present them on the other screen, figured out with a white arrow in Figure 7, which is just behind the steering wheel so that driver can re-check the navigation message just by glancing downwards for only tiny period.

4. Conclusions

This study aims to investigate New Energy Vehicle (NEV) which has been attracting the public a lot recently on the basis of user interface (UI) from some specific cognitive psychological perspectives. Three potential UI problems have been demonstrated in this study. First, the button defined as hanging up the phone call is not the most appropriate option. As shown in Figure 8, performance is an inverted U-shaped function of arousal which is called the Yerkes-Dodson Law. Based on this, the lower the optimal arousal level is, the more difficult the task is [4]. In other words, maximal performance is at a lower arousal level for a complex

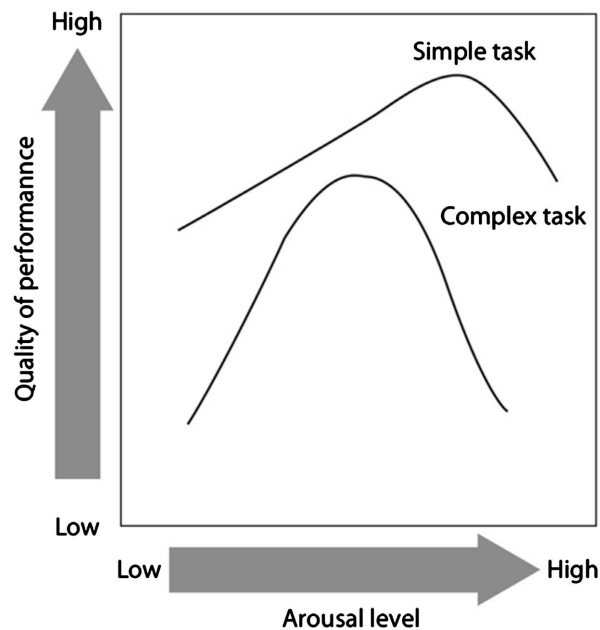**Figure 7.** The more appropriate screen for navigation message.

Figure 8. The Yerkes-Dodson Law.

task than for a simple task. Thus, this confusion about the hang-up button may increase drivers' arousal level leading to poorer quality of performance which is driving in this situation. Second, the huge screen has both pros and cons. The advantages of this huge screen are that this enables a clearer view of the navigation for the driver and other passengers can enjoy their in-car lives by using this huge screen watch some movies or dramas. On the other hand, the disadvantage of the huge screen is that some related information is located separately which may lead drivers to misperceive them and then their later schedules may be affected by this misperception. Third, only a brief auditory navigation message may not be as useful as it is supposed to be. When drivers are driving, their arousal level is at a higher level. As mentioned before, a lower arousal level can achieve a more optimal performance while humans are doing a complex task, which means drivers with a relatively high arousal level cannot perceive a brief auditory message properly leading to poorer driving performance.

In sum, even though the in-car assistance systems and the interior design of vehicle are getting smarter and smarter, it does not increase the efficiency and convenience of vehicle as much as public's expectation. Therefore, instead of the button which one Han EV forces to press, a typical phone symbol will be a better choice to replace the previous one. The designer should also place information which is related to each other together or closer than those not. In addition, the navigation message should be better presented in both visual presentation and auditory presentation. There must be an interval between two types of presentation as well. Although this study has demonstrated three different UI problems about NEV, it is almost based on only one specific type of NEV which is Han EV, which means that similar studies should also be conducted on other types of NEV in the future with the purpose of making a more generalized conclusion.

Moreover, this study is almost based on qualitative research lacking more empirical evidence for each problem so that relative quantitative research should be added to obtain more detail results. In addition, the improvement suggestions corresponding to each problem should also be refined in the coming future.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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