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Neural Decision-Making Application of Internet Product Interaction Design Based on EEG

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ABSTRACT

With the rapid development of information technology, the rapid growth of Internet plus brings many new challenges to science. At present, in the practice of information product design emphasizing user experience, there is an urgent need for new human factors measurement methods and tools to more accurately and objectively evaluate the effect of product interaction design, so as to provide theoretical support and basis for product design and decision-making. Firstly, this paper summarizes and combs the research progress and related achievements of scholars at home and abroad in recent five years from the two aspects of cognitive ability research of product interaction design and neural decision-making technology of product interaction design scheme. Secondly, it puts forward the research objectives, contents and technical route of neural decision-making in product interaction design, summarizes the application field of neural decision-making in Internet product interaction design based on EEG at the present stage, finally points out that the current research still has problems such as cross individual, cross time, cross task and EEG data source, and puts forward the prospect of EEG neural decision-making in the field of Internet product interaction design.

Keywords: Interaction design, Neural decision-making, Cognitive ability, Emotional experience, EEG

INTRODUCTION

Internet products have penetrated into all aspects of people's work, education, health, communication and entertainment (Biswas et al., 2016); Online information search, reservation, shopping and other apps can not only bring convenience to users, but also help users improve work efficiency. The "digital 2018" Internet Research Report shows that the total number of Internet users around the world has exceeded 4 billion, and the number of domestic Internet users has increased rapidly, reaching 772 million as of January 2018. Studying the interactive design of Internet products and improving the user experience of products will help to increase the social welfare of Internet users and improve work efficiency and knowledge dissemination efficiency. At present, the interaction design of Internet products increasingly emphasizes user experience, and there is an urgent need for new human factors measurement

methods and tools to more accurately and objectively evaluate the effect of product interaction design, so as to provide theoretical support and basis for product design and decision-making. Neural measurement is different from traditional human factors research methods. It overcomes the subjective deviation of questionnaire, scale and other methods, and can dynamically grasp the user's cognitive process of the product in the millisecond accuracy, so as to provide neurological decision-making basis and guidance for design practice.

Users' cognition of products includes perception, attention, memory, thinking and other aspects, especially attention, working memory and spatial perception have an important impact on the learning and use of products. The above cognitive factors indirectly affect the user's sense of control and overall feeling of the product, and ultimately affect the user's perception of the product user experience. However, the mechanism of cognitive ability affecting network behavior is complex. The existing research methods pay more attention to the behavior research results (such as usability research), which is difficult to reveal the dynamic process of user cognition, the brain cognitive mechanism of users in the process of interacting with products, and it is impossible to use the theoretical results to guide the design. Therefore, the research on neural decision-making of Internet product design is of great significance to the interaction design of Internet products.

RESEARCH STATUS OF EGG IN PRODUCT DESIGN

The research of product interaction design at home and abroad is divided into two main directions: one is the research on the cognitive ability of product interaction design, and the other is the neural decision-making technology of product interaction design scheme. The following reviews the research of the two technologies at home and abroad.

Research on Cognitive Ability of Product Interaction Design

"Cognitive ability" includes verbal information, intellectual skills, cognitive strategies, attitudes and motor skills]. Over the past 20 years, there have been "cognitive models" of "reading ability", "cognitive ability of" working space "," cognitive ability of "reading ability" and "cognitive ability of" visual ability ". The most systematic and in-depth research on cognitive ability in the field of human-computer interaction belongs to virtual cognitive modeling. For example, the models soar, act and epic combined with psychology and artificial intelligence, the simplified GOMS (goals, operators, methods, and selection rules) of these models, the models ease and cogtool dedicated to improving interactive inclusiveness, and guide considering the ability limitations related to disability and aging. Funded by the EU horizon 2020 research and innovation project, Greek researchers have recently developed a new virtual user model that can simulate the mild cognitive impairment of the elderly, and will develop a cognitive prediction model. Most of these studies have established complex virtual user model prototypes from the technical point of view, but they are still unable to understand the dynamic brain cognitive process of users using products. Due to the large gap between theoretical

discovery and design practice, the transformation of Ergonomics application has not been completed.

Cambridge University has explored the user's cognitive ability and the inclusive evaluation of product design, and believes that the cognitive abilities that have a direct impact on design include: working memory, long-term memory, mental model, planning and problem-solving ability, language and communication ability. From the perspective of product use, neerincx and others defined the cognitive ability of users as intelligence, memory, language and reading ability. In the I-design interdisciplinary project funded by the British Society for engineering and material research (EPSRC), Cambridge University conducted research on the sensory, motor and cognitive abilities of British adults in order to provide designers with comprehensive user data reference. However, limited by conditions, this study only collected several easily measured "cognitive ability" data based on psychology, which is not closely related to human-computer interaction, and has not yet formed interactive cognitive ability knowledge for designers. How to transform user data into designer knowledge is a major "challenge and opportunity" in design research.

There are also studies involving cognitive ability in China. Rao Peilun of Tsinghua University pointed out that cognitive aging generally includes perceptual aging, memory aging, attention aging and intelligence aging [26]. Zhang Hongbing of Shanghai University proposed that multi-channel user interface design is more suitable for users with cognitive impairment. The applicant's research team sampled people aged 50-80 in urban and rural China (with an average age of 64), collected user cognitive ability data mainly through self-report, and found that there were significant differences in the use of information products between urban and rural users. The study also found that it is necessary to develop new cognitive tests that are more relevant to design and increase objective cognitive experimental measurements. However, cognitive ability is complex and difficult to measure. The measurement of cognitive ability has not been involved in the new round of "survey of basic ergonomic parameters of Chinese adults".

Neural Decision Technology of Product Interaction Design Scheme Research Contents

The concept of neural management and neural design was first put forward by Professor Qingguo Ma of Zhejiang University in China. Through 10 years of practice, it provides a lot of theoretical basis for the development of neural design. At present, many neural management teams at home and abroad have carried out research on product neuro-measurement from different perspectives, and preliminarily achieved the following results: a) the cognitive process of product interaction is complex. Neuro-measurement research divides it into early components and late components, and relevant research has been carried out from different stages. Qingguo Ma research team of Zhejiang University (2011-2014) found that N1 was related to early attention, P2 responded significantly in evaluating aesthetics, and there was a significant difference in the amplitude of beauty and nonbeauty. In addition, N2 is a

good measurement index in terms of innovation, N400 in terms of familiarity, etc. Due to the complex composition of cognitive factors in the process of product interaction, there are many corresponding cognitive neural indicators, and they are still in the exploratory stage. At present, there is no complete index system for practical application reference. The latest research not only focuses on the neural response components, but also studies the bands related to the neural activity, such as theta band and delta band, which are found to be related to neural activities such as product memory and classification. b) Multiple ERP components related to decision-making can be used to evaluate the response level of user experience. Guo Fu (2016) of Northeast University and Chengqi Xue (2016) of Southeast University found that the classic components of P300 related to cognition respond in the process of product appearance experience and interface interaction. ERP components related to cognition mostly belong to late components, which have measurement significance for interactive interface recognition, navigation recognition and so on. c) For the LPP component related to emotion, Jin Jia et al. (2014) found in the research of warning signs that users will have a large LPP amplitude for words with strong warning. Compared with existing studies, it is found that the modified component is helpful to judge the emotional state after users' information understanding. d) The analysis of resting EEG data shows that theta band of parietal region is an important index of cognitive load monitoring, and time-frequency analysis is the main analysis method of this kind of data. In addition, cognitive laterality analysis can also reflect the cognitive state of interaction process.

RESEARCH ON NEURAL DESIGN APPLYING IN PRODUCT INTERACTION DESIGN

Research Contents

Through neural measurement, we will study the ERP components and neural mechanism of users in the process of product interaction, build a neural measurement index system to evaluate product interaction design, and put forward neural measurement standards to provide basis for design decision-making. The research contents are as follows:

The attention neural mechanism of product icon shape, color and other design elements. Mis-operation in the use of Internet products is usually caused by factors such as inattention and recognition errors. Therefore, it is very important to study the influence of various design elements on the components of attention neural response, including latency, amplitude and response position. This study focuses on two cognitive neural components: N2 and LPP. N2 is a cognitive neural response component of early attention. LPP is a neural component related to attention after full cognition, and reflects the emotional changes of users. It is an important cognitive neural index of emotional experience.

Neurocognitive mechanism of product interaction design decision. Previous studies have shown that product decision-making is related to P300 components in cognitive nerve. In interaction design, the amplitude of P300

corresponding to easy to identify icons is greater than that of P300 corresponding to difficult to identify icons. However, the interaction design of Internet products is an overall process, and user identification is also an overall comparison process. Therefore, whether P300 in the interaction design decision-making process can effectively represent decision-making information needs to be explored in this study.

Research on emotional experience of product interaction design. The composition of user experience is very complex. It is generally divided into hedonic experience and practical experience. The interactive design attributes related to hedonism include design aesthetics, emotional experience, physiological experience, cognitive experience, etc. each experience attribute corresponds to one or more neurometric indicators. Some studies have only involved some ERP components related to aesthetics, emotion and cognition, and mostly discussed the availability and sensitivity of this indicator from the theoretical level, There is still a lack of relevant research on user experience design practice. Therefore, this study takes the emotional experience as the research object to explore the changes of users' emotional experience in the process of product interaction.

Technology Roadmap

This study adopts the method of combining empirical research and theoretical research. The empirical research adopts the research methods of questionnaire, in-depth interview, behavior record and EEG experiment. Based on information communication theory, interaction design theory, Situational Cognition Theory and Wilson information behavior model, according to the research objectives and contents, the research is divided into two modules, corresponding to a number of research contents respectively. The overall framework of the technical route is shown in Figure 1, and each module contains several tasks. The technical route focuses on two aspects: interactive design neural decision-making and Ergonomics application. They are interdependent. Interactive design neural decision-making originates from the theory of cognitive psychology and serves design; Ergonomics application aims at improving the accessibility of the interactive interface, and the effect of Ergonomics application is tested through various indicators of neural decision-making. The technical route is as follows:

In the design of neural decision-making part, firstly, study the attention neural response mechanism of various elements of interactive design, pay attention to the amplitude, latency and response area of attention neurocognitive components, compare the impact of different design elements on neural components, and provide ergonomic application suggestions; Secondly, the neural response component of the overall decision-making of interactive design scheme is studied to provide a theoretical basis for Ergonomics application decision-making; Thirdly, the emotional body of product interaction design scheme is studied.

Test the neural response component, and provide the decision-making basis of user emotion for Ergonomics application by judging the user's emotional response. Finally, a set of effective neural decision-making and

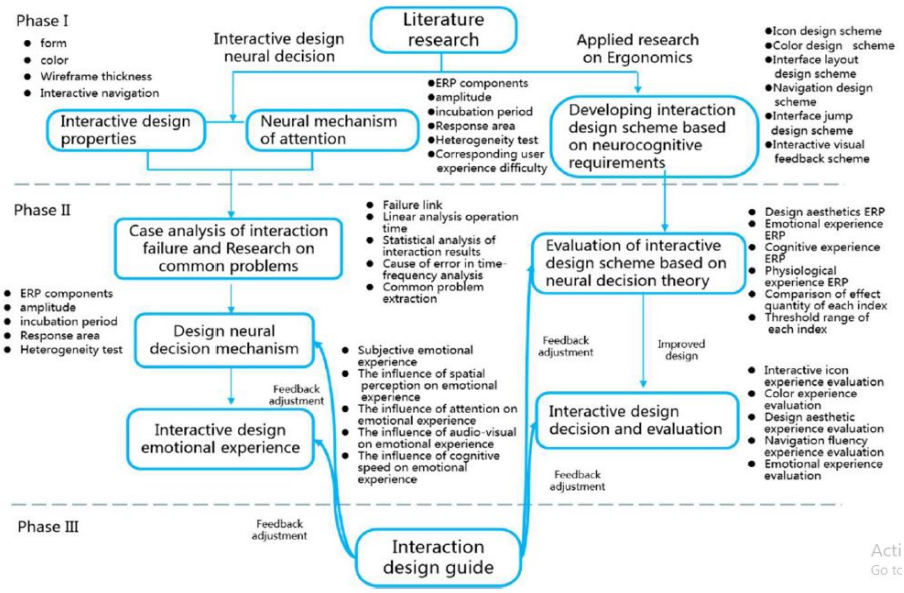

Figure 1: Technology roadmap.

ergonomic application methods for interactive design of Internet products are formed.

Ergonomics application part: firstly, carry out literature research around Situational Cognition Theory, interaction design theory and Wilson information behavior theory, and then collect and sort out the commonly used app interaction cases in China; According to the neuroscience basis of neural decision-making, it provides guidance for design practice. Design and develop a set of interactive design scheme in line with neurocognitive theory, carry out neural decision-making evaluation on the scheme, and vertically compare the advantages and disadvantages of the scheme, so as to provide a method for Ergonomics application.

Experimental Method Design

This study uses EEG experimental method and combined with technical route to do the following experiments: A. design EEG experiments in which attributes affect the neurocognitive mechanism of attention. The experiment plans to adopt a series of basic design neural experiments to carry out EEG experiments on interactive icons, colors, aesthetics, etc. in the design practice, so as to explore the guidelines of design elements in line with the neurocognitive mechanism of attention. b. EEG experiment of overall neural decision-making of interactive design scheme. The experiment intends to adopt the classic oddball experimental paradigm, take the excellent interaction design scheme as the target stimulation material and the ordinary scheme as the background stimulation material, observe the role of P300 EEG component in the decision-making process, and explore the application of this component in the decision-making of interaction design scheme. c. Neural evaluation experiment of emotional experience in

interactive design. The experiment takes the influence of operation fluency on emotional experience as the experimental goal, and measures users' emotional experience through simple operation. In addition, for the problems found in the experiment, feed back to the designer to make a new round of design scheme. d. Interaction design scheme, ergonomic behavior experiment and EEG experiment. The experiment adopts behavioral experiment and EEG experiment paradigm to observe the user's subjective feedback and EEG feedback on the design scheme. Through the subjective and objective joint evaluation, it provides the basis for the decision-making of design scheme.

Key Technology

Frequency domain analysis and time-frequency analysis technology of EEG signals. General EEG ERP experiments mainly focus on time domain analysis, which mainly discusses the latency, amplitude and response distribution, and less studies the frequency domain and time-frequency information. Frequency domain analysis takes the electrode as the research object to analyze the power distribution. Time-frequency analysis is a combination of the two. In this study, the comprehensive consideration of neural measurement indicators requires not only time-domain information, but also frequency-domain information. Therefore, the comprehensive evaluation of neural measurement indicators is one of the key technologies of this study.

Multiple comparison test technique of repeated measurement analysis of variance. EEG experimental data is large and there are many collection points, so it is easy to appear false and significant in statistical analysis. Multiple comparison and correction technology can reasonably avoid this risk, but under what conditions and which correction technology is used is a key technology. Through long-term accumulation, our research team has a good grasp of greenhouse geisser correction technology and Bonferroni multiple test technology.

RESEARCH TRENDS

The traditional design adopts the perceptual evaluation method to evaluate the product design and interactive interface. Perceptual evaluation is the explicit result of neural evaluation, but perceptual evaluation is easy to be affected by social approval effect in life. Sometimes it will express distortion and mislead product development and decision-making. Design neural evaluation is an implicit measurement of user experience, which does not directly require users to provide subjective feedback. In the process of using or watching, the EEG data of users are analyzed through event-related potentials to understand the real experience of users. Design neural evaluation is more objective and accurate, but the difficulty lies in the selection and analysis of ERP components. This study systematizes the ERP components of user experience measurement and explores targeted measurement indicators, which is a preliminary preparation for design neuro-evaluation and is of great significance to the development of design neurology.

Through the research on the brain response of APP shape, color and graphic complexity, this paper puts forward the neural design guide of APP

icon to help users quickly and accurately find the required app among the many apps in mobile phones, and use the neural response characteristics of attention to reduce the search time and improve efficiency. Eliminate app icon mis-selection and mis-operation. Summarize the neural response characteristics of icons, refine the common problems in icon design, and provide a research basis for design intervention. Take the interface layout, attention of navigation and semantic neural response mechanism as the research object, improve the interaction efficiency of product interface, and eliminate the phenomena of unclear key information, difficult to find, chaotic navigation space and lost navigation. On the basis of neural measurement, using the way of design intervention, this paper deeply analyzes the key neural response indicators affecting interaction performance, puts forward the dynamic response model of users' cognitive Internet product interaction, develops interaction design methods and tools, and enriches the connotation and extension of interaction design. Measure the emotional response of users in the use of Internet products, and take it as an important index to evaluate Internet products. Establish the neural response index related to emotional experience as an important basis for design decision-making.

CONCLUSION

This study studies interaction design decision-making from the perspective of cognitive nerve, re-examines the causes of interaction design failure, condenses common problems, brings cognitive factors such as neural mechanism, neural decision-making and emotional experience into ergonomics research, and constructs interaction design direction and interaction experience decision-making method serving design. From the perspective of neuroscience, it expands the connotation of interaction design and provides a theoretical basis for eliminating the cognitive impairment of interaction design. In addition, the basic framework of neural decision-making in product interaction design is established, and the neurocognitive indexes suitable for Internet product interaction design decision-making are explored, which provides a theoretical basis for design decision-making. By integrating the methods of experimental measurement and qualitative research, this paper finds the mapping relationship between user cognition and interactive behavior by setting interactive tasks related to design, uses the method of design intervention to detect the availability and pertinence of typical interactive task design schemes, and comprehensively explains the mechanism of design elements affecting user neurocognition. In the aspect of neural decision-making of design scheme, the method of combining neural measurement and behavior experiment is adopted to make the decision-making result more accurate and objective. The successful implementation of this project research will play a positive role in promoting human factors research to serve the design and application, and help the design of Internet information products better meet the needs of users. It has both theoretical innovation and good application prospects.

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