

Data Tracking and Authorization Interface Analysis based on Adolescent and Adult Groups

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Abstract. Privacy-secure interaction is a crucial aspect of digital services. Users' decisions regarding data tracking authorization are easily influenced by various factors. Adolescents generally exhibit lower levels of understanding and efficiency in fulfilling privacy policies. While existing theoretical support for privacy protection, analyses of the differences in decision-making and implementation across different age groups remain scarce. Therefore, this paper analyzes privacy authorization interfaces from the perspectives of neurophysiology, cognitive psychology, and interface design. By reviewing privacy authorization interfaces and exploring cognitive differences, this study analyzes their usability across adolescents and adults with different cognitive and developmental characteristics. Based on the above analysis, this paper finds that adolescents are more prone to impulsive decision-making than adults, and current interface designs show a higher level of completion among "neutral user" groups. In the future, interface design should focus on the development of intelligent assistance, striving to address the imbalance caused by age differences.

Keywords: Privacy and security; Data tracking; Age differences; Cognitive psychology.

1 Introduction

With the explosive growth of digital footprints, the era of big data has also ushered in a new era of privacy interfaces [1]. Current data tracking interfaces mainly focus on informing users of the types of their datasets, obscuring the ultimate purpose of these behaviors: psychological positioning—inferring users' psychological traits and influencing their unique preferences [1]. According to research, the sensitivity of information affects an individual's willingness to share information; when information is considered sensitive, the willingness to disclose it decreases [2]. If the interface design simply lists data coldly without conveying the sensitivity of the information, users cannot express their true intentions. The contradiction between the perceived risks of data security and the design philosophy leads to differences in usability.

The accelerated growth of Internet information, including video, has been unceasingly adding to the competence of adolescent analysis on their part and getting Internet details [3]. Research has found that youngsters below eighteen years of age interpret sources of information by their senses and this behavior is going to evolve even after growing older [4]. Although regulations

on the protection of minors online are constantly being improved and developed, the feasibility of privacy authorization interfaces still has significant shortcomings. In particular, when considering the cognitive characteristics of adolescents, existing interfaces often cannot match the actual development level of adolescents' risk perception and decision-making abilities. Therefore, distinguishing age differences has become a necessary prerequisite for improving the interaction mechanism.

According to existing research results, the development of artificial intelligence is mainly based on human brain research [5]. Psychology is one of the theoretical foundations for the development of artificial intelligence. Cognitive psychology studies the higher psychological processes of humans, including thinking, decision-making, reasoning, motivation, and emotion [6]. In human-computer interaction, the cognitive psychology of users is highly reflected. Interface design and application are by no means just purely technical issues. They are related to a series of ethical issues, such as human well-being, privacy, fairness, freedom from prejudice, universal usability, and informed consent [7]. Therefore, privacy interaction interfaces should be differentiated according to individual cognitive differences. At present, the feasibility and design of data tracking privacy interfaces based on different age groups are not comprehensive enough. This paper aims to explore whether there are usability differences between data tracking interfaces in adolescents whose cognitive abilities are in a critical developmental period and mature adults.

2 Problem Analysis Based on Multiple Perspectives

2.1 Decision-making model for adolescents

Most studies on privacy authorization interfaces (such as cookies and app permission requests) aim to study human emotions and behaviors and analyze homogeneous adult groups. However, adolescents have different decision-making methods when facing privacy risks. Secondly, decision evaluation is mostly based on task efficiency rather than the true understanding and thinking of the terms. To explore the interaction process, researchers can first analyze the differences in the Model Human Processor (MHP). Artificial intelligence simplifies the human brain into an information processing system and provides models that can be analyzed and used to quantify human behavior. Studies have found that when reading prompts with certain information difficulty, such as data tracking authorization interfaces, eye movement speed is no longer a factor that limits reading speed. Cognitive processing ability plays a key role in processing complex information. In other words, when users face interface choices, they need to call cognitive processing models rather than simple perceptual processing models [8]. The influence of age on cognitive processing models has a neurophysiological basis. The P300 component has a "branching path model" in MHP. By the participation of the P300 component, the selection path is divided into "deliberate path" and "automatic path". The significant difference in decision speed caused by these two selection methods [9]. Studies have shown that there are significant differences in the amplitude of P300 fluctuations when performing dual tasks at different ages, mainly in the handling of postural balance problems between the adult and elderly groups [10]. In dual tasks, resources compete for resources, and adolescents are likely to perform more poorly than adults in the dual tasks of reading data to track complex texts and conducting risk assessments.

2.2 Comparison of Adult Decision-Making Models

At present, the development direction of artificial intelligence is gradually integrating cognitive psychology into artificial intelligence, so that it can not only simulate the rational thinking of the human brain, but also evaluate emotional thinking and achieve more realistic and efficient emotional interaction [6]. There are significant differences in cognitive development between the adolescent stage and the adult stage. Adolescents are in the critical period of cognitive development. GABA can inhibit the circuit, and the development of the prefrontal cortex is not yet fully mature, while the adult stage is more stable [11]. Specifically, adolescents have weaker control over behavioral cognition, greater variability, and high cognitive load when completing advanced tasks, making them prone to fatigue or errors. Secondly, the activity and neural control of the dopamine system in the cerebral cortex reach their peak during adolescence. Compared with the cautious decision-making of adults, adolescents have a stronger motivation to explore the unknown [11]. Therefore, the plasticity mechanism of adolescent neural development reflects the instability and low efficiency of risk decision-making.

2.3 Evidence of differences in availability

Data tracking authorization interfaces are related to user privacy. Developers want to analyze user interaction data to calculate user preferences and create exclusive page pushes. However, the usual interface design only informs users of the permission content and ignores further guidance, actual purpose and risk warnings. This is not conducive to risk assessment of human-computer interaction, especially for high-risk personalities (such as impulsive and adventurous groups). In the experiment of Coventry, Jeske, Blythe, Turland and Briggs (2016) [12], it was found that although users have the concept of valuing privacy behavior, they will sacrifice privacy permissions for convenience in actual interaction. The study also explored the actual effect of "social norms" and found that "social norm" prompts can help users make decisions more cautiously. In this case, impulsive and adventurous situations will also be reduced. Interface design without normative prompts is not friendly to adolescents, but among adults, cognitive differences and the degree of caution in thinking make the click completion rate higher.

2.4 The Influence of Interface Design Factors on Perception

This section systematically analyzes the application of nudge theory in interface design and its availability across different age groups. In the research report by Acquisti[13] et al., six design concepts of "nudge" were proposed, including information design, presentation design, default setting design, incentive and cost design, reversibility and fault tolerance design, and timing design. The concepts cover the protection of the user interaction experience and the avoidance of potential risks. In terms of the differences among age groups, educational prompts and timely feedback have an important impact on reducing impulsive behavior, but there is still a risk of comprehension for adolescents whose prefrontal cortex is not fully developed. The framing effect stipulates that the interface should describe the consequences of behavior through positive/negative statements, but in the actual selection process, the experience of adults may lead to an over-reliance on experience, thereby ignoring the intention of the text. Therefore, the interface that currently lacks data tracking of prompt information tends to be more "neutral user" in design. When users cannot obtain more comprehensive prompt

information (including consequences and effects) through the interface, decision-making efficiency will be greatly affected, which is especially unfriendly to adolescents with large variations in thinking. Based on the most direct changes brought about by aging, adults have a biological advantage in understanding and cognition. However, when there is sufficient interface assistance (including text and icons), teenagers tend to use "active thinking" (more inclined to take risks and learn rather than perform fixed analysis based on existing knowledge) to demonstrate a higher degree of choice completion.

3 Discussion

The primary finding of this paper is that adolescents exhibit a significant separation between cognition and behavior when making behavioral decisions, which is related to the privacy paradox. Despite having awareness of privacy protection, they often exhibit erroneous actions that are inconsistent with their cognition in actual behavioral decisions. This is mainly attributed to the unique cognitive patterns of adolescence. The path selection of dual tasks makes adolescents' decisions risky. The modern interface design typically utilizes this cognitive vulnerability, which leads to an increased rate of clicks to agree. The guiding role should be reinforced with the help of auxiliary design to the role of "social norms"[12]. The cognitive psychological weakness in decision is displayed in adolescents. The consequence of this is an analysis that causes risky and impulsive decisions. The icon design ought to be added to the interface design to facilitate understanding that would support promoting active thinking according to complete cognition.

The legal and ethical issues are also involved in the usability of interface design issues. In this paper, the analysis is done on age differences in task completion rates of a data tracking authorization interface. There are restricting forces in the decision-making that include the environment of interaction, culture and psychological conditions during interaction. These inconsistencies and ambiguities result in theoretical design issues: is interface design neutral (autonomous in decision-making) according to null theory, or neutral according to some other approach? In the current paper, assisted design in the context of law is explored and discovered that regulations are easier to use regarding the response to tasks. Although this paper is a guide to interface design, it deals with technical and ethical issues. According to a paternalistic approach, the extent of help brought about by prompts can hardly be defined, and it is difficult to design a system that balances across age groups.

4 Conclusion

This paper determines that adolescents and adults have dissimilar characteristics and thinking styles of decision-makers, which are very influential to the software interface variations of data tracking authorization interfaces. Perspective analysis based on neurobiology and cognitive psychology discloses the fact that adolescents are at an emotional stage of mental development with decision-making that is impulsive and risky, which is a common phenomenon. Designing auxiliaries (like prompts of social norms) displays more usability differences in adolescents. Conversely, adults are wary of thinking and are also easily influenced through paranoia, which makes them overlook the actual meaning of the interface

and gives them incentives when making decisions. In the context of contemporary interface design, the neutral thinking group in the adult population (possessing or even analysing decisions based on cautious thinking) shows better completion rates on many occasions. Adolescents, often in the former level, experience cognitive biases, which lead to rashness.

To address the current shortcomings in data tracking prompts, which often lack sufficient content, design and development should place greater emphasis on the guidance process. Interface design for adolescents should strengthen comprehension aids, such as icons. Then, consequence warnings and social norms lists allow adolescents, who are at the age of critical cognitive development and susceptible to spur of the moment decision-making, to make considerations and conscious choices. Considering the differences between interaction decisions and task responses that occur based on the differences of the users, the data tracking privacy interface would have to incorporate an AI assistant. Answers to the questions of the users are available by selecting prompts, which allows the researcher to focus more specifically on solutions to user needs.

References

- [1] Matz, S. C., Appel, R. E., Kosinski, M.: Privacy in the age of psychological targeting. *Current Opinion in Psychology*. 31, pp. 116–121 (2019)
- [2] Slepchuk, N., Milne, G. R.: Informing the design of better privacy policies. *Current Opinion in Psychology*. 31, pp. 106–111 (2019)
- [3] Lovato, S. B., Piper, A. M.: Young children and voice search: What we know from human–computer interaction research. *Frontiers in Psychology*. 10, p. 8 (2019)
- [4] Danovitch, J. H., Alzahabi, R.: Children show selective trust in technological informants. *Journal of Cognition and Development*. 14, pp. 499–513 (2013)
- [5] Nadji-Tehrani, M., Eslami, A.: A brain-inspired framework for evolutionary artificial general intelligence. *IEEE Transactions on Neural Networks and Learning Systems*. 31, pp. 5257–5271 (2020)
- [6] Zhao, J., Wu, M., Zhou, L., Wang, X., Jia, J.: Cognitive psychology-based artificial intelligence review. *Frontiers in Neuroscience*. 16, Art. no. 1024316 (2022)
- [7] Hochheiser, H., Valdez, R. S.: Human–computer interaction, ethics, and biomedical informatics. *Yearbook of Medical Informatics*. 29, pp. 93–98 (2020)
- [8] Card, S., Moran, T., Newell, A.: The model human processor: An engineering model of human performance. *Handbook of Perception and Human Performance*. Vol. 2, pp. 1–35 (1986)
- [9] Higashino, T., et al.: Revisiting the model human processor: A neurophysiological study based on P300 and Bereitschaftspotential. *Frontiers in Human Neuroscience*. 19, Art. no. 1690746 (2025)
- [10] Tortora, S., et al.: Age-related differences in visual P300 ERP during dual-task postural balance. In *Proceedings of the 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. pp. 6511–6514. IEEE (2021)
- [11] Larsen, B., Luna, B.: Adolescence as a neurobiological critical period for the development of higher-order cognition. *Neuroscience and Biobehavioral Reviews*. 94, pp. 179–195 (2018)
- [12] Coventry, L. M., et al.: Personality and social framing in privacy decision-making: A study on cookie acceptance. *Frontiers in Psychology*. 7, Art. no. 1341 (2016)
- [13] Acquisti, A., et al.: Nudges for privacy and security: Understanding and assisting users’ choices online. *ACM Computing Surveys*. 50, Art. no. 44 (2017)