Exploring the Impact of Cognitive Styles on the Visualization of Privacy Policies

Areti Tsolakidou
Aristotle University of Thessaloniki
Thessaloniki, Greece
atsolaka@csd.auth.gr

George E. Raptis
Human Opsis
Patras, Greece
graptis@humanopsis.com

Christina Katsini
Human Opsis
Patras, Greece
ckatsini@humanopsis.com

Christos Katsanos
Aristotle University of Thessaloniki
Thessaloniki, Greece
ckatsanos@csd.auth.gr

ABSTRACT

Cognitive styles shape how individuals process information, impacting their interactions with various forms of data, including visualizations. In this paper, we report a user study that explores the influence of two prominent cognitive styles, Field Dependence-Independence and Visualizer-Verbalizer, on the processing of privacy policy visualizations. In a between-subjects study, we investigate whether these cognitive styles affect processing time and cognitive load when users use differently visualized privacy policies. The results reveal differences among individuals with differing cognitive styles, especially regarding processing time, mental effort, and frustration. These results provide insights in shaping the design of more user-friendly and accessible privacy policy visualizations, contributing to enhanced user comprehension and engagement in digital security. Our study underscores the importance of considering cognitive diversity when developing interfaces for information-heavy domains, ultimately striving for more inclusive designs.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Empirical studies in HCI**; *Visualization techniques*; • **Security and privacy** → **Human and societal aspects of security and privacy**; *Usability in security and privacy*.

KEYWORDS

human-computer interaction, usable security and privacy, privacy policy, cybersecurity, cognitive theory, cognitive style, user study, visualization.

ACM Reference Format:

Areti Tsolakidou, George E. Raptis, Christina Katsini, and Christos Katsanos. 2023. Exploring the Impact of Cognitive Styles on the Visualization of Privacy Policies. In *27th Pan-Hellenic Conference on Progress in Computing and Informatics (PCI 2023), November 24–26, 2023, Lamia, Greece.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3635059.3635076

PCI 2023, November 24–26, 2023, Lamia, Greece

ACM ISBN 979-8-4007-1626-3/23/11.
https://doi.org/10.1145/3635059.3635076

1 INTRODUCTION

Cognitive styles, the unique ways individuals process information, play a fundamental role in shaping how people perceive and interact with the world around them. Two prominent cognitive styles that garnered significant attention in research are Field Dependence-Independence [45] and Visualizer-Verbalizer [23]. Although not exhaustive, these cognitive styles are critical in understanding how individuals process, analyze, and interpret various forms of information, including different types of visualizations [43].

Visualizations are used across various domains, with usable security and privacy domain being critical, considering that users need to comprehend and efficiently process the privacy policies of applications they engage with. These policies often contain complex legal and technical language, making them challenging for many users to understand fully. Considering that cognitive styles influence how people process information in usable security [16, 35] and when interacting with visualizations [39, 43], a question arises: do cognitive styles influence how users process and perceive privacy policy visualizations?

To delve deeper into this inquiry, we performed a user study to explore whether cognitive styles impact the processing time and cognitive workload, two widely used dimensions for evaluating privacy policies, experienced by users when they engage with different visualizations. The remainder of the paper is structured as follows: we first present the background and the research objective of the work; next, we report the user study; finally, we discuss the findings and conclude the paper.

2 BACKGROUND AND RESEARCH OBJECTIVE

2.1 Cognitive styles

Socio-cognitive theories [23, 37, 42] suggest that people differ in how they seek, represent, process, and retrieve information, depending on their cognitive characteristics, such as cognitive abilities/skills and cognitive styles. Unlike cognitive abilities, cognitive styles denote a tendency to behave in a certain manner, and thus, several researchers [3, 22, 37, 45] have used cognitive styles to explain empirically the observed differences in how people process information. Extensive research efforts have reported that differences in cognitive styles have an impact on individuals' performance, experience, and teamwork in diverse fields such as e-learning [7], cultural heritage [33], gaming [2, 24], security [16], business and management [4], and e-commerce and marketing [25]. Next, we present two of the most widely used cognitive styles: Field Dependence-Independence and Visualizer-Verbalizer.

2.1.1 Field Dependence-Independence (FD-I). The FD-I cognitive style is the most prominent cognitive style regarding the perception dimensions of cognitive processing [27, 28], such as selective attention and field structuring. It is an established and validated single-dimension style that characterizes people as either field-dependent (FD) or field-independent (FI), based on their ability to extract visual information in complex scenes [9, 45]. FIs disentangle a field into its components, isolate important information from a complex whole, and are not influenced by the perceptual field, while FDs tend to see the perceptual field as a whole, process information globally, and are less attentive to detail. When searching for visual cues, FDs tend to follow a more holistic strategy and have a more disoriented visual behavior, starting from the outer regions of the scene and ending up in the details. On the other hand, FIs tend to identify critical cues quickly and adopt an analytic approach by following specific distinct scene characteristics, such as shapes and colors [1, 34].

2.1.2 Visualizer-Verbalizer (VV). The VV cognitive style is based on the dual-coding theory [31] and describes individual preferences for processing visual versus verbal information. Visualizers tend to think concretely and personalize information. On the other hand, verbalizers prefer to process information through words and are more objective [12]. High-imagery ability is linked to visualizers, while low-imagery ability is linked to verbalizers [8, 21]. Verbalizers excel at reading and sequential information-processing tasks, while visualizers excel at visual search and structured information-processing tasks [14]. Recent research [6, 23] divides visualizers into object- and spatial-visualizers. Object-visualizers have a strong ability to visualize and manipulate images of objects, such as shapes, figures, and patterns, and may excel at tasks that require mental manipulation of objects, such as jigsaw puzzles or assembling models. On the other hand, spatial-visualizers have a strong ability to visualize and manipulate spatial information, such as maps, graphs, and three-dimensional (3D) objects. They tend to think in terms of pictures and mental images and may use strategies such as mental rotation to solve spatial problems.

2.2 Visualizations of Privacy Policy

Online privacy has become an increasingly important concern, with regulations, court rulings, and changes in business practices altering the online user experience. A fundamental aspect of data privacy is the empowerment of users, enabling them to make informed decisions and choose between competing products and services [38]. The primary means of achieving this are through privacy policies, terms of service, or end-user license agreements. These legal documents define the terms of using a product or service and inform users about the collection and utilization of their data [38].

However, current privacy policies have issues in terms of user experience. They are often challenging to comprehend due to their length, use of technical jargon, and advanced reading level [13, 26, 41]. Consequently, users often need help reading and largely ignore these policies, even when granting consent [29]. Previous research has suggested alternative ways to visualize the content of these policies without replacing the legally binding privacy policy itself. Varying visualizations tend to enhance users' understanding and engagement [17, 19, 20, 41]. Some of the most widely adopted and researched visualizations of privacy policy include (Figure 1):

- Privacy Policy Long Text (PPLT) is the traditional, lengthy, and often complex visualization of privacy policies that websites provide to inform users about how they collect, use, and protect personal data. They are typically filled with legal and technical language, making them difficult for the average user to understand. Users are often presented with a wall of text when they encounter these policies.
- Privacy Policy Short Text (PPST) [36] is a concise and easily understandable representation of the most critical aspects of a privacy policy. The purpose of PPST is to provide users with a clear summary of the key contents of a privacy policy, focusing on the data collection practices that have the most significant implications for the user's privacy.
- Textured Privacy Policy (TPP) [17] accompanies visual content (i.e., images) to small segments of textual information. The most critical parts of the privacy policy are presented in combination with images that directly refer to the textual content. TPPs aim to guide users to focus on the visual content and read the text of the privacy policy next to it more carefully.
- Privacy Policy Nutrition Label (PPNL) [19, 36] describes the privacy policy as a table that provides a summarized and simplified view of the type of data collected, how that data is used, and whether it is disclosed to other companies or the public website. This table typically has rows representing different types of data collected and columns representing operational purposes and data recipients.

To evaluate the users' experience when using the different privacy policy visualizations, two main dimensions are used: processing (also described as attention or exposure) time [17, 19, 20, 36] and cognitive workload [5, 40].

2.3 Research Objective

Prior research has delved into the impact of cognitive styles on user interactions with usable security and privacy services, particularly in the context of user authentication [15, 16, 35], and also has explored how individuals with varying cognitive characteristics engage when utilizing visualization tools, such as plots [18, 39, 43]. However, the intersection of these factors, cognitive styles and visualization of privacy policies, has not been explored in the field of usable security and privacy, representing a critical gap in our understanding, as effectively conveying privacy policy information is a significant challenge within the usable security and privacy domain. Hence, our primary research objective is to explore whether cognitive style plays a role in shaping how individuals perceive and engage with different visualizations of privacy policies. We specifically focus on two well-established dimensions: processing time [17, 19, 20, 36] and cognitive workload [5, 40].

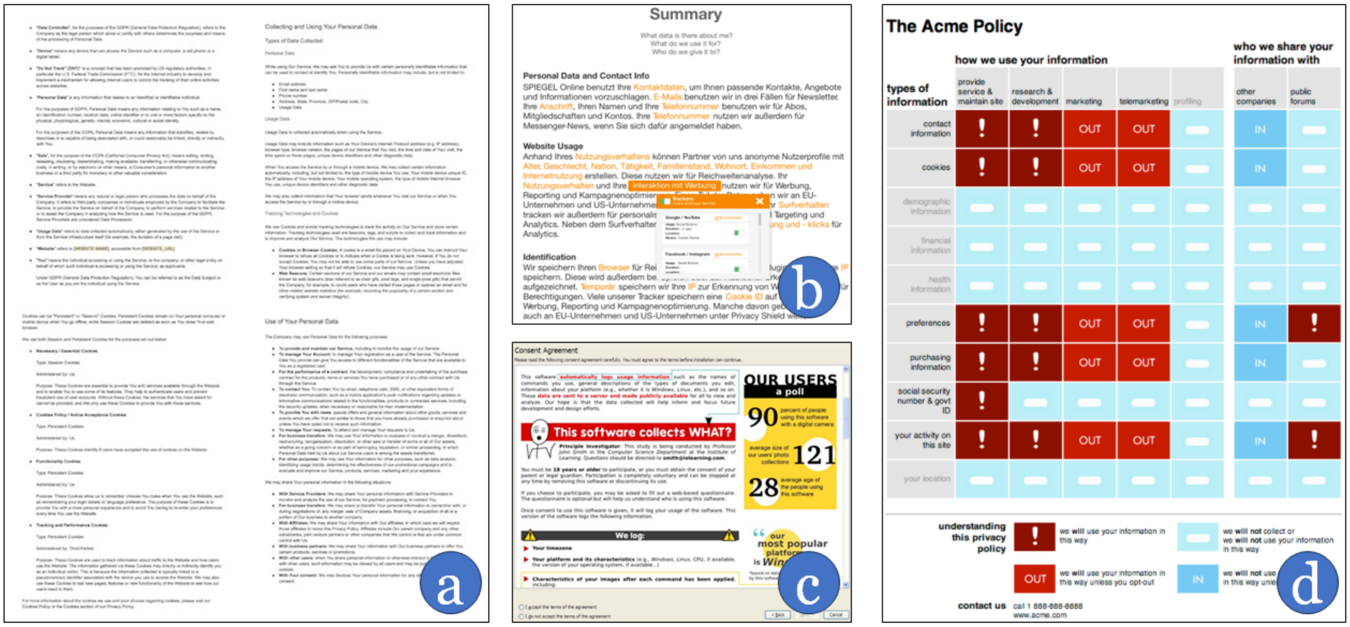


Figure 1: Common privacy policy visualizations: a) Privacy Policy Long Text (PPLT), b) Privacy Policy Short Text (PPST) [36], c) Textured Privacy Policy (TPP) [17], d) Privacy Policy Nutrition Label (PPNL) [19].

3 STUDY

3.1 Methodology

3.1.1 Hypotheses. To answer our research question, we formed the following null hypotheses.

- $H1_0$ Individuals with different cognitive styles do not have differences regarding processing time in any visualization of privacy policy.
- $H2_0$ Individuals with different cognitive styles do not have differences regarding cognitive workload in any visualization of privacy policy.

To investigate our hypotheses, we conducted a statistical analysis using independent samples t-tests tests for each visualization. In this analysis, cognitive styles was the independent variable, while processing time and cognitive workload were the dependent variables. We adopted a significance level of 0.05 for all tests. It is important to note that all tests adhered to the necessary assumptions unless explicitly specified in the Results section.

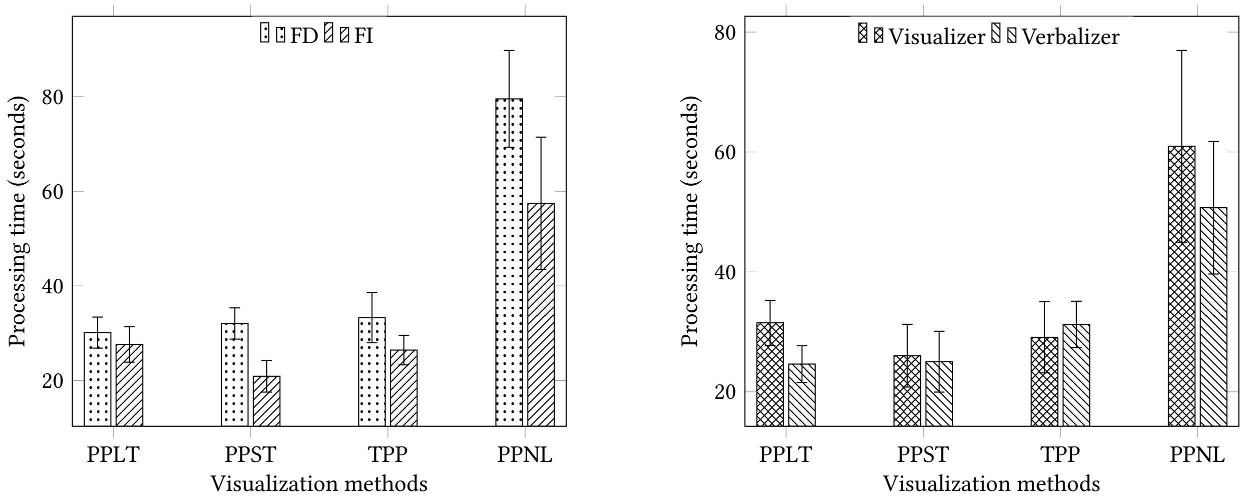
3.2 Instruments and metrics

Regarding the cognitive style, we were based on FD-I and VV, considering that they are widely used cognitive styles in the literature. To measure the FD-I style, we used the Group Embedded Figures Test (GEFT) [30]; to measure the VV style, we used the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ) [6]. To assess workload, we used the NASA Task Load Index (NASA-TLX) [11], which is a widely used validated tool for measuring workload dimensions [10]. It consists of six dimensions (i.e., mental demand, physical demand, temporal demand, performance, effort, and frustration) on a 100-point scale. The overall workload is calculated by summing the responses of each dimension. Regarding the visualization methods, we used the PPLT, PPST, TPP, and PPNL versions discussed in the previous section.

3.2.1 Participants. Fifty-four individuals took part in our study (age: $M = 23$, $SD = 4$; 19 self-described as females and 35 self-described as males). Regarding their cognitive style, 22 participants were characterized as FDs and 32 as FIs; 36 were characterized as visualizers (12 spatial- and 24 object-visualizers) and 18 as verbalizers. Regarding the privacy policy visualization methods, we aimed to achieve a balanced distribution, leading to 14 participants using the PPLT version, 14 participants using the PPST version, 13 participants using the TPP version, and 13 participants using the PPNL version.

3.2.2 Procedure. To investigate our hypotheses, we conducted a between-subjects study with the following procedure:

1. we recruited the study participants using varying methods, including personal contacts and social media announcements;
2. the potential participants received information about the study and how their data will be used;
3. the participants entered a web-based application that first asked them to process/configure the privacy policy. We followed a sequential approach to deliver the visualization methods, meaning that the first participant was allocated with the PPLT version, the second participant with the PPST version, the third participant with the TPP version, the fourth participant with the PPNL version, the fifth participant with the PPLT version, and so on;
4. during the privacy policy session, we collected the processing timings;



(a) Processing time for FD-I

(b) Processing time for VV

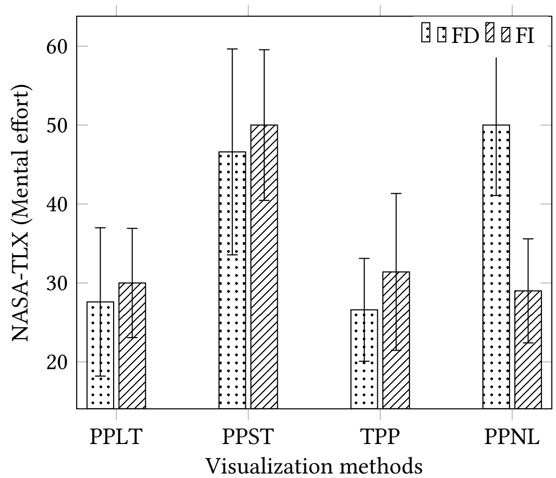
Figure 2: Processing time (in seconds) for FD-I and VV cognitive styles across various privacy policy visualizations.

(5) the participants undertook the GEFT and OSIVQ tests (to measure their FD-I and VV cognitive style);
(6) the participants completed the NASA-TLX questionnaire;
(7) we analyzed the collected data, the results of which are discussed in the subsequent section.

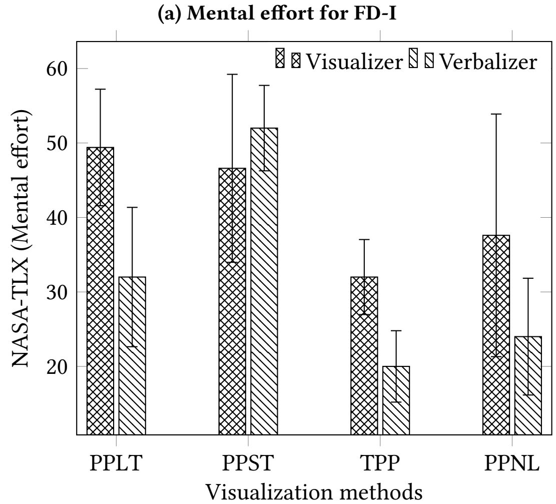
3.3 Results

3.3.1 Processing time. Regardless of the visualization of the privacy policy, FDs and FIs had similar processing times, with no statistically significant differences observed. This pattern held for most visualization methods. However, an interesting distinction emerged for the PPST method, with FIs completing processing more swiftly than FDs (FDs: M = 32.048, SD = 5.229; FIs: M = 20.898, SD = 6.492; t = 3.194, p = .004). This phenomenon can be attributed to the fact that FIs typically use a more systematic and analytical approach when handling visual information, enabling them to extract policy details more efficiently. This advantage becomes particularly evident when the visual information is in a specific format, such as text, and is concise, as FIs' structured reading and content evaluation approach proves faster than that of FD users. We received similar results for the VV cognitive style; we found no differences for processing times regardless of the visualization of the privacy policy. Focusing on each visualization method, we observe that for the PPLT method, verbalizers needed less time to process it than visualizers (marginal difference; Visualizers: M = 31.509, SD = 5.663; Verbalizers: M = 24.632, SD = 5.861, t = 2.151, p = .053). This could be explained as follows: verbalizers tend to perform more detailed processing of visual information, and thus, they can extract such information (e.g., policy-related) more quickly. Especially when visual information is given in a specific way (e.g., detailed text), the structured approach they take to reading and evaluating the content may be faster than that of visualizers. Figure 2 depicts the results regarding the processing time.

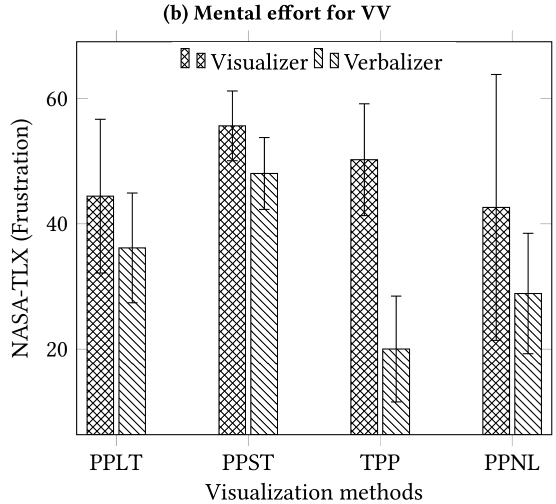
3.3.2 Cognitive workload. Regarding FD-I, we observe no differences for the overall cognitive workload. However, FDs assessed that they had to put more mental effort when using the PPNL method than FIs (FDs: M = 50.000, SD = 14.142; FIs: M = 29.091, SD = 10.445; t = 2.511, p = .029). This can be explained as follows: FIs tend to perform more organized and analytical visual information processing; thus, they can extract valuable information from a policy that combines textual and visual elements more easily. This is also amplified by the fact that the visual information is given in a more interactive form, allowing the user to choose the constraints they want; the structured approach they take to reading and evaluating the content may be more efficient than that of FD users. Regarding VV, we observe that verbalizers had a lower overall cognitive workload than visualizers regardless of the visualization method of the privacy policy (Visualizers: M = 49.528, SD = 7.173; Verbalizers: M = 45.356, SD = 5.623, t = 2.155, p = .036). Focusing on each dimension, we observe that visualizers experienced a higher mental demand when processing TPP than verbalizers (Visualizers: M = 32.012, SD = 7.978; Verbalizers: M = 20.000, SD = 9.167, t = 2.714, p = .024). Most policies are based more on textual information than visual information, thus, verbalizers tend to analyze the privacy policy content more efficiently and with less mental effort than visualizers, extracting valuable information. We also observe that visualizers had higher frustration scores than verbalizers when using the TPP version (Visualizers: M = 50.238, SD = 14.139; Verbalizers: M = 20.021, SD = 16.154, t = 4.708, p = .004). This result suggests that visualizers experienced higher levels of insecurity, discouragement, stress, and annoyance when using the TPP version compared to verbalizers. This may be due to TPP's combination of visual and textual elements, where the textual information carries greater importance. Consequently, this combination could potentially confuse visualizers, as they typically have a preference for visual content over textual content, thus, leading them to higher levels of frustration. Figure 3 depicts the results regarding the dimensions of the cognitive workload.



(a) Mental effort for FD-I



(b) Mental effort for VV



(c) Frustration for VV

Figure 3: NASA-TLX scores (100-point scale) for FD-I and VV cognitive styles across various privacy policy visualizations.

4 DISCUSSION

The results of this study provide valuable insights into the relationship between cognitive styles and the visualization of privacy policies in the context of usable security and privacy. The main practical implication is the design of privacy policy visualizations tailored to the users' cognitive styles. Considering that individuals with different cognitive styles may have varying preferences and efficiencies when interacting with privacy policy visualizations, the designers of privacy policy visualizations and interfaces should consider these differences to create user-friendly and effective visualizations. For example, when targeting FIs, a more structured and concise textual format may be preferable, while FDs may benefit from interactive elements. In this direction, personalizing privacy policy visualizations and interfaces based on users' cognitive styles could be explored. For instance, allowing users to choose their preferred visualization style (e.g., text-heavy, interactive, visual) could enhance user engagement and comprehension. Moreover, developing training and educational materials could cater to different cognitive styles. By understanding how FD-I and VV individuals interact with privacy policies, targeted educational content can be created to better inform users about their privacy rights and responsibilities. Besides the usable security and privacy domain, the study results indicate that differences in processing time and cognitive load when handling specific types of privacy policy visualizations could contribute to user modeling. These differences could lead to the implicit elicitation of cognitive styles, a phenomenon observed in other activities like gaming [32, 44].

Our study has also theoretical implications, which are twofold. First, it advances our understanding of the intricate relationship between cognitive styles and information visualization within the usable security and privacy domain. By exploring how individuals with different cognitive styles engage with and perceive privacy policy visualizations, this research contributes to developing theories that encompass the psychological dimensions of user behavior in security-related tasks. Second, this study underscores the relevance of cognitive psychology in the domain of usable security and privacy, bridging the gap between cognitive science and security technology. Explaining how cognitive styles influence processing time and cognitive workload in the context of privacy policies enriches the theoretical foundation for studying the interplay of cognitive factors and user experiences in security and privacy settings. Consequently, these theoretical insights lay the groundwork for more comprehensive and nuanced models of user behavior and usability in privacy and security.

4.1 Limitations and Future Work

While we made efforts to comprehensively investigate the impact of cognitive styles on privacy policy visualizations, our study has several limitations that should be acknowledged. A limitation of this study is its relatively small sample size, which may limit the generalizability of the findings to a broader population. Additionally, the study focused on only two cognitive styles (FD-I and VV) and examined two specific dimensions (processing time and cognitive workload). Future research could benefit from including a more diverse range of cognitive styles and exploring additional dimensions of user interaction, such as user comprehension, trust, and decision-making, to provide a more comprehensive understanding of how cognitive styles impact usable security and privacy experiences.

In terms of future work, a larger-scale study with a more extensive and diverse participant pool would allow for more robust conclusions and generalizability. Furthermore, a longitudinal study design could be employed to investigate the long-term effects of cognitive styles on user interactions with privacy policy visualizations, shedding light on how these effects evolve. Additionally, incorporating more dimensions for evaluating usability and user experience would provide a more holistic perspective. Lastly, considering additional research techniques, such as interviews and eye-tracking, could offer deeper insights into the cognitive processes and visual attention patterns of users when engaging with privacy policies, enriching the research landscape in usable security and privacy.

5 CONCLUSION

The presented study highlights the impact of cognitive styles (Field Dependence-Independence and Visualizer-Verbalizer) on how individuals process information and interact with data, particularly in visualizing privacy policies. Through a between-subjects study, we explored whether these cognitive styles affect critical factors such as processing time and cognitive load when using differently visualized privacy policies. The results of our study have unveiled differences in processing time, mental effort, and frustration levels. These findings have implications for the design of privacy policy visualizations, emphasizing the importance of crafting user-friendly and accessible interfaces in the usable security and privacy domain. By doing so, we can enhance user understanding and engagement in digital security. Ultimately, we aim to create more inclusive and practical designs that empower users to navigate privacy policies confidently and efficiently, tailored to their unique cognitive preferences and needs.

REFERENCES

[1] Sultan A. Alharthi, George E. Raptis, Christina Katsini, Igor Dolgov, Lennart E. Nacke, and Z O. Toups. 2018. Toward Understanding the Effects of Cognitive Styles on Collaboration in Multiplayer Games. In *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing* (Jersey City, NJ, USA) *(CSCW '18)*. ACM, New York, NY, USA, 169–172. https://doi.org/10.1145/3272973.3274047

[2] Sultan A. Alharthi, George E. Raptis, Christina Katsini, Igor Dolgov, Lennart E. Nacke, and Z O. Toups. 2021. Investigating the Effects of Individual Cognitive Styles on Collaborative Gameplay. *ACM Transactions on Computer-Human Interaction* 28, 4, Article 23 (2021), 49 pages. https://doi.org/10.1145/3445792

[3] Christopher W. Allinson and John Hayes. 1996. The Cognitive Style Index: A Measure of Intuition-Analysis For Organizational Research. *Journal of Management Studies* 33, 1 (1996), 119–135. https://doi.org/10.1111/j.1467-6486.1996.tb00801.x

[4] Steven J. Armstrong, Eva Cools, and Eugene Sadler-Smith. 2012. Role of Cognitive Styles in Business and Management: Reviewing 40 Years of Research. *International Journal of Management Reviews* 14, 3 (Sep 2012), 238–262. https://doi.org/10.1111/j.1468-2370.2011.00315.x

[5] Mehrdad Bahrini, Nima Zargham, Alexander Wolff, Dennis-Kenji Kipker, Karsten Sohr, and Rainer Malaka. 2022. It's Long and Complicated! Enhancing One-Pager Privacy Policies in Smart Home Applications. In *Nordic Human-Computer Interaction Conference* (Aarhus, Denmark) *(NordiCHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 73, 13 pages. https://doi.org/10.1145/3546155.3546657

[6] Olesya Blazhenkova and Maria Kozhevnikov. 2009. The New Object-Spatial-Verbal Cognitive Style Model: Theory and Measurement. *Applied Cognitive Psychology* 23, 5 (2009), 638–663. https://doi.org/10.1002/acp.1473 arXiv:https://onlinelibrary.wiley.com/doi/pdf/10.1002/acp.1473

[7] Sherry Y. Chen and Xiaohui Liu. 2008. An Integrated Approach for Modeling Learning Patterns of Students in Web-Based Instruction: A Cognitive Style Perspective. *ACM Transactions on Computer-Human Interaction* 15, 1, Article 1 (May 2008), 28 pages. https://doi.org/10.1145/1352782.1352783

[8] Francis J. Di Vesta, Gary Ingersoll, and Phyllis Sunshine. 1971. A Factor Analysis of Imagery Tests. *Journal of Verbal Learning and Verbal Behavior* 10, 5 (1971), 471–479. https://doi.org/10.1016/s0022-5371(71)80017-8

[9] Nigel Ford. 2000. Cognitive Styles and Virtual Environments. *Journal of the American Society for Information Science* 51, 6 (2000), 543–557. https://doi.org/10.1002/(SICI)1097-4571(2000)51:6<543::AID-ASI6>3.0.CO;2-S

[10] Sandra G. Hart. 2006. Nasa-Task Load Index (NASA-TLX); 20 Years Later. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 50, 9 (2006), 904–908. https://doi.org/10.1177/154193120605000909

[11] Sandra G. Hart and Lowell E. Staveland. 1988. Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. *Advances in Psychology* 52 (1988), 139–183. https://doi.org/10.1016/S0166-4115(08)62386-9

[12] Clementina Kuhlman Hollenberg. 1970. Functions of Visual Imagery in the Learning and Concept Formation of Children. *Child Development* 41, 4 (1970), 1003. https://doi.org/10.2307/1127328

[13] Carlos Jensen and Colin Potts. 2004. Privacy Policies as Decision-Making Tools: An Evaluation of Online Privacy Notices. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Vienna, Austria) *(CHI '04)*. Association for Computing Machinery, New York, NY, USA, 471–478. https://doi.org/10.1145/985692.985752

[14] David H. Jonassen and Barbara L. Grabowski. 2012. *Handbook of Individual Differences, Learning, and Instruction.* Routledge, New York, NY. https://doi.org/10.4324/9780203052860

[15] Christina Katsini, Christos Fidas, George E. Raptis, Marios Belk, George Samaras, and Nikolaos Avouris. 2018. Eye Gaze-driven Prediction of Cognitive Differences During Graphical Password Composition. In *23rd International Conference on Intelligent User Interfaces* (Tokyo, Japan) *(IUI '18)*. ACM, New York, NY, USA, 147–152. https://doi.org/10.1145/3172944.3172996

[16] Christina Katsini, Christos Fidas, George E. Raptis, Marios Belk, George Samaras, and Nikolaos Avouris. 2018. Influences of Human Cognition and Visual Behavior on Password Strength During Picture Password Composition. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) *(CHI '18)*. ACM, New York, NY, USA, Article 87, 14 pages. https://doi.org/10.1145/3173574.3173661

[17] Matthew Kay and Michael Terry. 2010. Textured Agreements: Re-Envisioning Electronic Consent. In *Proceedings of the Sixth Symposium on Usable Privacy and Security* (Redmond, Washington, USA) *(SOUPS '10)*. Association for Computing Machinery, New York, NY, USA, Article 13, 13 pages. https://doi.org/10.1145/1837110.1837127

[18] Jinjing Ke, Pinchao Liao, Jie Li, and Xiaowei Luo. 2023. Effect of Information Load and Cognitive Style on Cognitive Load of Visualized Dashboards for Construction-related Activities. *Automation in Construction* 154 (2023), 105029. https://doi.org/10.1016/j.autcon.2023.105029

[19] Patrick Gage Kelley, Joanna Bresee, Lorrie Faith Cranor, and Robert W. Reeder. 2009. A "Nutrition Label" for Privacy. In *Proceedings of the 5th Symposium on Usable Privacy and Security* (Mountain View, California, USA) *(SOUPS '09)*. Association for Computing Machinery, New York, NY, USA, Article 4, 12 pages. https://doi.org/10.1145/1572532.1572538

[20] Patrick Gage Kelley, Lucian Cesca, Joanna Bresee, and Lorrie Faith Cranor. 2010. Standardizing Privacy Notices: An Online Study of the Nutrition Label Approach. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Atlanta, Georgia, USA) *(CHI '10)*. Association for Computing Machinery, New York, NY, USA, 1573–1582. https://doi.org/10.1145/1753326.1753561

[21] John R Kirby, Phillip J Moore, and Neville J Schofield. 1988. Verbal and Visual Learning Styles. *Contemporary Educational Psychology* 13, 2 (1988), 169–184. https://doi.org/10.1016/0361-476x(88)90017-3

[22] Michael Kirton. 1976. Adaptors and Innovators: A Description and Measure. *Journal of Applied Psychology* 61, 5 (1976), 622–629. https://doi.org/10.1037/0021-9010.61.5.622

[23] Maria Kozhevnikov. 2007. Cognitive Styles in the Context of Modern Psychology: Toward an Integrated Framework of Cognitive Style. *Psychological Bulletin* 133, 3 (2007), 464. https://doi.org/10.1037/0033-2909.133.3.464

[24] Oskar Ku, Chi-Chen Hou, and Sherry Y. Chen. 2016. Incorporating Customization and Personalization into Game-based Learning: A Cognitive Style Perspective. *Computers in Human Behavior* 65 (2016), 359–368. https://doi.org/10.1016/j.chb.2016.08.040

[25] Jia-Jiunn Lo and Yun-Jay Wang. 2012. Development of an Adaptive EC Website With Online Identified Cognitive Styles of Anonymous Customers. *International Journal of Human-Computer Interaction (IJHCI)* 28, 9 (Sep 2012), 560–575. https://doi.org/10.1080/10447318.2011.629952

[26] Ewa Luger, Stuart Moran, and Tom Rodden. 2013. Consent for All: Revealing the Hidden Complexity of Terms and Conditions. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Paris, France) *(CHI '13)*. Association for Computing Machinery, New York, NY, USA, 2687–2696. https:

//doi.org/10.1145/2470654.2481371

[27] Alan Miller. 1987. Cognitive Styles: An Integrated Model. *Educational Psychology* 7, 4 (Jan. 1987), 251–268. https://doi.org/10.1080/0144341870070401

[28] Czeslaw S. Nosal. 1990. Psychological Models of Mind. *PWN, Warsaw* (1990).

[29] Jonathan A. Obar and Anne Oeldorf-Hirsch. 2020. The Biggest Lie on the Internet: Ignoring the Privacy Policies and Terms of Service Policies of Social Networking Services. *Information, Communication & Society* 23, 1 (2020), 128–147. https://doi.org/10.1080/1369118X.2018.1486870

[30] Philip K. Oltman, Evelyn Raskin, and Herman A. Witkin. 1971. *Group Embedded Figures Test (GEFT) Test Booklet.* Consulting Psychologists Press Palo Alto, CA.

[31] Allan Paivio. 1986. *Mental Representations: A Dual-Coding Approach.* Oxford University Press, New York, NY, USA. https://doi.org/10.1093/acprof:oso/9780195066661.001.0001

[32] Sotirios Petsas, George E. Raptis, and Christos Katsanos. 2023. Turn & Slide: Designing a Puzzle Game to Elicit the Visualizer-Verbalizer Cognitive Style. In *Human-Computer Interaction – INTERACT 2023*, José Abdelnour Nocera, Marta Kristín Lárusdóttir, Helen Petrie, Antonio Piccinno, and Marco Winckler (Eds.). Springer Nature Switzerland, Cham, 46–56. https://doi.org/10.1007/978-3-031-42293-5_4

[33] George E. Raptis, Christos A. Fidas, Christina Katsini, and Nikolaos M. Avouris. 2019. A Cognition-centered Personalization Framework for Cultural-Heritage Content. *User Modeling and User-Adapted Interaction* 29 (Mar 2019), 9–65. Issue 1. https://doi.org/10.1007/s11257-019-09226-7

[34] George E. Raptis and Christina Katsini. 2021. Analyzing Scanpaths From A Field Dependence-Independence Perspective When Playing A Visual Search Game. In *ACM Symposium on Eye Tracking Research and Applications* (Virtual Event, Germany) *(ETRA '21 Short Papers)*. Association for Computing Machinery, New York, NY, USA, Article 37, 7 pages. https://doi.org/10.1145/3448018.3459655

[35] George E. Raptis, Christina Katsini, Marios Belk, Christos Fidas, George Samaras, and Nikolaos Avouris. 2017. Using Eye Gaze Data and Visual Activities to Infer Human Cognitive Styles: Method and Feasibility Studies. In *Proceedings of the 25th Conference on User Modeling, Adaptation and Personalization* (Bratislava, Slovakia) *(UMAP '17)*. ACM, New York, NY, USA, 164–173. https://doi.org/10.1145/3079628.3079690

[36] Daniel Reinhardt, Johannes Borchard, and Jörn Hurtienne. 2021. Visual Interactive Privacy Policy: The Better Choice?. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI '21)*. Association for Computing Machinery, New York, NY, USA, Article 66, 12 pages. https://doi.org/10.1145/3411764.3445465

[37] Richard Riding and Indra Cheema. 1991. Cognitive Styles - An Overview and Integration. *Educational Psychology* 11, 3-4 (Jan. 1991), 193–215. https://doi.org/10.1080/0144341910110301

[38] Paul M Schwartz and Daniel Solove. 2009. Notice & Choice. In *The Second NPLAN/BMSG Meeting on Digital Media and Marketing to Children*, Vol. 7. Berkeley Media Studies Group, Berkeley, CA, 6 pages.

[39] Ben Steichen and Bo Fu. 2020. Cognitive style and information visualization—modeling users through eye gaze data. *Frontiers in Computer Science* 2 (2020), 562290.

[40] Carolin Stellmacher, Jette Ternieten, Daria Soroko, and Johannes Schöning. 2022. Escaping the Privacy Paradox: Evaluating the Learning Effects of Privacy Policies With Serious Games. *Proc. ACM Hum.-Comput. Interact.* 6, CHI PLAY, Article 232 (oct 2022), 20 pages. https://doi.org/10.1145/3549495

[41] Madiha Tabassum, Abdulmajeed Alqhatani, Marran Aldossari, and Heather Richter Lipford. 2018. Increasing User Attention with a Comic-Based Policy. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) *(CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–6. https://doi.org/10.1145/3173574.3173774

[42] Joachim Tiedemann. 1989. Measures of Cognitive Styles: A Critical Review. *Educational Psychologist* 24, 3 (June 1989), 261–275. https://doi.org/10.1207/s15326985ep2403_3

[43] Dereck Toker, Cristina Conati, Ben Steichen, and Giuseppe Carenini. 2013. Individual User Characteristics and Information Visualization: Connecting the Dots through Eye Tracking. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Paris, France) *(CHI '13)*. Association for Computing Machinery, New York, NY, USA, 295–304. https://doi.org/10.1145/2470654.2470696

[44] Alexandros Tremopoulos, George E. Raptis, and Christos Katsanos. 2022. WhatShapeWhatColor: Designing a Puzzle Game to Elicit the Field Dependence-Independence Cognitive Style. In *Proceedings of the 25th Pan-Hellenic Conference on Informatics* (Volos, Greece) *(PCI '21)*. Association for Computing Machinery, New York, NY, USA, 200–205. https://doi.org/10.1145/3503823.3503861

[45] Herman A. Witkin, Carol Ann Moore, Donald R. Goodenough, and Patricia W. Cox. 1977. Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications. *Review of Educational Research* 47, 1 (1977), 1–64. https://doi.org/10.3102/00346543047001001