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Engineering Psychology and Cognitive Ergonomics

18th International Conference, EPCE 2021

Held as Part of the 23rd HCI International Conference, HCII 2021

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Proceedings



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Foreword

Human-Computer Interaction (HCI) is acquiring an ever-increasing scientific and industrial importance, and having more impact on people's everyday life, as an ever-growing number of human activities are progressively moving from the physical to the digital world. This process, which has been ongoing for some time now, has been dramatically accelerated by the COVID-19 pandemic. The HCI International (HCII) conference series, held yearly, aims to respond to the compelling need to advance the exchange of knowledge and research and development efforts on the human aspects of design and use of computing systems.

The 23rd International Conference on Human-Computer Interaction, HCI International 2021 (HCII 2021), was planned to be held at the Washington Hilton Hotel, Washington DC, USA, during July 24–29, 2021. Due to the COVID-19 pandemic and with everyone's health and safety in mind, HCII 2021 was organized and run as a virtual conference. It incorporated the 21 thematic areas and affiliated conferences listed on the following page.

A total of 5222 individuals from academia, research institutes, industry, and governmental agencies from 81 countries submitted contributions, and 1276 papers and 241 posters were included in the proceedings to appear just before the start of the conference. The contributions thoroughly cover the entire field of HCI, addressing major advances in knowledge and effective use of computers in a variety of application areas. These papers provide academics, researchers, engineers, scientists, practitioners, and students with state-of-the-art information on the most recent advances in HCI. The volumes constituting the set of proceedings to appear before the start of the conference are listed in the following pages.

The HCI International (HCII) conference also offers the option of 'Late Breaking Work' which applies both for papers and posters, and the corresponding volume(s) of the proceedings will appear after the conference. Full papers will be included in the 'HCII 2021 - Late Breaking Papers' volumes of the proceedings to be published in the Springer LNCS series, while 'Poster Extended Abstracts' will be included as short research papers in the 'HCII 2021 - Late Breaking Posters' volumes to be published in the Springer CCIS series.

The present volume contains papers submitted and presented in the context of the 18th International Conference on Engineering Psychology and Cognitive Ergonomics (EPCE 2021), an affiliated conference to HCII 2021. I would like to thank the Co-chairs, Don Harris and Wen-Chin Li, for their invaluable contribution to its organization and the preparation of the proceedings, as well as the members of the Program Board for their contributions and support. This year, the EPCE affiliated conference has focused on topics related to human performance and error, cognitive processes, cognitive psychology in aviation and air traffic control, and cognitive psychology in interaction design.

I would also like to thank the Program Board Chairs and the members of the Program Boards of all thematic areas and affiliated conferences for their contribution towards the highest scientific quality and overall success of the HCI International 2021 conference.

This conference would not have been possible without the continuous and unwavering support and advice of Gavriel Salvendy, founder, General Chair Emeritus, and Scientific Advisor. For his outstanding efforts, I would like to express my appreciation to Abbas Moallem, Communications Chair and Editor of HCI International News.

July 2021

Constantine Stephanidis

HCI International 2021 Thematic Areas and Affiliated Conferences

Thematic Areas

- HCI: Human-Computer Interaction
- HIMI: Human Interface and the Management of Information

Affiliated Conferences

- EPCE: 18th International Conference on Engineering Psychology and Cognitive Ergonomics
- UAHCI: 15th International Conference on Universal Access in Human-Computer Interaction
- VAMR: 13th International Conference on Virtual, Augmented and Mixed Reality
- CCD: 13th International Conference on Cross-Cultural Design
- SCSM: 13th International Conference on Social Computing and Social Media
- AC: 15th International Conference on Augmented Cognition
- DHM: 12th International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management
- DUXU: 10th International Conference on Design, User Experience, and Usability
- DAPI: 9th International Conference on Distributed, Ambient and Pervasive Interactions
- HCIBGO: 8th International Conference on HCI in Business, Government and Organizations
- LCT: 8th International Conference on Learning and Collaboration Technologies
- ITAP: 7th International Conference on Human Aspects of IT for the Aged Population
- HCI-CPT: 3rd International Conference on HCI for Cybersecurity, Privacy and Trust
- HCI-Games: 3rd International Conference on HCI in Games
- MobiTAS: 3rd International Conference on HCI in Mobility, Transport and Automotive Systems
- AIS: 3rd International Conference on Adaptive Instructional Systems
- C&C: 9th International Conference on Culture and Computing
- MOBILE: 2nd International Conference on Design, Operation and Evaluation of Mobile Communications
- AI-HCI: 2nd International Conference on Artificial Intelligence in HCI

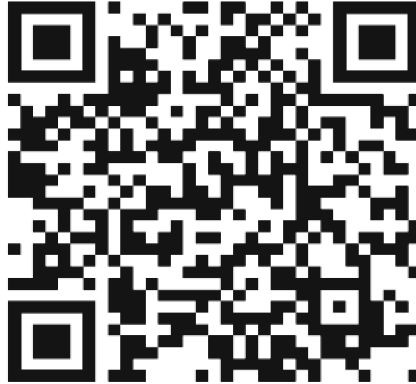
List of Conference Proceedings Volumes Appearing Before the Conference

1. LNCS 12762, Human-Computer Interaction: Theory, Methods and Tools (Part I), edited by Masaaki Kurosu
2. LNCS 12763, Human-Computer Interaction: Interaction Techniques and Novel Applications (Part II), edited by Masaaki Kurosu
3. LNCS 12764, Human-Computer Interaction: Design and User Experience Case Studies (Part III), edited by Masaaki Kurosu
4. LNCS 12765, Human Interface and the Management of Information: Information Presentation and Visualization (Part I), edited by Sakae Yamamoto and Hirohiko Mori
5. LNCS 12766, Human Interface and the Management of Information: Information-rich and Intelligent Environments (Part II), edited by Sakae Yamamoto and Hirohiko Mori
6. LNAI 12767, Engineering Psychology and Cognitive Ergonomics, edited by Don Harris and Wen-Chin Li
7. LNCS 12768, Universal Access in Human-Computer Interaction: Design Methods and User Experience (Part I), edited by Margherita Antona and Constantine Stephanidis
8. LNCS 12769, Universal Access in Human-Computer Interaction: Access to Media, Learning and Assistive Environments (Part II), edited by Margherita Antona and Constantine Stephanidis
9. LNCS 12770, Virtual, Augmented and Mixed Reality, edited by Jessie Y. C. Chen and Gino Fragomeni
10. LNCS 12771, Cross-Cultural Design: Experience and Product Design Across Cultures (Part I), edited by P. L. Patrick Rau
11. LNCS 12772, Cross-Cultural Design: Applications in Arts, Learning, Well-being, and Social Development (Part II), edited by P. L. Patrick Rau
12. LNCS 12773, Cross-Cultural Design: Applications in Cultural Heritage, Tourism, Autonomous Vehicles, and Intelligent Agents (Part III), edited by P. L. Patrick Rau
13. LNCS 12774, Social Computing and Social Media: Experience Design and Social Network Analysis (Part I), edited by Gabriele Meiselwitz
14. LNCS 12775, Social Computing and Social Media: Applications in Marketing, Learning, and Health (Part II), edited by Gabriele Meiselwitz
15. LNAI 12776, Augmented Cognition, edited by Dylan D. Schmorrow and Cali M. Fidopiastis
16. LNCS 12777, Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management: Human Body, Motion and Behavior (Part I), edited by Vincent G. Duffy
17. LNCS 12778, Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management: AI, Product and Service (Part II), edited by Vincent G. Duffy

18. LNCS 12779, Design, User Experience, and Usability: UX Research and Design (Part I), edited by Marcelo Soares, Elizabeth Rosenzweig, and Aaron Marcus
19. LNCS 12780, Design, User Experience, and Usability: Design for Diversity, Well-being, and Social Development (Part II), edited by Marcelo M. Soares, Elizabeth Rosenzweig, and Aaron Marcus
20. LNCS 12781, Design, User Experience, and Usability: Design for Contemporary Technological Environments (Part III), edited by Marcelo M. Soares, Elizabeth Rosenzweig, and Aaron Marcus
21. LNCS 12782, Distributed, Ambient and Pervasive Interactions, edited by Norbert Streitz and Shin'ichi Konomi
22. LNCS 12783, HCI in Business, Government and Organizations, edited by Fiona Fui-Hoon Nah and Keng Siau
23. LNCS 12784, Learning and Collaboration Technologies: New Challenges and Learning Experiences (Part I), edited by Panayiotis Zaphiris and Andri Ioannou
24. LNCS 12785, Learning and Collaboration Technologies: Games and Virtual Environments for Learning (Part II), edited by Panayiotis Zaphiris and Andri Ioannou
25. LNCS 12786, Human Aspects of IT for the Aged Population: Technology Design and Acceptance (Part I), edited by Qin Gao and Jia Zhou
26. LNCS 12787, Human Aspects of IT for the Aged Population: Supporting Everyday Life Activities (Part II), edited by Qin Gao and Jia Zhou
27. LNCS 12788, HCI for Cybersecurity, Privacy and Trust, edited by Abbas Moallem
28. LNCS 12789, HCI in Games: Experience Design and Game Mechanics (Part I), edited by Xiaowen Fang
29. LNCS 12790, HCI in Games: Serious and Immersive Games (Part II), edited by Xiaowen Fang
30. LNCS 12791, HCI in Mobility, Transport and Automotive Systems, edited by Heidi Krömker
31. LNCS 12792, Adaptive Instructional Systems: Design and Evaluation (Part I), edited by Robert A. Sottilare and Jessica Schwarz
32. LNCS 12793, Adaptive Instructional Systems: Adaptation Strategies and Methods (Part II), edited by Robert A. Sottilare and Jessica Schwarz
33. LNCS 12794, Culture and Computing: Interactive Cultural Heritage and Arts (Part I), edited by Matthias Rauterberg
34. LNCS 12795, Culture and Computing: Design Thinking and Cultural Computing (Part II), edited by Matthias Rauterberg
35. LNCS 12796, Design, Operation and Evaluation of Mobile Communications, edited by Gavriel Salvendy and June Wei
36. LNAI 12797, Artificial Intelligence in HCI, edited by Helmut Degen and Stavroula Ntoa
37. CCIS 1419, HCI International 2021 Posters - Part I, edited by Constantine Stephanidis, Margherita Antona, and Stavroula Ntoa

38. CCIS 1420, HCI International 2021 Posters - Part II, edited by Constantine Stephanidis, Margherita Antona, and Stavroula Ntoa
39. CCIS 1421, HCI International 2021 Posters - Part III, edited by Constantine Stephanidis, Margherita Antona, and Stavroula Ntoa

<http://2021.hci.international/proceedings>



18th International Conference on Engineering Psychology and Cognitive Ergonomics (EPCE 2021)

Program Board Chairs: **Don Harris**, *Coventry University, UK* and **Wen-Chin Li**, *Cranfield University, UK*

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- Peng Liu, China
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- Lei Wang, China
- Jingyu Zhang, China

The full list with the Program Board Chairs and the members of the Program Boards of all thematic areas and affiliated conferences is available online at:

<http://www.hci.international/board-members-2021.php>



HCI International 2022

The 24th International Conference on Human-Computer Interaction, HCI International 2022, will be held jointly with the affiliated conferences at the Gothia Towers Hotel and Swedish Exhibition & Congress Centre, Gothenburg, Sweden, June 26 – July 1, 2022. It will cover a broad spectrum of themes related to Human-Computer Interaction, including theoretical issues, methods, tools, processes, and case studies in HCI design, as well as novel interaction techniques, interfaces, and applications. The proceedings will be published by Springer. More information will be available on the conference website: <http://2022.hci.international/>:

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Contents

Cognitive Psychology in Aviation

Validation of Virtual Reality Cognitive Assessment for Pilots Across the Lifespan	3
<i>Oluchi Audu, Kathleen Van Benthem, and Chris M. Herdman</i>	
Culture's Consequences on the Categorisation of Causal Factors in Aviation Accident Reports	19
<i>Wesley Tsz-Kin Chan and Wen-Chin Li</i>	
Floating Iceberg Model of Psychological Competence Towards Airline Transport Pilots' Professionalism Lifecycle Management System.	28
<i>Shu Li, Lei Wang, and Ming Zeng</i>	
Evaluation of Fatigue Induced During the Flight Tasks	38
<i>Bo Shao, Zhen Wang, and Shan Fu</i>	
The Relationship Between Cognitive Ability and Flight Driving Performance in Adolescent Pilot Cadets	52
<i>Jun Tan and Xianghong Sun</i>	
An Improved Washout Algorithm for UPRT Scenario	65
<i>Wei Tang, Zhen Wang, and Shan Fu</i>	
Emotional Stressor on Human Errors in Flight: A Heart Rate Variance Examination	80
<i>Shuo Wang, Lei Wang, and Shu Li</i>	
Multiple Physiological Indexes Analysis in Commercial Flight Tasks for Fatigue Evaluation	91
<i>Xi Yang, Zhen Wang, and Shan Fu</i>	
Electroencephalographic Signals and Pilot Situation Awareness During Simulated Flight: A Case for Enhanced Digital Technology in General Aviation.	101
<i>Alexia Ziccardi, Kathleen Van Benthem, and Chris M. Herdman</i>	

Cognitive Psychology in Air Traffic Control

A Preliminary Field Study of Air Traffic Controllers' Fatigue for Interface Design.	119
<i>Zhenling Chen, Jianping Zhang, Wenchao Jing, Xiaofei Peng, Pengxin Ding, Yiyu Chen, Xiaoqiang Tian, Yanzhong Gu, and Guoliang Zou</i>	

Supervising Multiple Remote Tower Operations: How to Develop and Test a New Work Position in the ATC Domain?	130
<i>Maik Friedrich, Felix Timmermann, and Jörn Jakobi</i>	
Psychophysical Coherence Training Regulating Air Traffic Controller's Heart Rate Variability and Resilience to Fatigue	142
<i>Wen-Chin Li, Jingyi Zhang, Peter Kearney, and Graham Braithwaite</i>	
Implementation Digital Tower for Apron Control on a Large-Scale of International Airport	151
<i>Pan Zou, Wen-Chin Li, and Jingyi Zhang</i>	
Studies on Cognitive Processes	
How Metacognitive Monitoring Feedback Influences Workload in a Location-Based Augmented Reality Environment	163
<i>Wenbin Guo and Jung Hyup Kim</i>	
Effect of Height Perception on State Self-Esteem and Cognitive Performance in Virtual Reality	172
<i>Grace Y. S. Leung, Adrian K. T. Ng, and Henry Y. K. Lau</i>	
The Influence of Gender on Human's Cognitive Ability and the Correlation Research of Different Cognitive Dimensions.	185
<i>Zhongqi Liu, Le Dong, and Qianxiang Zhou</i>	
Neurophysiological Visual Classification Indicators in the Brain-Computer Interface	197
<i>Sergey Lytaev</i>	
An Evaluation of Two-Dimensional Digital Input Models for Mathematical Structure: Effects on Working Memory, Cognitive Load, and Efficiency	212
<i>Francis Quinby, Seyeon Kim, Marco Pollanen, Wesley S. Burr, and Michael G. Reynolds</i>	
Evaluation of Relationship Quality Within Dyads Through the Performance in Dual-Player Cooperative Tasks	223
<i>Haijiang Yan, Kai Yu, and Guozhen Zhao</i>	
Cognitive Activity Recognition Based on Self-supervised Learning from EEG Signals.	234
<i>Yifeng Yang, Yingjie Zhao, Yanyu Lu, and Shan Fu</i>	
Human Error and Human Performance	
A Qualitative Study on the Workload of High-Speed Railway Dispatchers . . .	251
<i>Zhenqi Chen, Zizheng Guo, Guo Feng, Lei Shi, and Jingyu Zhang</i>	

Computer Aided Search Tasks in a Naturally Occurring Environment	261
<i>Kyle Harrington, James Pinchin, and Sarah Sharples</i>	
Effect of Predictive Next-Letter Highlighting and Its Delays on the Bare-Handed Input in Virtual Reality.	280
<i>Haikun Lin, Shu Ma, Zhen Yang, Chunyan Kang, and Hongting Li</i>	
Methodology to Quantify Accuracy for Procedure Execution Analysis.	292
<i>Sarah O'Meara, Kimberly Jenks, Christopher Stevens, Jennifer Mindock, and Stephen Robinson</i>	
Human Factors Analysis for Aviation Accidents and Incidents in Singapore.	308
<i>H. R. Mohandas and Tham Kah Weng</i>	
Preliminary Analysis of Human Error Prediction Model by Using Biological Information.	324
<i>Yuto Saito, Muhammad Nur Adilin Mohd Anuardi, Ryota Matsubara, and Midori Sugaya</i>	
Using Eye Tracking to Analyze the Effects of Spatial Contiguity in MOOC Video Subtitles.	336
<i>Xinyong Zhang</i>	
Cognition and Design	
System Performance and Empathetic Design Enhance User Experience for Fault Diagnosis Expert System	357
<i>Li Lin, Xiaoyue Pang, Jingyu Zhang, Xianghong Sun, and Liang Zhang</i>	
The Effect of Diagonal Bar Position in Prohibition Signs on Recognition Efficiency of the Signs	368
<i>Meng Liu, Xiangling Zhuang, Yuhua Huang, Huiling Yang, and Guojie Ma</i>	
A Survey Study of Factors Influencing Smart Phone Fluency.	377
<i>Xinze Liu, Weina Qu, Cheng Wang, Qian Zhang, and Yan Ge</i>	
Pseudo Human Sense in the Loop: Proposal of a Presentation Support Method by Pseudo Feedback of Audience Sense.	389
<i>Kureha Noguchi, Yoshinari Takegawa, and Keiji Hirata</i>	
The Design Challenges of Drone Swarm Control	408
<i>Fabrice Saffre, Hanno Hildmann, and Hannu Karvonen</i>	
Effect of Red Blue 3D Videos on Visual Fatigue	427
<i>Guilei Sun, Yun Lin, Linghua Ran, and Yanhua Meng</i>	

Human-Centered HMI for Crane Teleoperation: Intuitive Concepts Based
on Mental Models, Compatibility and Mental Workload 438
Felix Top, Sebastian Pütz, and Johannes Fottner

Author Index 457