

# A Diagnostic Tool on Time Perception of Children with ADHD

Pongpanote Gongsook<sup>1</sup>(✉), Janneke Peijnenborgh<sup>2</sup>,  
Christian Sallustro<sup>1</sup>, Erik van der Spek<sup>1</sup>, Jun Hu<sup>1</sup>, Francesco Bellotti<sup>3</sup>,  
Matthias Rauterberg<sup>1</sup>, and Jos Hendriksen<sup>2</sup>

<sup>1</sup> Department of Industrial Design, Eindhoven University of Technology,  
5600 MB Eindhoven, The Netherlands

{p.gongsook, c.sallustro, e.d.v.d.spek, j.hu,  
G.W.M.Rauterberg}@tue.nl

<sup>2</sup> Kempenhaeghe, Center for Neurological Learning Disabilities,  
5591 VE Heeze, The Netherlands

{PeijnenborghJ, HendriksenJ}@kempenhaeghe.nl

<sup>3</sup> ELIOS Lab – DITEN, University of Genova, Via Opera Pia 11/a,  
16145 Genoa, Italy

franz@elios.unige.it

**Abstract.** ADHD is among the most common childhood developmental disorder which may affect the school achievements. Children with ADHD may show symptoms of time perception problems. Although ADHD is a clinical diagnosis with several approaches, no diagnostic tool has been designed to detect the symptoms of time perception problems in ADHD children. A computer game can be a powerful tool to be used as part of the psychological assessment and yield better accuracy in ADHD diagnosis. In this paper, we present our concept of a diagnostic tool on time perception for children with ADHD-symptoms.

**Keywords:** ADHD · Diagnostic tool · Serious game · Time perception

## 1 Introduction

Attention Deficit Hyperactivity Disorder (ADHD) has been widely researched in the past decades. Several hypotheses have been formulated on the causes of this disorder, as it could be derived both genetically and environmentally [1]. Some researchers have already proposed a tool targeting the cognitive functions for ADHD diagnosis [2–4].

Children with ADHD may have difficulties in processing, reading and telling time [5, 6] and a diminished functioning of reaction time and information processing speed [7]. Therefore, for an alternative to general cognitive measurements, we are interested to investigate the question on whether a computer game on time perception may contribute to a diagnostic process for children aged 4-8 years old. In this paper, we briefly describe what ADHD is and approaches to the diagnosis (Sect. 2), as well as why the diagnosis on time perception using computer games is of importance for our current design and development (Sect. 3).

## 2 Attention Deficit Hyperactivity Disorder (ADHD)

ADHD is a behavioral and developmental disorder identified by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) [8]. Its symptoms must be present before the age of seven, persist for at least six months, must be maladaptive for the development of the child, inconsistent with the person's developmental level, and severe enough to impact daily functioning across several environment settings [9]. They reveal subtle but clear impairments in several complex functional systems such as selective attention, memory, motor speed and visuomotor ability, inhibitory control, and working memory [2].

Despite that we have DSM-IV guidelines for ADHD, no absolute methods for diagnosis have been defined. Moreover, it is difficult to diagnose ADHD since this developmental disability can not be diagnosed until children are six years of age, when they are exposed to classroom learning of academic tasks [10]. There are some computer games designed for ADHD diagnosis for example IntegNeuro [11], and Groundskeeper [12]. IntegNeuro is designed to assess people aged 6–96 years old, while Groundskeeper has been designed to target people from 6–17 years old.

We agree with Greenberg [13] that there is no such game that fits all age groups, the diagnostic game should be tailored to match the specific age group. The target age group of children in our project is 4–8 years old, the reason for choosing this age range complies with what Kalff [14] stated: (1) there is a limited amount of research conducted with children 4–8 years old, and (2) The symptoms that can be diagnosed as belonging to ADHD are not obviously shown but will gradually emerge when the children grows up.

## 3 A Diagnostic Tool on Time Perception

Time perception is a conceptual understanding that enables us to predict, anticipate, and respond to events occurring in the environment [15]. Children with ADHD may have deficits in working memory, that is related to time perception [16]. In addition, we know that children with ADHD may have brain abnormalities in some regions such as the pre-frontal cortex, basal ganglia, striatum, corpus callosum, nucleus caudatus, globus pallidus and cerebellum [17]. Those regions relate to the conceptual understanding of time [18]. Moreover, unlike other symptoms that could decline when the child grow up, time perception problems still remain even when the child becomes an adult [19]. This makes time perception a suitable factor for diagnosis. Therefore, we contend that if we have a better understanding of time perception in children with ADHD, we can train time perception, which contributes to the treatment of attention problems in children with ADHD.

### 3.1 Game as a Diagnostic Tool

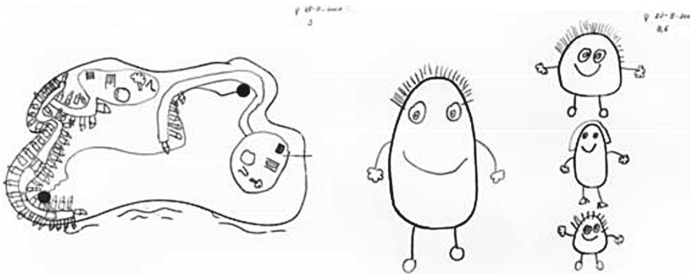
Computer games offer players with intense and often relentless action, immediate rewards, challenging, and appealing stories, which seems to be something the brain of

children with ADHD eagerly desire, and they hardly get from the everyday life outside the digital world [20]. The game we are creating is well fitted to the term of serious game [21]. It is designed specifically for diagnostic purposes with immersive environments, and multimodal interaction.

We aim at giving them the feeling that they are playing instead of being tested. Computer games could give an advantage over a plain psychological test because it does not induce a type of the Hawthorne effect [22], where kids behave differently when they know they are being studied. Using a game could therefore improve the ecological and external validity of ADHD diagnosis.

### 3.2 Current Project Approach

We have formed a collaborative and multidisciplinary working team of computer scientists and designers from Eindhoven University of Technology, and psychologists from Kempenhaeghe, center for neurological learning disabilities. The development of the diagnostic tool is roughly divided into three phases in each iteration: design, implementation, and evaluation, with a spiral model [23, 24]. In the design phase we applied participatory design model (PD) [25] and user-centred design (UCD) [26]. We working with psychologists for their requirement, and re-design the diagnostic tool regarding to their feedback and comments. Children have been involved and observed do they understand our designed user-interaction, and asked how the non-player control characters in the game should looks like (see Fig. 1).



**Fig. 1.** Sample design of game scene and non-player control characters by a child

According to Zapata-Rivera and Bauer [27], there are some important items that should be taken into account when designing the game: (1) avoid to construct irrelevant content which need knowledge or skills on the player's side that are unrelated to our assessment goal, (2) limit other types of user interaction, but do not make the game boring or repetitive, (3) if we need more cognitive processing in working memory, we must introduce high interactivity and engagement, (4) players need support from in-game tutorial to become familiar and know how to interact with the game environment, and (5) provide formative feedback to the players.



**Fig. 2.** Sample screenshot of the diagnostic tool

The diagnostic tool will be used with a supervision from a psychologist. It is a single player game display in first person view using 23 inch LCD touch screen. Duration for diagnosing with our tool is set to the maximum of 30 minutes per session so the child will not feel too much fatigue. The diagnostic tool has a controlled linear story to secure that every child who plays our diagnostic tool will experience the same story progression. We have designed mini games to test specific aspects of time perception and related aspects such as time estimation, reaction time, and waiting time behavior.

Figure 2 shows one of the mini games which testing on children inhibition with go-nogo signals, the child has to clean banana peels from the pathway but the cleaning will be successful only when the monkey is hiding behind the leftmost banana trees. We believe that children who perform worse in the mini games have more possible deficits in the relevant executive functions. We already had a small evaluation test with normal children and received very positive feedback.

## 4 Future Work

We would like to explore whether information of time perception does contribute to an understanding of children with ADHD. Before going to conduct a clinical experiment with children, we will conduct a pilot test to get qualitative data and observations from children's behaviors to assess key game features such as usability, usefulness playfulness and attractiveness.

## 5 Conclusion

ADHD is a developmental behavior disorder which impedes the learning achievements of children. Psychologists use a combination of various approaches to diagnose ADHD. But there is no existing computer game which is designed extensively to diagnose possible deficits in time perception which we know is associated with ADHD.

In this paper we present our concept of a diagnostic tool, and mini games. We strongly believe that a computer game on time perception will definitely contribute to the diagnostic process for children aged 4–8 years old. We are not yet receiving the confirmation, but from the evaluation feedback we consider that we are getting closer to receive the answer soon.

**Acknowledgement.** This work was supported by the Erasmus Mundus Joint Doctorate in Interactive and Cognitive Environments (ICE), which is funded by the EACEA Agency of the European Commission under EMJD ICE FPA n 2010-0012. We are also very grateful for the collaboration with Dr. Jos Hendriksen, Prof. Dr. Hans Vles, Prof. Dr. Bert Aldenkamp, and Janneke Peijnenborgh MSc. from Kempenhaeghe, Center for Neurological Learning Disabilities, and Christian Sallustro from the User System Iteration (USI) program, Eindhoven University of Technology.

## References

1. Attention-Deficit/Hyperactivity Disorder: Causes of ADHD. <http://www.webmd.com/add-adhd/guide/adhd-causes>
2. Gualtieri, C., Johnson, L.: ADHD: Is objective diagnosis possible? *Psychiatry (Edmont)*. **2**, 44–53 (2005)
3. Elwood, R.W.: MicroCog: assessment of cognitive functioning. *Neuropsychol. Rev.* **11**, 89–100 (2001)
4. Gualtieri, C.T., Johnson, L.G.: Reliability and validity of a computerized neurocognitive test battery, *CNS Vital Signs. Arch. Clin. Neuropsychol.* **21**, 623–643 (2006)
5. Hurks, P.P., Hendriksen, J.G.: Retrospective and prospective time deficits in childhood ADHD: The effects of task modality, duration, and symptom dimensions. *Child Neuropsychol.* **17**, 34–50 (2010)
6. Barkley, R., Koplowitz, S.: Sense of time in children with ADHD: effects of duration, distraction, and stimulant medication. *J. Int. Neuropsychol. Soc.* **3**, 359–369 (1997)
7. Leth-Steensen, C., Elbaz, Z.K., Douglas, V.I.: Mean response times, variability, and skew in the responding of ADHD children: a response time distributional approach. *Acta Psychol. (Amst)* **104**, 167–190 (2000)
8. American Psychological Association: *Diagnostic and Statistical Manual of Mental Disorders*, Washington, D.C. (1994)
9. Goldman, L.S., Genel, M., Bezman, R.J., Slanetz, P.J.: Diagnosis and treatment of attention-deficit/hyperactivity disorder in children and adolescents. *JAMA J. Am. Med. Assoc.* **279**, 1100–1107 (1998)
10. Glascoe, F.P.: Early detection of developmental and behavioral problems. *Pediatr. Rev.* **21**, 272–279, quiz 280 (2000)
11. New breakthrough in diagnosis of ADHD. <http://sydney.edu.au/news/84.html?newsstoryid=4501>
12. Montini, L.: CogCubed Is Using Games to Help Diagnose ADHD. <http://www.health2con.com/news/2013/04/16/cogcubed-is-using-games-to-diagnose-adhd/>
13. Greenberg, B.S., Sherry, J., Lachlan, K., Lucas, K., Holmstrom, A.: Orientations to video games among gender and age groups. *Simul. Gaming* **41**, 238–259 (2010)

14. Kalf, A.C., Hendriksen, J.G.M., Kroes, M., Vles, J.S.H., Steyaert, J., Feron, F.J.M., van Zeben, T.M.C.B., Jolles, J.: Neurocognitive performance of 5- and 6-year-old children who met criteria for attention deficit/hyperactivity disorder at 18 months follow-up: results from a prospective population study. *J. Abnorm. Child Psychol.* **30**, 589–598 (2002)
15. Toplak, M.E., Rucklidge, J.J., Hetherington, R., John, S.C.F., Tannock, R.: Time perception deficits in attention-deficit/hyperactivity disorder and comorbid reading difficulties in child and adolescent samples. *J. Child Psychol. Psychiatry* **44**, 888–903 (2003)
16. Barkley, R.A., Murphy, K.R., Bush, T.: Time perception and reproduction in young adults with attention deficit hyperactivity disorder. *Neuropsychology* **15**, 351–360 (2001)
17. Wassenberg, R., Hendriksen, J.G., Hurks, P.P., Feron, F.J., Keulers, E.H., Vles, J.S., Jolles, J.: Development of inattention, impulsivity, and processing speed as measured by the d2 Test: results of a large cross-sectional study in children aged 7–13. *Child Neuropsychol.* **14**, 195–210 (2008)
18. Toplak, M.E., Dockstader, C., Tannock, R.: Temporal information processing in ADHD: Findings to date and new methods. *J. Neurosci. Methods* **151**, 15–29 (2006)
19. Biederman, J., Mick, E., Faraone, S.V.: Age-dependent decline of symptoms of attention deficit hyperactivity disorder: impact of remission definition and symptom type. *Am. J. Psychiatry* **157**, 816–818 (2000)
20. Bioulac, S., Arfi, L., Bouvard, M.P.: Attention deficit/hyperactivity disorder and video games: a comparative study of hyperactive and control children. *Eur. Psychiatry* **23**, 134–141 (2008)
21. Bellotti, F., Berta, R., De Gloria, A.: Designing Effective Serious Games: Opportunities and Challenges for Research. *Int. J. Emerg. Technol. Learn. (iJET)* **5**, 22–35 (2010)
22. McCarney, R., Warner, J., Iliffe, S., van Haselen, R., Griffin, M., Fisher, P.: The Hawthorne Effect: a randomised, controlled trial. *BMC Med. Res. Methodol.* **7**, 30 (2007)
23. Boehm, B.: A spiral model of software development and enhancement. *Computer* **21**, 61–72 (1988)
24. Rauterberg, M., Strohm, O., Kirsch, C.: Benefits of user-oriented software development based on an iterative cyclic process model for simultaneous engineering. *Int. J. Ind. Ergon.* **16**, 391–410 (1995)
25. Read, J., Gregory, P., Macfarlane, S., Mcmanus, B., Gray, P.: An investigation of participatory design with children – informant, balanced and facilitated design. In: *Interaction Design and Children*, pp. 53–64 (2002)
26. Rauterberg, M.: User centered design: what, why, and when. In: Graefe, E. (ed.) *tekomp Jahrestagung*, pp. 175–178. Gesellschaft fuer technische Kommunikation e.V, Wiesbaden (2003)
27. Zapata-Rivera, D., Bauer, M.: Exploring the role of games in educational assessment. In: Clarke-Midura, J., Mayrath, M., Robinson, D. (eds.) *Technology-Based Assessments for Twenty-First-Century Skills: Theoretical and Practical Implications from Modern Research*, pp. 147–169. Information Age, Charlotte (2011)

Alessandro De Gloria (Ed.)

LNCS 8605

# Games and Learning Alliance

Second International Conference, GALA 2013  
Paris, France, October 23–25, 2013  
Revised Selected Papers



Springer

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, Lancaster, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Friedemann Mattern

*ETH Zurich, Zürich, Switzerland*

John C. Mitchell

*Stanford University, Stanford, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*TU Dortmund University, Dortmund, Germany*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Gerhard Weikum

*Max Planck Institute for Informatics, Saarbruecken, Germany*



More information about this series at <http://www.springer.com/series/7409>

Alessandro De Gloria (Ed.)

# Games and Learning Alliance

Second International Conference, GALA 2013  
Paris, France, October 23–25, 2013  
Revised Selected Papers

*Editor*  
Alessandro De Gloria  
University of Genova  
Genova  
Italy

ISSN 0302-9743                      ISSN 1611-3349 (electronic)  
ISBN 978-3-319-12156-7            ISBN 978-3-319-12157-4 (eBook)  
DOI 10.1007/978-3-319-12157-4

Library of Congress Control Number: 2014953269

LNCS Sublibrary: SL3 – Information Systems and Applications, incl. Internet/Web, and HCI

Springer Cham Heidelberg New York Dordrecht London

© Springer International Publishing Switzerland 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media ([www.springer.com](http://www.springer.com))

## Preface

The second GALA Conference was held during October 23–25 at the Dassault Systèmes (Paris). The Serious Games Society supported and organized the conference along with the Games and Learning Association, the Network of Excellence on Serious Games funded by the European Union under the Seventh Framework Programme. The conference has been devoted to Serious Games (SGs) and aimed at gathering, building, and nurturing an expert community on SGs which involves academic, industrial developers, teachers, and corporate decision makers, to promote knowledge share, technology transfer, and business development. SGs aim at improving learning processes by providing attractive, motivating, and effective tools. So far, effectiveness of SGs has been shown by recent studies (e.g., [1, 2]), but the potential of SGs in education is still far to be fulfilled. Furthermore, there is a growing need for scientific and engineering methods and tools for efficiently building games as means that provide effective learning experiences (e.g., [3–5]). An effective application of SGs for education and training demands appropriate metrics, analytics, tools, and techniques for in-game user assessment. This can be achieved in particular by measuring elements such as learning outcomes and engagement, considering the twofold nature of SGs as compelling games that achieve precise educational goals (e.g., [6, 7]). Recent technological advances have brought what was once expensive, specialized Human–Computer Interaction (HCI) equipment located in research labs, to our family rooms and classes at an affordable cost. Devices such as stereo cameras, eye trackers, tablets and smartphones, pointing devices, motion sensors, sensors related to the central and peripheral nervous systems (e.g., galvanic skin response, heart rate, neuronal activity) [8, 9], amongst others, not only provide innovative interaction methods and techniques, but also present opportunities to develop innovative solutions for continuous user monitoring and assessment (e.g., [10–12]). All in all, design of SGs is a very complex activity, involving different constraints, targets, and disciplines, which is being investigated but is still far from maturity [13–15]. This book reports the studies presented during the conference, addressing the above-mentioned call for paper indications. The book is divided into two parts. The first and main part includes three SG research tracks: design, technology, and application. The second part reports the results of the Workshop “Acquiring 21st Century Skills: gaining insight in the design and applicability of a serious game with 4C-ID” and presents short papers describing the posters exhibited during the conference.

The first research track is dedicated to SG design. The first paper describes the gamification process in a safety and energy-efficiency application context, while the second describes a location-based SG for promoting citizens' preparedness to flooding situations. The third article presents two case studies of SGs for supporting music research, while the fourth gives an overview of the conceptual development and technical implementation of an early staged prototype combining a business simulation and an SG. Learning analytics (LA) are discussed in the next two papers, the first paper devoted to a practical experience on using LAs in educational games and the second

stressing the importance of the game log files for developing LAs. The last paper of the track deals with the relationship between entertainment games and SGs and what SG designers may learn from entertainment game design. The second research track is devoted to the technology applied in SGs. The first paper presents an accessible multiplatform game engine for a new version of the eAdventure educational game authoring platform. The second paper proposes an agent paradigm as a methodological tool to guide the design of SGs in the social field. The next article presents the F1 game, used to demonstrate how learning takes place in the domain of the Formula 1. An additional paper shows the learning path for solving learning difficulties in the use of money and other basic business activities by kids with cognitive disabilities. Two studies deal with significant enabling technologies. The Haptic technology is presented as a provider of a physical control layer that could enhance the immersion of virtual reality. Voice emotion recognition, on the other hand, is presented in the context of improving learning through webcams and microphone. The flow experience and how it can facilitate the game evaluation and design process is discussed in another paper, while the last article in the track presents the perspective of executive functions and discusses how they can help provide a more coherent approach to understanding the cognitive benefits of playing games. The third track of the research part is dedicated to SG applications. The first paper presents a business simulation game with an agent-based deliberative model of consumer behavior, while second paper deals with the evaluation of team collaboration in digital entertainment games. A cultural heritage application is considered in the next paper, presenting the key features, design solutions, and game mechanics of the Fort Ross Virtual Warehouse SG, while a subsequent study presents a Game-Based Learning MOOC for entrepreneurship. A case study presents how to deal with cultural awareness in a game concerning deployment of troops in Afghanistan. Another study provides a handy toolkit for evaluating the effectiveness of a SG for cultural awareness and heritage. The next paper investigates the gambling interactive experience, understanding how games of chance are structured and how they are related to cognitive errors and biases that occur in both frequent and infrequent gamblers. Another article describes a player-specific conflict handling ontology. The last paper in the track presents a compelling case for the use of games as a method for carrying out useful computational work by players in order to define new tools for designing SGs.

The second part of the book starts with the presentation of a workshop exploring how a widely applied instructional design model, 4C-ID, can ease the uptake of SGs by offering teachers a model fitting their background to assess games on the applicability in their learning contexts. The final part of the book collects short papers describing the exhibited posters, addressing a wide range of topics, from user profiling to knowledge convergence measure and from design to description of new SGs in different application fields.

In summary, as the above description may have shown, we are confident that a variety of stakeholders in the field of SGs—industrial developers, researchers, teachers, corporate decision makers, etc.—may find in this book a rich material for their work and inspiration for their activities.

## References

1. Connolly, T.M., Boyle, E.A., MacArthur, E., Hainey, T., Boyle, J.M.: A systematic literature review of the empirical evidence on computer games and serious games. *Comput. Educ.* **59**(2), 661–686 (2012)
2. Wouters, P., van Oostendorp, H., van Nimwegen, C., van der Spek, E.D.: A meta-analysis of the cognitive and motivational effects of serious games. *Comput. Educ.* **60**(1), 412–425 (2013)
3. Greitzer, F.L., Kuchar, O.A., Huston, K.: Cognitive science implications for enhancing training effectiveness in a serious gaming context. *ACM J. Educ. Res. Comput.* **7**(3), 2:1–2:16 (2007)
4. Marfisi-Schottman, I., Labat, J.-M., Carron, T.: Building on the case teaching method to generate learning games relevant to numerous educational fields. In: *IEEE International Conference on Advanced Learning Technologies (iCALT 2013)*, Beijing, China, 15–18 July 2013
5. Bellotti, F., Berta, R., De Gloria, A., D’Ursi, A., Fiore, V.: A serious game model for cultural heritage. *ACM J. Comput. Cult. Herit.* **5**(4) (2012)
6. Howell, K., Glinert, E., Holding, L., Swain, C.: How to build serious games. *Commun. ACM* **50**(7), 44–49 (2007)
7. Doucet, L., Srinivasan, V.: Designing entertaining educational games using procedural rhetoric: a case study. In: *Proceedings of 5th ACM SIGGRAPH Symposium on Video Games*, Los Angeles, CA, July 2010 (2010)
8. Berta, R., Bellotti, F., De Gloria, A., Pranantha, D., Schatten, C.: Electroencephalogram and physiological signal analysis for assessing flow in games. *IEEE Trans. Comput. Intell. AI Games* **5**(2), 164–175 (2013)
9. Ninaus, M., Kober, S.E., Friedrich, E.V.C., Dunwell, I., de Freitas, S., Arnab, S., Ott, M., Kravcik, M., Lim, T., Louchart, S., Bellotti, F., Hannemann, A., Thin, A.G.G., Berta, R., Wood, G., Neuper, C.: Neurophysiological methods for monitoring brain activity in serious games and virtual environments: a review. *Int. J. Technol. Enhanced Learn. (IJTEL)* **6**(1), 78–103 (2014)
10. Bellotti, F., Kapralos, B., Lee, K., Moreno-Ger, P., Berta, R.: Assessment in and of serious games: an overview. *Adv. Hum. Comput. Interact.* (2013). Article ID 136864. doi:10.1155/2013/136864
11. Shute, V.J, Ke, F.: Games, learning, and assessment. In: Ifenthaler, D., Eseryel, D., Ge, X. (eds.) *Assessment in Game-Based Learning: Foundations, Innovations and Perspectives*, pp. 43–58. Springer, New York (2012)
12. el Blanco, Á., Serrano-Laguna, Á., Freire, M., Martínez-Ortiz, I., Fernández-Manjón, B.: E-learning standards and learning analytics. Can data collection be improved by using standard data models? In: *Proceedings of the IEEE Engineering Education Conference (EDUCON)*, pp. 1255–1261 (2013). doi:10.1109/EduCon.2013.6530268
13. Bellotti, F., Berta, R., De Gloria, A.: Designing effective serious games: opportunities and challenges for research. Special Issue: Creative learning with serious games. *Int. J. Emerg. Technol. Learn. (IJET)* **5**, 22–35 (2010)

14. Arnab, S., Lim, T., Carvalho, M.B., Bellotti, F., de Freitas, S., Louchart, S., Suttie, N., Berta, R., De Gloria, A.: Mapping learning and game mechanics for serious games analysis. *Br. J. Educ. Technol.* (2014). doi:10.1111/bjet.12113
15. Ritterfeld, U., Cody, M., Vorderer, P. (eds.) *Serious Games: Mechanisms and Effects*. Routledge, New York (2009)

October 2013

Alessandro De Gloria

# Organization

## General Chair

Alessandro De Gloria                      University of Genoa, Italy

## General Co-chair

Jean Menu                                      Serious Game Lab, France

## Workshop and Tutorial Chair

David Wortley                                Gamification and Enabling Technologies, UK

## Program Committee

Aida Azadegan	University of the West Scotland, UK
Albert Angehrn	INSEAD, France
Alessandro Berni	NATO, Italy
Ana Paiva	INESC-ID, Portugal
Andreas Oikonomou	University of Derby, UK
Anthony Brooks	Aalborg University, Denmark
Audrius Jurgelionis	Fraunhofer, Germany
Baltasar Fernández-Manjón	Complutense University of Madrid, Spain
Bianca Falcidieno	CNR IMATI, Italy
Brian Goldiez	University of Central Florida, USA
Carmen Padron	ATOS, Spain
Carolina Islas Sedano	University of Eastern Finland, Finland
Christos Gatzidis	Bournemouth University, UK
Damien Djaouti	IRIT, France
Daniel Burgos	UNIR, Spain
David Wortley	Gamification and Enabling Technologies, UK
Dirk Ifenthaler	Open Universities Australia, Australia
Donald Brinkman	Microsoft, USA
Erik Duval	Katholieke Universiteit Leuven, Belgium
Erik van der Spek	Technical University of Eindhoven, The Netherlands
Fabrizia Mantovani	Università di Milano Bicocca, Italy
Francesco Bellotti	University of Genoa, Italy
Francisco José Gallego Durán	University of Alicante, Spain



Frank Dignum	University of Utrecht, The Netherlands
George Lepouras	University of Peloponnese, Greece
Igor Mayer	Technical University of Delft, The Netherlands
Ioana Stanescu	Carol I National Defence University, Romania
Ion Roceanu	Carol I National Defence University, Romania
Ivan Lombardi	Catholic University Sacred Heart, Italy
J.C. Hertz	Author of Joystick Nation, USA
Jannicke M. Baalsrud Hauge	Bremer Institut für Produktion und Logistik GmbH, Germany
Johann Riedel	University of Nottingham, UK
Josef Froschauer	Vienna University of Technology, Austria
Kam Star	Playgen, UK
Katerina Mania	Technical University of Crete, Greece
Kristian Kiili	Tampere University of Technology, Finland
Kurt Debattista	University of Warwick, UK
Kyung-Sik Kim	Dankook University, South Korea
Leonardo Caporarello	SDA Bocconi School of Management, Italy
Lucia Pannese	imaginary, Italy
Marcello Carrozzino	Institute for Advanced Studies Lucca, Italy
Margarida Romero	Esade, Spain
Maria Magdalena Popescu	Carol I National Defence University, Romania
Marius Preda	Institut National des Télécommunications, France
Mark McMahon	Edith Cowan University, Western Australia
Matthias Rauterberg	Technical University of Eindhoven, The Netherlands
Michael Derntl	RWTH Aachen University, Germany
Michael Kickmeier-Rust	Technical University of Graz, Austria
Michela Mortara	CNR, Italy
Miguel Encarnação	University of Louisville, USA
Milos Kravcik	RWTH Aachen University, Germany
Muriel Ney	Imag, France
Nahum D. Gershon	MITRE, USA
Nathalie Charlier	Katholieke Universiteit Leuven, Belgium
Norman Badler	University of Pennsylvania, USA
Ole-Ivar Holthe	Geelix, Norway
Olivier Irrmann	Aalto University, Finland
Pablo Moreno-Ger	Complutense University of Madrid, Spain
Panagiotis Petridis	Serious Games Institute, UK
Paolo Riva	Università di Milano Bicocca, Italy
Per Backlund	Högskolan i Skövde, Sweden
Peter Van Rosmalen	Open University of the Netherlands, The Netherlands
Rafael Bidarra	Delft University of Technology, The Netherlands
Ralph Klamma	RWTH Aachen University, Germany
Riccardo Berta	University of Genoa, Italy

Rob Nadolsky	Open University of the Netherlands, The Netherlands
Rosa Maria Bottino	National Research Institute, Italy
Rui Prada	INESC-ID, Portugal
Sandy Louchart	Heriot-Watt University, UK
Sara de Freitas	Coventry University, UK
Simon Egenfeldt-Nielsen	Serious Games Interactive, Denmark
Staffan Bjork	Chalmers, Sweden
Stephen Lane	University of Pennsylvania, USA
Steve Ellis	NASA, USA
Sung Hyun Cho	Hongik University, South Korea
Tanya Krzywinska	Brunel University, UK
Theo Lim	Heriot-Watt University, UK
Travis Ross	Indiana University, USA
William Fisher	Quicksilver, USA
Wim Westera	Open University of the Netherlands, The Netherlands
Yiorgos Chrysanthou	University of Cyprus, Cyprus

### **Local Arrangements Committee**

Patricia Doherty	Dassault Systèmes, France
Caroline Freyther	Dassault Systèmes, France
Claudia Schoke	Dassault Systèmes, France
Elisa Lavagnino	University of Genoa, Italy

### **Publications Chair**

Riccardo Berta	University of Genoa, Italy
----------------	----------------------------

### **Communication Chair**

Francesco Bellotti	University of Genoa, Italy
--------------------	----------------------------

### **Administrative Chair**

Patricia Doherty	Dassault Systèmes, France
Elisa Lavagnino	University of Genoa, Italy

# Contents

## SG Design

Energy-Efficient and Safe Driving Using a Situation-Aware Gamification Approach in Logistics . . . . .	3
<i>Roland Klemke, Milos Kravcik, and Felix Bohuschke</i>	
Learning Analytics and Educational Games: Lessons Learned from Practical Experience. . . . .	16
<i>Ángel Serrano-Lagunaa, Javier Torrente, Borja Maneroa, Ángel del Blanco, Blanca Borro-Escribanoa, Iván Martínez-Ortiza, Manuel Freirea, and Baltasar Fernández-Manjón</i>	
Designing Games with a Purpose for Data Collection in Music Research. Emotify and Hooked: Two Case Studies . . . . .	29
<i>Anna Aljanaki, Dimitrios Bountouridis, John Ashley Burgoyne, Jan Van Balen, Frans Wiering, Henkjan Honing, and Remco Veltkamp</i>	
Learning Analytics in Serious Gaming: Uncovering the Hidden Treasury of Game Log Files . . . . .	41
<i>Wim Westera, Rob Nadolski, and Hans Hummel</i>	
Generating Computational Models for Serious Gaming . . . . .	53
<i>Wim Westera</i>	
COMBI naTion: The Fusion of Serious Gaming and COBIT . . . . .	64
<i>Martin Fritsch, Sascha Müller-Feuerstein, and Rainer Groß</i>	
The Move Beyond Edutainment: Have We Learnt Our Lessons from Entertainment Games? . . . . .	77
<i>Aida Azadegan, Jannicke Balsrud Hauge, Francesco Bellotti, Riccardo Berta, Rafael Bidarra, Casper Harteveld, Johann C.K.H. Riedel, and Ioana Andreea Stanescu</i>	
Flooded: A Location-Based Game for Promoting Citizens' Preparedness to Flooding Situations . . . . .	90
<i>Sondre Johan Mannsverk, Ines Di Loreto, and Monica Divitini</i>	

## SG Technology

Development of a Game Engine for Accessible Web-Based Games. . . . .	107
<i>Javier Torrente, Ángel Serrano-Laguna, Ángel del Blanco Aguado, Pablo Moreno-Ger, and Baltasar Fernández-Manjón</i>	

FILTWAM and Voice Emotion Recognition. . . . .	116
<i>Kiavash Bahreini, Rob Nadolski, and Wim Westera</i>	
A Survey of Haptics in Serious Gaming. . . . .	130
<i>Shujie Deng, Jian Chang, and Jian J. Zhang</i>	
An Agent Based Methodology to Design Serious Game in Social Field. . . . .	145
<i>Manuel Gentile, Dario La Guardia, Valentina Dal Grande, Simona Ottaviano, and Mario Allegra</i>	
Lecture Notes in Computer Science: Beyond simulators, Using F1 Games to Predict Driver Performance, Learning and Potential. . . . .	157
<i>Matthew Hislop, Aparajithan Sivanathan, Theodore Lim, James M. Ritchie, Gnanathusharan Rajendran, and Sandy Louchart</i>	
Paths for Cognitive Rehabilitation: From Reality to Educational Software, to Serious Games, to Reality Again. . . . .	172
<i>Francesco Curatelli, Chiara Martinengo, Francesco Bellotti, and Riccardo Berta</i>	
Towards an Understanding of the Relationship Between Executive Functions and Learning Outcomes from Serious Computer Games. . . . .	187
<i>James Boyle and Elizabeth A. Boyle</i>	
Flow Experience as a Quality Measure in Evaluating Physically Activating Serious Games. . . . .	200
<i>Kristian Kiili, Arttu Perttula, Sylvester Arnab, and Marko Suominen</i>	
<b>SG Applications</b>	
A Business Simulation with an Agent-Based Deliberative Model of Consumer Behaviour. . . . .	215
<i>Márcia L. Baptista, Carlos Martinho, Francisco Lima, Pedro A. Santos, and Helmut Prendinger</i>	
Stealth Assessment of Teams in a Digital Game Environment. . . . .	224
<i>Igor Mayer, Dirk van Dierendonck, Theo van Ruijven, and Ivo Wenzler</i>	
Unveiling California History Through Serious Games: Fort Ross Virtual Warehouse. . . . .	236
<i>Nicola Lercari, Michela Mortara, and Maurizio Forte</i>	
Entrepreneurship Competence Assessment Through a Game Based Learning MOOC. . . . .	252
<i>Mireia Usart and Margarida Romero</i>	

Evaluation of “Cultural Awareness – Afghanistan Pre-deployment”:  
 A User Study . . . . . 265  
*Alessandra Tesei, Alessandra Barbieri, Ion Roceanu, and Daniel Beligan*

Evaluating the Effectiveness of Serious Games for Cultural Awareness:  
 The Icura User Study . . . . . 276  
*Michela Mortara, Chiara Eva Catalano, Giusy Fiucci, and Michael Dertnl*

Beyond Gambling Temptations: An Experimental Design Project to Detoxify  
 Players from Irresistible Illusions of Gambling . . . . . 290  
*Annamaria Andrea Vitali, Margherita Pillan, and Pietro Righi Riva*

Player-Specific Conflict Handling Ontology . . . . . 304  
*Charline Hondrou, Eleni Tsalapati, Amaryllis Raouzaïou, Kostas Karpouzis,  
 and Stefanos Kollias*

Doing Useful Work Using Games . . . . . 316  
*Kam Star*

**Workshop**

Acquiring 21st Century Skills: Gaining Insight into the Design and  
 Applicability of a Serious Game with 4C-ID . . . . . 327  
*Peter van Rosmalen, Elizabeth A. Boyle, Rob Nadolski,  
 John van der Baaren, Baltasar Fernández-Manjón, Ewan MacArthur,  
 Tiina Pennanen, Madalina Manea, and Kam Star*

**Posters**

An Instructional Approach for Developing Serious Games . . . . . 337  
*Félix Buendía-García, Sol García-Martínez, Eva M<sup>a</sup> Navarrete-Ibañez,  
 and M<sup>a</sup> Jesús Cervelló-Donderis*

User Profiling: Towards a Facebook Game that Reveals Cognitive Style . . . . 349  
*Angeliki Antoniou, Ioanna Lykourantzou, Jenny Rompa, Eric Tobias,  
 George Lepouras, Costas Vassilakis, and Yannick Naudet*

Quantitative Approach in Measuring Knowledge Convergence  
 in Serious Games . . . . . 354  
*Ariadna Padrós and Margarida Romero*

The 5/10 Method: A Method for Designing Educational Games . . . . . 364  
*Johan Jeuring, Rick van Rooij, and Nicolas Pronost*

Balancing Fidelity of Simulation Game Environments to Increase  
 Situational Awareness Skills . . . . . 370  
*Heide Lukosch*

Gaming for Policy Makers: It’s Serious! . . . . . 376  
*Josine G.M. van de Ven, Hester Stubbé, and Micah Hrehovcsik*

Serious Game Design for Vehicular Language Learning Addressing  
Work Needs . . . . . 383  
*Hariklia Tsalapatas, Olivier Heidmann, Rene Alimisi, Spyros Tsalapatas,  
Spyros Kourias, Martin Sillaots, Bernardo Hourmat, Michela Tramonti,  
Steffan Oie, and Elias Houstis*

Harmonizing Interoperability – Emergent Serious Gaming in Playful  
Stochastic CAD Environments . . . . . 390  
*Z. Kosmadoudi, Theodore Lim, James M. Ritchie, Y. Liu, R. Sung,  
Jannicke Balsrud Hauge, Samir Garbaya, Robert E. Wendrich,  
and Ioana A. Stanescu*

A Diagnostic Tool on Time Perception of Children with ADHD . . . . . 400  
*Pongpanote Gongsook, Janneke Peijnenborgh, Christian Sallustro,  
Erik van der Spek, Jun Hu, Francesco Bellotti, Matthias Rauterberg,  
and Jos Hendriksen*

**Author Index . . . . . 407**