SLOTZ: A Game-Based Measure of Problem Gambling

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SLOTZ: A Game-Based Measure of Problem Gambling

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Abstract

The last decade has seen a marked increase in gambling availability and participation. This increase is in part due to a rapid proliferation in digital platforms of gambling delivery, including online betting and smartphone betting applications. In turn, this rise in gambling availability and participation has led to an increase in the prevalence of gambling-related issues. This is particularly concerning, as relatively few problem gamblers ever engage in treatment, despite experiencing substantial psychological and social impairment as a result of their gambling. Difficulties with engagement are likely to stem from the many barriers problem gamblers face when seeking treatment, including financial issues, stigma, embarrassment and shame. Successful utilisation of digital technologies may help overcome barriers often faced by more traditional face-to-face mental health assessments and interventions, with these novel forms of digital delivery being potentially better suited to fostering user engagement, motivation and retention in mental health assessments and interventions.

To date, virtual reality technologies present as one the most efficacious forms of digital mental health assessments and interventions, providing a range of interactive systems, environments and mechanisms by which mental health assessment and intervention can be enacted. Review of the literature and meta-analysis, as reported in Chapter 3, supported the efficacy of virtual reality-based interventions, though issues regarding methodological rigour remain. Yet despite the promise of virtual reality-based assessments and interventions, their development and implementation has been sluggish. For this reason, there appears to be a need to explore the utility of alternative digital delivery platforms.

Video games provide a more readily-accessible, cost-effective digital delivery platform for mental health assessment and intervention. Mental health video games aim to make the processes of change and learning more meaningful and engaging. As is reported in Chapter 4, review of the literature revealed that mental health video game assessments and interventions have successfully been investigated in the assessment and treatment of a number of populations and presentations. Moreover, it was observed that mental health video games may pose a particularly useful platform for engaging hard-to-reach populations such as problem gamblers, engaging users emotionally, capturing their attention and promoting continuing engagement. However, it was concluded that the lack of empirically supported theory, methodological rigour and psychometric validation in the literature makes it difficult to draw overall conclusions regarding the efficacy and utility of mental health video games. It was determined that there remains a need in the literature for robust examples of the development and implementation of empirically driven, well-validated mental health video games.

The overall aim of this thesis was to explore the role digital technologies can play in the development and delivery of mental health assessment and intervention, with particular focus placed upon the area of problem gambling. To this end, a novel mental health video game assessment of problem gambling was developed (SLOTZ). Game play was developed in accordance with game design and gambling-related neuropsychological theory. Initial conceptualization, development, piloting and the first iteration of revision and refinement of SLOTZ game play is described over the course of Chapter 5 and Chapter 6. Levels of immersion and engagement were found to be high, with participants observed to find SLOTZ game engaging and enjoyable. Two SLOTZ sub-tests were observed to significantly correlate with established measures of gambling

severity and to demonstrate an ability to significantly predict gambling severity in participants. Implications, limitations and directions for future research are discussed in Chapter 7 and Chapter 8.

Overall, findings from this thesis provide evidence that problem gambling can be identified and predicted via video game play. SLOTZ presents as an economical, engaging, enjoyable, and psychometrically validated means of problem gambling assessment that is likely to be wide-in-reach and less psychological, socially and financially aversive to populations who are historically difficulty to engage. Moreover, this thesis provides a sound example of the process of empirically testing digital mental health video assessments and interventions via a multi-step iterative process of pilot testing and refinement, demonstrating the utility of video games in mental health assessment and interventions.

Statement of Originality

This work has not been previously submitted for a degree or diploma in any university. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the thesis itself.

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List of Publications

Section 9.1 of the Griffith University Code for the Responsible Conduct of Research ("Criteria for Authorship"), in accordance with Section 5 of the Australian Code for the Responsible Conduct of Research states:

To be named as an author, a researcher must have made a substantial scholarly contribution to the creative or scholarly work that constitutes the research output, and be able to take public responsibility for at least that part of the work they contributed. Attribution of authorship depends to some extent on the discipline and publisher policies, but in all cases, authorship must be based on substantial contributions in a combination of one or more of:

- Conception and design of the research project
- Analysis and interpretation of research data
- Drafting or making significant parts of the creative or scholarly work or critically revising it so as to contribute significantly to the final output.

Section 9.3 of the Griffith University Code (Responsibilities of Researchers""), in accordance with Section 5 of the Australian Code, states: Researchers are expected to:

Offer authorship to all people, including research trainees, who meet the criteria for authorship listed above, but only those people.

- Accept or decline offers of authorship promptly in writing.
- Include in the list of authors only those who have accepted authorship.
- Appoint one author to be the executive author to record authorship and manage correspondence about the work with the publisher and other interested parties.

- Acknowledge all those who have contributed to the research, facilitates, or materials but who do not qualify as authors, such as research assistants, technical staff, and advisors on cultural or community knowledge. Obtain written consent to name individuals.

Included in this thesis are published papers (Chapters 3 and 4) which are co-authored with other researchers. My contribution to each co-authored paper is outlined at the front of each relevant chapter. The bibliographic details for these papers are:**Chapter 3: Turner, W.**, & Casey, L. (2014). Outcomes associated with virtual reality in psychological interventions: Where are we now? *Clinical Psychology Review, 34(8),* 634-644. doi: 10.1016/j.cpr.2014.10.003

Chapter 4: Turner, W., Thomas, B., & Casey, L. (2016). Developing games for mental health: A primer. P*rofessional Psychology-Research and Practice, 47(3),* 242-249. doi: 10.1037/pro0000082

Finally, Chapter 5, Chapter 6 and Chapter 7 are presented within the thesis as unpublished papers, with the intent to submit these for publication following final submission of this thesis.

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I must acknowledge and thank those who volunteered their time and extensive patience during the development phase of SLOTZ. In all honesty, the first few versions of the game prior to piloting were excruciatingly laborious and plagued with technical issues, so I greatly appreciate your loyalty and efforts. I would also like to thank Relationships Australia Queensland for advertising this research and my colleagues and friends who helped spread the word via social media.

Finally, I would like to thank my partner, Sheetal Prasad, and my dearest friends, for their constant support, patience and faith in my abilities. Balancing research, coursework, work and social commitments has been a constant battle, and I would never have been able to make it through this process without you all.

Chapter 1. Overview

Overview

Expansion in gambling availability and accessibility has led to problem gambling prevalence rates between 0.15% to 5% of the adult populations in the United States, Canada, Europe, Asia and Australia (Calado & Griffiths, 2016; Stucki and Rihs-Middel, 2007; Productivity Commission, 2010). Though conceptualisation, classification and identification of problem gamblers can prove difficult (Petry et al., 2008; Richard & Humphrey, 2014; Rugle, 2014), several assessment and diagnostic assessments have been developed and reviewed (Stinchfield, 2014).

Many mental health practitioners are likely to have limited training or experience in the assessment and diagnosis of problem gambling (Petry et al., 2008; Richard & Humphrey, 2014). Of similar concern is the knowledge that approximately only ten percent of problem gamblers ever seek treatment (Cunningham et al., 2012), despite reporting moderate to severe emotional, financial, occupational and relationship strain, poor health, comorbid substance issues, and social issues (Delfabbro, 2014; Goudriaan et al., 2013; Petry, 2009; Richard & Humphrey, 2014). Common barriers to problem gambling assessment and treatment often include access issues, stigma, embarrassment and shame (Cunningham et al., 2012; Giovanni et al, 2016). To overcome these barriers, there is a need for assessment and intervention platforms that are active, affordable, effective, emotionally engaging, relatively wide in reach and user friendly (Fleming et al., 2016).

The rapid proliferation of digital technologies has led to a surge in the application and evaluation of technology in mental health assessments and interventions (Brand et al., 2017; Clough & Casey, 2015; Delfabbro et al., 2016; King & Delfabbro, 2016; Mohr, Cuijpers, & Lehman, 2011). While traditional face-to-face assessments

and treatments have been successfully modified for digital delivery, they typically suffer from high rates of attrition, lower rates uptake, low user engagement, and questionable reach and impact with target populations (Clough & Casey, 2015; Gilbody et al., 2015; Hermes et al., 2016; Jones, 2014; Melville, Casey & Kavanagh, 2010; Postel et al., 2011). More novel forms of digital delivery may be better suited to fostering user engagement, motivation and retention in mental health assessments and interventions.

Virtual Reality (VR) arguably presents as an efficacious form of novel digital mental health assessment and intervention (Lumsden et al., 2016; Turner & Casey, 2014). VR assessments and interventions can provide a range of interactive systems, environments and mechanisms by which psychological and behavioural change can be targeted in novel and engaging ways. Often applying similar if not identical mechanisms of action to traditional face to face interventions, VR assessments and interventions are able to effectively treat and address a plethora of psychological disorders and behavioural issues (Carlbring & Andersson, 2006; Fox et al., 2009; Lumsden et al., 2016; Parson, 2015; Turner & Casey, 2014).

However, despite promising empirical support for their use, there has been substantially less uptake in VR technologies than was originally predicted, largely due to exorbitant costs, unintuitive software, poor design and concerns regarding the quality and impartiality of their empirical support (Fink, 2017; Peterson, 2017; Swant, 2018; Turner & Casey, 2014). Subsequently, while the utilisation of VR technology may prove useful, evaluation of other digital delivery platforms that may be more accessible, user-friendly and affordable is warranted.

Mental health video game assessments and interventions may provide an especially useful means of assessment and intervention, as they are often more readily

accessed by individuals than traditional face-to-face assessments and interventions (Kato, 2012; Kharrazi et al., 2012; Landers, 2014; Lau et al., 2017; Morford et al., 2014; Turner & Casey, 2014; Rahmani & Boren, 2012). Mental health video game assessments and interventions aim to make learning more meaningful and engaging via the inclusion of video game mechanics (Gopinath Bharathi et al., 2016; Landers, 2014). Video games may pose a particularly useful platform for engaging addiction populations such as problem gamblers, typically engaging individuals emotionally, capturing their attention and promoting ongoing engagement (Baranowski et al., 2013; Gopinath Bharathi et al., 2016; Landers, 2014; Lau et al., 2017; Van Bennekom et al, 2017).

Mental health games have targeted a variety of populations, including children (Barranowski et al., 2012; Graves et al., 2010), adolescents (Trivedi et al., 2010), adults (Saposnik et al., 2010), and the elderly (Basak et al., 2008; Szturm et al., 2008). Additionally, mental health video games have focussed upon areas such as stress reduction (Miller et al., 2011), increasing physical activity (Baranowski et al., 2012; Bonetti et al., 2010; Maddison et al., 2011), disease/disorder education (Cunningham et al., 2012; Petry, 2009; Wood et al., 2014), physical rehabilitation (Saposnik et al., 2010), improving executive functioning and clinical diagnosis (Kharrazi et al., 2012; Rahmani & Boren, 2012). Despite the growing body of mental health video game literature, studies more often than not suffer from limited to no reference of underlying theory, lack of rigorous evaluation, poor study design and limited sample sizes (Kato, 2012; Kharrazi et al., 2012; Lumsden et al., 2016; Turner & Casey, 2014; Turner, Thomas & Casey, 2016). Whilst methodological rigour is increasing, substantial improvements in testing and reporting are needed if video games are to become an

accepted, empirically supported platform for the delivery of mental health assessments and interventions (Kharrazi et al., 2012; Lumsden et al., 2016; Turner et al., 2016).

Aim of the Thesis

The overall aim of this thesis was to explore the role digital technology can play in the development and delivery of mental health assessments and interventions, with an emphasis on the area of problem gambling. To aid readers, chapters have been written in accordance with the Publication Manual of the American Psychological Association, Sixth Edition (American Psychological Association, 2010), with tables and figures embedded in text. As the majority of chapters are presented in the form of published and unpublished manuscripts, references are provided at the end of each respective chapter. A diagrammatic representation of the thesis structure is presented in Figure 1.1

Chapter 2. An Introduction to Problem Gambling Assessment and Intervention

Chapter 2 consists of an overview of literature relevant to assessment and treatment of problem gambling. This chapter introduces key concepts and issues regarding the conceptualisation, aetiology, prevalence, assessment and treatment of problem gambling. Additionally, this general introduction chapter summarises the role brief interventions play in the treatment of problem gambling, and explains the need for the development of easily accessible, engaging, user-friendly problem gambling brief assessments and interventions.

Chapter 3. Outcomes Associated with Virtual Reality in Psychological Interventions: Where Are We Now?

The first published paper in this thesis (Chapter 3) consists of an examination of the efficacy and methodological rigour of the most empirically supported type of digitally delivered mental interventions: virtual reality-based interventions (Turner &

Casey, 2014). The aim of this study was to conduct a meta-analysis of virtual reality interventions and to examine the methodological rigour of these studies. Thirty studies were included in the analysis and were required to: have used a randomised controlled trial design; to have been published in a scholarly journal; to have focused primarily on psychological and/or behavioural intervention; to include psychometrically validated measures; to include reported means and standard deviations; and to include at least one clinical/sub-clinical group. Virtual reality interventions were observed to be more effective than non-intervention wait-lists and to be comparable in effectiveness to other active interventions. Though methodological rigour was not observed to impact upon outcomes, the need for greater emphasis on methodological rigour and psychometric validation was identified. Overall, virtual reality interventions were observed to present as a promising, efficacious form of mental health intervention.

Chapter 4. Developing Games for Mental Health – A Primer

The second published paper (Chapter 4) in this thesis consists of an overview of trends in the field of mental health video games, as well as an introduction to key games development concepts and brief guide to the development process (Turner et al., 2016). A literature review of mental health video games identified a need for guidance in the development and empirical testing of mental health video games. This chapter summarises key factors that may require consideration prior to game development and provides a checklist to guide clinicians and researchers in the development of mental health video games.

Chapter 5. Immersion and Engagement Testing of SLOTZ – A Game-based Measure of Problem Gambling

Following review of the literature reported upon in Chapter 2, Chapter 3 and Chapter 4, mental health video games were identified as a highly accessible, affordable, engaging and promising delivery platform form for digital mental health assessment and intervention, despite the paucity of well-conducted empirical research. Consequently, a mental health video game assessment of problem gambling was developed in accordance with game design theory and gambling-related neuropsychological theory.

Development and psychometric validation of SLOTZ was completed over the course of two empirical studies, in accordance with recommendations made more recently across digital mental health fields (Clough & Casey, 2015; Jones, 2014; Lumsden et al., 2016; Turner et al., 2016). Accordingly, Chapter 5 reports the piloting of SLOTZ (Turner & Casey, 2018a). This chapter reports on the development of, and evaluation of user immersion enjoyment, and engagement in a mental health video game assessment of problem gambling.

Chapter 6. SLOTZ: Measuring Problem gambling via Video Game Play

As noted above, development and psychometric validation of SLOTZ was completed over the course of two empirical studies, in accordance with recommendations made across digital mental health fields (Clough & Casey, 2015; Jones, 2014; Lumsden et al., 2016; Turner et al., 2016). Accordingly, Chapter 6 reports on the psychometric evaluation of SLOTZ, conducted to determine its utility and validity as a screening tool for problem gambling (Turner & Casey, 2018b).

Chapter 7. Levelling Up: Considerations for the Development and Utilisation of Mental Health Video Games

Chapter 7 (Turner & Casey, 2018c) provides an updated summary of the current state of mental health video games. The utility of mental health video games is explored, as are current challenges in their use, potential solutions for these challenges, suggestions for future research, and brief examples of the purpose and process of mental health video game development.

Chapter 8. Summary

Chapter 8 provides an overarching summary of this thesis. It provides a review of the stated aims and an overall summary of findings, implications and the importance of this research.

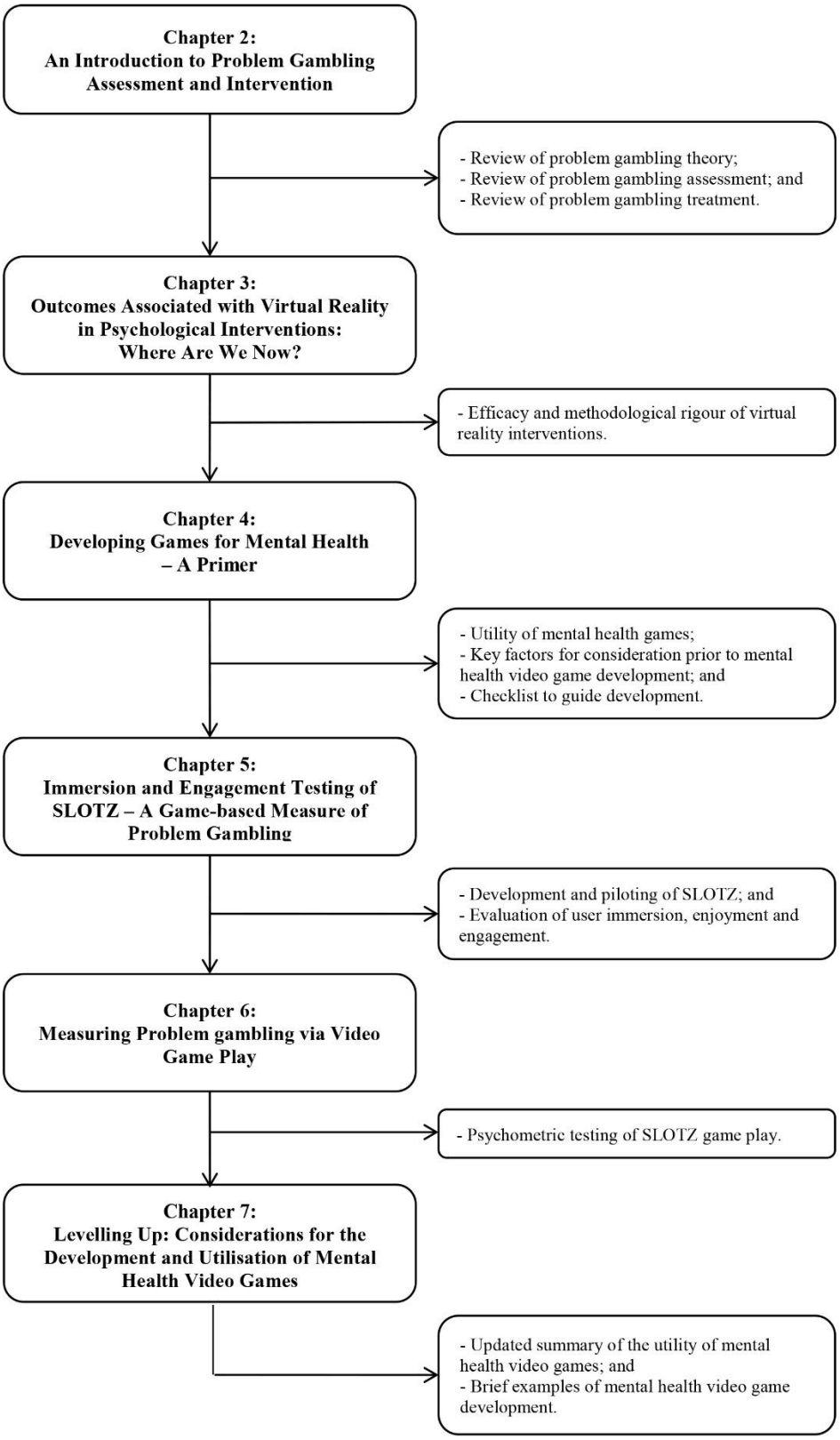

Figure 1.1. Focus and Sequence of Studies Included in the Thesis

References

American Psychological Association. (2010). *Publication manual of the American Psychological Association* (6th ed.). Washington, D.C: American Psychological Association.

Baranowski, T., Abdelsamad, D., Baranowski, J., O'Connor, T. M., Thompson, D., Barnett, A. & Chen, T. (2012). Impact of an active video game on healthy children's physical activity. P*ediatrics, 129(3),* 636-642. doi: 10.1542/peds.2011-2050

Baranowski, T., Buday, R., Thompson, D., Lyons, E. J., Lu, A. S., & Baranowski, J. (2013). Developing games for health behavior change: getting started. G*ames Health Journal, 2(4),* 183-190. doi: 10.1089/g4h.2013.0048.

Basak, C., Boot, W. R., Voss, M. W., & Kramer, A. F. (2008). Can training in a real-time strategy video game attenuate cognitive decline in older adults? *Psychology and Aging, 23(4),* 765-777. doi: 10.1037/a0013494

Blinn-Pike, L., Worthy, S. L., & Jonkman, J. N. (2010). Adolescent Gambling: A Review of an Emerging Field Of Research. *J Adolesc Health, 47*(3), 223-236. doi: 10.1016/j.jadohealth.2010.05.003

Bonetti, A. J., Drury, D. G., Danoff, J. V., & Miller, T. A. (2010). Comparison of acute exercise responses between conventional video gaming and isometric resistance exergaming. J*ournal of Strength and Conditioning Research, 24(7),* 1799-1803. doi: 10.1519/JSC.0b013e3181bab4a8

Brand, J., Porentz, P. & Mathew, T. (2014). Digital Australia. *Interactive Games & Entertaining Association*. Retrieved from http://www.igea.net/2013/10/digital-australia-2014/Entertain Software Association, 2016

Carlbring, P., & Andersson, G. (2006). Internet and psychological treatment. How well can they be combined? *Computers in Human Behavior, 22*(3), 545-553. doi: 10.1016/j.chb.2004.10.009

Clough, B., & Casey, L. (2015). Smart designs for smart technologies: Research challenges and emerging solutions for scientist-practitioners within e-mental health. *Professional Psychology: Research and Practice, doi:* 10.1037/pro0000053

Cunningham, J.A., Hodgins, D.C., Toneatto, T., & Murphy, Me. (2012). A Randomized Controlled Trial of a Personalized Feedback Intervention for Problem Gamblers. *PLoS One, 7*(2). doi: 10.1371/journal.pone.0031586

Delfabbro, P., King, D. L., & Derevensky, J. L. (2016). Adolescent gambling and problem gambling: Prevalence, current issues, and concerns. *Current Addiction Reports, 3*(3), 268-274. Doi: 10.1007/s40429-016-0105-z

Delfabbro, P. (2014). Behavioral Risk Factors in Disordered Gambling and Treatment Implications. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Dowling, N. (2014). The Cognitive-Behavioral Treatment of Female Problem Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Fink, C. (2017). Why Consumer Adoption of VR And AR Will Be Slow. *Forbes.* Retrieved from https://www.forbes.com/sites/charliefink/2017/12/13/why-consumer-adoption-of-vr-ar-will-be-slow/#1cbb8625359f

Fleming, T., de Beurs, D., Khazaal, Y., Gaggioli, A., Riva, G., Botella, C., Banos, R. M., Aschieri, F., Bavin, L. M., Kleiboer, A., Merry, S., Ming Lau, H., & Riper, H.

(2016). Maximizing the impact of e-therapy and serious gaming: Time for a paradigm shift. *Frontiers in Psychiatry, 7,* 65. doi: 10.3389/fpsyt.2016.00065

Fox, J., Arena, D., & Bailenson, J. N. (2009). Virtual Reality: A Survival Guide for the Social Scientist. *Journal of Media Psychology: Theories, Methods, and Applications, 21*(3), 95-113. doi: 10.1027/1864-1105.21.3.95

Gilbody, S., Littlewood, E., Hewitt, C., Brierley, G., Tharmanathan, P., Araya, R., . . . REEACT Team. (2015). Computerised cognitive behaviour therapy (cCBT) as treatment for depression in primary care (REEACT trial): Large scale pragmatic randomised controlled trial. *BMJ : British Medical Journal, 351,* h5627. doi: 10.1136/bmj.h5627

Giovanni, M., Fabiola, S., Federica, F., Mariangela, C., Nicola, P., Ilaria, T., . . . Giannantonio Massimo, D. (2016). Gambling disorder and suicide: An overview of the associated co-morbidity and clinical characteristics. *International Journal of High Risk Behaviors and Addiction, Inpress(Inpress).* e30827. doi: 10.5812/ijhrba.30827

Gopinath Bharathi, A.K. B., Singh, A., Tucker, C. S., & Nembhard, H. B. (2016). Knowledge discovery of game design features by mining user-generated feedback. *Computers in Human Behavior, 60,* 361-371. doi: 10.1016/j.chb.2016.02.076

Goudriaan, A.E., van Holst, R.J., Veltman, D.J., & van den Brink, W. (2013). Contributions from Neuroscience and Neuropsychology. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Graves, L.E., Ridgers, N.D., Atkinson, G., & Stratton, G. (2010). The effect of active video gaming on children's physical activity, behavior preferences and body composition. P*aediatric Exercise Science, 22,* 535–546. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed

Hermes, E.DA., Merrel, J., Clayton, A., Morris, C. & Rowe, M. (2016). Computer-based self-help therapy: A qualitative analysis of attrition. *Health Informatics Journal,* n/a, n/a. doi: 10.1177/2F1460458216683536

Jones, D. J. (2014). Future directions in the design, development, and investigation of technology as a service delivery vehicle. *Journal of Clinical Child and Adolescent Psychology: The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53, 43(1),* 128-142. doi: 10.1080/15374416.2013.859082

Kato, P.M. (2012). Evaluating Efficacy and Validating Games for Health. *Games Health Journal, 1(1),* 74-76. doi: 10.1089/g4h.2012.1017

Kharrazi, H., Lu, A. S., Gharghabi, F., & Coleman, W. (2012). A Scoping Review of Health Game Research: Past, Present, and Future. *Games Health Journal,1(2).* doi: 10.1089/g4h.2012.0011

King, D., & Delfabbro, P. (2016). Early exposure to digital simulated gambling: A review and conceptual model. Computers in Human Behavior, 55, 198-206. 10.1016/j.chb.2015.09.012

Landers, R. N. (2014). Developing a theory of gamified learning: Linking serious games and game design of learning. *Simulation & Gaming, 45(6),* 752-768. doi: 10.1177/1046878114563660

Lau, P. W. C., Lau, E. Y., Wang, J. J., Choi, C., & Kim, C. G. (2017). A pilot study of the attractive features of active videogames among chinese primary school children. *Games for Health Journal, 6(2),* 87-96. 10.1089/g4h.2016.0021

Lumsden, J., Edwards, E. A., Lawrence, N. S., Coyle, D., & Munafò, M. R. (2016). Gamification of cognitive assessment and cognitive training: A systematic review of applications and efficacy. *JMIR Serious Games, 4(2),* e11. 10.2196/games.5888

Maddison, R., Foley, L., Ni Mhurchu, C., Jiang, Y., Jull, A., Prapavessis, H. & Rodgers, A. (2011). Effects of active video games on body composition: A randomized controlled trial. T*he American Journal of Clinical Nutrition, 94(1),* 156-163. doi: 10.3945/ajcn.110.009142

Melville, K. M., Casey, L. M., & Kavanagh, D. J. (2010). Dropout from internet-based treatment for psychological disorders. *British Journal of Clinical Psychology, 49*(4), 455-471. doi: 10.1348/014466509X472138

Miller, K., Rodger, S., Kipping, B., & Kimble, R. M. (2011). A novel technology approach to pain management in children with burns: A prospective randomized controlled trial. *Burns: Journal of the International Society for Burn Injuries, 37(3),* 395-405. doi: 10.1016/j.burns.2010.12.008

Mohr, D. C., Cuijpers, P., & Lehman, K. (2011). Supportive accountability: A model for providing human support to enhance adherence to eHealth interventions. *Journal of Medical Internet Research, 13*(1), e30. doi: 10.2196/jmir.1602

Morford, Z. H., Witts, B. N., Killingsworth, K. J., & Alavosius, M. P. (2014). Game design: The intersection between behavior analysis and game design

technologies. *The Behavior Analyst, 37(1),* 25-40. doi: 10.1007/s40614-014-0006-1

Parsons, T. (2015). Virtual reality for enhanced ecological validity and experimental control in the clinical, affective and social neurosciences. *Frontiers in Human Neuroscience, 9,* 660. doi: 10.3389/fnhum.2015.00660

Peterson, T. (2017). How marketers are wrestling with virtual reality's adoption issue. *MarTech Today.* Retrieved from https://martechtoday.com/marketers-wrestling-virtual-realitys-adoption-issue-205285

Petry, N. (2009). Disordered Gambling and Its Treatment. *Cognitive and Behavioral Practice, 16,* 457-467.

Petry, N.M., Weinstock, J., Ledgerwood, D.M., & Morasco, B. (2008). A Randomized Trial of Brief Interventions for Problem and Pathological Gamblers. *Journal of Consulting and Clinical Psychology, 76*(2), 318-328. doi: 10.1037/0022-006X.76.2.318

Postel, M. G., Haan, H. A. d., Huurne, E. D. t., Palen, J. v. d., Becker, E. S., & Jong, C. A. J. d. (2011). Attrition in web-based treatment for problem drinkers. *Journal of Medical Internet Research, 13*(4), e117-e117. doi: 10.2196/jmir.1811

Productivity Commission (2010). *Australia's Gambling Industries, Report No. 50*. Canberra: Ausinfo

Rahmani, E. & Boren, S.A. (2012). Videogames and Health Improvement: A Literature Review of Randomized Controlled Trials. *Games Health Journal,1(5),* 331-341. doi: 10.1089/g4h.2012.0031

Richard, D.C. & Humphrey, J. (2014). The Conceptualization and Diagnosis of Disordered Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.),

The Wiley-Blackwell Handbook of Disordered Gambling: John Wiley & Sons, Ltd.

Rugle, L. (2014). Case Conceptualization with Clients Presenting with Disordered Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Saposnik, G., Teasell, R., Mamdani, M., Hall, J., McIlroy, W. & Cheung, D. (2010). Effectiveness of virtual reality using Wii gaming technology in stroke rehabilitation: A pilot randomized clinical trial and proof of principle. S*troke; a Journal of Cerebral Circulation, 41(7),* 1477-1484. doi: 10.1161/STROKEAHA.110.584979

Stinchfield, R. (2014). A review of problem gambling assessment instruments and brief screens. In (Richard, D. C. S., Blaszczynski, A., & Nower, L. (eds), *The Wiley-Blackwell Handbook of Disordered Gambling (1st Ed.).* Chichester, West Sussex, UK: Wiley-Blackwell.

Stucki, S., & Rihs-Middel, M. (2007). Prevalence of adult problem and pathological gambling between 2000 and 2005: An update. *Journal of Gambling Studies, 23*(3), 245-257. doi: 10.1007/s10899-006-9031-7

Swant, M. (2018). What Needs to Come First for VR to Take Off, Mass Hardware Adoption or Compelling Content? *Adweek.* Retrieved from http://www.adweek.com/digital/what-needs-to-come-first-for-vr-to-take-off-mass-hardware-adoption-or-compelling-content/

Szturm, T., Betker, A. K., Moussavi, Z., Desai, A., & Goodman, V. (2011). Effects of an interactive computer game exercise regimen on balance impairment in frail

community-dwelling older adults: A randomized controlled trial. P*hysical Therapy, 91(10),* 1449. doi: 10.2522/ptj.20090205

Trivedi, R. H., Wilson, M. E., Peterseim, M. M., Cole, K. B., & Teed, R. G. W. (2010). A pilot study evaluating the use of EyeSpy video game software to perform vision screening in school-aged children. J*ournal of AAPOS, 14(4),* 311-316. doi: 10.1016/j.jaapos.2010.03.008

Turner, W.A., & Casey, L. (2014). Outcomes associated with virtual reality in psychological interventions: Where are we now? *Clinical Psychology Review, 34(8),* 634-644. doi: 10.1016/j.cpr.2014.10.003

Turner, W. A., Thomas, B., & Casey, L. M. (2016). Developing games for mental health: A primer. *Professional Psychology: Research and Practice, 47(3),* 242.

van Bennekom, M. J., Kasanmoentalib, M. S., de Koning, P. P., & Denys, D. (2017). A virtual reality game to assess obsessive-compulsive disorder. *Cyberpsychology, Behavior, and Social Networking, 20(11),* 718-722. doi: 10.1089/cyber.2017.0107

Wood, S. K., Eckley, L., Hughes, K., Hardcastle, K. A., Bellis, M. A., Schrooten, J., . . . Voorham, L. (2014). Computer-Based Programmes for the Prevention and Management of Illicit Recreational Drug Use: A Systematic Review. *Addict Behav, 39*(1), 30-38. doi: 10.1016/j.addbeh.2013.09.010

Turner & Casey, (2018a). *Immersion and Engagement Testing of SLOTZ: A Game-based Measure of Problem Gambling.* Unpublished manuscript.

Turner & Casey, (2018b). *Measuring Problem gambling via Video Game Play.* Unpublished manuscript.

Turner & Casey, (2018c). *Levelling up: Considerations for the development and utilisation of mental health video games.* Unpublished manuscript.

Chapter 2. An Introduction to Problem Gambling Assessment and Intervention

Introduction

The rapid expansion of gambling availability and accessibility in the past led to a dramatic increase in gambling-related problems globally (Delfabbro, King & Derevensky, 2016; Dowling, 2014; Manning et al., 2017; Productivity Commission, 2010). Wide variations exist in problem gambling prevalence rates globally, due to variations and improvements in methodology and survey instruments over time (Calado & Griffiths, 2016; Dowling, Youssef, Jackson, Pennay Francis, Pennay, et al., 2016; Markham & Young, 2016). Nonetheless, prevalence rates have been observed to lie between 0.15% to 5% of the adult populations in the United States, Canada, Europe, Asia and Oceania (Calado & Griffiths, 2016; Stucki and Rihs-Middel, 2007; Productivity Commission, 2010).

Problem gamblers frequently report moderate to severe emotional, financial, occupational and relationship strain, poor health, comorbid substance issues, and social issues (Delfabbro, 2014; Goudriaan et al., 2013; Manning et al., 2017; Petry, 2009; Productivity Commission, 2010; Richard & Humphrey, 2014). High rates of suicidal ideation and attempts are also reported among problem gamblers (Fong, 2005; Giovanni et al, 2016; Lewis, Black & McMullen, 2016). Despite this, only around one in ten problem gamblers will ever seek treatment (Cunningham et al., 2012; Giovanni et al, 2016). Given this, it would appear that it is imperative that assessments and interventions be developed that can identify and engage gamblers before their symptoms grow too severe.

Defining Problem Gambling

Problem gambling is a term most frequently used to refer to individuals with gambling related issues (Petry, 2009; Williams & Volberg, 2014). Confusingly,

definitions vary from denoting individuals with less severe, or sub-clinical, levels of gambling related issues (Petry, 2005; Richard & Humphrey, 2014), to being indicative of any and all maladaptive patterns of gambling that result in personal, family and/or vocational impairment (Williams & Volberg, 2014). Academics generally define problem gambling as a difficulty in limiting money and/or time spent on gambling, leading to adverse financial, psychological, employment or relationship difficulties (Petry, Ginley & Rash, 2017; Stucki & Rihs-Middel, 2007; Williams & Volberg, 2014). Throughout this thesis, 'Problem Gambling' and 'Problem Gamblers' refer to individuals presenting with clinical or sub-clinical symptoms consistent with Gambling Disorder (Petry et al., 2007; APA 2013). Mental health practitioners and community services are increasingly likely to come across problem gamblers, yet many are likely to have limited training in or experience with such issues (Lewis et al., 2016; Petry et al., 2008; Richard & Humphrey, 2014). As noted above, identification and classification of these individuals can often prove difficult, as can conceptualisation and treatment (Petry et al., 2008; Richard & Humphrey, 2014; Rugle, 2014). Nevertheless, problem gamblers can be differentiated from non-gamblers and recreational gamblers. While a detailed review of these differences is beyond the scope of this chapter, a brief summary of key differences across neurocognitive and social characteristics is provided below.

Characteristics of Problem Gambling

Neurocognitive Characteristics

Recent advances in the neurocognitive understanding of addiction propose that addiction arises from an imbalance between three systems: an impulsive neural system that promotes automatic, habitual and salient behaviour, based within the amygdala; a reflective neural system for decision-making, forecasting consequences of a behaviour

and inhibitory control, based within the prefrontal cortex; and a neural system that integrates interoceptive states into conscious feeling and decision-making processes involved in risk and reward, based within the insula (Brand, Labudda, & Markowitsch, 2006; Brevers & Noel, 2013; Goldstein et al., 2009; Goldstein & Volkow, 2011; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2006; Hofmann et al., 2009; Houben & Wiers, 2009; Krain, Wilson, Arbuckle, Castellanos, & Milham, 2006; Naqvi & Bechara, 2009; Noel, Brevers, Bechara, 2013; Verdejo-Garcia et al., 2012). In their 2010 paper, van Holst et al. summarise four key cognitive-emotional processes that they propose play an important role in the development and maintenance of the above-mentioned neurocognitive imbalance: reward and punishment processing, attentional bias and cue reactivity, impulsivity, and decision making and executive function.

Reward and punishment processing. Problem gamblers typically share a common behavioural trajectory: a tendency to increase frequency and duration of play, along with increases in the amount of money gambled (Breen & Zuckerman, 1999; Petry, 2009; Richard & Humphrey, 2014). Increases in frequency, duration and money spent are associated with concepts of ‘chasing loses’, classical and operant conditioning, and positive reinforcement (Breen & Zuckerman, 1999; Delfabbro, 2014). When facing losses, problem gamblers will increase the frequency and size of bets made, in effect ‘chasing’ the positive reinforcement on which they have become so reliant (Breen & Zuckerman, 1999; Delfabbro, 2014). Similar ‘chasing’ behaviours arise in problem gamblers as they build tolerance to current levels of reinforcement, with greater frequencies or larger amounts of wins required for satiation (Delfabbro, 2014).

Classical and operant conditioning are theorised to play a pivotal role in the development and maintenance of problem gambling (Blaszczynski & Nower, 2002;

Redish et al., 2007; van Holst et al., 2010). Operant conditioning occurs within gambling when rewards are delivered according to a variable-ratio schedule, the intermittent nature of the reward resulting in an increased neurological arousal or 'high' (Blaszczynski & Nower, 2002). Classical conditioning thus occurs when the repeated stimulus-response pairing of 'highs' and gambling-related stimuli become associated over time (van Holst et al., 2010).

Neurobiological sensitivity to reward is hypothesised to play a significant role in gambling-related conditioning, with lower dopamine receptor density leading individuals to be more likely to seek rewarding behaviours than those with greater dopamine receptor density and thus, neurobiological reward sensitivity (Gaher et al., 2015; van Holst et al., 2010; Volkow et al., 2002). Individuals with lower neurobiological reward sensitivity are hence less likely to experience 'highs', and as such, are likely to require larger rewards of longer periods of gambling to experience similar reward-related dopamine 'wins' (Clark et al., 2013; van Holst et al., 2010). Negative reinforcement may also occur during gambling, with 'wins' reducing aversive feelings associated with anxiety, depression, etc (Blaszyzynski & Nower, 2002; Clark et. al., 2013). Finally, reduced neurobiological sensitivity to punishment may also maintain problem gambling, with some problem gamblers requiring stronger negative cues when developing associations between gambling performance and 'losses' or negative feedback (Goudriaan et al., 2006; van Holst et al., 2010).

Attentional bias and cue reactivity. When exposed to gambling-related stimuli, problem gamblers can experience escalations in gambling urge and subsequently gambling behaviour, with cues eliciting both cognitive and physiological reactions (e.g., increased heart rate; Richard & Humphrey, 2014). Neuropsychological research

appears to support apparent differences in problem and non-problem gambler cue-reactivity and reward sensitivity levels, with differences in brain activity observed during studies of gambling related cue exposure (Goudriaan et al., 2013; Richard & Humphrey, 2014). Cue reactivity can be defined as a physiological reaction and desire to engage in a given behaviour, and has been extensively researched in substance use populations (Fregni et al., 2008; van Holst et al., 2010). Attentional bias can be defined as a strong preference in attention toward addiction-related stimuli when compared to non-related stimuli (Goudriaan et al., 2013; Honsi et al., 2013; van Holst et a., 2010). Attentional bias and cue reactivity are hypothesised to play a significant role in both the perpetuation of problem gambling and relapse after treatment: preferences in attention are likely to lead problem gamblers to more frequently attend to gambling-related cues, subsequently experiencing physiological reactions and desires or 'cravings' to engage in future gambling (Fregni et al., 2008; Goudriaan et al., 2013; Honsi et al., 2013; van Holst et a., 2010).

Impulsivity. Impulsivity, the tendency to act rashly without forethought or consideration of consequences, may pre-date the onset of problematic behaviour, with elevated impulsivity in children and adolescents observed to be associated with subsequent alcohol and substance use (Flack & Buckby, 2018). Within the area of gambling, research has primarily focussed upon impulsivity in relation to response inhibition, the suppression of an automatic response and delay discounting, a preference for immediately available small rewards over deferred larger rewards (Balconi et al., 2015; Camchong et al., 2007; Goudriaan et al., 2013; van Holst et al., 2010). Problem gamblers may also engage in more risky decision making even when faced with diminishing control over their choices, indicating significant deficits in inhibitory

control (Balconi et al., 2015; Goodie, 2005; Goudriaan et al., 2013). Failure at self-control during gambling may involve the deregulation of both impulsive processes in the amygdala and reflective processes in the prefrontal cortex, impeding the individual's capacity to circumvent immediately salient stimuli in the service of long-term goals (Brand, Labudda, & Markowitsch, 2006; Brevers & Noel, 2013; Goldstein et al., 2009; Goldstein & Volkow, 2011; Naqvi & Bechara, 2009; Noel, Brevers, Bechara, 2013; Verdejo-Garcia et al., 2012).

Decision making and executive function. Problem gamblers are subject to an assortment of cognitive errors, as noted by Blaszczynski and Nower (2014); Clark et al. (2013); Monaghan, Blaszyzynski and Nower (2009); and Richard and Humphrey (2014). Problem gamblers frequently overestimate their probability of winning (Monaghan, Blaszyzynski & Nower, 2009) and are likely to suffer from illusions of control, expecting their personal successes to be more probable than would objectively be expected (Langer, 1975; Yarritu, Matute & Vadillo, 2014) and believing themselves able to control independent events (Kallmen et al., 2008; Monaghan, Blaszyzynski & Nower, 2009). Problem gamblers are also likely to be susceptible to superstitious rituals, employing illogical, unfounded and unrelated strategies in the hopes of influencing outcomes (Monaghan, Blaszyzynski & Nower, 2009). Illusions of control over the prediction of random patterns of events are so common amongst problem gamblers, the phenomenon has been termed the 'Gambler's Fallacy' (Monaghan, Blaszyzynski & Nower, 2009; Petry, 2009). Problem gamblers are also likely to possess positively biased memories of gambling ('hindsight' bias; Calvillo & Rutchick, 2013; Petry, 2009) and to be preoccupied with gambling (Richard & Humphrey, 2014).

Preoccupation with gambling can be at such a level that it overwhelms cognitive processing, allowing greater reactivity to gambling related cues and placing greater emphasis on memories of wins as opposed to losses (Blaszczynski & Nower, 2014; Richard & Humphrey, 2014). Cognitive errors, excessive cognitive rigidity and errors in working memory, may provide evidence of executive dysfunction and impaired self-awareness (Jauregui, Urbiola & Estevez, 2016; Mallorquí-Bagué et al., 2018; Mansueto et al., 2016; Domínguez-Salas, Díaz-Batanero, Lozano-Rojas, Verdejo-García, 2016; van Timmerman et al., 2018). Problem gambling and impaired gambling decision-making has been associated with frontal lobe function deficits, inhibitory deficits, delay discounting, risk seeking and other executive functioning impairments, demonstrating the significant role executive dysfunction and cognitive errors may play in maintaining problem gambling (Balconi et al., 2015; Camchong et al., 2007; Goudriaan et al., 2013).

Social Characteristics

Gambling as an activity can be isolating, excluding other leisure activities and social interaction, expediting a problem gambler's reliance on gambling reward, with no other form of reward or escape available (Petry, 2005; Richard & Humphrey, 2014). Abstinence from gambling would thus grow increasingly aversive, reinforcing the problem gamblers reliance on gambling reward and maladaptive emotion regulation (Richard & Humphrey, 2014).

Whilst problem gamblers report a range of motivations to gamble, problem gambling severity is repeatedly associated with the avoidance of and coping with emotional distress (Petry, 2005; Stewart et al., 2008). Problem gambling is highly comorbid, with high rates of substance use, major depression, dysthymia, manic episodes, generalised anxiety, panic specific phobias and social phobia observed

amongst problem gamblers (Blinn-Pike, Lokken Worthy & Jonkman, 2010; Froberg, Hallqvist & Tengstrom, 2013; Petry, 2009). Consequently, treatment of problem gamblers often necessitates the determination of the functional role gambling may play in emotion regulation (Blaszczynski & Nower, 2014; Petry, 2005; Richard & Humphrey, 2014).

Australian Cultural Characteristics

Culturally, Australia appears to be rather accepting of gambling. Australians spent $1272.81 per capita within the 2015-2016 period, demonstrating an increase of spending of 3.9% from the 2014-2015 period (Queensland Government Statistician's Office, 2017). Despite increase in spending, however, early research indicates an overall decrease in gambling participation in addition to expenditure, with gambling comprising 3.1% of Australian household consumption expenditure within the 2008-2009 period, down from a rate of 3.9% in 1988-1989. Within Queensland, overall gambling participation rates were found to have fallen, with reductions in lottery product use, gaming machines, card games and bingo between the periods of 2001-2012, though wagering on horse racing, harness racing, greyhound racing and sports betting were observed to have slightly increased over this period (Queensland Government, 2013). Nationally, electronic gaming machines (EGMs) dominate Australian gambling expenditure, despite a general decline in EGM spending (Productivity Commission, 2010; Queensland Government, 2013; Queensland Government Statistician's Office, 2017). Conversely, sports wagering and online gambling expenditure appear to have grown over the last decade, though online gambling substantially more so (Productivity Commission, 2010; Queensland Government Statistician's Office, 2017).

Diagnostic Changes: DSM-IV TR to DSM 5

First introduced into the American Psychiatric Association's (1980) Diagnostic and Statistical manual of Mental Disorders, Third Edition (DSM-III) as a 'disorder of impulse control, not elsewhere classified', the diagnosis of gambling related issues has changed substantially over time (Petry 2009; Petry, 2005; Richard & Humphrey, 2014). Gambling remained in the impulse-control section for the Diagnostic and Statistical manual of Mental Disorders, Fourth Edition – Test Revised (APA, 2000), with several diagnostic criteria paralleling those used for substance use disorders (DSM-IV TR; Petry, 2009). A substantial theoretical shift, however, occurred with the publication of the Diagnostic and Statistical manual of Mental Disorders, Fifth Edition (DSM-5; APA 2013). Differences in DSM-IV TR and DSM-5 required criteria for gambling related diagnoses are displayed in Table 2.1.

Diagnostic criteria have changed between editions. Most notable has been the removal of the criteria "has committed illegal acts such as forgery, fraud, theft, or embezzlement to finance gambling" (APA, 2013). Though some gamblers may resort to illegal acts in order to finance further gambling, many do not (Petry, 2005; Richard & Humphrey, 2014). Criteria required for diagnosis have been dropped from five to four (APA, 2000; APA, 2013), arguably improving classification accuracy and reducing false negatives (Stinchfield, 2003; Richard & Humphrey, 2014). Additionally, a time-period of 12 months has been added to diagnostic criteria (APA, 2013). For this reason, a diagnosis can include a specifier of 'early remission' for gamblers reporting no symptoms for more than three, but less than 12 months (APA, 2013). Equally as important is the inclusion of specifiers of severity. Severity can range between mild (4-5 criteria met), moderate (6-7 criteria met) and severe (8-9 criteria met; APA, 2013).

Interestingly, criteria related to preoccupation with gambling and ‘chasing’ losses are singled out as the most common endorsed amongst diagnoses of mild gambling disorder (APA, 2013), symptoms frequently identified as indicators of problem gambling (Richard & Humphrey, 2014).

Gambling as an Addiction

The DSM-5 has seen problematic gambling revised as disorganised gambling, a behavioural addiction, with the new label of ‘Gambling Disorder’ (APA, 2013; Richard & Humphrey, 2014). Several arguments were made in favour of the change. Diagnostic features of Pathological Gambling were often found to lack sensitivity to lower level gambling problems (Nelson et al., 2009), whilst some criteria (i.e., lying about gambling and illegal activities) were found to only present in the most severe of cases (Richard & Humphrey, 2014). Added to this were observations that certain symptoms appeared to grow unstable over time, indicative of nonlinear courses of development or temporal inconsistency in diagnostic criteria (Richard & Humphrey, 2014).

Strong parallels were observed between disordered gambling and substance use disorders, as were high levels of comorbidity (Potenza, 2006; Petry, 2005). It is unsurprising then, that disordered gambling was refashioned within an addiction paradigm (Richard & Humphrey, 2014). Commonalities have been observed between behavioural substance-based addictions (e.g., psychosocial and neurological features), with behavioural addictions seen to exist on a continuum of severity (Griffiths, 2005; Richard & Humphrey, 2014).

Prevalence of Problem Gambling

The reported prevalence of problem gambling can vary widely between nations and studies. Prevalence rates of problem gambling can lie between 0.15% and 4.7% of the adult populations in the United States, Canada, Europe and Asia (Delfabbro, et al., 2016; Dowling, 2014; Stucki and Rihs-Middel, 2007), with similar rates reported within Australia (0.7%-1.7%; Productivity Commission, 2010). Prevalence studies have been conducted across the United States, the United Kingdom and other areas of Europe, Asia, Canada and Australia (Delfabbro, et al., 2016; Dowling, 2014; Stucki and Rihs-Middel, 2007; Williams & Volberg, 2014). However, comparisons of prevalence rates can prove difficult, with notable differences in problem gambling measures, time frames and administration observed (Williams & Volberg, 2014). A more accurate depiction of prevalence rates can be obtained via weighting and comparing studies (Williams & Volberg, 2014; Williams et al., 2012). Though an analysis of adjusted prevalence rates, Williams et al. (2012) determined an average international standardised prevalence rate of 2.4%, with a prevalence rate of 2% across Australian states. Denmark, the Netherlands and Germany were observed to possess the lowest standardised prevalence rates, with the highest rates observed across Hong Kong, Macau, Singapore and South Africa (Williams et al., 2012).

Social gamblers are not free from gambling related issues. In numerous cases, the prevalence of difficulties faced by social gamblers is greater than the problem gambling prevalence rate (Productivity Commission, 2010). Approximately 4% of all gamblers are believed to spend beyond self-imposed limits or to face difficulty in resisting gambling urges (Productivity Commission, 2010). Around 4% of gamblers lose track of time or reality when gambling, while roughly 10% of gamblers incorrectly

believe they could win more frequently if they were to utilise specific strategies or systems (Productivity Commission, 2010). Additionally, up to 8% of problem gamblers may report adverse health impacts as a result of their gambling, with over 17% of gamblers reporting that gambling has an adverse effect on their lives (Productivity Commission, 2010). Within the state of Queensland, non-problem gamblers have been found to account for approximately half of those often or always experiencing gambling control problems (Productivity Commission, 2010). Subsequently, interventions or governmental policies with only modest efficacy or reach may have the potential to greatly reduce gambling-related harms in a population simply because their target populations are so large (Productivity Commission, 2010).

Interestingly, problem gambling rates appear to have declined relative to earlier reports, with some nations experiencing more dramatic decreases in prevalence than others and at different times (Delfabbro, et al., 2016; Dowling, 2014; Williams & Volberg, 2014). Problem gambling prevalence rates appear to have peaked in the 2000s for Australia, coinciding with a period of rapid introduction and expansion of gaming venues (e.g., casinos and electronic gaming machines; Productivity Commission, 2010; Queensland Government Statistician's Office, 2017; Williams & Volberg, 2014). However, as the mechanisms of action involved in decreasing problem gambling prevalence rates are most likely complex (Delfabbro, et al., 2016; Williams & Volberg, 2014), the decline in Australian problem gambling rates cannot easily be attributed to any one factor.

Table 1.1

Comparison of Diagnostic Criteria for DSM IV-TR and DSM 5 Gambling Related Disorders

Diagnostic Manual	DSM IV-TR	DSM 5
Disorder (Manual Section)	Pathological Gambling (Impulse Control)	Gambling Disorder (Addiction)
Diagnostic Criteria	A. Persistent and recurrent maladaptive gambling behaviour as indicated by five (or more) of the following: 1. Is preoccupied with gambling (e.g., preoccupied with reliving past gambling experiences. Handicapping or planning the next venture, or thinking of ways to get money with which to gamble) 2. Needs to gamble with increasing amounts of money in order to achieve the desired excitement 3. Has repeated unsuccessful efforts to control, cut back, or stop gambling 4. Is restless or irritable when attempting to cut down or stop gambling 5. Gambles as a way of escaping from problems or of relieving a dysphoric mood (e.g., feelings of helplessness, guilt, anxiety, depression) 6. After losing money gambling, often returns another day to get even (chasing one's losses) 7. Lies to family members, therapist, or others to conceal the extent of involvement with gambling 8. Has committed illegal acts such as forgery, fraud, theft, or embezzlement to finance gambling 9. Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of gambling 10. Relies on others to provide money to relieve a desperate financial situation caused by gambling B. The gambling behaviour is not better accounted for by a manic episode.	A. Persistent and recurrent problematic gambling behaviour leading to clinically significant impairment or distress, as indicated by the individual exhibiting four (or more) of the following in a 12-month period: 1. Needs to gamble with increasing amounts of money in order to achieve the desired excitement. 2. Is restless or irritable when attempting to cut down or stop gambling. 3. Has made repeated unsuccessful efforts to control, cut back, or stop gambling. 4. Is often preoccupied with gambling (e.g., having persistent thoughts of reliving past gambling experiences, handicapping or planning the next venture, thinking of ways to get money with which to gamble). 5. Often gambles when feeling distressed (e.g., helpless, guilty, anxious, depressed). 6. After losing money gambling, often returns another day to get even (“chasing” one’s losses). 7. Lies to conceal the extent of involvement with gambling. 8. Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of gambling. 9. Relies on others to provide money to relieve desperate financial situations caused by gambling. B. The gambling behaviour is not better explained by a manic episode.

Problem Gambling Assessment

A multitude of clinical measurement and screening instruments now exist for the assessment of problem gambling. Instruments range in size from single-item (Rockloff et al., 2011) through to 142-item measures (Stinchfield, 1999; Stinchfield & Winters, 2001; Stinchfield, Winters, et al., 2007). Forms of administration can vary, with self-administered screening instruments, mental health worker-administered questionnaires and structured clinical interviews available (Challet-Bouju et al., 2016; Williams & Volberg, 2014; Stinchfield, 2014).

Despite the proliferation of problem gambling measures present in the literature, these instruments lack evidence of rigorous psychometric testing (Challet-Bouju et al., 2016; Stinchfield, 2014). The most commonly used and psychometrically supported of these instruments are the Canadian Problem Gambling Index (CPGI; Ferris & Wynne, 2001), the South Oaks Gambling Screen (SOGS: Lesieur & Blume, 1987) and clinical measures utilising DSM-IV-TR pathological gambling diagnostic criteria (Stinchfield, 2014; Williams & Volberg, 2014). Even these more rigorously tested measures suffer from insufficient psychometric evaluation, with issues relating to ecological validity, lack of standardised administration, reliability, specificity and sensitivity, and unrepresentative samples reported (Challet-Bouju et al., 2016; Gambino, 2006; Williams & Volberg, 2014; Stinchfield, 2014). Briefer instruments appear to fare even worse in these regards, raising concerns around their use in online problem gambling self-assessments (Challet-Bouju et al., 2016; Stinchfield, McCready & Turner, 2012). Finally, questions have been raised regarding the level of distinctiveness between the varying problem gambling instruments. Problem gambling instrument development studies frequently include identical or rephrased items from pre-existing, well-validated

measures, which are found to present as some of the new instruments' most psychometrically sound items (Stinchfield, 2014). This raises questions over the utility of further instrument development, as revision and further validation of pre-existing measures is likely to be of more benefit to the field of problem gambling as a whole (Stinchfield, 2014).

Engaging and Treating Problem Gambling

Problem gambling is treatable: 70-85% of those who gamble problematically achieve positive treatment outcomes at 12-months follow-up, with rates decreasing to 50% over longer-periods of time (Blaszczynski & Nower, 2014; Pallesen, Mitsen, Kvale, Johnson, & Molde, 2005). As with much of problem gambling research, investigation into effective and efficacious treatments is in its infancy (Ledgerwood et al., 2014; Petry, 2009). Though countless treatment approaches have been applied to problem gambling, few have been subjected to empirical analysis (Petry, 2005; Petry, 2009; Westphal, 2008; Wynn et al., 2014). Common treatments include Gamblers Anonymous, Cognitive Behavioural Therapy, and Brief or Motivational Enhancement Therapies (Westphal, 2008; Wynn et al., 2014). In recent years, preliminary psychopharmacological studies have been conducted, though considerably more research is needed before appraisals can be made of their relative effectiveness (Blaszczynski & Nower, 2014; Wynn et al., 2014). The effect natural recovery may have on rates of treatment is also unclear, with estimates that 36-39% of lifetime pathological gamblers attain remission despite few ever-seeking treatment (Slutske, 2006).

Cognitive Behavioural Therapy

Cognitive Behavioural Therapy (CBT) represents the current ‘gold’ standard (‘best practise’) in problem gambling treatment (Blaszczynski & Nower, 2014; Pallesen, et al., 2005; Petry, 2005; Productivity Commission, 2010; Toneatto & Millar, 2004; Westphal, 2008; Wynn et al., 2014). CBT problem gambling treatments have demonstrated efficacy whether delivered individually, via groups, via self-help manuals or in combination with motivational enhancement or mindfulness strategies (Blaszczynski & Nower, 2014; Gooding & Tarrier, 2009; Petry, 2005). CBT problem gambling treatments are also able to be delivered online via the Internet, whether through personal computers, smart phones or tablets (Blaszczynski & Nower, 2014; Ledgerwood, Loree & Lundahl, 2014). Though CBT problem gambling treatments can vary in regard to their emphasis on cognitive and behavioural aspects of treatment, they will typically engage individuals in identifying, monitoring and challenging cognitive distortions about gambling, reinforce non-gambling related behaviours, and educate individuals in maintenance and relapse prevention (Petry, 2005; Westphal, 2008; Wynn et al., 2014). However, CBT treatments are often intensive, requiring numerous sessions (Petry, 2005; Ledgerwood et al., 2014). Additionally, while computer-based and online CBT treatments may be less burdensome than face-to-face delivered treatment programmes, digital CBT treatments are typically plagued by low rates of uptake and high rates of attrition (Eysenbach, 2005; Gilbody et al., 2015; Hermes et al., 2016; Melville, Casey & Kavanagh, 2010; Postel et al., 2011). Consequently, some problem gamblers may be better served through briefer, less intensive forms of treatment such as Brief Motivational Interviewing and Normative Feedback (Petry, 2005; Wynn et al., 2014).

Brief Interventions

Briefer, less intense forms of treatment may often be better suited to less severe problem gamblers or problem gamblers (Cunningham et al., 2012; Petry, 2009; Petry, 2005; Wynn et al., 2014). Problem gamblers rarely seek help for their gambling problems, due to a myriad of factors including societal stigma and self-stigma (Baxter et al., 2016; Hing et al., 2016; Petry, 2009), executive functioning issues and impaired awareness (Jauregui, Urbiola & Estevez, 2016; Mallorquí-Bagué et al., 2018; Mansueto et al., 2016; Domínguez-Salas, Díaz-Batanero, Lozano-Rojas, Verdejo-García, 2016; van Timmerman et al., 2018).

Consisting of approximately one to four sessions, brief interventions have demonstrated effectiveness in the treatment of problem gambling (Cunningham et al., 2012; Larimer et al., 2012; Petry, 2009; Petry, 2005). A brief intervention commonly employed in the treatment of addictions is that of motivational or personalised feedback (Cunningham et al., 2012; Petry, 2009; Wynn et al., 2014).

Motivational or personalised feedback interventions have demonstrated efficacy in the treatment of other addictions including problem drinking (Burke, Arkowitz & Menchola, 2003; Carey, Scott-Sheldon, Carey & DeMartini, 2007; Riper et al., 2009) smoking, and other substance uses (Cunningham et al., 2012; Petry, 2005; Petry, 2009), and have been found to encourage behavioural change in aggressive partners (Woodin & O'Leary, 2010). Problem gamblers are presented with summaries of their own gambling behaviours compared to those of others in the general population, affording them opportunity to evaluate their own problematic gambling behaviour (Cunningham et al., 2012). Through this personalised feedback, problem gamblers are made aware of the consequences of their gambling, resulting in increased commitment to change and

reductions in gambling-related behaviours (Wynn et al., 2014). Brief motivational feedback interventions are cost-effective, less labour intensive than face to face interventions, readily updateable, available on a 24-hour basis, and available to a larger proportion of individuals (Cunningham et al., 2012; Petry, 2009; Wynn et al., 2014).

To date, motivational or personalised feedback has presented with mixed results (Wynn et al., 2014). In a study of 180 problem gamblers, Petry et al. (2008) observed that 10 minutes of brief advice about gambling incorporating personalised feedback, motivational interviewing techniques and steps to reduce gambling, resulted in significantly decreased gambling frequency relative to a control. Treatment gains and significant differences were maintained at 9-months follow-up (Petry et al., 2008). Conversely, in a study of 176 problem gamblers, Cunningham et al. (2012) observed that individuals receiving partial feedback (feedback without normative comparisons) displayed significant reductions in frequency of gambling, whereas those receiving full personalised normative feedback did not. Cunningham et al. (2012) noted a (non-significant) trend in which waitlist problem gamblers displayed initial reductions in gambling between baseline and three-month follow-up, hypothesising that assessment in of itself may be enough to stimulate reductions in problematic gambling, a phenomenon known as pre-test sensitisation or assessment reactivity (Bernstein, Bernstein & Heeren, 2010; French & Sutton, 2010; Godin et al., 2010; Morwitz & Fitzsimons, 2004).

An argument can be made for the employment of brief motivational feedback interventions over more efficacious interventions such as CBT. An intervention's demonstrated efficacy does not necessarily guarantee impact: efficacious interventions delivered poorly can result in a low impact, whereas simpler, more modestly efficacious

interventions can be quite effective whilst reaching a greater number of individuals (Halford & Casey, 2010; Hedman et al., 2013; Ophuis et al., 2017).

Halford and Casey (2010) put forth an example of such a scenario by examining the treatment of depression with CBT. Despite CBT being a well-established and highly cost-effective efficacious treatment for depression, it is appallingly underutilised, with the vast majority of individuals receiving treatment through general medical practitioners with little or no adequate training (Issakidis & Andrews, 2004; Halford & Casey, 2010). Subsequently, the impact of CBT on depression is low despite its strong evidence base (Halford & Casey, 2010). Similar patterns of care (i.e., primarily provided via GPs) have been observed across Australia for the treatment of anxiety disorders (Issakidis & Andrews, 2004). Consequently, it is strongly recommended that brief motivational interventions be developed for the treatment of problem gambling (Cunningham et al, 2012; Larimer et al., 2012; Petry et al., 2008; Petry, 2009; Riper et al., 2009; Wynn et al., 2014).

Conclusion

In light of the above, it appears that there is a clear need for problem gambling assessments and interventions to be developed that are empirically supported, wider in reach than traditional therapies, and able to effectively engage and motivate individuals to complete treatment (Halford & Casey, 2010; Hedman et al., 2013; Josephine et al., 2017; Melville et al., 2010; Ophuis et al., 2017; Wynn et al., 2014). Given the rapid growth in the accessibility and sophistication of online digital technologies (Brand et al., 2017; Clough & Casey, 2015; Delfabbro et al., 2016; King & Delfabbro, 2016), now would seem an opportune time to explore whether more novel forms of problem

gambling assessment and intervention can effectively utilise online digital technologies to increase engagement, motivation and outcomes.

References

American Psychiatric Association. (1980). *Diagnostic and Statistical Manual of Mental Disorders*. Washington, D.C

American Psychiatric Association (2000). *Diagnostic and Statistical Manual of Mental Disorders: DSM-IV-TR.* Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders: DSM-5*. Arlington, VA: American Psychiatric Association.

Baxter, A., Salmon, C., Dufresne, K., Carasco-Lee, A., & Matheson, F. I. (2016). Gender differences in felt stigma and barriers to help-seeking for problem gambling. *Addictive Behaviors Reports, 3,* 1-8. doi: 10.1016/j.abrep.2015.10.001

Bernstein, J. A., Bernstein, E., & Heeren, T. C. (2010). Mechanisms of change in control group drinking in clinical trials of brief alcohol intervention: Implications for bias toward the null. *Drug and Alcohol Review, 29*(5), 498-507. doi: 10.1111/j.1465-3362.2010.00174.x

Balconi, M., Finocchiaro, R., & Canavesio, Y. (2015). Reward sensitivity (behavioral activation system), cognitive, and metacognitive control in gambling behavior: Evidences from behavioral, feedback-related negativity, and P300 effect. *The Journal of Neuropsychiatry and Clinical Neurosciences, 27(3),* 219-227. doi: 10.1176/appi.neuropsych.14070165

Blaszczynski, A., & Nower, L. (2002). *A pathways model of problem and pathological gambling.* Addiction, 97(5), 487-499. doi: 10.1046/j.1360-0443.2002.00015.x

Blaszczynski, A, & Nower, L. (2014). Cognitive-Behavioral Therapy: Translating Research into Clinical Practice. In D. C. S. Richard, A. Blaszczynski & L.

Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons Ltd.

Blinn-Pike, L., Worthy, S. L., & Jonkman, J. N. (2010). Adolescent Gambling: A Review of an Emerging Field Of Research. *J Adolesc Health, 47*(3), 223-236. doi: 10.1016/j.jadohealth.2010.05.003

Brand, M., Labudda, K., & Markowitsch, H. J. (2006). Neuropsychological correlates of decision-making in ambiguous and risky situations. *Neural Networks, 19*(8), 1266-1276. doi: 10.1016/j.neunet.2006.03.001

Brand, M., Young, K. S., Laier, C., Wölfling, K., & Potenza, M. N. (2016). Integrating psychological and neurobiological considerations regarding the development and maintenance of specific internet-use disorders: An interaction of person-affect-cognition-execution (I-PACE) model. *Neuroscience and Biobehavioral Reviews, 71*, 252-266. doi: 10.1016/j.neubiorev.2016.08.033

Breen, R.B., & Zuckerman, M. (1999). ‘Chasing' In Gambling Behavior: Personality and Cognitive Determinants. *Personality and Individual Differences, 27*(6), 1097-1111. doi: 10.1016/s0191-8869(99)00052-5

Brevers, D., & Noël, X. (2013). Pathological gambling and the loss of willpower: A neurocognitive perspective. *Socioaffective Neuroscience & Psychology, 3*(1), 21592-16. doi: 10.3402/snp.v3i0.21592

Burke, B. L., Arkowitz, H., & Menchola, M. (2003). The efficacy of motivational interviewing: A meta-analysis of controlled clinical trials. *Journal of Consulting and Clinical Psychology, 71*(5), 843-861. doi: 10.1037/0022-006X.71.5.843

Calvillo, D. P., & Rutchick, A. M. (2014). Domain knowledge and hindsight bias among poker players: Hindsight bias in poker. *Journal of Behavioral Decision Making, 27*(3), 259-267. doi: 10.1002/bdm.1799

Challet-Bouju, G., Perrot, B., Romo, L., Valleur, M., Magalon, D., Fatseas, M., . . . JEU Group. (2016). Harmonizing screening for gambling problems in epidemiological surveys - development of the rapid screener for problem gambling (RSPG). *Journal of Behavioral Addictions, 5(2),* 239-250. doi: 10.1556/2006.5.2016.030

Carey, K. B., Scott-Sheldon, L. A. J., Carey, M. P., & DeMartini, K. S. (2007). Individual-level interventions to reduce college student drinking: A meta-analytic review. *Addictive Behaviors, 32*(11), 2469-2494. doi: 10.1016/j.addbeh.2007.05.004

Camchong, J., Goodie, A. S., McDowell, J. E., Gilmore, C. S., & Clementz, B. A. (2007). A cognitive neuroscience approach to studying the role of overconfidence in problem gambling. *Journal of Gambling Studies, 23(2),* 185-199. doi: 10.1007/s10899-006-9033-5

Clark, L., Averbeck, B., Payer, D., Sescousse, G. T., Winstanley, C. A., & Xue, G. (2013). *Pathological choice: The neuroscience of gambling and gambling addiction.* The Journal of Neuroscience, 33(45), 17617-17623. doi: 10.1523/JNEUROSCI.3231-13.2013

Clough, B., & Casey, L. (2015). Smart designs for smart technologies: Research challenges and emerging solutions for scientist-practitioners within e-mental health. *Professional Psychology: Research and Practice.* doi: 10.1037/pro0000053

Cunningham, J.A., Hodgins, D.C., Toneatto, T., & Murphy, Me. (2012). A Randomized Controlled Trial of a Personalized Feedback Intervention for Problem Gamblers. *PLoS One, 7*(2). doi: 10.1371/journal.pone.0031586

Delfabbro, P. (2014). Behavioral Risk Factors in Disordered Gambling and Treatment Implications. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Delfabbro, P., King, D. L., & Derevensky, J. L. (2016). Adolescent gambling and problem gambling: Prevalence, current issues, and concerns. *Current Addiction Reports, 3*(3), 268-274. Doi: 10.1007/s40429-016-0105-z

Delfabbro, P., King, D., Lambos, C., & Puglies, S. (2009). Is Video-Game Playing a Risk Factor for Pathological Gambling in Australian Adolescents? *Journal of Gambling Studies, 25*(3), 391-405. doi: 10.1007/s10899-009-9138-8

Domínguez-Salas, S., Díaz-Batanero, C., Lozano-Rojas, O. M., & Verdejo-García, A. (2016). Impact of general cognition and executive function deficits on addiction treatment outcomes: Systematic review and discussion of neurocognitive pathways. *Neuroscience and Biobehavioral Reviews, 71*, 772-801. doi: 10.1016/j.neubiorev.2016.09.030

Dowling, N. (2014). The Cognitive-Behavioral Treatment of Female Problem Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Eysenbach, G. (2005). The law of attrition. *Journal of Medical Internet Research, 7*(1), e11. doi: 10.2196/jmir.7.1.e11

Flack, M., & Buckby, B. (2018). *Impulsivity and problem gambling: Can the anticipated emotional rewards explain the relationship?* International Journal of Mental Health and Addiction, , 1-15. doi: 10.1007/s11469-018-9950-4

Fregni, F., Liguori, P., Fecteau, S., Nitsche, M. A., Pascual-Leone, A., & Boggio, P. S. (2008). *Cortical stimulation of the prefrontal cortex with transcranial direct current stimulation reduces cue-provoked smoking craving: A randomized, sham-controlled study.* Journal of Clinical Psychiatry, 69(1), 32-40. doi: 10.4088/JCP.v69n0105

French, D. P., & Sutton, S. (2010). Reactivity of measurement in health psychology: How much of a problem is it? what can be done about it? *British Journal of Health Psychology*, *15*(3), 453-468. doi: 10.1348/135910710X492341

Fong, T. W. (2005). The biopsychosocial consequences of pathological gambling. *Psychiatry*, 3(2), 22–30. doi: 10.1016/j.psychres.2012.03.052

Fröberg, F., Hallqvist, J., Tengström, A., Medicinska fakulteten, Medicinska och farmaceutiska vetenskapsområdet, Uppsala universitet, . . . Allmänmedicin och preventivmedicin. (2013). Psychosocial health and gambling problems among men and women aged 16-24 years in the swedish national public health survey. *European Journal of Public Health*, *23*(3), 427-433. doi: 10.1093/eurpub/cks129

Gaher, R. M., Hahn, A. M., Shishido, H., Simons, J. S., & Gaster, S. (2014;2015;). A*ssociations between sensitivity to punishment, sensitivity to reward, and gambling.* Addictive Behaviors, 42, 180-184. doi: 10.1016/j.addbeh.2014.11.014

Gambino, B. (2006). Reflections on accuracy. *Journal of Gambling Studies, 22*(4), 393-404. doi: 10.1007/s10899-006-9025-5

Gilbody, S., Littlewood, E., Hewitt, C., Brierley, G., Tharmanathan, P., Araya, R., . . . REEACT Team. (2015). Computerised cognitive behaviour therapy (cCBT) as treatment for depression in primary care (REEACT trial): Large scale pragmatic randomised controlled trial. *BMJ : British Medical Journal, 351,* h5627. doi: 10.1136/bmj.h5627

Giovanni, M., Fabiola, S., Federica, F., Mariangela, C., Nicola, P., Ilaria, T., . . . Giannantonio Massimo, D. (2016). Gambling disorder and suicide: An overview of the associated co-morbidity and clinical characteristics. *International Journal of High Risk Behaviors and Addiction, Inpress(Inpress).* e30827. doi: 10.5812/ijhrba.30827

Godin, G., Sheeran, P., Conner, M., Delage, G., Germain, M., Bélanger-Gravel, A., & Naccache, H. (2010). Which survey questions change behavior? randomized controlled trial of mere measurement interventions. *Health Psychology, 29*(6), 636-644. doi: 10.1037/a0021131

Goldstein, R. Z., Craig, A. D. (., Bechara, A., Garavan, H., Childress, A. R., Paulus, M. P., & Volkow, N. D. (2009). The neurocircuitry of impaired insight in drug addiction. *Trends in Cognitive Sciences, 13*(9), 372-380. doi: 10.1016/j.tics.2009.06.004

Goldstein, R. Z., & Volkow, N. D. (2011). Dysfunction of the prefrontal cortex in addiction: Neuroimaging findings and clinical implications. *Nature Reviews Neuroscience, 12*(11), 652-669. doi: 10.1038/nrn3119

Goodie, A. S. (2005). The role of perceived control and overconfidence in pathological

gambling. *Journal of Gambling Studies, 21(4),* 481-502. doi: 10.1007/s10899-005-5559-1

Goudriaan, A. E., Oosterlaan, J., de Beurs, E., & van den Brink, W. (2006). Psychophysiological determinants and concomitants of deficient decision making in pathological gamblers. *Drug and Alcohol Dependence, 84*(3), 231-239. doi: 10.1016/j.drugalcdep.2006.02.007

Goudriaan, A.E., van Holst, R.J., Veltman, D.J., & van den Brink, W. (2013). Contributions from Neuroscience and Neuropsychology. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Gooding, P., & Tarrier, N. (2009). A Systematic Review and Meta-Analysis of Cognitive-Behavioural Interventions to Reduce Problem Gambling: Hedging Our Bets? *Behav Res Ther, 47*(7), 592-607. doi: 10.1016/j.brat.2009.04.002

Griffiths, M. A. (2005). “Components’’ Model of Addiction within a Biopsychosocial Framework. *Journal of Substance Use, 10,* 191–197. doi: 10.1080/14659890500114359

Halford, K., & Casey, L. M. (2010). Taking it to the People: Using Technology to Enhance the Impact of Couple Relationship Education. In K. Hahlweg, M. Grawe-Gerber & D. H. Baucom (Eds.), *Enhancing Couples: The Shape of Couple Therapy to Come*. Cambridge, MA: Hogrefe Publishing.

Hedman, E., Andersson, E., Lindefors, N., Andersson, G., Rück, C., Ljótsson, B., . . . Psykologi. (2013). Cost-effectiveness and long-term effectiveness of internet-based cognitive behaviour therapy for severe health anxiety. *Psychological Medicine, 43*(2), 1-12. doi: 10.1017/S0033291712001079

Hing, N., Nuske, E., Gainsbury, S. M., Russell, A. M. T., & Breen, H. (2016). How does the stigma of problem gambling influence help-seeking, treatment and recovery? a view from the counselling sector. *International Gambling Studies, 16*(2), 263-280. doi: 10.1080/14459795.2016.1171888

Hofmann, W., Friese, M., & Strack, F. (2009). Impulse and self-control from a dual-systems perspective. *Perspectives on Psychological Science, 4*(2), 162-176. doi: 10.1111/j.1745-6924.2009.01116.x

Honsi, A., Mentzoni, R. A., Molde, H., & Pallesen, S. (2013). Attentional bias in problem gambling: A systematic review. *Journal of Gambling Studies, 29(3),* 359-375. doi: 10.1007/s10899-012-9315-z

Houben, K., & Wiers, R. W. (2009). Response inhibition moderates the relationship between implicit associations and drinking behavior. *Alcoholism Clinical and Experimental Research, 33*(4), 626-633. doi: 10.1111/j.1530-0277.2008.00877.x

Issakidis, C., Sanderson, K., Corry, J., Andrews, G., & Lapsley, H. (2004). Modelling the population cost-effectiveness of current and evidence-based optimal treatment for anxiety disorders. *Psychological Medicine, 34*(1), 19-35. doi: 10.1017/S003329170300881X

Jauregui, P., Urbiola, I., & Estevez, A. (2016). Metacognition in pathological gambling and its relationship with anxious and depressive symptomatology. *Journal of Gambling Studies, 32*(2), 675-688. doi: 10.1007/s10899-015-9552-z

Josephine, K., Josefine, L., Philipp, D., David, E., & Harald, B. (2017). Internet- and mobile-based depression interventions for people with diagnosed depression: A systematic review and meta-analysis. *Journal of Affective Disorders, 223*, 28-40. doi: 10.1016/j.jad.2017.07.021

Kallmen, H., Andersson, P., & Andren, A. (2008). Are Irrational Beliefs and Depressive Mood More Common Among Problem Gamblers than Non-Gamblers? A Survey Study of Swedish Problem Gamblers and Controls. *Journal of Gambling Studies, 24(4),* 441–450. doi: 10.1007/s10899-008-9101-0.

King, D., & Delfabbro, P. (2016). Early exposure to digital simulated gambling: A review and conceptual model. Computers in Human Behavior, 55, 198-206. 10.1016/j.chb.2015.09.012

King, D.L., Ejova, A., & Delfabbro, P.H. (2012). Illusory Control, Gambling, and Video Gaming: An Investigation of Regular Gamblers and Video Game Players. *Journal of Gambling Studies, 28*(3), 421-435. doi: http://dx.doi.org/10.1007/s10899-011-9271-z

Krain, A. L., Wilson, A. M., Arbuckle, R., Castellanos, F. X., & Milham, M. P. (2006). Distinct neural mechanisms of risk and ambiguity: A meta-analysis of decision-making. *Neuroimage, 32*(1), 477-484. doi: 10.1016/j.neuroimage.2006.02.047

Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology, 32*(2), 311-328. doi: 10.1037/0022-3514.32.2.311

Larimer, M.E., Neighbors, C., Lostutter, T.W., Whiteside, U., Cronce, J.., Kaysen, D., & Walker, D.D. (2012). Brief Motivational Feedback and Cognitive Behavioral Interventions for Prevention of Disordered Gambling: A Randomized Clinical Trial. *Addiction, 107*(6), 1148-1158. doi: 10.1111/j.1360-0443.2011.03776.x

Ledgerwood, D. M., Loree, A., & Lundahl, L. H. (2014). Predictors of treatment outcome in Disordered Gambling. In (Richard, D. C. S., Blaszczynski, A., &

Nower, L. (eds), *The Wiley-Blackwell Handbook of Disordered Gambling (1st Ed.).* Chichester, West Sussex, UK: Wiley-Blackwell.

Lewis, L., Black, P. L., & McMullen, K. (2016). Problem gambling: "Behind the eight ball". *Journal of Social Work Practice in the Addictions, 16*(3), 290-305. doi: 10.1080/1533256X.2016.1200984

Mallorquí-Bagué, N., Tolosa-Sola, I., Fernández-Aranda, F., Granero, R., Fagundo, A. B., Lozano-Madrid, M., . . . Jiménez-Murcia, S. (2018). Cognitive deficits in executive functions and decision-making impairments cluster gambling disorder sub-types. *Journal of Gambling Studies, 34*(1), 209-223. doi: 10.1007/s10899-017-9724-0

Manning, V., Dowling, N., Lee, S., Rodda, S., Garfield, J., Volberg, R., . . . Lubman, D. (2017). Problem gambling and substance use in patients attending community mental health services. *Journal of Behavioral Addictions, 6(4),* 678-688. doi: 10.1556/2006.6.2017.077

Mansueto, G., Pennelli, M., De Palo, V., Monacis, L., Sinatra, M., & De Caro, M. F. (2016). The role of metacognition in pathological gambling: A mediation model. *Journal of Gambling Studies, 32*(1), 93-106. doi: 10.1007/s10899-014-9519-5

Melville, K. M., Casey, L. M., & Kavanagh, D. J. (2010). Dropout from internet-based treatment for psychological disorders. *British Journal of Clinical Psychology, 49*(4), 455-471. doi: 10.1348/014466509X472138

Monaghan, S., Blaszczynski, A., & Nower, L. (2009). *Consequences of winning: The role of gambling outcomes in the development of irrational beliefs.*

Behavioural and Cognitive Psychotherapy, 37(1), 49-59. doi:10.1017/S135246580800502X

Morwitz, V. G., & Fitzsimons, G. J. (2004). The mere-measurement effect: Why does measuring intentions change actual behavior? *Journal of Consumer Psychology, 14*(1-2), 64-74. doi: 10.1207/s15327663jcp1401&2_8

Naqvi, N. H., & Bechara, A. (2008;2009;). The hidden island of addiction: The insula. *Trends in Neurosciences, 32*(1), 56-67. doi: 10.1016/j.tins.2008.09.009

Nelson, S. E., Gebauer, L., LaBrie, R. A., & Shaffer, H. J. (2009). Gambling Problem Symptom Patterns and Stability across Individual and Timeframe. *Psychology of Addictive Behaviors, 23(3),* 523-533. doi: 10.1037/a0016053

Noël, X., Brevers, D., & Bechara, A. (2013). A neurocognitive approach to understanding the neurobiology of addiction. *Current Opinion in Neurobiology, 23*(4), 632-638. doi: 10.1016/j.conb.2013.01.018

Ophuis, R., Lokkerbol, J., Heemskerk, S., van Balkom, A., Hiligsmann, M., & Evers, S. (2017). Cost-effectiveness of interventions for treating anxiety disorders: A systematic review. *Journal of Affective Disorders, 210*, 1-13. doi: 10.1016/j.jad.2016.12.005

Pallesen, S., Mitsem, M., Kvale, G., Johnsen, B., & Molde, H. (2005). Outcome of psychological treatments of pathological gambling: A review and meta-analysis. *Addiction, 100*(10), 1412-1422. doi: 10.1111/j.1360-0443.2005.01204.x

Petry, N. M. (2005). *Pathological gambling: Etiology, Comorbidity, and Treatments.* Washington, DC: American Psychological Association.

Petry, N. M. (2009). Disordered gambling and its treatment. *Cognitive and Behavioral Practice, 16*(4), 457-467. doi: 10.1016/j.cbpra.2009.02.005

Petry, N., Ginley, M., & Rash, C. (2017). A systematic review of treatments for problem gambling. *Psychology of Addictive Behaviors, 31*(8), 951-961. doi: 10.1037/adb0000290

Petry, N. M., & Madden, G. J. (2010). *Discounting and Pathological Gambling.* US; Washington; DC: American Psychological Association. doi: 10.1037/12069-010

Petry, N.M., Weinstock, J., Ledgerwood, D.M., & Morasco, B. (2008). A Randomized Trial of Brief Interventions for Problem and Pathological Gamblers. *Journal of Consulting and Clinical Psychology, 76*(2), 318-328. doi: 10.1037/0022-006X.76.2.318

Petry, N.M., Weinstock, J., Morasco, B.J. & Ledgerwood, D.M. (2009). Brief Motivational Interventions for College Student Problem Gamblers. *Addiction, 104*(9), 1569-1569. doi: 10.1111/j.1360-0443.2009.02652.x

Postel, M. G., Haan, H. A. d., Huurne, E. D. t., Palen, J. v. d., Becker, E. S., & Jong, C. A. J. d. (2011). Attrition in web-based treatment for problem drinkers. *Journal of Medical Internet Research, 13*(4), e117-e117. doi: 10.2196/jmir.1811

Potenza, M. N. (2006). Should Addictive Disorders Include Non–Substance-Related Conditions? *Addiction, 101,* 142–151. doi: 10.1111/j.1360-0443.2006.01591.x

Productivity Commission (2010). *Australia's Gambling Industries, Report No. 50.* Canberra: Ausinfo

Queensland Government. (2013). *Queensland Household Gambling Survey 2011–12.* Office of Liquor and Gaming regulation, Department of Justice and Attorney

General. Retrieved from https://publications.qld.gov.au/dataset/liquor-and-gambling-research/resource/79c83075-5dd6-48f7-84b1-8bd6b106eaff

Queensland Government Statistician's Office. (2017). Australian Gambling Statistics (33rd Edition). Queensland Treasury. Retrieved from http://www.qgso.qld.gov.au/products/reports/aus-gambling-stats/

Redish, A. D., Jensen, S., Johnson, A., & Kurth-Nelson, Z. (2007). *Reconciling reinforcement learning models with behavioral extinction and renewal: Implications for addiction, relapse, and problem gambling.* Psychological Review, 114(3), 784-805. doi:10.1037/0033-295X.114.3.784

Richard, D.C. & Humphrey, J. (2014). The Conceptualization and Diagnosis of Disordered Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Riper, H., van Straten, A., Keuken, M., Smit, F., Schippers, G., & Cuijpers, P. (2009). Curbing Problem Drinking with Personalized-Feedback Interventions: A Meta-Analysis. *Am J Prev Med, 36*(3), 247-255. doi: 10.1016/j.amepre.2008.10.016

Rockloff, M. J., Ehrich, J., Themessl-Huber, M., & Evans, L. G. (2011). Validation of a one item screen for problem gambling. *Journal of Gambling Studies, 27(4),* 701-707. doi: 10.1007/s10899-010-9232-y

Rugle, L. (2014). Case Conceptualization with Clients Presenting with Disordered Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Slutske, W. S. (2006). Natural recovery and treatment-seeking in pathological gambling: Results of two U.S. national surveys. *American Journal of Psychiatry, 163*(2), 297-302. doi: 10.1176/appi.ajp.163.2.297

Stewart, S. H., Zack, M., Collins, P., & Klein, R. M. (2008). Subtyping Pathological Gamblers On The Basis Of Affective Motivations for Gambling: Relations to Gambling Problems, Drinking Problems, and Affective Motivations for Drinking. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors, 22(2)*, 257-268. doi: 10.1037/0893-164X.22.2.257

Stinchfield, R. (2002). Reliability, validity, and classification accuracy of the south oaks gambling screen (SOGS). *Addictive Behaviors, 27*(1), 1-19. doi: 10.1016/S0306-4603(00)00158-1

Stinchfield, R. (2010). A critical review of adolescent problem gambling assessment instruments. *International Journal of Adolescent Medicine and Health, 22*(1), 77-93. Retrieved from https://www.degruyter.com/view/j/ijamh

Stinchfield, R. (2014). A review of problem gambling assessment instruments and brief screens. In (Richard, D. C. S., Blaszczynski, A., & Nower, L. (eds), *The Wiley-Blackwell Handbook of Disordered Gambling (1st Ed.).* Chichester, West Sussex, UK: Wiley-Blackwell.

Stinchfield, R., & Winters, K. C. (2001). Outcome of Minnesota's gambling treatment programs. *Journal of Gambling Studies, 17(3)*, 217-245. doi: 10.1023/A:1012268322509

Stinchfield, R., McCready, J., & Turner, N. (2012). *A comprehensive review of problem gambling screens and scales for online self-assessment.* Report prepared for

the Ontario Problem Gambling Research Centre. Retrieved from http://greo.ca/sites/default/files/documents/Stinchfield%20et%20al%282012%29A_comprehensive_review_of_PG_self_assessment_tools.pdf

Stinchfield, R., Winters, K. C., Botzet, A., Jerstad, S., & Breyer, J. (2007). Development and psychometric evaluation of the gambling treatment outcome monitoring system (GAMTOMS). *Psychology of Addictive Behaviors, 21(2),* 174-184. doi: 10.1037/0893-164X.21.2.174

Toneatto, T., & Millar, G. (2004). Assessing and treating problem gambling: Empirical status and promising trends. *Canadian Journal of Psychiatry, 49(8),* 517. doi: 10.1177/070674370404900803

van Holst, R. J., van den Brink, W., Veltman, D. J., & Goudriaan, A. E. (2010). *Why gamblers fail to win: A review of cognitive and neuroimaging findings in pathological gambling.* Neuroscience and Biobehavioral Reviews, 34(1), 87-107. doi:10.1016/j.neubiorev.2009.07.007

van Timmeren, T., Daams, J. G., van Holst, R. J., & Goudriaan, A. E. (2018). Compulsivity-related neurocognitive performance deficits in gambling disorder: A systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews, 84,* 204-217. doi: 10.1016/j.neubiorev.2017.11.022

Verdejo-García, A., Lubman, D. I., Schwerk, A., Roffel, K., Vilar-López, R., MacKenzie, T., & Yücel, M. (2012). Effect of craving induction on inhibitory control in opiate dependence. *Psychopharmacology, 219*(2), 519-526. doi: 10.1007/s00213-011-2512-0

Volberg, R. A., Gupta, R., Griffiths, M. D., Olason, D. T., & Delfabbro, P. (2010). An international perspective on youth gambling prevalence studies. *Int J*

Adolescent Med Health, 22(1), 3-38.

Westphal, J. R. (2008). How well are we helping problem gamblers? an update to the evidence base supporting problem gambling treatment. *International Journal of Mental Health and Addiction, 6*(2), 249-264. doi: 10.1007/s11469-007-9072-x

Williams, R., & Volberg, R. (2014). The classification accuracy of four problem gambling assessment instruments in population research. *International Gambling Studies, 14*(1), 15-28. doi: 10.1080/14459795.2013.839731

Williams, R. J., Volberg, R. A., & Stevens, R. M. G. (2012). *The Population Prevalence of Problem Gambling: Methodological Influences, Standardized Rates, Jurisdictional Differences, and Worldwide Trends.* Ontario Problem Gambling Research Centre.

Woodin, Erica M., & O'Leary, K. Daniel. (2010). A Brief Motivational Intervention for Physically Aggressive Dating Couples. *Prevention Science, 11*(4), 371-383. doi: 10.1007/s11121-010-0176-3

Wynn, J., Hudyma, A., Hauptman, E., Nicole Houston, T., & Michael Faragher, J. (2014). Treatment of problem gambling: Development, status, and future. *Drugs and Alcohol Today, 14*(1), 42-50. doi: 10.1108/DAT-10-2013-0044

Yarritu, I., Matute, H., & Vadillo, M. A. (2014). Illusion of control: The role of personal involvement. *Experimental Psychology, 61*(1), 38-47. doi: 10.1027/1618-3169/a000225

Chapter 3: Statement of Contribution to Co-Authored Published Paper

Turner, W., & Casey, L. (2014). Outcomes associated with virtual reality in psychological interventions: Where are we now? *Clinical Psychology Review, 34(8)*, 634-644. doi: 10.1016/j.cpr.2014.10.003

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are: Wesley Adam Turner and Dr Leanne M. Casey. My contribution to the paper involved: conception of the study design, data collection and analyses, and writing of the manuscript. The co-author provided review of drafts and supervisory advice.

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Name of Student: Wesley Adam Turner

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Co-author of paper: Dr Leanne M. Casey (Primary Supervisor)

Chapter 3. Outcomes Associated with Virtual Reality in Psychological Interventions: Where Are We Now?

Chapter 3: Foreword

As noted in the literature review in Chapter 2, there is substantial evidence that suggests that current approaches to the assessment and treatment of problem gambling are problematic. The majority of problem gambling instruments available in the literature lack evidence of rigorous psychometric testing. Additionally, instrument development studies typically include items from pre-existing, well-validated measures, raising questions over the utility of developing and introducing new instruments in the measurement of problem gambling. Revision and further validation of pre-existing problem gambling measures is thus likely to be of more utility to the field as a whole. Moreover, while CBT presents as the 'gold standard' empirically supported treatment for problem gambling, it is often intensive and extensive in delivery. Furthermore, Problem Gamblers present as an especially difficult population to engage and retain in treatment, rarely seeking help from mental health professionals. Briefer, less intensive forms of treatment such as Brief Motivational Interviewing and Normative Feedback may thus better serve Problem Gamblers. For the above reasons, it was concluded in Chapter 2 that there appeared a need for problem gambling assessments and interventions that are empirically supported, wider in reach than traditional therapies, and able to effectively engage and motivate individuals to complete treatment.

Given the ongoing growth apparent in the accessibility and sophistication of online digital technologies, it was felt that it was timely to explore whether more novel forms of problem gambling assessment could effectively utilise online digital technologies to increase engagement, motivation and outcomes. Two potential assessment and treatment delivery platforms were explored: virtual reality-based and video game-based assessments and treatments. However, subsequent review of the literature indicated that there appeared to be a substantial gulf in quality between the psychometric testing of virtual reality-based

and video game-based assessments and treatments, with virtual reality-based studies presenting as the more empirically evaluated and supported of the two. Whilst research relating to the utilisation of virtual reality-based assessments and treatments was at a sufficient level to conduct more advanced analyses such as meta-analyses, research relating to game-based assessments and treatments was determined to still be in its infancy. As a result of the abovementioned literature review, it was decided that the primary aim of this thesis would be the development and psychometric testing of a virtual reality-based assessment and treatment for problem gambling. The first step in this process was thus to formally review the current state of virtual reality-based assessments and treatments in the literature (Chapter 3). Further information regarding the search strategy employed as part of Chapter 3's meta-analysis is provided in Appendix B.

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Chapter 4: Statement of Contribution to Co-Authored Published Paper

Turner, W., Thomas, B., & Casey, L. (2016). Developing games for mental health: A primer. *Professional Psychology-Research and Practice, 47(3)*, 242-249. 10.1037/pro0000082

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are: Wesley Adam Turner, Beth Thomas and Dr Leanne M. Casey. My contribution to the paper involved: conception of the study, a literature review, and writing of the manuscript. The co-authors provided expertise advice and information, review of drafts and supervisory advice.

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Name of Student: Wesley Adam Turner

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Co-author of paper: Beth Thomas

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Co-author of paper: Dr Leanne M. Casey (Primary Supervisor)

Chapter 4. Developing Games for Mental Health - A Primer

Chapter 4: Foreword

As highlighted in Chapter 3, virtual reality-based assessments and treatments present as an efficacious form of novel digital mental health delivery platform. Nonetheless, it became apparent between the periods of 2013 to 2016 that the uptake of virtual reality-based systems was occurring at a substantially slower rate than had initially been predicted. Reasons for this diminished uptake included accessibility issues, high costs of operation, unintuitive software, design issues and concerns regarding the quality and impartiality of their empirical testing. Subsequently, while the utilisation of virtual reality technology would have provided an empirically supported platform for the development of a novel means of problem gambling assessment and treatment, evaluation of other digital delivery platforms that may be more accessible, user-friendly and affordable was warranted. For this reason, it was decided that video game technology would thus present as a more practical platform for the development and psychometric testing of a problem gambling instrument.

Mental health video game-based assessments and treatments may provide an especially useful platform of delivery, as they can be readily accessed via personal computer, laptops, tablets and smartphones. Video game-based assessments and treatments aim to make learning more meaningful and engaging via the inclusion of video game mechanics, and may pose a particularly useful platform for engaging addiction populations: engaging individuals emotionally, capturing their attention and promoting treatment adherence. Review of relevant literature identified that the current standard of evidence associated with the field hampered overall conclusions from being made in regard to psychometric validity and treatment outcomes. Moreover, there appeared to be a paucity of information available to researchers and clinicians regarding

the development and empirical testing of game-based assessments and treatments. To advance the field as a whole, it was determined that a guide to well-designed, methodologically rigorous, and theoretically driven games for mental health studies was needed.

The aim of Chapter 4 was to provides researchers and clinicians with an overview of current trends in games for mental health, to provide an introduction to games development theory and terminology, and to provide a concise guide to the game development process from a researcher and clinician perspective. To aid researchers and clinicians, a checklist to guide the process of mental health games development was constructed. Researchers and clinicians are encouraged to refer to this checklist before approaching video game developers and/or commencing game development.

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Chapter 5. Immersion and Engagement Testing of SLOTZ – A Game-based Measure of Problem Gambling

Chapter 5: Foreword

As highlighted in Chapter 4, video games present as a highly accessible, affordable, engaging and promising delivery platform for digital mental health assessment and treatment, with greater accessibility and uptake than that seen among virtual reality-based technologies. Given that briefer treatments such as Brief Motivational Interviewing and Normative Feedback have been observed to be effective in the treatment of substance and behavioural addictions, as has assessment itself (the pre-test sensitisation or assessment reactivity phenomenon), it was determined that development of a problem gambling assessment instrument should thus form the primary focus of this thesis. Consequently, a mental health video game assessment of problem gambling was developed in accordance with game design theory and gambling-related neuropsychological theory. Subsequent studies following the completion of the piloting and psychometric testing of this instrument would thus include formalised treatment components. Development and psychometric validation of SLOTZ was completed over the course of two empirical studies (Chapter 5 and Chapter 6), in accordance with recommendations made within the digital mental health fields.

Chapter 5 reports on the development and evaluation of participants' immersion, enjoyment and engagement in a video game-based assessment of problem gambling. Game play was developed in accordance with game design and gambling-related neuropsychological theory, in conjunction with the game development checklist depicted in Chapter 4. Game mechanics suitable to gambling-related neuropsychological theory were incorporated into gameplay (i.e., effortful challenges, chance, performance-based feedback, visual leader boards, progression levels, numerical reward points, and clearly defined success win states). Four sub-tests were

developed: a modified pictorial version of the Dot Probe Paradigm to measure attentional bias; a confidence in decision-making assessment to measure overconfidence in decision making and metacognition; a decision-making task; and a procedurally generated endless runner level to measure illusory correlations, cognitive flexibility, and common problem gambling-related cognitive biases. Screenshots of SLOTZ gameplay are provided in Appendix D.

Finally, Chapter 5 is presented as an unpublished paper, with the intent to submit this paper for publication following final submission of this thesis.

Abstract

Game-based assessments and interventions may provide an attractive platform of problem gambling assessment, as they are more readily accessed by individuals who may be reluctant to present on a face to face basis. However, it is essential that the development of gamified assessments and interventions be guided by both mental health and game design theory if they are to be recognised as effective, engaging and valid platforms of delivery within the mental health field. This study reports on the development and user evaluation of SLOTZ: a game-based measure of problem gambling. SLOTZ was developed in accordance with game design and neurocognitive theory. Nineteen participants were invited to participate in the immersion and engagement testing of this game. Participants completed two pre- and post-game play questionnaires measuring gambling-related cognitions, demographic information, immersion and qualitative feedback. SLOTZ participants' overall levels of immersion and engagement were found to be high with significant differences observed between SLOTZ immersion scores and immersion scores reported in Jennet et al's (2008) Immersion Questionnaire study. Both Non-Problem Gamblers and Problem Gamblers found SLOTZ game play to be engaging and enjoyable suggesting that SLOTZ can provide an appealing and suitable platform for large-scale screening of problem gambling. SLOTZ is the first problem gambling assessment to integrate game design mechanics and neurocognitive theory. This study provides evidence that psychological assessments that are wider in reach can be developed in ways that are engaging, enjoyable, user friendly and accessible to traditionally difficult to engage clinical populations such as problem gamblers.

Immersion and Engagement Testing of SLOTZ – A Game-based Measure of Problem Gambling

Problem gamblers (PGs) rarely seek treatment (Cunningham et al., 2012), despite reporting significant emotional, financial, occupational and relationship strain, poor health, comorbid substance issues, and social issues (Delfabbro, 2014; Goudriaan et al., 2013; Petry, 2009; Richard & Humphrey, 2014). Assessments and platforms that are user friendly and wider in reach may provide means of overcoming these barriers (Fleming et al., 2016). However, game-based assessments and interventions need to incorporate both mental health and game design theory, if they are to be recognised as immersive, engaging, effective, and valid platforms of delivery within the mental health field (Gopinath Bharathi et al., 2016; Landers, 2004; Morford et al., 2014; Turner, Thomas & Casey, 2016).

Balancing Theory, Immersion and User Enjoyment

Gamified assessments and interventions have been used with a variety of populations and treatment areas, including children, adolescents, adults, the elderly, anxiety, stress reduction, psychoeducation and clinical diagnosis (Baranowski et al., 2012; Basak et al., 2008; Graves et al., 2010; Kharrazi et al., 2012; Miller et al., 2011; Opris et al., 2012; Rahmani & Boren, 2012; Rutherford et al., 2011; Saposnik et al., 2010; Schoene et al., 2011; Szturm et al., 2008; Trivedi et al., 2010; Turner & Casey, 2014; Wood et al., 2014). Despite this, there is often little reference to empirically supported theory in development of these gamified assessments and interventions (Kharrazi et al., 2012; Lau et al., 2017; Turner & Casey, 2014). Concepts such as

immersion are also seldom mentioned, despite the vital role they play in promoting game enjoyment (Jennett et al., 2008; Turner & Casey, 2014).

Immersion encompasses the amount of time players invest in a game, the effort and attention they devote to play, and the degree to which their levels of self-awareness lessen during play to the point where players may feel disconnected from reality and solely focussed upon game play (Brown and Cairns, 2004; Haywood and Cairns, 2006; Jennett et al., 2008). It is essential that gamified assessments and interventions be developed in such a way that they effectively incorporate both mental health and game design theory, rather than simply borrow features from either if they are to be recognised as immersive, engaging, effective, and valid platforms of delivery within the mental health field (Gopinath Bharathi et al., 2016; Landers, 2004; Morford et al., 2014; Turner, Thomas & Casey, 2016).

Gamification features

Though still in its infancy, substantial research has been conducted into the processes by which gamification is reported to improve learning (Gopinath Bharathi et al., 2016; Landers, 2014; Simoes et al., 2013). Of particular note is Lander's (2014) conceptual differentiation between the aims of serious games and gamification, the latter of which aims to improve a user's attitude toward or engagement with the program, rather than the nature of the program itself. User understanding of the purpose of gamification in an assessment or intervention is not required, so long as a change in target attitudes and/or behaviours occurs (Landis, 2014). Within this framework, developers of gamified assessments must take particular care in how they engage users, carefully balancing the need to encourage engagement and enjoyment whilst not eliciting erroneous neurocognitive, affective and/or behaviour responses. Key game

mechanics that successfully engage users for extended periods of time have been identified, with successful incorporation of these mechanics likely to improve user engagement, enjoyment and subsequent learning (Gopinath Bharathi et al., 2016; Landis, 2014). However, precisely how the aforementioned framework and key game mechanics can be tailored to clinical populations is less understood. Given the inherent difficulty in engaging problem gamblers in assessment and treatment, they present as a clinical population in vital need of more engaging means of assessment and treatment (Cunningham et al., 2012; Fleming et al., 2016) that are more psychometrically valid and objective than self-report (Balconi et al., 2015; Goudriaan et al., 2013).

Gambling-Related Cognitive Distortions and Metacognition

PGs engage in heuristics and associated cognitive distortions more frequently than people who do not problem gamble (Camchong et al., 2007; Fortune & Goodie, 2012; Hardoon et al., 2001; Petry, 2005; Raylu & Oei, 2004). Reported differences include references to the availability of others' wins, gambler's fallacy, illusion of control, illusory correlations, inherent memory bias, overconfidence in decision making, switching and double switching, and trends in number picking (Fortune & Goodie, 2012). Addressing these cognitive distortions plays a pivotal role in the treatment of problem gambling. However, existing measures are limited in their ability to measure individual cognitive processes (Brevers et al., 2014; Spada et al, 2014; Mansueto et al., 2016), largely due to deficits in insight into symptom severity and negative outcomes (Brevers et al., 2014; Spada et al, 2014; Mansueto et al., 2016). For this reason, there is a need for more objective means to provide psychometrically valid assessment of problem gambling (Stinchfield, 2014).

Neurocognitive Assessment of Problem Gambling

There is increasing focus on the neurocognitive features of problem gambling (Balconi et al., 2015; Goudriaan et al., 2013, Honsi et al., 2013). Problem gambling has been associated with attention deficits, frontal lobe function deficits, preference for immediate rewards, risk seeking and other executive functioning impairments (Balconi et al., 2015; Camchong et al., 2007; Goudriaan et al., 2013).

PGs perform poorly on neurocognitive assessments requiring higher order attention and report greater difficulty with attentional control in general (Camchong et al., 2007). They also prefer choices that bring immediate reward even when these choices are coupled with negative outcomes, suggesting a tendency towards reward sensitivity and diminished inhibition (Balconi et al., 2015). PGs also display gambling-related cue reactivity and attentional bias, typically exhibiting greater preferences for gambling-related stimuli (Goudriaan et al., 2013; Honsi et al., 2013). PGs also display greater overconfidence in their decisions than non-PGs (Goodie, 2005), and will engage in more risky decision making even when faced with diminishing control over their choices (Balconi et al., 2015; Goodie, 2005; Goudriaan et al., 2013). Neurocognitive and brain-imaging studies suggest that addictions, including behavioural addictions such as problem gambling, can be understood via an imbalance across three neural systems: the amygdala, prefrontal cortex and insula (Brevers & Noel, 2013; Noel, Brevers & Bechara, 2013). Failure at self-control in Problem Gamblers may involve the deregulation of both impulsive processes in the amygdala and reflective processes in the prefrontal cortex, impeding the individual's capacity to circumvent immediately salient stimuli in the service of long-term goals via the insula (Brand, Labudda, & Markowitsch, 2006; Brevers & Noel, 2013; Goldstein et al., 2009; Goldstein & Volkow,

2011; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2006; Hofmann et al., 2009; Houben & Wiers, 2009; Krain, Wilson, Arbuckle, Castellanos, & Milham, 2006; Naqvi & Bechara, 2009; Noel, Brevers, Bechara, 2013; Verdejo-Garcia et al., 2012).

A variety of neurocognitive measures can be used to assess areas such as attentional bias (reaction time, addiction stroop tasks, flicker tasks, attentional blink tasks, etc.), decision making (Analogue Risk Task, Cambridge Gambling Task, Georgia Gambling Task, Iowa Gambling Task, etc.) and cognitive flexibility (fluency tasks, Wisconsin Card Sorting Task, etc.; Goudriaan et al., 2013; Honsi et al., 2013). These neurocognitive measures provide opportunity to assess more behaviourally analogous responses associated with gambling-related cognitive and motivational functions (Goudriaan et al., 2013) but are limited in their availability and reach as they are predominately designed to be laboratory-based assessment tools (Goudriaan et al., 2013; Honsi et al., 2013). While many have been made available for internet-based administration, they are still laboratory-based and experimental in nature, and not designed with the explicit intent to screen for problem gambling and to be an engaging and enjoyable experience.

Current Study

This study examines whether game design and neurocognitive theory can be used to develop a game-based assessment of gambling. Specifically, this study: 1) reports on the development of SLOTZ a game-based measure of problem gambling; 2) evaluates participant levels of immersion within SLOTZ game play; and 3) evaluates participant levels of engagement with game play.

Materials and Method

Participants

Nineteen participants (including non-gamblers, social or non-PGs, and self-identified PGs) participated in this study. Participant demographic information is presented in Table 4.1. Participants were recruited via email, social networking sites and flyers posted across a university campus and were required to have an adequate understanding of written English, adequate or corrected vision, and to be over 18 years of age (Appendix A). Exclusion criteria included a psychotic disorder or manic/hypomanic episode being experienced around the time of assessment, and for participants to not possess a history of serious neurological or medical conditions (e.g., traumatic brain injury) in order to control for conditions associated with impulsivity and impaired self-control (e.g., Bipolar Disorder, Schizoaffective Disorder and other conditions affecting executive functioning). Ethical approval was obtained from Griffith University Ethics Committee (reference number 2016/148; Appendix C).

Procedure

Participants completed two questionnaires prior to gameplay (consisting of gambling-related cognition items and assessment items) and two questionnaires post gameplay (consisting of immersion items and qualitative feedback) and informed that questionnaires and gameplay would take approximately 60 to 80 minutes to complete. Participation occurred anywhere participants had access to the internet and on any digital device possessing a web browser. Participants were informed of their anonymity prior to participation, with data collected during the study remaining de-identified at all times.

SLOTZ A game-based measure of Problem Gambling

A game-based measure of problem gambling was created (SLOTZ) via Construct 2 (Scirra Limited, 2014), a cross platform, HTML5 based game editor. Game play feedback was provided to participants upon completion of the game (i.e., total score, poker chips found, correct trivia responses selected). Game mechanics that best fit with gambling-related neurocognitive theory were selected for the current study. These were challenges (effortful tasks that are required to be solved); chance (the involvement of random luck); feedback (the provision of performance-based information); leader boards (visual displays of user progressions and comparisons); levels (defined steps in game progression); points (numerical rewards for game progression); and win states (defined end-game/success).

Participants earned points in the form of currency pop-ups (e.g., +$50 in green text) for successful or correct actions or responses in line with level goals. Incorrect responses would result in either no increase or a reduction in points, depending on level goals (e.g., '$0' in red text or '-$250' in red text). Total scores were displayed within levels as well as at the end of each level, with a leader board of high scores displayed at the end of each level. Transitions between levels were clearly defined via on-screen display (i.e., Level 3 of 4 - Cups). Successful completion of each level would result in a visual win state celebration (i.e., on-screen fireworks), with a unique end-game state also displayed. Demographic and clinical items were incorporated into the pilot version of SLOTZ, with four subtests developed around current problem gambling and neurocognitive theory. Depictions of each of the four SLOTZ subtests are displayed in Figure 3.1 and Appendix D.

Table 4.1.

Descriptive statistics for SLOTZ pilot study participants

	Pilot study participants (*N* = 19)
Sex	
Female	7
Male	12
Age	*M* = 30.32, *SD* = 5.02
Preferred type of gambling	
Bingo	3
Cards	4
Electronic gaming machine	4
Lotto	6
Internet	*0*
Other casino games	4
Sport betting	7
Vision corrected via glasses, contacts, etc.	9
Number of digital devices in household	
1 to 2 devices	2
3 to 4 devices	4
5 or more devices	13

'Reaction Time' Sub-Test

A modified picture-based version of the Dot Probe Paradigm (DPP) was incorporated into SLOTZ game play. Attentional bias is deemed to be exhibited when participants display longer reactions times to addiction-related stimuli (i.e., words or images) than their reaction times to neutral stimuli (Brevers et al., 2013; Honsi et al., 2013), and has been observed among problem gamblers (Bruce & Jones, 2004; Honsi et al., 2013). The DPP is an extensively used and empirically supported measure used to investigate the effect of emotionally salient stimuli on attention in clinical populations (Koster et al., 2004; Lipp & Derakshan, 2005; MacLeod et al., 1986). Individuals

experiencing attentional bias are typically found to display longer reaction times to emotionally salient stimuli (e.g., fear-related images and words, substance-related images and words, etc.) than to neutral stimuli, with longer reaction times to salient stimuli commonly observed amongst individuals suffering from addiction (Brevers et al., 2013; Bruce & Jones, 2004; Honsi et al., 2013).

In a reversal of the typical DPP process, the SLOTZ-based DPP oriented participants to the centre of the screen via on-screen instructional prompts or rewards. Participants were presented with two images simultaneously: one gambling-related and one non-gambling related. Reaction time in selecting the target image was then recorded. The SLOTZ-based DPP consisted of an initial 10-trial practice block and two 100-trial blocks. Participants were instructed to select gambling related images during block one, and to select non-gambling related images during block two. Correct and incorrect selections were displayed on screen via text and financial rewards/losses (e.g., ‘Nice!’ and ‘+$50’ or ‘Try Again!’ and ‘-$25’). Scores were based upon total money won, gambling related image reaction times, non-gambling related image reaction times, frequency of correct selections and frequency of incorrect selections.

‘Trivia’ Sub-Test

Overconfidence in decision making and metacognition was assessed using a modified confidence in decision making assessment (Goodie, 2005). PGs typically exhibit greater overconfidence in their decision making than controls, regardless of actual performance (Goodie, 2005). Participants answered general knowledge questions and provided an assessment of their level of confidence in each answer (Goodie, 2005). Differences between actual performance and confidence was assessed to explore metacognitive ability (Brevers et al., 2014).

Participants were asked to choose between two possible answers to general knowledge questions. After selecting their response, participants were given the choice of taking a chance ('Gain $66 or Gain Nothing') or having a guaranteed win ('Gain $50 even if you're wrong'). Guaranteed and chance wins resulted in a reward of points and positive feedback. Unsuccessful chance decisions resulted in negative feedback (e.g., 'Oh No!' and 'Try Again!'). Participants were also asked to estimate how many trivia responses they had correctly chosen ('Most of them', 'Some of them', and 'Few of them'). Scores were based on correct responses, incorrect responses, correct chances taken, incorrect chances taken and frequency of self-evaluation choices.

'Cups' Sub-Test

Risky decision making has been associated with numerous neurological and psychological presentations including problem gambling (Buelow & Suhr, 2009; Bechara, 2000), and is most frequently measured via the Iowa Gambling Task (IGT). A decision-making task using similar principles was developed and incorporated into SLOTZ game play. After being presented with four cups, participants were asked to choose the cup they believed had a poker chip placed behind it. Participants were not informed that poker chip placement would be randomly allocated upon patterns (Bechara, 1994; Bowman et al., 2005). Continual selection of cups one or two would result in an overall financial loss of $250, with continual selection of cups three and four resulting in an overall financial gain of $250. Overall financial losses and gains were not randomised across cups, so as to ensure participants choices reflected risk bias.

Wins and losses were displayed on screen via text and financial rewards/losses (e.g., 'Nice!' and '+$500' or 'Try Again!' and '-$175'). Participants were given the opportunity to allow the computer to choose a cup every 15 trials, to measure need for

control and overconfidence in decision making. Scores were based upon total money won, differences between total winning and losing selections, selection changes between 20 block trials (Buelow & Suhr, 2009) and frequency of computer-based choices allowed.

'Roulette' Sub-Test

Two cognitive biases commonly observed amongst PGs are the gambler's fallacy (a mistaken belief that something that has occurred more frequently than normal will happen less frequently in the future), and the hot-hands fallacy (the mistaken belief that random success is more likely to occur in the future) (Sun & Wang, 2010; Xu & Harvey, 2014). Adherence to a belief in the hot-hands fallacy may perpetuate belief in the gambler's fallacy (Xu & Harvey, 2014), and indicate overestimation of control (illusions of control; Lyons et al., 2013; Sun & Wang, 2010; Xu & Harvey, 2014). A procedurally generated endless runner level was developed to measure these cognitive biases. Participants were instructed to hit roulette wheel spinners placed on newly generated platforms to win money. Falling off the screen from missing a platform would result in a financial loss. Player controls was limited to jumping across platforms, with platform height randomly generated within an achievable range to measure reaction time and flexibility in the face of changing patterns. Randomly generated blue and red die would scroll across the top of the screen. At varying intervals, participants would be asked to determine whether game play grew more difficult based upon the presentation of die (e.g., blue dice present, red dice present, both dice present, no change). Participants' errors (falling off-screen), correlations chosen, and total winnings were used in score calculations.

Level Transitions

PGs typically prefer immediate rewards over delayed rewards, engaging in disadvantageous, short-term centric decision-making behaviours (Goudriaan et al., 2013). PGs also typically possess an exaggerated optimism towards odds against winning and overconfidence in skill and luck (Lignuel et al., 2013). Decision making processes relating to risk and reward were assessed during level transition screens. Between levels, participants were asked to choose to double the previous level's winnings with a 50% chance of losing winnings, or to keep their level winnings with no chance. Scores were calculated based upon frequency of chances taken.

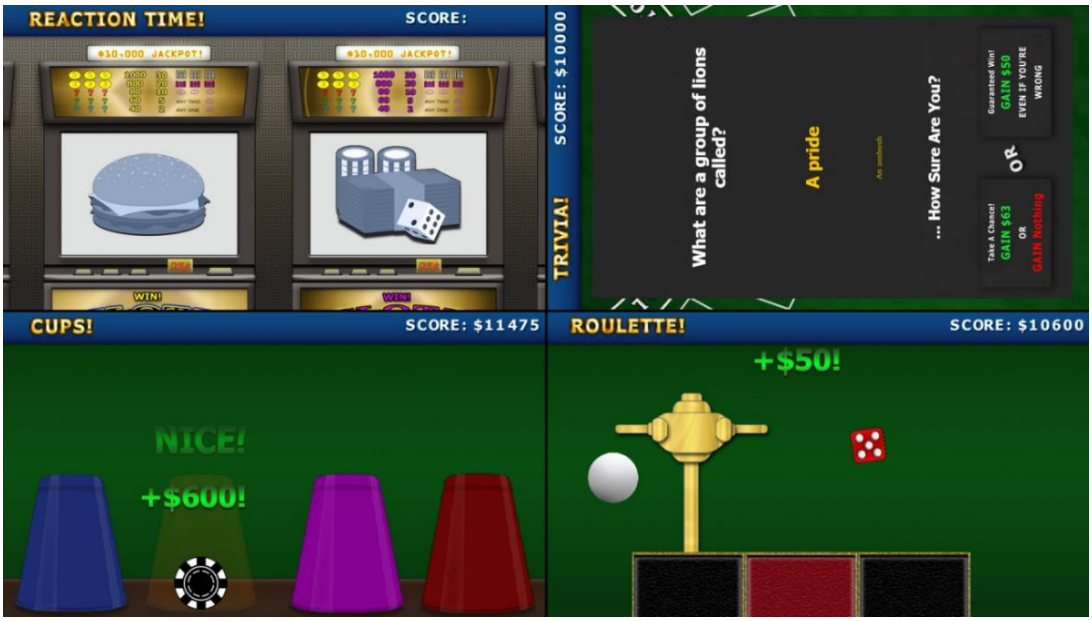

Figure 3.1. SLOTZ subtests as they are depicted in-game to participants.

Immersion and Engagement

The Immersion Questionnaire (IQ; Jennett et al., 2008) is a 31-item 5-point Likert scale questionnaire. Items within the IQ load upon three individual-related

factors relating to immersion (cognitive involvement, real world dissociation, emotional involvement) and two game-related factors (challenge and control). Scores can range from 30 to 150, with higher scores reflecting greater levels of immersion. In their original study (Jennet et al., 2008), 41 participants engaged in either an immersive task (playing Half Life, a 3-dimensional first-person shooter game) or a non-immersive task (clicking boxes with a simple graphics user-interface) for 10 minutes. Mean IQ scores were 66.00 (*SD* = 13.55) for immersive task participation and 44.90 (*SD* = 22.10) for non-immersive task participation. Three IQ items were scored separately to evaluate participant engagement (i.e., "How much did you want to win the game?") and enjoyment (i.e., "How much would you say you enjoyed playing the game?" and "Would you play the game again?").

Qualitative Feedback

Upon completion of the study, participants were asked to provide suggestions for how SLOTZ gameplay could be improved via an open-ended question: "Do you have any suggestions for how this game could be improved?".

Data Analysis

Data were screened for outliers and normality, with data observed to be normally distributed. Outliers were included in final analyses because of the limited sample size. Welch's *t*-tests were run to investigate significant differences in IQ scores, as recommended by de Winter (2013) in the assessment of extremely small sample sizes (i.e., N = ≤ 5). Repeated-measures t-tests were conducted to investigate significant differences in SLOTZ participants' ratings of overall ratings of enjoyment ("how much would you say you enjoyed playing the game?"), interest in winning during game play ("how much did you want to "win" the game?") and interest in playing SLOTZ again ("would you like to play

the game again?”). Hedge’s *g* was calculated for significant *t*-tests, with 95% confidence intervals (CI) provided.

Results

Missing Data and Preliminary Analyses

All nineteen participants were included in the analyses, having completed all three assessment phases (pre-assessment, in-game assessment, and post-assessment). Participants were grouped based on PGSI and DSM 5 item endorsement, resulting in the identification of two groups (Non-Problem Gamblers, n = 14; Problem Gamblers, n = 5).

Gambling Severity

Of the 19 participants recruited, none were observed to present with symptoms consistent with a diagnosis of Gambling Disorder via the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (i.e., a minimum of four Gambling Disorder symptoms; American Psychiatric Association, 2013). Five participants were observed to score above the “non-problem gambling” range as scored on the Problem Gambling Severity Index (PGSI). Specifically, three participants were observed to fall within the “low” range of gambling problems, with two participants observed to fall within the “moderate” range of gambling problems, as scored upon the PGSI.

Immersion Questionnaire and Qualitative Feedback

Welch’s *t*-tests were conducted to investigate differences in IQ scores. Total IQ scores were significantly higher than those reported by Jennet et al. (2008). A statistically significant difference was observed between SLOTZ IQ scores (M = 83.68, SD = 14.64) and Jennet et al. (2008) immersive task IQ scores (M = 66.00, SD = 13.55, N = 20) according to Welch’s *t*-test, $t(36.39) = 3.91$, $p = <.001$, with a large effect size

detected (Hedge's g = 1.23, 95% CI = 0.55, 1.91). A statistically significant difference was also observed between SLOTZ IQ scores and Jennet et al. (2008) non-immersive task scores (M = 44.90, SD = 15.20, N = 21) according to Welch's t-test, $t(37.84)$ = 8.22, p = <.001, with a large effect size detected (Hedge's g = 2.54, 95% CI = 1.71, 3.38). No significant difference in IQ scores were observed between Problem Gamblers (M = 91.20, SD = 12.85) and Non-Problem Gamblers according to Welch's t-test, $t(8.08)$ = 1.46, p = .181.

Repeated measures t-tests were conducted between overall ratings of enjoyment (M = 2.89, SD = 0.99), interest in winning during game play (M = 2.74, SD = 1.10) and interest in playing SLOTZ again (M = 1.89, SD = 0.94). A significant difference was observed between participant ratings of enjoyment and interest in playing SLOTZ again $t(18)$ = 4.14, p = <.001, with a large effect size detected (Hedge's g = 1.01, 95% CI 0.71, 1.32). A significant difference was also observed between participant ratings of interest in winning during gameplay and interest in playing SLOTZ again $t(18)$ = 3.83, p = <.001, with a large effect size detected (Hedge's g = 0.81, 95% CI = 0.49, 1.14). No significant difference was observed between participant ratings of enjoyment and interest in winning during gameplay $t(18)$ = 0.62, p = .546.

Qualitative Feedback

Eleven participants provided qualitative feedback for the purpose of revision and error fixing. Four of the 11 participants reported experiencing technical difficulties related to programming and/or platform-specific issues (i.e., "the roulette level got stuck in a loop and seemed to take forever", "the trivia game appeared in mobile format on a laptop, so that was quite hard as I had to turn my head sideways"). Six participants commented on the game's length of time, stating that a reduction in gameplay would be

advantageous (i.e., “for the game reaction time, the change of images was quite slow so it looked like I was clicking on the non-gambling object when I was supposed to be clicking on the gambling object and vice versa’, “cups game timing could be faster”, “trivia items could be faster”, and “roulette game was a little long, I grew impatient”). Only one of the 11 participants reported that they found the game boring and unenjoyable, stating that “it was frustrating that I could opt out of playing, I got bored”.

Discussion

The aim of the present study was to report on the development of a game-based measure of problem gambling, and to evaluate participant levels of immersion and engagement with SLOTZ game play. Statistically significant differences in immersion were observed between SLOTZ game play participants and Jennet et al. (2008) immersive and non-immersive task participants. Given that Jennet et al.’s (2008) immersive task consistent of 10 minutes playing Half Life, a 3-dimensional first-person shooter game, these results may indicate that participants found SLOTZ game play to be reasonably immersive and enjoyable. No statistically significant differences in participant levels of immersion were observed between Problem Gamblers and Non-Problem Gamblers, and participants' overall levels of immersion and engagement were found to be high. These results indicate that both Non-Problem Gamblers and Problem Gamblers found SLOTZ game play to be engaging and enjoyable, and suggest that SLOTZ may thus provide an appealing and suitable platform for large-scale screening use.

Implications

SLOTZ presents a novel form of problem gambling assessment that may be seen as an engaging, enjoyable and approachable form of assessment. It has the potential to

be tailored to appeal to a variety of different populations, as cosmetic changes to SLOTZ are unlikely to affect the underlying neurocognitive, cognitive, emotional and behaviour measures incorporated via game play. Consequently, use of this measure may improve recruitment within socio-cultural minorities. Other areas of addiction or health behaviours issues could potentially also be targeted via similar approaches to those employed via SLOTZ including smoking, cannabis use, methamphetamine use, and overeating. Assessment measures such as SLOTZ have the potential to provide more cost-effective means of assessment with much greater reach than existing measures.

Limitations and Directions for Future Research

There are several limitations to this study. Firstly, our results were based upon a limited sample size, which in turn precluded the application of more advanced statistical analyses. Further analyses with substantially larger sample sizes will be required to determine this measure's ability to discriminate between Non-Problem Gamblers and Problem Gamblers on measures other than PGSI and DSM 5-related items (i.e., SLOTZ subtest scores), as well as to evaluate the accuracy of each of the four SLOTZ subtests. Secondly, the composition of our sample size was predominately male (36% female, 63% male). Whilst this is comparable to global gender gaps in problem gambling prevalence (Dowling, 2014), future studies will require greater gender parity. Finally, though technical difficulties relating to programming and/or software compatibility issues were reported by four of the 19 participants, it afforded the opportunity to identity and rectify programming issues and inconvenient or unsuitable elements of game play based upon participant feedback. This small-scale user testing is often a critical stage with game and application development, as it can diminish the occurrence

of technical and usability issues during larger-scale implementation (Clough & Casey, 2015; Turner, Thomas & Casey, 2016).

Conclusion

SLOTZ presents as the first measure to integrate game design mechanics and neurocognitive theory in order to screen for problem gambling. This study provides preliminary evidence that game-based assessments can be engaging, enjoyable and user friendly. Researchers and mental health professionals should be encouraged to explore and guide the development of novel, game-based approaches to assessment and intervention, to ensure that future tools provide effective, engaging and valid psychological assessments that are able to reach PGs, other addictions, and other traditionally more difficulty to engage clinical populations.

References

Balconi, M., Finocchiaro, R., & Canavesio, Y. (2015). Reward sensitivity (behavioral activation system), cognitive, and metacognitive control in gambling behavior: Evidences from behavioral, feedback-related negativity, and P300 effect. The *Journal of Neuropsychiatry and Clinical Neurosciences, 27(3),* 219-227. doi: 10.1176/appi.neuropsych.14070165

Bechara, A., Damasio, H., Damasio, A. R., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50(1),* 7-15. doi: 10.1016/0010-0277(94)90018-3

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex, 10(3),* 295-307. 10.1093/cercor/10.3.295

Brand, M., Labudda, K., & Markowitsch, H. J. (2006). Neuropsychological correlates of decision-making in ambiguous and risky situations. *Neural Networks, 19*(8), 1266-1276. doi: 10.1016/j.neunet.2006.03.001

Brevers, D., & Noël, X. (2013). Pathological gambling and the loss of willpower: A neurocognitive perspective. *Socioaffective Neuroscience & Psychology, 3*(1), 21592-16. doi: 10.3402/snp.v3i0.21592Brevers, D., Cleeremans, A., Bechara, A., Greisen, M., Kornreich, C., Verbanck, P., & Noël, X. (2014). Impaired metacognitive capacities in individuals with problem gambling. *Journal of Gambling Studies, 30(1),* 141-152. doi: 10.1007/s10899-012-9348-3

Bowman, C. H., Evans, C. E. Y., & Turnbull, O. H. (2005). Artificial time constraints on the iowa gambling task: The effects on behavioural performance and subjective experience. *Brain and Cognition, 57(1),* 21-25. doi: 10.1016/j.bandc.2004.08.015

Buelow, M. T., & Suhr, J. A. (2009). Construct validity of the iowa gambling task. *Neuropsychology Review, 19(1),* 102-114. doi: 10.1007/s11065-009-9083-4

Camchong, J., Goodie, A. S., McDowell, J. E., Gilmore, C. S., & Clementz, B. A. (2007). A cognitive neuroscience approach to studying the role of overconfidence in problem gambling. *Journal of Gambling Studies, 23(2),* 185-199. doi: 10.1007/s10899-006-9033-5

Clough, B., & Casey, L. (2015). The smart therapist: A look to the future of smartphones and mHealth technologies in psychotherapy. *Professional Psychology-Research and Practice, 46*(3), 147-153. doi: 10.1037/pro0000011

Cunningham, J.A., Hodgins, D.C., Toneatto, T., & Murphy, Me. (2012). A Randomized Controlled Trial of a Personalized Feedback Intervention for Problem Gamblers. *PLoS One, 7(2).* doi: 10.1371/journal.pone.0031586

Delfabbro, P. (2014). Behavioral Risk Factors in Disordered Gambling and Treatment Implications. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

de Winter, J. C .F. (2013). Using the student's "t"-test with extremely small sample sizes. Practical Assessment, Research & Evaluation, 18(10). Retrieved from http://pareonline.net/

Dowling, N. (2014). The Cognitive-Behavioral Treatment of Female Problem Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Fleming, T., de Beurs, D., Khazaal, Y., Gaggioli, A., Riva, G., Botella, C., Banos, R. M., Aschieri, F., Bavin, L. M., Kleiboer, A., Merry, S., Ming Lau, H., & Riper,

H. (2016). Maximizing the impact of e-therapy and serious gaming: Time for a paradigm shift. *Frontiers in Psychiatry, 7,* 65. doi: 10.3389/fpsyt.2016.00065

Fortune, E. E., & Goodie, A. S. (2012). Cognitive distortions as a component and treatment focus of pathological gambling: A review. *Psychology of Addictive Behaviors, 26(2),* 298-310. doi: 10.1037/a0026422

Goldstein, R. Z., Craig, A. D. (., Bechara, A., Garavan, H., Childress, A. R., Paulus, M. P., & Volkow, N. D. (2009). The neurocircuitry of impaired insight in drug addiction. *Trends in Cognitive Sciences, 13*(9), 372-380. doi: 10.1016/j.tics.2009.06.004

Goldstein, R. Z., & Volkow, N. D. (2011). Dysfunction of the prefrontal cortex in addiction: Neuroimaging findings and clinical implications. *Nature Reviews Neuroscience, 12*(11), 652-669. doi: 10.1038/nrn3119

Goodie, A. S. (2005). The role of perceived control and overconfidence in pathological gambling. *Journal of Gambling Studies, 21(4),* 481-502. doi: 10.1007/s10899-005-5559-1

Gopinath Bharathi, A.K. B., Singh, A., Tucker, C. S., & Nembhard, H. B. (2016). Knowledge discovery of game design features by mining user-generated feedback. *Computers in Human Behavior, 60,* 361-371. doi: 10.1016/j.chb.2016.02.076

Goudriaan, A.E., van Holst, R.J., Veltman, D.J., & van den Brink, W. (2013). Contributions from Neuroscience and Neuropsychology. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Goudriaan, A. E., Oosterlaan, J., de Beurs, E., & van den Brink, W. (2006). Psychophysiological determinants and concomitants of deficient decision making in pathological gamblers. *Drug and Alcohol Dependence, 84*(3), 231-239. doi: 10.1016/j.drugalcdep.2006.02.007

Hardoon, K. K., Baboushkin, H. R., Derevensky, J. K., & Gupta, R. (2001). Underlying cognitions in the selection of lottery tickets. *Journal of Clinical Psychology, 57(6),* 749-763. doi: 10.1002/jclp.1047

Hofmann, W., Friese, M., & Strack, F. (2009). Impulse and self-control from a dual-systems perspective. *Perspectives on Psychological Science, 4*(2), 162-176. doi: 10.1111/j.1745-6924.2009.01116.x

Honsi, A., Mentzoni, R. A., Molde, H., & Pallesen, S. (2013). Attentional bias in problem gambling: A systematic review. *Journal of Gambling Studies, 29(3),* 359-375. doi: 10.1007/s10899-012-9315-z

Houben, K., & Wiers, R. W. (2009). Response inhibition moderates the relationship between implicit associations and drinking behaviour. *Alcoholism Clinical and Experimental Research, 33*(4), 626-633. doi: 10.1111/j.1530-0277.2008.00877.x

Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective attention to threat in the dot probe paradigm: Differentiating vigilance and difficulty to disengage. *Behaviour Research and Therapy, 42(10),* 1183-1192. doi: 10.1016/j.brat.2003.08.001

Krain, A. L., Wilson, A. M., Arbuckle, R., Castellanos, F. X., & Milham, M. P. (2006). Distinct neural mechanisms of risk and ambiguity: A meta-analysis of decision-making. *Neuroimage, 32*(1), 477-484. doi: 10.1016/j.neuroimage.2006.02.047

Jennett, C., Cox, A. K., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. International Journal of Human - *Computer Studies, 66(9),* 641-661. doi: 10.1016/j.ijhcs.2008.04.004

Landers, R. N. (2014). Developing a theory of gamified learning: Linking serious games and game design of learning. *Simulation & Gaming, 45(6),* 752-768. doi: 10.1177/1046878114563660

Lignuel, R., Sescousse, G., Barbalat, G., Domenech, P., & Dreher, J-C. (2013). Shifted risk preferences in pathological gambling. *Psychological Medicine (2013), 43,* 1059–1068. doi: 10.1017/S0033291712001900

Lipp, O. V., & Derakshan, N. (2005). Attentional bias to pictures of fear-relevant animals in a dot probe task. *Emotion, 5(3),* 365-369. doi: 10.1037/1528-3542.5.3.365

Lyons, J., Weeks, D. J., & Elliott, D. (2013). The gambler's fallacy: A basic inhibitory process? *Frontiers in Psychology, 4,* 72. Retrieved from https://www.frontiersin.org/journals/psychology

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95(1),* 15-20. doi: 10.1037/0021-843X.95.1.15

Mansueto, G., Pennelli, M., De Palo, V., Monacis, L., Sinatra, M., & De Caro, M. F. (2016;2015;). The role of metacognition in pathological gambling: A mediation model. *Journal of Gambling Studies, 32(1),* 93-106. doi: 10.1007/s10899-014-9519-5

Morford, Z. H., Witts, B. N., Killingsworth, K. J., & Alavosius, M. P. (2014). Game design: The intersection between behavior analysis and game design

technologies. *The Behavior Analyst, 37(1),* 25-40. doi: 10.1007/s40614-014-0006-1

Naqvi, N. H., & Bechara, A. (2008;2009;). The hidden island of addiction: The insula. *Trends in Neurosciences, 32*(1), 56-67. doi: 10.1016/j.tins.2008.09.009

Noël, X., Brevers, D., & Bechara, A. (2013). A neurocognitive approach to understanding the neurobiology of addiction. *Current Opinion in Neurobiology, 23*(4), 632-638. doi: 10.1016/j.conb.2013.01.018

Petry, N. M. (2005). P*athological gambling: Etiology, Comorbidity, and Treatments. W*ashington, DC: American Psychological Association.

Petry, N. M. (2009). Disordered gambling and its treatment. *Cognitive and Behavioral Practice, 16*(4), 457-467. doi: 10.1016/j.cbpra.2009.02.005

Raylu, N., & Oei, T. P. S. (2004). The gambling related cognitions scale (GRCS): Development, confirmatory factor validation and psychometric properties. *Addiction, 99(6),* 757-769. doi: 10.1111/j.1360-0443.2004.00753.x

Richard, D.C. & Humphrey, J. (2014). The Conceptualization and Diagnosis of Disordered Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Scirra. (2014). *Construct 2 (Version r173)* [Game Engine]. Retrieved from www.scirra.com

Spada, M. M., & Roarty, A. (2015). The relative contribution of metacognitions and attentional control to the severity of gambling in problem gamblers. *Addictive Behaviors Reports, 1,* 7-11. doi: 10.1016/j.abrep.2015.02.001

Stinchfield, R. (2002). Reliability, validity, and classification accuracy of the south oaks gambling screen (SOGS). Addictive Behaviors, 27(1), 1-19. doi: 10.1016/S0306-4603(00)00158-1

Sun, Y., & Wang, H. (2010). Gambler's fallacy, hot hand belief, and the time of patterns. *Judgment and Decision Making, 5(2),* 124-132. Retrieved from http://journal.sjdm.org/

Turner, W., Thomas, B., & Casey, L. (2016). Developing games for mental health: A primer. *Professional Psychology-Research and Practice, 47*(3), 242-249. doi: 10.1037/pro0000082

Verdejo-García, A., Lubman, D. I., Schwerk, A., Roffel, K., Vilar-López, R., MacKenzie, T., & Yücel, M. (2012). Effect of craving induction on inhibitory control in opiate dependence. *Psychopharmacology, 219*(2), 519-526. doi: 10.1007/s00213-011-2512-0

Xu, J., & Harvey, N. (2014). Carry on winning: The gamblers' fallacy creates hot hand effects in online gambling. *Cognition, 131(2),* 173-180. doi: 10.1016/j.cognition.2014.01.002

Chapter 6. SLOTZ: Measuring Problem Gambling via Video Game Play

Chapter 6: Foreword

As noted in Chapter 5, it is recommended that development and psychometric validation of mental health video games be conducted in two stages: (Stage 1) game play piloting; and (Stage 2) psychometric testing. While results obtained from the piloting of SLOTZ (Chapter 5) appeared promising regarding participants' ratings of immersion, engagement and enjoyment, larger-scale psychometric validation of SLOTZ was required.

Chapter 6 reports on the psychometric evaluation of SLOTZ test validity (e.g., face validity, content validity, convergent validity, discriminant validity, concurrent validity, predictive validity, etc.), so as to determine the validity and utility of its use a screening tool for problem gambling.

Qualitative feedback obtained via piloting (Chapter 5) lead to several changes being made to SLOTZ game play. These included:

- Accelerating level transitions;
- Accelerating participants' actions and consequences (e.g., on-screen display of rewards and punishments for participant selections);
- Removal of the Dot Probe Paradigm Subtest due to it being the source of the majority of reported technical issues and the least immersive, engaging and enjoyable subtest; and
- Replacement of the Dot Probe Paradigm Subtest with a substantially faster subtest consisting of a modified Stroop Task. Screenshots of SLOTZ gameplay are provided in Appendix D.

Finally, Chapter 6 is presented as an unpublished paper, with the intent to submit this paper for publication following final submission of this thesis.

Abstract

Relatively few problem gamblers ever seek treatment, despite experiencing substantial bio-psycho-social impairment because of their gambling. Game-based assessments and interventions may provide an important platform of assessment that can much more readily accessed than traditional face to face treatments. Game-based clinical assessments need to incorporate both games design and psychological theory, if they are to be recognised as engaging, effective and valid means of assessment. This study reports on the psychometric properties of SLOTZ, a game-based measure that has been recently developed to assess problem gambling. One hundred and seventy participants were invited to engage in playing SLOTZ after completing a questionnaire measuring gambling-related cognitions and demographic information. Item reliability, correlational and regression analyses were conducted. Nine SLOTZ Sub-Test variables were included in final analyses, demonstrating test validity. Two SLOTZ Sub-Test variables were found to significantly correlate with established measures of gambling severity andto significantly predict gambling severity scores. Findings from this study demonstrate the utility of rigorous validation testing during the development of clinical assessments, provide evidence that gambling severity can be identified and predicted via video game play, and support the utility of developing game-based clinical assessments.

SLOTZ: Measuring Problem Gambling via Video Game Play

Only approximately one in ten problem gamblers (PGs) will engage in psychological treatment, despite experiencing significant negative psychological, social and physical outcomes (Cunningham et al., 2012; Delfabbro, 2014; Goudriaan et al., 2013; Petry, 2009; Richard & Humphrey, 2014). This issue of treatment uptake is not just specific to problem gambling (Fleming et al., 2016). Individuals typically engage in addictive behaviours to reduce or escape unpleasant, negative emotions and experiences of self-awareness, which can in turn lead to feelings of shame and inadequacy, and further reduce the likelihood of treatment engagement (Schlagintweit et al., 2017; Yi & Kanetkar, 2011). To address this, there is a need for assessment and treatment platforms to be developed that are wider in reach and provide an engaging, user-friendly approach (Fleming et al., 2016). Game-based approaches may be particularly useful for addictive behaviours in providing a platform that is easily accessible and less susceptible to recall bias, interviewer bias and social desirability bias (Gopinath Bharathi et al., 2016; Kato, 2012; Kharrazi et al., 2012; Landers, 2014; Lau et al., 2017; Lumsden et al., 2016; Morford et al., 2014; Turner & Casey, 2014; Rahmani & Boren, 2012; Van Bennekom et al, 2017).

Game-Based Psychological Assessments

Despite their advantages, most game-based assessments to date make little reference to the use of empirically supported theory to drive their development (Clough & Casey 2015; Kharrazi et al., 2012; Lau et al., 2017; Lumsden et al., 2016; Parsons, 2015; Riley et al., 2013; Turner & Casey, 2014). The apparent lack of psychometric validation of these game-based assessments is similarly concerning, as these

instruments are often presented as being scientifically sound despite limited evidence of test validity (Kato, 2013; Lumsden et al., 2016). Calls have been made for researchers to conduct smaller pilot studies during early development of their game-based assessments, with an aim to conduct larger psychometric evaluations following the piloting stage (Clough & Casey, 2015; Lumsden et al., 2016; Turner, Thomas & Casey, 2016). An example of the effective implementation of this process can be seen in the validation of TagTiles by Verhaegh et al. (2007) and Verhaegh et al. (2013). In their 2007 study, Verhaegh et al. present findings from the piloting of their game-based platform for cognitive assessment (i.e., procedural memory, motor skills, executive functions and spatial skills), demonstrating that children appreciated their game and found it appropriately challenging. Psychometric validation of TagTiles is presented in Verhaegh et al.'s (2013) follow-up study. Participants' TagTiles subtest results were compared to results obtained from standardised cognitive assessments, including the WISC-III, Raven's progressive matrices and RAKIT's Memory Span (Vergaeh et al., 2013). Similar psychometrically sound evaluations of game-based assessments have been conducted by McPherson and Burns (2007; 2008), and Quiroga et al. (2015; 2016).

While other validation studies have been conducted on game-based assessments, these have focused on primarily puzzle-like cognitive assessments (e.g., working memory and processing speed) and less accessible and costly virtual reality-based clinical assessments (Lumsden et al., 2016; Parsons, 2015). As with game-based educational and psychological interventions, game-based assessments can also be hampered by difficulties in balancing participant engagement and enjoyment with psychological theory (Royle, 2008; Wang et al., 2009). Gameplay enjoyment should be

first and foremost in researchers' minds, with psychological theory and research aims moulded around engaging gameplay (Barbosa et al., 2014; Royle, 2008; Wang et al., 2009). Easily accessible, affordable, enjoyable, empirically supported and well-validated game-based clinical assessments are all but non-existent (Brand et al., 2014; Gopinath Bharathi et al., 2016; Landers, 2014).There appears to be a need for easily-accessible game-based clinical assessments to be developed in such a way that they effectively incorporate game-design theory, psychological theory, and well-established methods of psychological measurement validation if they are to be recognised as engaging, effective, and valid (Gopinath Bharathi et al., 2016; Landers, 2004; Lumsden et al., 2016; Morford et al., 2014; Turner, Thomas & Casey, 2016). Sufficient theory and guidance now exists on the development of games for psychological intervention and assessment (Adams & Rollings, 2010; Lumsden et al., 2016; Moura & Batram, 2014; Turner, Thomas & Casey, 2016), as well as issues of concern specific to psychological research (e.g. issues pertaining to privacy and data integrity; Baker & Bufka, 2011; Domsch, 2013; Jones, 2014; Luxton et al., 2011; Turner, Thomas & Casey, 2016). In making use of game development theory, it is important then to incorporate findings from the psychological literature in order to identify the specific factors requiring assessment in a game-based approach.

Neurocognitive Assessment of Gambling

PGs perform poorer on neurocognitive assessments than controls, demonstrating neurocognitive similarities to drug addictions including deficits in attention, frontal lobe functioning, preference for immediate rewards, risk seeking and other executive functioning abilities, and greater difficulty with attentional control (Balconi et al., 2015; Brevers et al., 2013; Camchong et al., 2007; Goudriaan et al., 2013; Honsi et al., 2013;

Leeman & Potenza, 2012). A variety of neurocognitive measures have been employed in the assessment of these problem gambling-related biases and deficits, targeting areas such as attentional bias, decision making and cognitive flexibility (Balconi et al., 2015; Brevers et al., 2013; Camchong et al., 2007; Goudriaan et al., 2013; Honsi et al., 2013; Leeman & Potenza, 2012). Whilst neurocognitive measures provide researchers with more ecologically valid means to examine problem gambling cognitive processes and behaviours (Goudriaan et al., 2013), their availability and reach is typically limited to experimental settings. While some neurocognitive measures have been made available for internet-based administration, they are still laboratory-based and experimental in nature (Goudriaan et al., 2013; Honsi et al., 2013). Moreover, none have been designed with the explicit intent to screen for problem gambling and to be an engaging and enjoyable experience.

Pilot Testing of SLOTZ

In an earlier study, we explored whether game design and neurocognitive theory could be used to develop a game-based assessment of problem gambling that users would find immersive and engaging (Turner & Casey, 2018). Participants were asked to complete two pre- and post-game play questionnaires measuring gambling-related cognitions, demographic information, immersion and qualitative feedback. Game mechanics that best fit gambling-related neurocognitive theory were incorporated into game play. Results from this study indicated that participants found SLOTZ game play to be engaging and enjoyable, providing evidence that clinical game-based assessments could be developed that is accessible, cost-effective, engaging, enjoyable, user friendly and wide in reach (Turner & Casey, 2018). While this small-scale preliminary study

was vital in the development of SLOTZ, larger-scale psychometric validation of the measure was required.

Current Study

This study aimed to explore the psychometric properties of SLOTZ: a game-based measure of gambling decision making. Specifically, this study consists of the evaluation SLOTZ's test validity (e.g., face validity, content validity, convergent validity, discriminant validity, concurrent validity and predictive validity), so as to determine its validity and utility as a screening tool for problem gambling.

Method

Participants

Participants were recruited via convenience sampling from social networking sites flyers posted across a university campus, a university undergraduate recruitment pool and an Australian problem gambling counselling service provider. Participants were required to have an adequate understanding of written English, adequate or corrected vision, and to be over 18 years of age. Exclusion criteria included a psychotic disorder or manic/hypomanic episode being experienced around the time of assessment, and for participants to not possess a history of serious neurological or medical conditions (e.g., traumatic brain injury) in order to control for conditions associated with impulsivity and impaired self-control (e.g., Bipolar Disorder, Schizoaffective Disorder and other conditions affecting executive functioning). Ethical approval was obtained from Griffith University Ethics Committee (reference number 2016/148; Appendix E) and the counselling service provider's ethical review. One hundred and seventy participants completed the study. Participant demographic information is presented in Table 5.1. There was a substantially higher proportion of female

participants (74.7%). The age of participants ranged from 17 to 50 years (*M* = 22.16, *SD* = 7.31). In order to examine SLOTZ's ability to identify problem severity across normal and clinical populations, participants were not required to be experiencing gambling-related issues at the time of assessment.

SLOTZ: A Game-Based Measure of Problem Gambling

Game play consisted of four Sub-Test games: a Stroop Game Sub-Test, a Trivia Game Sub-Test, a Four-Card Monte Sub-Test and a procedurally generated Runner Game Sub-Test. Sub-Tests administration was randomly ordered, to limit the effect of task ordering. These four Sub-Test games are depicted in Appendix D. A full description of the development of SLOTZ Sub-Test games is reported in Turner & Casey (2018). Qualitative feedback obtained from participants during piloting (Turner & Casey, 2018) lead to revision of SLOTZ gameplay, including the replacement of a Dot Probe Paradigm Sub-Test with a modified pictorial Stroop Task Sub-Test.

Stroop Game Sub-Test

Attentional bias to gambling-related stimuli was assessed via a modified pictorial stroop task (Ashwin et al., 2006; Bourke & Gormley, 2012; Bruce & Jones, 2004; Ó'Ciardha & Gormley, 2009). Participants were presented with an image that randomly varied between gambling-related and non-gambling-related stimuli, and between three colours (blue, red, yellow). Participants were then presented a selection of three colour boxes (blue, red, yellow) and tasked with selecting the colour that matched the presented stimuli image. Participants' reaction times in selecting correct colours were recorded over an initial 10-trial practice block and two 100-trial blocks. Data pertaining to total money won, gambling related image reaction times, non-

gambling related image reaction times, frequency of correct selections and frequency of incorrect selections were recorded for analysis.

Trivia Game Sub-Test

Overconfidence in decision making and metacognition was assessed via the incorporation of a confidence in decision making assessment based upon the work of Camchong et al. (2007) and Goodie (2005). Participants were presented with general knowledge questions and asked to choose between two possible answers. Once a response was selected, participants were given the choice of taking a chance ('Gain $66 or Gain Nothing') or having a guaranteed win ('Gain $50 even if you're wrong'). Participants were also asked to estimate how many trivia responses they had correctly chosen ('Most of them', 'Some of them', and 'Few of them'). Data pertaining to correct responses, incorrect responses, correct chances taken, incorrect chances taken, and frequency of self-evaluation choices were recorded for analysis.

Four Cup Monte Sub-Test

A decision-making task using principles similar to those depicted in the Iowa Gambling Task (IGT) was developed and incorporated into SLOTZ game play (Bechara et al., 2000; Bowman et al., 2005; Brevers et al, 2013; Lakey et al., 2007). Participants were presented with four cups and tasked with choosing the cup that had a poker chip placed behind it. Participants were given the opportunity to allow the computer to choose a cup every 15 trials, with the intent to measure need for control and overconfidence in decision making. Data pertaining to total money won, differences between total winning and losing selections, selection changes between 20 block trials (Buelow & Suhr, 2009) and frequency of computer-based choices allowed were recorded for analysis.

Runner Game Sub-Test

The Runner Game sub-test consisted of a procedurally generated endless runner level intended to measure behaviours and responses associated with illusory correlations, cognitive flexibility, and common problem gambling-related cognitive biases: the gambler's fallacy and the hot-hand fallacy (Lyons et al., 2013; Sun & Wang, 2010; Xu & Harvey, 2014). Participants were instructed to hit roulette wheel spinners placed on newly generated platforms to win money, while falling off the screen from missing a platform would result in a financial loss. At varying intervals, participants would be asked to determine whether game play grew more difficulty based upon the presentation of randomly generated die scrolling across the top of the screen (e.g., blue dice present, red dice present, both dice present, no change). Data pertaining to participants' errors (falling off-screen), correlations chosen, and total winnings were used in score calculations were recorded for analysis.

Additional In-Game Assessments

Decision making processes relating to risk and reward were also assessed during level transition screens (Goudriaan et al., 2013; Lignuel et al., 2013), with participants asked whether they wished to double the previous level's winnings with a 50% chance of losing winnings, or to keep their level winnings with no chance. Scores were calculated based upon frequency of chances taken. Total winnings across all game-play was also recorded for analysis.

Materials

Gambling-related cognitions

The Gambling-Related Cognitions Scale (GCRS; Raylu & Oei, 2004) is a 23-item, 7-point Likert scale questionnaire (Appendix F). Items within the GCRS load

upon five factors relating to gambling-related cognitions: illusions of control, predictive control, interpretive bias, gambling-related expectancies, and impaired control. The GCRS has demonstrated internal reliability (total α = .93; sub-scale α = .77-.91), concurrent and discriminant validity with measures of depression, anxiety and gambling severity, and has been tested across age groups and cultures (Raylu & Oei, 2004).

Problem gambling severity

The Problem Gambling Severity Index (PGSI; Ferris, 2001) is a nine-item subscale of the Canadian Problem Gambling Index designed to measure problem gambling severity (Appendix G). The PGSI divides respondents into four gambler sub-types based upon their scores: non-PGs (0), low risk gamblers (1-2), moderate risk gamblers (3-7), and PGs (8-27). The PGSI has demonstrated internal consistency (α = 0.82) and reliability (r = .78, Ferris, 2001). Responses range from 0 (‘never’) to 3 (‘almost always’).

Items additional to those in the PGSI were generated to compare responses to Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association, 2013) Gambling Disorder diagnostic criteria, in order to identify both sub-clinical (at risk and problem gambling) and clinical (Gambling Disorder) presentations (Petry, 2005; Williams & Volberg, 2014). Participants were deemed to have endorsed DSM 5 Gambling Disorder diagnostic criteria if they selected DSM 5 Gambling Disorder criteria responses of ‘most of the time ‘or ‘almost always’ (Appendix H). Participants were not deemed to have met criteria if they selected ‘sometimes’ or ‘never’. Gambling Disorder severity ratings are given based upon criteria endorsement, ranging from mild (4-5 criteria endorsed) through to moderate (6-7 criteria endorsed) and severe (8-9 criteria endorsed).

Preferred forms of gambling, frequency and expenditure

Participants were also asked to report their preferred forms of gambling, as well as their frequency of gambling and gambling expenditure over the previous 30-day period.

Procedure

Participants were invited to participate in the psychometric assessment of a game-based measure of gambling decision making. They were asked to complete a questionnaire prior to gameplay, consisting of gambling-related cognition items and assessment items. Participants were informed that questionnaires and gameplay would take approximately 60 to 80 minutes to complete. Participation could occur anywhere participants had access to the internet and on any digital device possessing a web browser. Participants were informed of their anonymity prior to participation, with data collected during the course of the study remaining de-identified at all times.

Statistical Analyses

Data screening was conducted in accordance with guidelines presented by Tabachnick and Fidell (2007). Participant data were screened for errors, missing values, univariate and multivariate outliers, and normality. Sixty univariate outliers were identified and transformed via Box-Cox transformations (Box & Cox, 1964). Four outlier participants were identified and removed from analysis as they were found to artificially inflate results, with the remaining 56 participants included in final analysis. The final total sample size was $n = 166$. Descriptive analyses and Cronbach's alpha were calculated, with reliability coefficients interpreted in accordance with guidelines presented by Robinson et al. (1991).

Pearson product-moment coefficient correlations were calculated among SLOTZ variables, and between SLOTZ variables and total DSM 5 criteria endorsement, GRCS scores, PGSI scores, and frequency and amount spent gambling. Point-Biserial coefficient correlations were calculated between individual DSM 5 criteria endorsement, and SLOTS variables, GRCS scores, PGSI scores, and frequency and amount spent gambling. Multivariate linear and logistic regressions were used to identify individual SLOTZ scores predictive of PGSI scores, total DSM 5 criteria endorsement, GRCS scores, frequency spent gambling, amount spent gambling, individual DSM 5 criteria endorsement, and GRCS sub-scales scores. All statistical analyses were performed in IMB SPSS Statistics 22.

Results

Descriptive Statistics and Reliability

As smaller tests and sub-tests (e.g., 4 items) commonly possess lower reliability coefficients, mean inter-item correlations are reported (Pallant, 2013), with an optimal range of .2 to .4 (Briggs & Cheek, 1986). Descriptive statistics and mean inter-item correlations for SLOTZ Sub-Tests are presented in Table 5.2. Nine variables were removed due to low Sub-Test inter-item correlations (DeVellis, 2012; Pallant, 2013). Three of the four final SLOTZ Sub-Tests demonstrated acceptable inter-item means (Stroop Game Sub-Test a = .45, Four Cup Monte Sub-Test a = .35, Trivia Game Sub-Test a = .44; DeVellis, 2012). As the Runner Game Sub-Test demonstrated a high level of inter-item correlation (.99) suggesting considerable overlap in items, only the total Runner Game Sub-Test Score was included in further analyses. Finally, variables were required to include three or more cases to be included in statistical analyses (Kirk, 2007; Weaver & Koopman, 2014).

Gambling Severity

A total of 166 participants were included in analysis. Seven participants were observed to present with symptoms consistent with a diagnosis of Gambling Disorder via the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (i.e., a minimum of four Gambling Disorder symptoms; American Psychiatric Association, 2013). Twenty-two participants were observed to score within the 'low' level of problems as scored on the PGSI, with 16 participants observed to fall within the 'moderate' level of problems as scored on the PGSI and two participants falling within the 'problem gambling' level as scored on the PGSI.

SLOTZ Sub-Test Intercorrelations

Correlation coefficients between SLOTZ Sub-Test variables are presented in Table 5.3. Several SLOTZ subtests were observed to possess significant within subtest correlations, with effect sizes ranging from small (.16) to large (.97). Given the strength of correlations between Trivia Game Sub-Test scores and Trivia Game Sub-Test gambling response accuracy scores, these items were deemed to measure an identical construct. Examination of the strength of correlations between Trivia Game Sub-Test scores and other Game Sub-Test scores lead to the decision to retain Trivia Game Sub-Test gambling response accuracy scores for further analyses, so as to avoid redundancy among Trivia Sub-Test items.

Gambling Severity Correlations

Correlation coefficients between gambling severity measures (total DSM 5 criteria endorsement, GRCS scores, PGSI scores, and frequency and amount spent gambling) are presented in Table 5.4. Significant correlations were observed between most gambling severity measures. GCRS total scores and sub-scale scores were

observed to significantly correlate with PGSI total scores, total DSM 5 criteria endorsement, and amount spent gambling, but were not found to significantly correlate with frequency of gambling. Table 5.5 displays correlation coefficients between individual DSM 5 criteria endorsement and other gambling severity measures (GRCS scores, PGSI scores, and frequency and amount spent gambling). Significant correlations were found between most gambling severity measures and individual DSM 5 criteria endorsement, with no significant correlations observed between several individual DSM 5 criteria and GRCS Illusion of Control Sub-Test scores, GRCS Predictive Control Sub-test scores, GRCS Gambling Expectancies Sub-Test, frequency of gambling, and amount spent gambling.

Correlation coefficients between DSM 5 severity ratings, PGSI severity ratings, and other gambling severity measures (PGSI scores, total DSM 5 criteria endorsement, GRCS scores, frequency and amount spent gambling) are presented in Table 5.6. Significant correlations were observed between DSM 5 mild severity ratings and the majority of other gambling severity measures, with fewer significant correlations observed between PGSI severity ratings and other gambling severity measures.

SLOTZ Sub-Test and Gambling Severity Correlations

Table 5.7 displays significant correlation coefficients between gambling severity measures and SLOTZ Sub-Test scores. SLOTZ FCM-D scores were observed to significantly correlate with several gambling severity measures, with effect sizes ranging from .16 to .27. Fewer significant correlations were observed between SLOTZ TR-O and gambling severity measures, with effect sizes ranging from .15 to .23. While SLOTZ RN-S scores were observed to significantly correlate with one GRCS subscale (illusion of control), this was found to be small (.15).

Predicting Gambling Severity

Variables with less than 10 cases were not included in regression analyses (Peduzzi et al., 1995; Wilson Van Hooris, Carmen & Morgan, 2007). Multivariate linear regressions were performed to assess the ability of FCM-D and TR-O scores to predict total DSM 5 criteria endorsement, GRCS total scores, and GRCS subscale scores. Multivariate linear regression results are presented in Table 5.8 and Table 5.9. FCM-D performance was observed to significantly and uniquely predict total DSM 5 criteria endorsement; total GRCS scores; and GRCS predictive control, inability to stop gambling, interpretive bias and gambling expectancies subscale scores. TR-O performance was observed to significantly and uniquely predict total GRCS scores and GRCS inability to stop gambling subscale scores. Squared semi-partial correlations revealed that FCM-D contributed to between 1.96% to 5.76% of unique variance, with TR-O contributing to between 0.25% and 3.24% of unique variance, respectively.

Multivariate logistic regressions were performed to assess the ability of FCM-D and TR-O scores to predict individual DSM 5 criteria endorsement. Multivariate logistic regression results are presented in Table 5.10. Inverting the odds ratios reveals that participants with higher FCM-D scores were observed to be 73% less likely to meet DSM 5 criteria relating to preoccupation with gambling, 67% less likely to meet DSM 5 criteria relating to using gambling as a means of coping, 59% less likely to meet DSM 5 criteria relating to habituation to gambling and 37% less likely to meet DSM 5 criteria relating to chasing losses. TR-O performance was not observed to significantly predict individual DSM 5 criteria endorsement.

Finally, a univariate logistic regression was performed to assess the ability of FCM-D scores to predict PGSI moderate risk severity ratings. Univariate logistic

regression results are presented in Table 5.11. Participants with higher FCM-D scores were observed to be 65% less likely to fall within the PGSI moderate risk level rating than those with lower FCM-D scores.

Discussion

The aim of this study was to evaluate the test validity of SLOTZ: a game-based measure of problem gambling, and to evaluate its ability to identify and predict gambling severity. While FCM Sub-Test and TR Sub-Test performance was observed to significantly predict DSM 5 criteria endorsement, total GRCS scores and some GRCS subscales scores, their overall predictive ability was observed to be low. FCM-D performance was observed to be more accurately able to identify DSM 5 Gambling Disorder criteria endorsement and PGSI moderate risk level ratings, indicating potential clinical utility as a means of screening for Problem Gambling.

Psychometric validation can often be a lengthy process and though it is rarely conducted among game-based clinical assessment studies (Clough & Casey 2015; Gopinath Bharathi et al., 2016; Kharrazi et al., 2012; Landers, 2004; Lau et al., 2017; Lumsden et al., 2016; Parsons, 2015; Riley et al., 2013; Morford et al., 2014; Turner & Casey, 2014), recommendations have been made as to how this process should be conducted (Lumsden et al., 2016). Specifically, it is recommended that smaller pilot studies of game-based assessment are conducted earlier in the development process, with larger psychometric evaluations conducted at a later stage (Clough & Casey, 2015; Lumsden et al., 2016; Turner, Thomas & Casey, 2016). Taken together, the current study and the preliminary small-scale testing of SLOTZ (Turner & Casey, 2018) provide further support for the importance of this methodologically rigorous process of testing and validation, with SLOTZ demonstrating high levels of participant

engagement and enjoyment, as well as evidence of face validity, convergent validity, discriminant validity, concurrent validity and predictive validity as can be seen via SLOTZ Sub-Tests' correlation and regression results. Consequently, findings from the current study and preliminary testing of SLOTZ provide evidence that gambling severity can be identified and predicted via video game play and demonstrate the utility of game-based clinical assessments.

Implications

Game-based clinical assessments have the potential to provide participants with a platform that is more readily accessible, engaging, motivating and less stressful than traditional delivery platforms (Gopinath Bharathi et al., 2016; Kato, 2012; Kharrazi et al., 2012; Landers, 2014; Lau et al., 2017; Morford et al., 2014; Turner & Casey, 2014; Rahmani & Boren, 2012; Verhaegh et al., 2013). Despite this, there exists a substantial lack of empirical evidence in the development and application of game-based assessment to date (Clough & Casey 2015; Kharrazi et al., 2012; Lau et al., 2017; Riley et al., 2013; Turner & Casey, 2014). To this end, SLOTZ presents as one of the first game-based clinical assessments developed in accordance with game design and neuropsychological theory.

The current study's findings, taken together with results obtained in the pilot testing of SLOTZ game play (Turner & Casey, 2018), suggest that a game-based approach provides a user-friendly and valid platform for the screening for problem gambling and gambling-related decision making. SLOTZ was developed drawing on game-design theory, psychological theory and psychological measurement principles are numerous. Non-significant sub-tests and variables were removed, leaving an abbreviated version of SLOTZ that is likely to be user friendly, engaging and easily

accessible. Game-play can be targeted at various clinical populations and minority groups, with cosmetic changes unlikely to affect underlying game-design and psychological theory. Finally, given the convergence of gambling and digital media (e.g., online gambling via mobile phones; Delfabbro et al., 2009; Kairouz et al., 2012; King et al., 2012) and the prevalence of psychosocial difficulties faced by even social gamblers (Petry et al., 2008; Productivity Commission, 2010), SLOTZ has the potential to offer an economical, wide-reaching means of screening for gambling-related difficulties, engaging individuals who are otherwise unlikely to ever seek help (Cunningham et al., 2012; Delfabbro, 2014; Goudriaan et al., 2013; Petry, 2009; Richard & Humphrey, 2014).

Limitations and directions for future research

The current study has several potential limitations. Firstly, our study included a relatively small number of participants (N = 170). While a larger sample size may arguably increase statistical power, there are benefits to conducting smaller sample size design studies. Larger sample size studies are typically conducted over substantially longer periods that often lead to an increase the likelihood that any findings will be outdated by the time they are published, an issue which is especially problematic in technology-based studies (Clough & Casey, 2015, Riley et al., 2013). Secondly, the number of participants meeting diagnostic criteria was observed to be lower than those meeting PGSI severity level cut-offs (Gambling Disorder n = 4, PGSI low risk n = 22, PGSI moderate risk n = 16). This discrepancy is hypothesised to be due to inherent differences in measurement between Gambling Disorder and the PGSI, with problem gambling not currently listed in the DSM 5 despite its widespread use in empirical literature (Chamberlain et al., 2017; Hodgins et al., 2011; Lorains et al., 2011; Petry,

2005; Williams & Volberg, 2014). Whilst some researchers use the term problem gambling to refer to one end of a spectrum of gambling-related difficulties (Petry, 2005; Williams & Volberg, 2014), future researchers may wish to place greater focus upon participants presenting with symptoms of problem gambling as opposed to Gambling Disorder, as doing so is likely to reach more individuals and may aid in the early identification of gambling-related difficulties. Thirdly, participants in the current study were predominately female (74.7% female, 25.3% male). Whilst this gender balance is commonly observed amongst undergraduate university research participants (Dickson et al., 2012) this may be problematic, as many of the neurocognitive biases assessed via SLOTZ game play are frequently observed among male PGs (Cunningham et al., 2012; Delfabbro, 2014; Goudriaan et al., 2013; Petry, 2009). For this reason, future studies may wish to examine whether gender differences in outcomes and engagement levels can be observed.

Fourthly, the majority of participants in the current study engaged in SLOTZ game play via their personal computer or laptop (97.1%). Given the adoption rate of other digital devices (e.g., smartphones and tablets) and game play via these devices (Brand et al., 2014; Entertainment Software Association, 2015; Gillett, 2012; Hamblen, 2013; Heggestuen, 2013; Newzoo, 2013), future studies may wish to examine outcomes obtained exclusively via these devices. Fifthly, given that administration was completed remotely, issues relating to participant understanding of the assessment process cannot be ruled out. Finally, given the nature of the standardised gambling severity measures included in this study, results obtained from these self-report measures and SLOTZ Sub-Test performance were susceptible to the effects of biases such as recall basis and social desirability bias. While SLOTZ game play included

several behavioural measures of gambling behaviour, future studies may wish to include additional behavioural measures during data analyses (e.g., Electronic Gaming Machine gambling behaviour; Lumsden et al., 2016; Parsons, 2015; Van Bennekom et al, 2017).

Conclusion

SLOTZ presents as a potentially ecologically valid measure of problem gambling. By incorporating games design and neuropsychological theory, it provides users with game play that is user-friendly, motivating, engaging and enjoyable, whilst also demonstrating a promising level of ability to identify potential PGs. Moreover, SLOTZ game play may provide an economical and wide-reaching platform for screening for clinical and socio-demographic populations who are historically difficulty to engage.

Table 5.1.

Demographic information for participants

	Mean/SD/Frequency (%)
Sex	
Female	127 (25.3%)
Male	43 (74.7%)
Age	*M* = 22.16, *SD* = 7.31
Vision corrected via glasses, contacts, etc.	78 (40.6%)
Digital device used	
Computer/Laptop	165 (97.1%)
Mobile	3 (1.8%)
Tablet	2 (1.2%)
Number of digital devices in household	
1 to 2 devices	8 (4.7%)
3 to 4 devices	34 (20.0%)
5 or more devices	128 (75.3%)
Adequate understanding of written English	169 (99.4%)
Education Level	
Primary	1 (0.6%)
Secondary	80 (47.1%)
Trade	1 (0.6%)
Diploma/Certificate	35 (20.6%)
Undergraduate Degree	49 (28.8%)
Postgraduate Degree	4 (2.4%)
Employment Status	
Full-time	12 (7.1%)
Part-time	51 (30.0%)
Casual/Temporary	53 (31.2%)
Unemployed	54 (31.8%)
Retired	0 (0.0%)
Income Level	
$0 - $399	119 (70.0%)
$400 - $799	38 (22.4%)

$800 - $1249	6 (3.5%)
$1250 - $1499	5 (2.9%)
$1500 - $1999	0 (0.0%)
$2000+	2 (1.2%)
Relationship Status	
Single	123 (72.4%)
Defacto	34 (20.0%)
Married	9 (5.3%)
Separated	1 (0.6%)
Divorced	2 (1.2%)
Widowed	1 (0.6%)
Preferred types of gambling	
Bingo	26 (15.3%)
Cards	50 (29.4%)
Electronic gaming machine	50 (34.1%)
Lotto	62 (36.5%)
Internet	12 (7.1%)
Other casino games	14 (8.2%)
Sport betting	33 (19.4%)

** Note. N = 170*

Table 5.2

Descriptive statistics for SLOTZ sub-tests

Sub-test/Variable	Mean (SD)	Range	Mean inter-item correlation
Stroop (ST) sub-test			.45
ST score (ST-S)	4573.80 (881.75)	-2825, 4900	
ST gambling reaction time (ST-GRT)	34.17 (7.73)	13.95, 55.38	
ST non-gambling reaction time (ST-NRT)	21.69 (6.51)	1.68, 40.65	
Four Cup Monte (FCM) sub-test			.35
FCM score (FCM-S)	-390.27 (1957.02)	-5050, 4550	
FCM win-loss discrepancy (FCM-D)	0.13 (4.43)	-12, 14	
Trivia (TR) sub-test			.44
TR Score (TR-S)	4506.89 (536.75)	2961, 5351	
TR gambling response accuracy (TR-GRA)	38.79 (16.28)	-10, 66	
TR Over-confidence (TR-O)	19.22 (159.37)	0, 1821.49	
Runner (RN) sub-test			-
RN score (RN-S)	4407.53 (455.36)	2300, 5150	

Note. n = 166.

Table 5.3

Correlations within SLOTZ Sub-Tests

Sub-tests and Variables	1	2	3	4	5	6	7	8	9
ST sub-test	-								
1. ST-S	.10	-							
2. ST-GRT	.16*	.67***	-						
3. ST-NRT	.040	.000							
FCM sub-test									
4. FCM-S	.10	-.11	-.06	-					
5. FCM-D	.08	.01	.03	.36***	-				
TRV sub-test									
6. TR-S	.25**	-.06	-.11	-.01	.03	-			
7. TR-GRA	.27***	-.03	-.08	-.02	.05	.97***	-		
8. TR-O	-.03	-.04	-.09	.05	.00	.16*	.19*	-	
RN sub-test									
9. RN-S	.18*	-.23**	-.11	.15	.02	.08	.10	.09	-

Note. ST = Stroop, ST-S = Stroop score, ST-GRT = Stroop Gambling reaction time, ST-NRT = Stroop non-gambling reaction time, FCM = Four Cup Monte, FCM-S = Four Cup Monte score, FCM-D = Four Cup Monte win-loss discrepancy, TR = Trivia, TR-S = Trivia score, TR-GRA = Trivia gambling response accuracy, TR-o = Trivia over-confidence, RN = Runner, RN=S = Runner score. *p <.05. **p <.01. ***p <.001.

Table 5.4

Pearson product-moment coefficient correlations among gambling severity measures

Measure/Item/Sub-scale	M	1	2	3	4	5	6	7	8	9	10
1. PGSI	0.77 (2.00)	-									
2. DSM 5 Criteria Total	0.55 (1.38)	.92***	-								
GRCS											
3. Illusion of Control	1.78 (1.08)	.21**	.25**	-							
4. Predictive Control	2.28 (1.19)	.29***	.32***	.71***	-						
5. Inability to Stop Gambling	1.44 (0.84)	.29***	.35***	.64***	.56***	-					
6. Interpretive Bias	2.24 (1.32)	.37***	.40***	.70***	.85***	.62***	-				
7. Gambling Expectancies	1.99 (1.21)	.32***	.35***	.59***	.72***	.66***	.80***	-			
8. Total	9.73 (4.99)	.35***	.39***	.80***	.92***	.71***	.94***	.87***	-		
9. 30-day Frequency of Gambling	5.95 (14.87)	.19*	.25**	.10	.10	.10	.16*	.10	.20	-	
10. 30-day Amount Spent Gambling	54.08 (148.47)	.29***	.35***	.29***	.31***	.23**	.31***	.28***	.34***	.34***	-

Note. PGSI – Problem Gambling Severity Index. DSM 5 – Diagnostic and Statistical Manual of Mental Disorders, 5th Edition. GRCS – Gambling-Related Cognitions Scale. *p <.05. **p <.01. ***p <.001.

Table 5.5

Point-Biserial coefficient correlations between individual DSM 5 criteria endorsement and other gambling severity measures

Measure/Sub-scale	Habituation	Restlessness	Loss of Control	Preoccupation	Coping	Chasing Losses	Lied to Conceal	Financial Relief
Cases meeting criteria *n* (%)	16 (9.6%)	6 (3.6%)	5 (3.0%)	9 (5.4%)	12 (7.2%)	30 (18.1%)	7 (4.2%)	5 (3.0%)
Cases not meeting criteria *n* (%)	150 (90.4%)	160 (96.4%)	161 (97.0%)	157 (94.6%)	154 (92.8%)	136 (81.9%)	159 (95.8%)	161 (97.0%)
PGSI	.61***	.42***	.29***	.43***	.53***	.85***	.35***	.35***
DSM 5 Total	.66***	.44***	.36***	.49***	.58***	.87***	.43***	.36***
GRCS								
Illusion of Control	.10	.18*	.23**	.29***	.20	.10	.23**	.21**
Predictive Control	.23**	.23**	.27***	.31***	.24**	.27***	.10	.18*
Inability to Stop Gambling	.41***	.34***	.23**	.26**	.31***	.20*	.21**	.18*
Interpretive Bias	.38***	.30***	.27***	.27***	.29***	.35***	.19*	.18*
Gambling Expectancies	.37***	.31***	.24**	.25**	.38***	.28***	.20	.10
Total	.34***	.29***	.27***	.28***	.30***	.31***	.18*	.17*
30-day Frequency of Gambling	.17*	.10	.17*	.17*	.10	.16*	.10	.10
30-day Amount Spent Gambling	.29***	.21**	.21**	.19*	.21**	.21**	.21**	.10

Note. PGSI – Problem Gambling Severity Index. DSM 5 – Diagnostic and Statistical Manual of Mental Disorders, 5th Edition. GRCS – Gambling-Related Cognitions Scale. *p <.05. **p <.01. ***p <.001.

Table 5.6

Point-Biserial coefficient correlations between individual DSM 5 severity levels, PGSI severity levels and other gambling severity measures

Measure/Sub-scale	Gambling Disorder - Mild	Gambling Disorder - Moderate	PGSI – Low risk	PGSI – Moderate risk
Cases meeting severity *n* (%)	7 (4.2%)	4 (2.4%)	22 (13.3%)	16 (9.6%)
Cases not meeting severity *n* (%)	159 (95.8%)	162 (97.6%)	144 (86.7%)	150 (90.4%)
PGSI Total	.70***	.35***	.16	.57***
DSM 5 Total	.81***	.42***	.24**	.49***
GRCS				
Illusion of Control	.26**	.08	.11	.00
Predictive Control	.24**	.06	.17*	.09
Inability to Stop Gambling	.45***	.32***	.12	.13
Interpretive Bias	.41***	.24**	.15*	.21**
Gambling Expectancies	.46***	.32***	.19*	.16*
Total	.41***	.26**	.17*	.13
30-day Frequency of Gambling	.025	-.02	.08	-.04
30-day Amount Spent Gambling	.46***	.38***	.01	.49***

Note. PGSI – Problem Gambling Severity Index. DSM 5 – Diagnostic and Statistical Manual of Mental Disorders, 5th Edition. GRCS – Gambling-Related Cognitions Scale. *p <.05. **p <.01. ***p <.001.

Table 5.7

Significantly correlating Gambling Severity measures and SLOTZ Sub-test variables

Variable	FCM-D	TR-O	RN-S
PGSI total[a]	-.22**	-.03	.02
PGSI Mild risk[b]	-.27***	-.01	-.10
DSM 5 Criteria			
Habituation[b]	-.25**	.15*	-.03
Restlessness[b]	-.16*	.18*	-.05
Loss of Control[b]	-.08	.21**	.04
Preoccupation[b]	-.25**	.00	-.08
Coping[b]	-.23**	.03	-.06
Chasing Losses[b]	-.16*	-.03	-.01
Total[a]	-.22**	.01	-.02
GRCS			
Illusion of Control[a]	-.14	.15	-.15*
Predictive Control[a]	-.24**	.20**	-.12
Inability to Stop Gambling[a]	-.17*	.23**	-.08
Interpretive Bias[a]	-.22**	.23**	-.07
Gambling Expectancies[a]	-.20**	.14	-.05
Total[a]	-.23**	.21**	-.10
30-day Amount Spent Gambling[a]	-.11	.17*	.04

Note. *F*CM-D – Four Cup Monte sub-test win-loss discrepancy, TR-O – Trivia sub-test over-confidence, RN-S – Runner sub-test score. [a] = Pearson product-moment coefficient correlation, [b] = Point-Biserial coefficient correlation. *p <.05. **p<.01.

Table 5.8

Multivariate linear regressions of FCM-D, TR-O and DSM 5 total scores and GRCS total scores

				FCM-D				TR-O			
Gambling Severity Measure	R^2	$F_{(2,163)}$	*Constant B* (SE)	*B* (SE)	β	95% CI	sr^2	*B* (SE)	β	95% CI	sr^2
DSM 5 Total	.051*	4.39	1.35 (0.30)	-0.30** (0.11)	-0.22	-0.51, -0.10	.048	0.07 (.11)	0. 05	-0.14, 0.27	.003
GRCS Total	.079**	6.97	12.66 (1.08)	-1.17** (0.38)	-0.24	-1.92, -0.42	.058	0.76* (0.38)	0.15	0.00, 1.51	.023

Note. FCM-D – Four Cup Monte sub-test win-loss discrepancy, TR-O – Trivia sub-test over-confidence. CI = confidence interval. sr^2 = squared semipartial correlations. ***p*<.01. **p*<.05.

Table 5.9

Multivariate linear regressions of FCM-D, TR-O and GRCS subscales

					FCM-D				TR-O		
GRCS Subscale	R^2	$F_{(2,163)}$	*Constant B* (SE)	*B* (SE)	β	95% CI	sr^2	*B* (SE)	β	95% CI	sr^2
Illusion of Control	.037*	3.13	2.16 (0.24)	-0.16 (0.84)	-0.14	-0.32, 0.01	.020	0.14 (0.08)	0.13	-0.03, 0.30	.017
Predictive Control	.085**	7.60	3.05 (0.26)	-0.30** (0.09)	-0.26	-0.48, -0.13	.068	0.17 (0.09)	0.14	-0.01, 0.35	.020
Inability to Stop Gambling	.067**	5.81	1.80 (0.19)	-0.16** (0.07)	-0.19	-0.29, -0.03	.020	0.15* (0.06)	0.18	0.02, 0.27	.032
Interpretive Bias	.068**	5.94	2.97 (0.29)	-0.29** (0.10)	-0.22	-0.49, -0.09	.048	0.18 (0.10)	0.14	-0.02, 0.38	.020
Gambling Expectancies	.058**	5.05	2.67 (0.27)	-0.26** (0.09)	-0.22	-0.45, -0.08	.048	0.12 (0.09)	0.10	-0.06, 0.30	.010

Note. FCM-D – Four Cup Monte sub-test win-loss discrepancy, TR-O – Trivia sub-test over-confidence. CI = confidence interval. sr^2 = squared semipartial correlations. ***p*<.01. **p*<.05.

Table 5.10

Multivariate logistic regressions of FCM-D, TR-O and DSM 5 criteria endorsement

	FCM-D				TR-O			
DSM 5 criteria	*B* (SE)	*OR*	95% CI	Wald χ^2	*B* (SE)	*OR*	95% CI	Wald
Habituation	-0.89 (0.32)	0.41**	0.22, 0.76	8.15	0.39 (0.20)	1.48	1.00, 2.17	3.90
Restlessness	-0.84 (0.29)	0.43	0.17, 1.08	3.20	0.32 (0.29)	1.38	0.78, 2.43	1.20
Loss of Control	-0.45 (0.49)	0.64	0.24, 1.67	0.84	0.35 (0.29)	1.42	0.80, 2.52	1.43
Preoccupation	-1.32 (0.44)	0.27**	0.11, 0.63	9.15	0.23 (0.29)	1.26	0.71, 2.22	0.63
Coping	-1.12 (0.36)	0.33**	0.16, 0.67	9.35	0.06 (0.30)	1.06	0.59, 1.91	0.04
Chasing Losses	-0.46 (0.22)	0.63*	0.41, 0.96	4.61	0.06 (0.19)	1.06	0.73, 1.55	0.11

Note. FCM-D – Four Cup Monte sub-test win-loss discrepancy, TR-O – Trivia sub-test over-confidence. CI = confidence interval. ***p*<.01. **p*<.05

Table 5.11

Univariate logistic regression of FCM-D and PGSI moderate risk level ratings

	FCM-D			
	B (SE)	*OR*	95% CI	Wald χ^2
PGSI Moderate Risk Level Rating	-1.05 (0.32)	0.35**	0.19, 0.66	10.74

Note. FCM-D – Four Cup Monte sub-test win-loss discrepancy. CI = confidence interval. ***p*<.01.

References

Adams, E., & Rollings, A., 1972. (2010). F*undamentals of game design (2nd Ed.).* Berkeley, Calif: New Riders.

American Psychiatric Association. (2013). D*iagnostic and Statistical Manual of Mental Disorders: DSM-5*. Arlington, VA: American Psychiatric Association.

Ashwin, C., Wheelwright, S., & Baron-Cohen, S. (2006). Attention bias to faces in asperger syndrome: A pictorial emotion stroop study. *Psychological Medicine, 36(6),* 835-843. 10.1017/S0033291706007203

Baker, D. C., & Bufka, L. F. (2011). Preparing for the telehealth world: Navigating legal, regulatory, reimbursement, and ethical issues in an electronic age. P*rofessional Psychology: Research and Practice, 42(6),* 405-411. doi: 10.1037/a0025037

Balconi, M., Finocchiaro, R., & Canavesio, Y. (2015). Reward sensitivity (behavioral activation system), cognitive, and metacognitive control in gambling behavior: Evidences from behavioral, feedback-related negativity, and P300 effect. *The Journal of Neuropsychiatry and Clinical Neurosciences, 27(3),* 219-227. doi: 10.1176/appi.neuropsych.14070165

Barbosa, A. F. S., Pereira, P. N. M., Dias, João A. F. F, & Silva, F. G. M. (2014). A new methodology of design and development of serious games. *International Journal of Computer Games Technology, 2014,* 1-8. 10.1155/2014/817167

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex, 10(3),* 295-307. 10.1093/cercor/10.3.295

Bourke, A. B., & Gormley, M. J. (2012). Comparing a pictorial stroop task to viewing time measures of sexual interest. *Sexual Abuse: A Journal of Research and Treatment, 24(5),* 479-500. 10.1177/1079063212438922

Bowman, C. H., Evans, C. E. Y., & Turnbull, O. H. (2005). Artificial time constraints on the Iowa gambling task: The effects on behavioural performance and subjective experience. *Brain and Cognition, 57(1),* 21-25. 10.1016/j.bandc.2004.08.015

Box, G., & Cox, D. (1964). An Analysis of Transformations. *Journal of the Royal Statistical Society. Series B (Methodological), 26(2),* 211-252. Retrieved from http://www.jstor.org/stable/2984418

Brand, J., Porentz, P. & Mathew, T. (2014). Digital Australia. *Interactive Games & Entertaining Association.* Retrieved from http://www.igea.net/2013/10/digital-australia-2014/

Brevers, D., Cleeremans, A., Bechara, A., Greisen, M., Kornreich, C., Verbanck, P., & Noël, X. (2013). Impaired metacognitive capacities in individuals with problem gambling. *Journal of Gambling Studies, 30(1),* 141-152. doi: 10.1007/s10899-012-9348-3

Briggs, S. R., & Cheek, J. M. (1986). The role of factor analysis in the development and evaluation of personality scales. *Journal of Personality, 54*(1), 106-148. doi: 10.1111/j.1467-6494.1986.tb00391.x

Bruce, G., & Jones, B. T. (2004). A pictorial stroop paradigm reveals an alcohol attentional bias in heavier compared to lighter social drinkers. *Journal of Psychopharmacology, 18(4),* 527-533. 10.1177/0269881104047280

Buelow, M. T., & Suhr, J. A. (2009). Construct validity of the iowa gambling task. *Neuropsychology Review, 19(1),* 102-114. doi: 10.1007/s11065-009-9083-4

Camchong, J., Goodie, A. S., McDowell, J. E., Gilmore, C. S., & Clementz, B. A. (2007). A cognitive neuroscience approach to studying the role of overconfidence in problem gambling. *Journal of Gambling Studies, 23(2),* 185-199. doi: 10.1007/s10899-006-9033-5

Chamberlain, S., Stochl, J., Redden, S., Odlaug, B., & Grant, J. (2017). Katent class analysis of gambling subtypes and impulsive/compulsive associations: Time to rethink diagnostic boundaries for gambling disorder? *Addictive Behaviors, 72,* 79-85. 10.1016/j.addbeh.2017.03.020

Clough, B., & Casey, L. (2015). The smart therapist: A look to the future of smartphones and mHealth technologies in psychotherapy. *Professional Psychology-Research and Practice, 46*(3), 147-153. doi: 10.1037/pro0000011

Cunningham, J.A., Hodgins, D.C., Toneatto, T., & Murphy, Me. (2012). A Randomized Controlled Trial of a Personalized Feedback Intervention for Problem Gamblers. *PLoS One, 7(2).* doi: 10.1371/journal.pone.0031586

Delfabbro, P., King, D., Lambos, C., & Puglies, S. (2009). Is Video-Game Playing a Risk Factor for Pathological Gambling in Australian Adolescents? *Journal of Gambling Studies, 25*(3), 391-405. doi: 10.1007/s10899-009-9138-8

Delfabbro, P. (2014). Behavioral Risk Factors in Disordered Gambling and Treatment Implications. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

DeVellis, R. F. (2012). Scale development: Theory and applications (Vol. 26): Sage publications.

Dickinson, E. R., Adelson, J. L., & Owen, J. (2012). Gender balance, representativeness, and statistical power in sexuality research using undergraduate student samples. *Archives of Sexual Behavior, 41(2),* 325-327. doi: 10.1007/s10508-011-9887-1

Domsch, S., & ebrary, I. (2013). *Storyplaying: Agency and narrative in video games*. Boston: De Gruyter.

Dowling, N. (2014). The Cognitive-Behavioral Treatment of Female Problem Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Entertainment Software Association (2015). The 2015 Essential Facts About the Computer and Video game Industry. *Entertainment Software Association*. Retrieved from http://www.theesa.com/wp-content/uploads/2015/04/ESA-Essential-Facts-2015.pdf

Ferris, J., & Wynne, H. (2001). T*he Canadian Problem Gambling Index: Final Report*. Ottawa, Ontario: Canadian Centre on Substance Abuse

Fleming, T., de Beurs, D., Khazaal, Y., Gaggioli, A., Riva, G., Botella, C., Banos, R. M., Aschieri, F., Bavin, L. M., Kleiboer, A., Merry, S., Ming Lau, H., & Riper, H. (2016). Maximizing the impact of e-therapy and serious gaming: Time for a paradigm shift. *Frontiers in Psychiatry, 7,* 65. doi: 10.3389/fpsyt.2016.00065

Gillett, F. (2012). Why tablets will become our primary computing device. *Forrester*. Retrieved from http://blogs.forrester.com/frank_gillett/12-04-23-why_tablets_will_become_our_primary_computing_device

Goodie, A. S. (2005). The role of perceived control and overconfidence in pathological gambling. *Journal of Gambling Studies, 21(4),* 481-502. doi: 10.1007/s10899-

005-5559-1

Gopinath Bharathi, A.K. B., Singh, A., Tucker, C. S., & Nembhard, H. B. (2016). Knowledge discovery of game design features by mining user-generated feedback. *Computers in Human Behavior, 60,* 361-371. doi: 10.1016/j.chb.2016.02.076

Goudriaan, A.E., van Holst, R.J., Veltman, D.J., & van den Brink, W. (2013). Contributions from Neuroscience and Neuropsychology. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Hamblen, M. (2013). Smartphone shipments to hit 1B – up 40% -- in 2013. *Computerworld.* Retrieved from https://www.computerworld.com/article/2484500/mobile-wireless/smartphone-shipments-to-hit-1b----up-40-----in-2013.html

Heggestuen, J. (2013). One in Every 5 People In the World Own A Smartphone, One in Every 17 Own A Tablet. *Business Insider.* Retrieved from http://www.businessinsider.com/smartphone-and-tablet-penetration-2013-10

Hodgins, D. C., Stea, J. N., & Grant, J. E. (2011). Gambling disorders. The Lancet, 378(9806), 1874-1884. 10.1016/S0140-6736(10)62185-X

Honsi, A., Mentzoni, R. A., Molde, H., & Pallesen, S. (2013). Attentional bias in problem gambling: A systematic review. *Journal of Gambling Studies, 29(3),* 359-375. doi: 10.1007/s10899-012-9315-z

Jones, D. J. (2014). Future directions in the design, development, and investigation of technology as a service delivery vehicle. Journal of Clinical Child and Adolescent Psychology: The Official Journal for the Society of Clinical Child

and Adolescent Psychology, Amer*ican Psychological Association, Division 53, 43(1),* 128-142. doi: 10.1080/15374416.2013.859082

Kairouz, S., Paradis, C., & Nadeau, L. (2012). Are Online Gamblers More At Risk Than Offline Gamblers? *Cyberpsychol Behav Soc Netw, 15*(3), 175-180. doi: 10.1089/cyber.2011.0260

Kato, P. (2012). Evaluating efficacy and validating games for health. *Games for Health Journal, 1*(1), 74-76. doi: 10.1089/g4h.2012.1017

Kharrazi, H., Lu, A. S., Gharghabi, F., & Coleman, W. (2012). A scoping review of health game research: past, present, and future. *Games Health Journal,1(2).* doi: 10.1089/g4h.2012.0011.

King, D.L., Ejova, A., & Delfabbro, P.H. (2012). Illusory Control, Gambling, and Video Gaming: An Investigation of Regular Gamblers and Video Game Players. J*ournal of Gambling Studies, 28*(3), 421-435. doi: http://dx.doi.org/10.1007/s10899-011-9271-z

Kirk, R. E. (2008). *Statistics: An introduction* (5th ed). Belmont, CA: Thompson/Wadsworth.

Lakey, C. E., Goodie, A. S., Lance, C. E., Stinchfield, R., & Winters, K. C. (2007). Examining DSM-IV criteria for pathological gambling: Psychometric properties and evidence from cognitive biases. *Journal of Gambling Studies, 23(4),* 479-498. doi: 10.1007/s10899-007-9063-7

Landers, R. N. (2014). Developing a theory of gamified learning: Linking serious games and game design of learning. *Simulation & Gaming, 45(6),* 752-768. doi: 10.1177/1046878114563660

Lau, P. W. C., Lau, E. Y., Wang, J. J., Choi, C., & Kim, C. G. (2017). A pilot study of the attractive features of active videogames among chinese primary school children. *Games for Health Journal, 6(2),* 87-96. 10.1089/g4h.2016.0021

Leeman, R. F., & Potenza, M. N. (2012). Similarities and differences between pathological gambling and substance use disorders: A focus on impulsivity and compulsivity. *Psychopharmacology, 219(2),* 469-490. 10.1007/s00213-011-2550-7

Lignuel, R., Sescousse, G., Barbalat, G., Domenech, P., & Dreher, J-C. (2013). Shifted risk preferences in pathological gambling. *Psychological Medicine (2013), 43,* 1059–1068. doi: 10.1017/S0033291712001900

Lorains, F. K., Cowlishaw, S., & Thomas, S. A. (2011). Prevalence of comorbid disorders in problem and pathological gambling: Systematic review and meta-analysis of population surveys. *Addiction, 106(3),* 490-498. 10.1111/j.1360-0443.2010.03300.x

Lumsden, J., Edwards, E. A., Lawrence, N. S., Coyle, D., & Munafò, M. R. (2016). Gamification of cognitive assessment and cognitive training: A systematic review of applications and efficacy. *JMIR Serious Games, 4(2),* e11. doi: 10.2196/games.5888

Luxton, D., June, J., & Kinn, J. (2011). Technology-based suicide prevention: Current applications and future directions. *Telemedicine and e-Health, 17(1),* 50-54. doi: 10.1089/tmj.2010.0091

Lyons, J., Weeks, D. J., & Elliott, D. (2013). The gambler's fallacy: A basic inhibitory process? *Frontiers in Psychology, 4,* 72. Retrieved from https://www.frontiersin.org/journals/psychology

McPherson, J., & Burns, N. R. (2007). Gs invaders: Assessing a computer game-like test of processing speed. *Behavior Research Methods, 39(4),* 876-883. 10.3758/BF03192982

McPherson, J., & Burns, N. R. (2008). Assessing the validity of computer-game-like tests of processing speed and working memory. *Behavior Research Methods, 40(4),* 969-981. doi: 10.3758/BRM.40.4.969

Morford, Z. H., Witts, B. N., Killingsworth, K. J., & Alavosius, M. P. (2014). Game design: The intersection between behavior analysis and game design technologies. *The Behavior Analyst, 37(1),* 25-40. doi: 10.1007/s40614-014-0006-1

Moura, D., & Bartram, L. (2014). Investigating players' responses to wayfinding cues in 3D video games. Paper presented at the 1513-1518. doi: 10.1145/2559206.2581328

Newzoo (2013). 2013 Global Games Market Report, *Newzoo BV*. Retrieved from http://www.newzoo.com/reports/

Ó'Ciardha, C. & Gormley, M. J. (2009). Comparing two implicit cognitive measures of sexual interest: A pictorial modified Stroop task and the Implicit Association Test. In Thornton, D., Laws, D. R. (Eds.), *Cognitive approaches to the assessment of sexual interest in sexual offenders* (pp. 177-201). Chichester, UK: Wiley

Pallant, J. (2013). *SPSS survival manual*: McGraw-Hill International.

Parsons, T. (2015). Virtual reality for enhanced ecological validity and experimental control in the clinical, affective and social neurosciences. *Frontiers in Human Neuroscience, 9,* 660. 10.3389/fnhum.2015.00660

Peduzzi, P., Concato, J., Feinstein, A., & Holford, T. (1995). Importance of events per independent variable in proportional hazards regression analysis .2. accuracy and precision of regression estimates. *Journal of Clinical Epidemiology, 48(12),* 1503-1510. Retrieved from https://www.journals.elsevier.com/journal-of-clinical-epidemiology

Petry, N. M. (2005). P*athological gambling: Etiology, Comorbidity, and Treatments. W*ashington, DC: American Psychological Association.

Petry, N.M., Weinstock, J., Ledgerwood, D.M., & Morasco, B. (2008). A Randomized Trial of Brief Interventions for Problem and Pathological Gamblers. J*ournal of Consulting and Clinical Psychology, 76*(2), 318-328. doi: 10.1037/0022-006X.76.2.318

Petry, N. M. (2009). Disordered gambling and its treatment. *Cognitive and Behavioral Practice, 16*(4), 457-467. doi: 10.1016/j.cbpra.2009.02.005

Productivity Commission (2010). A*ustralia's Gambling Industries, Report No. 50*. Canberra: Ausinfo

Quiroga M. A., Escorial S., Román F. J., Morillo D., Jarabo A., Privado J., … Colom R. (2015). Can we reliably measure the general factor of intelligence (g) through commercial video games? Yes, we can! *Intelligence, 53,* 1–7. doi: 10.1016/j.intell.2015.08.004

Quiroga, M., Roman, F., De La Fuente, J., Privado, J., & Colom, R. (2016). The measurement of intelligence in the XXI century using video games. *Spanish Journal of Psychology, 19.* doi: 10.1017/sjp.2016.84

Rahmani, E. & Boren, S.A. (2012). Video games and Health Improvement: A Literature Review of Randomized Controlled Trials. *Games Health Journal,1(5),* 331-341. doi: 10.1089/g4h.2012.0031.

Raylu, N., & Oei, T. P. S. (2004). The gambling related cognitions scale (GRCS): Development, confirmatory factor validation and psychometric properties. *Addiction, 99(6),* 757-769. doi: 10.1111/j.1360-0443.2004.00753.x

Richard, D.C. & Humphrey, J. (2014). The Conceptualization and Diagnosis of Disordered Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Riley, W. T., Glasgow, R. E., Etheredge, L., & Abernethy, A. P. (2013). Rapid, responsive, relevant (R3) research: A call for a rapid learning health research enterprise. *Clinical and Translational Medicine, 2*(1), 1-6. doi: 10.1186/2001-1326-2-10

P Robinson, John & Shaver, Phillip & Wrightsman, Lawrence. (1991). Criteria for Scale Selection and Evaluation. *Measures of Personality and Social Psychological Attitudes, 1*. doi: 10.1016/B978-0-12-590241-0.50005-8.

Royle, K. (2008). Game-Based Learning: A Different Perspective ," Innovate: Journal of Online Education, Vol 4 (4). Retrieved from http://nsuworks.nova.edu/innovate/vol4/iss4/4

Schlagintweit, H. E., Thompson, K., Goldstein, A. K., & Stewart, S. H. (2017). An investigation of the association between shame and problem gambling: The mediating role of maladaptive coping motives. *Journal of Gambling Studies, 33(4),* 1067-1079. 10.1007/s10899-017-9674-6

Sun, Y., & Wang, H. (2010). Gambler's fallacy, hot hand belief, and the time of patterns. *Judgment and Decision Making, 5(2),* 124-132. Retrieved from http://journal.sjdm.org/

Tabachnick, Barbara G., & Fidell, Linda S. (2007). U*sing Multivariate Statistics*. Boston: Pearson/Allyn & Bacon.

Turner, W. A., & Casey, L. M. (2014). Outcomes associated with virtual reality in psychological interventions: Where are we now? *Clinical Psychology Review, 34(8),* 634-644. doi: 10.1016/j.cpr.2014.10.003

Turner, W., Thomas, B., & Casey, L. (2016). Developing games for mental health: A primer. *Professional Psychology-Research and Practice, 47*(3), 242-249. doi: 10.1037/pro0000082

van Bennekom, M. J., Kasanmoentalib, M. S., de Koning, P. P., & Denys, D. (2017). A virtual reality game to assess obsessive-compulsive disorder. *Cyberpsychology, Behavior, and Social Networking, 20(11),* 718-722. 10.1089/cyber.2017.0107

Verhaegh, J., Resing, W. C. M., Jacobs, A. P. A., & Fontijn, W. F. J. (2009). Playing with blocks or with the computer? Solving complex visual–spatial reasoning tasks: comparing children’s performance on tangible and virtual puzzles. Educational & Child Psychology, 26(3), 18–29. Retrieved from https://www1.bps.org.uk/publications/member-network-publications/member-publications/educational-child-psychology

Verhaegh, J., Fontijn, W. F. J., & Resing, W. C. M. (2013). On the correlation between children's performances on electronic board tasks and nonverbal intelligence test measures. *Computers and Education, 69,* 419-430. doi: 10.1016/j.compedu.2013.07.026

Volberg, R. A., Gupta, R., Griffiths, M. D., Ólason, D. T., & Delfabbro, P. (2010). An international perspective on youth gambling prevalence studies. *International Journal of Adolescent Medicine and Health, 22*(1), 3-38. Retrieved from https://www.degruyter.com/view/j/ijamh

Wang, H., Shen, C., & Ritterfeld, U. (2009). Enjoyment of digital games: What makes them "seriously" fun. In Ritterfeld, U., Cody, M. J., & Vorderer, P. (Eds). *Serious games: Mechanisms and effects* (1st ed.). New York: Routledge.

Weaver, B., & Koopman, R. (2014). An SPSS macro to compute confidence intervals for pearsons correlation. *Tutorials in Quantitative Methods for Psychology, 10*(1), 29-39. Retrieved from https://doaj.org/

Williams, R. J., Volberg, R. A., & Stevens, R. M. G. (2012). T*he Population Prevalence of Problem Gambling: Methodological Influences, Standardized Rates, Jurisdictional Differences, and Worldwide Trends. O*ntario Problem Gambling Research Centre.

Williams, R., & Volberg, R. (2014). The classification accuracy of four problem gambling assessment instruments in population research. *International Gambling Studies, 14*(1), 15-28. doi: 10.1080/14459795.2013.839731

Wilson Van Voorhis, Carmen R, & Morgan, B. K. (2007). Understanding power and rules of thumb for determining sample sizes. *Tutorials in Quantitative Methods for Psychology, 3(2),* 43-50. doi; 10.20982/tqmp.03.2.p043

Xu, J., & Harvey, N. (2014). Carry on winning: The gamblers' fallacy creates hot hand effects in online gambling. *Cognition, 131(2),* 173-180. doi: 10.1016/j.cognition.2014.01.002

Turner & Casey, (2018). Immersion and Engagement Testing of SLOTZ: A Game-based Measure of Problem gambling. Manuscript submitted for publication.

Yi, S., & Kanetkar, V. (2011). Coping with guilt and shame after gambling loss. *Journal of Gambling Studies, 27(3),* 371-387. doi: 10.1007/s10899-010-9216-y

Chapter 7. Leveling Up: Considerations for the Development and Utilisation of Mental Health Video Games

Chapter 7: Foreword

At the time of authorship, Chapter 4 highlighted the paucity of information available to researchers and clinicians wishing to develop and evaluate game-based mental health assessments and treatments. In the period following its publication (2016 to 2018), there has been a rapid expansion in the application of game mechanics within the field of mental health. For this reason, it was determined that there existed a need to provide an updated summary of the current state of mental health video game-based assessments and treatments (Chapter 7). To this end, Chapter 7 includes an exploration of the utility of mental health video game-based assessments, as well as current challenges in their use, potential solutions for these challenges, and suggestions for future research.

Additionally, to guide researchers and clinicians in the development of mental health video game-based assessments and treatments, three examples of mental health video games are provided. Included as a specific example is a summary of the development, piloting (Chapter 5) and psychometric evaluation (Chapter 6) of SLOTZ.

Finally, Chapter 7 is presented as an unpublished paper, with the intent to submit this paper for publication following final submission of this thesis.

Abstract

Video games are increasingly presenting as an outlet for both social and pleasurable activities in modern life. This has led to a rapid expansion in the application of game mechanics to the field of mental health. This paper provides a summary of the current state of mental health video games. Key challenges and potential solutions are discussed, as are directions for future development and research. Two hypothetical examples of targeted mental health video games are presented. A summary of the development and psychometric validation of our own mental health video game is also presented, so as to demonstrate the importance and utility of a multi-stage process of game piloting and psychometric validation. While mental health video games are not without their challenges and limitations, effective use of psychological theory and video game theory can result in the development of mental health assessments and interventions that increase user engagement, social engagement and therapeutic reach. Clinicians and researchers are encouraged to utilise the emerging body of mental health video game research during the development of their assessments and interventions. Experimentation with emerging technologies and various types of video game play provides clinicians and researchers will be able to engage populations that are traditionally far harder to reach.

Levelling Up: Considerations for the Development and Utilisation of Mental Health Video Games

Video games are ubiquitous in modern life, presenting as an outlet for both social and pleasurable activities (Gopinath Bharathi et al., 2016; Kovess-Masfety et al., 2016; Johnson et al., 2013). Individuals can access video games via smartphones, tablet devices, personal computers and an assortment of varying sized consoles. Gameplay is observed across cultures, genders and ages, with the global uptake of gaming growing rapidly (Brand, Lorentz & Mathew, 2014; Entertainment Software Association, 2015; Newzoo, 2013). This has resulted in a rapid expansion in the application of game mechanics to varying non-game contexts, including mental health assessment and intervention (Bharathi et al., 2016; Kato, 2012; Kharrazi et al., 2012; Landers, 2014; Lau et al., 2017; Rahmani & Boren, 2012). By incorporating game mechanics, mental health video games aim to make the process of learning, behaviour change and assessment more meaningful and engaging (Bharathi et al., 2016; Landers, 2014).

In this paper, we provide a summary of the current state of mental health video games and discuss challenges and future directions for their use. Specific focus is placed upon the utility of mental health video games, current challenges in their use and potential solutions, as well as suggestions for future research and development.

The Utility of Mental Health Video Games

To date, much has been written on the relative strengths and limitations of mental health video games (e.g., Baranowski et al., 2015; Lumsden et al., 2016; Turner & Casey, 2014; Turner et al., 2016). Mental health video games have targeted a variety of populations for various educational and clinical purposes (Kharrazi et al., 2012;

Rahmani & Boren, 2012; Turner et al., 2016), with video game gameplay linked to a myriad of positive mental health outcomes (Baranowski et al., 2013; Gopinath Bharathi et al., 2016; Johnson et al., 2013; Kahn et al., 2013), as well as greater levels of user engagement with mental health assessments and interventions (Garcia-Rodriguez et al., 2012; Wood et al., 2014). While the increase in the utilisation of mental health video games has led to the development of an emerging body of research concerning how best to adapt video games for mental health purposes (Lumsden et al., 2016; Turner et al., 2016), numerous challenges remain to be overcome if metal health video games are to be regarded as reliable and valid platforms for assessment and intervention (Kharrazi et al., 2012; Lumsden et al., 2016; Rahmani & Boren, 2012; Turner & Casey, 2014).

Current Challenges and Potential Solutions

Mental health video games possess several limitations. Commonly discussed limitations specific to technology include the potential to exacerbate executive dysfunction in at-risk children, negatively impact upon academic performance and the development of video game addiction (Anderson et al., 2007; Bailey et al., 2010; Gentile, 2009; Kronenberger et al., 2005), as well as difficulties faced in balancing clinical aims and user enjoyment of gameplay (Baranowski et al., 2015; Turner & Casey, 2018b). Other commonly discussed limitations concern those associated with mental health assessments and interventions as a whole, including issues with adherence and dropout (Motjabai et al., 2011; Warnick et al., 2012; Uebelacker et al., 2012), as well as issues with methodological rigour and empirical testing (Eichenberg & Schott, 2017; Lumsden et al., 2016; Turner & Casey, 2014; Turner et al., 2016). In this section, we discuss some of the key ways in which video games can address common challenges

faced by more traditional face-to-face mental health assessments and interventions, as well as challenges faced more specifically by mental health video games.

Reaching Target Populations

There remains a strong need for the development of mental health platforms that can reach a wide variety of populations (Fleming et al., 2016; Kazdin, 2011). Delivering mental health video games online may provide rapid and cost-effective access to under-represented, hard-to-reach populations (Chu & Snider, 2013; King et al., 2014; Ramo & Prochaska, 2012). The use of online recruitment and data collection can be directly targeted to potential participants via focussed advertising on social media platforms, and can bypass traditional face-to-face recruitment barriers such as requirements for assistance and permission from professional services (King et al., 2014). Online recruitment and data collection may also overcome barriers faced with traditional face-to-face recruitment of hard-to-reach populations, including beliefs that participation presented no personal benefit to the individual or the wider community, fear of being judged, fear of authority, fear of public exposure of illegal or stigmatised behaviours, fear that participation could hard them individually or their community, frequently changing contact information, inability to take time off work for participation, lack of child care options, mistrust in clinicians and researchers, and transport difficulties (Bonevski et al., 2014; Venn et al., 2014).

Timely user engagement is often a difficult process, with delays, unrepresentative samples and participation dropout all too common (Harris et al., 2015; Kayrouz et al., 2016; King et al., 2014; Loxton et al., 2015). The use of online recruitment and data collection has the potential to reduce delays between engagement and participation, factors which often result in marked reductions in participant interest

and dropout (King et al., 2014). Online engagement can be more time-effective, with users recruited up to 2.5 times faster than traditional recruitment strategies in some instances (Batterham, 2014; Harris et al., 2015; Kayrouz et al., 2016; Loxton et al., 2015; Unlu et al., 2014). User balance can be managed online, with varying populations targeted for recruitment in real-time via focussed advertising (e.g., focussing upon older participants later in recruitment so as to avoid positive age skewness; King et al., 2014). Additionally, clinicians and researchers administering mental health video games may wish to monitor the type of digital devices users access their assessments or interventions on (e.g., personal computer, smartphone, tablet, etc.), so as to examine target populations' device preferences for future use (Batterham, 2014; Harris et al., 2015; Kayrouz et al., 2016; King et al., 2014; Loxton et al., 2015; Unlu et al., 2014).

Compliance and Standard of Care Issues

Given the inherently rewarding and enjoyable design of video games, mental health video games may be especially effective in ensuring assessment or intervention compliance (Boot et al., 2013; Lumsden et al., 2016; Turner et al., 2016). However, mental health video games are necessarily limited in their ability to provide participants with interpersonal contact and individual guidance, potentially restricting participants' opportunities to fully engage in treatment and achieve optimal outcomes (Eichenberg & Schott, 2017). To this end, it is recommended that they be viewed as an adjunct to more focussed individual or group-based intervention, or conversely utilised as a 'first-line therapy' for lower severity presentations, prevention, psychoeducation and/or clinical screening similar to the utilisation of Brief Motivational Interviewing and Normative Feedback interventions in the assessment and treatment of other addictions and health

behaviour issues (Baranowski et al., 2015; Burke, Arkowitz & Menchola, 2003; Carey, Scott-Sheldon, Carey & DeMartini, 2007; Cunningham et al., 2012; Eichenberg & Schott, 2017; Petry, 2005; Petry, 2009; Riper et al., 2009; Woodin & O'Leary, 2010) (. Appropriate standards of participant care can also be difficult to maintain in mental health video games (Eichenberg & Schott, 2017; Jones, 214). Consequently, it is recommended that clear procedures are developed and tested for responding to clients experiencing emotional and/or physical distress and emergency situations (Jones, 2014; King et al., 2014; Turner et al., 2016), and that prospective and engaged participants be encouraged to contact researchers via email, website or toll-free phone numbers with any questions or concerns.

Engaging Different Age Groups

Though little research exists regarding specific age group preferences for video games types, differences in video game developmental suitability and engagement have been observed (Baranowski et al., 2005; Birk et al., 2017; Boot et al., 2013; Khosravi & Ghapanchi, 2016; van't Riet et al., 2014). Younger children are typically more interested and willing to engage in physically active video games (e.g., 'exergaming') than adolescents and adults, who have a greater preference for more traditional video games (e.g., First Person Shooters and Role-Playing Games) and casual/social video games (Baranowski et al., 2015; Boot et al., 2013; Birk et al., 2017; Entertainment Software Association, 2015; Wang, 2011). Of particular concern, adolescents frequently report low rates of mental health help-seeking, high drop-out rates, a distrust of health professionals, fear of being stigmatised and uncertainty over whether they can be effectively helped, as well as greater preferences for anonymity, emotional safety, online support and support via social networking sites (Bradford & Rickwood, 2012;

King et al, 2010; Rice et al., 2014). Given these preferences, casual and social mental health video games may be particularly well suited to adolescents.

Finally, video games are rarely designed with older adults in mind (Derboven et al., 2012; Boot et al., 2013; Skjæret et al., 2015). Mental health video games that require devices to be held for long periods or at awkward angles, and rapid and/or repetitive fine motor movements, may be ineffectual with older adult participants whom are more likely to experience arthritis-related pain, eyestrain and other negative physical symptoms (Boot et al., 2013; Khosravi & Ghapanchi, 2016). However, these issues are likely to play less of an impact upon rehabilitative video games (Eggenberger et al., 2016; Khosravi & Ghapanchi, 2016; Skjæret et al., 2015; van't Riet et al., 2014). Clinicians and researchers are encouraged to comprehensively review the physical, emotional, cognitive and socio-economic limitations of their target age groups when developing mental health video games.

Cost Issues and Technological Barriers

The majority of well validated mental health video games are expensive or limited in availability, typically administered in experimental settings (e.g., interactive tables and virtual reality at universities or clinics; Baranowski et al., 2015; Lumsden et al., 2016; Parson, 2015; Turner & Casey, 2018b). Virtual reality serves as an invaluable reminder of the potential issues that costs and technological barriers can play in the adoption of mental health video game assessments and interventions. Despite substantial empirical support for their clinical application (Lumsden et al., 2016; Parson, 2015; Turner & Casey, 2014), virtual reality mental health games have fallen well short of their original promise (Fink, 2017; Peterson, 2017; Swant, 2018). Frequently plagued by awkward hand-held controllers, motion sickness, optics issues,

limited fields of view, pixilation issues and a lack of accessible and affordable hardware, quality content and delivery platforms like Android, Apple and Microsoft, virtual reality technology has reportedly seen substantially less market growth than originally predicted (Fink, 2017; Peterson, 2017; Swant, 2018). An often-touted alternative to virtual reality is augmented reality, in which computer graphics are typically superimposed over images captured by the user's smartphone (e.g., Pokemon Go; Baranowski, 2016; Baranowski et al., 2015). While augmented reality is typically less costly than virtual reality and provides greater opportunity for smartphone-driven development (Peterson, 2017), it frequently suffers from unintuitive user interfaces (Fink, 2017), as well as a lack of collaboration between game designs and health professionals (Baranowski, 2016; Baranowski et al., 2015).

Nonetheless, financial restrictions, as well as restrictions in available technological resources (e.g., access to only smartphones and tablets), need not be insurmountable barriers (Turner et al., 2016). It is possible to develop low-tech mental health video games that are inexpensive, effective and wide in reach (Baranowski et al., 2015; Lumsden et al., 2016; Turner & Casey, 2018b). Casual and social games, typically accessed via smartphones and tablets, provide inexpensive, low-tech, easy to learn and engaging user experiences (Baniqued et al., 2013; McGloin et al., 2016; Merikivi et al., 2017). Casual and social games are particularly enticing to users, as they often require shorter time commitments, can be played sporadically, and often afford opportunities for personal and social comparisons (Chen et al., 2016; McGloin et al., 2016; Park et al., 2014).

Implications and Applications

How can clinicians and researchers determine the best types of games for varying target populations? Clarification of the target population's demographics is vital, as is the overall purpose of the planned mental health video game. To demonstrate this process, we provide two brief hypothetical examples of targeted mental health video games below, and present a summary of the development of our own mental health video game assessment to demonstrate the importance and utility of psychometric validation.

Example 1 – Arousal Regulation Training for Children

A classroom-based mental health video game is developed for children 8-10 years-of-age. Following an extensive literature review, the development team determines that in order to develop children's ability to regulate their level of arousal, they need to engage in activities involving vigorous physical movements, relaxation exercises and self-control exercises. As barriers to the adoption of school-based video game interventions typically include insufficient time, high costs and lack of technological resources (Baranowski et al., 2015), the development team identifies a need for their game to be especially easy to use, time-limited and low-tech. Consequently, they develop a game that can be administered via laptop, interactive whiteboard, personal computer, or projector. Gameplay consists of brief 5-minute vignettes where a 3-dimensional character directs children to imitate their movements, cycling through a warm up, vigorous physical movements interspersed with sudden stops to develop impulse control, and a cool down. Teachers are tasked with recording their students' successes and errors, with individual and class-wide rewards provided for successful imitation. Scores are recorded on the game's online database, with

classes competing against each other for a larger reward upon completion of the pilot study. To aid in user testing and psychometric validation, children, their parents and teachers are asked to complete pre and post intervention questionnaires, with follow-up assessments conducted at six months and twelve months post intervention.

Example 2 – Social Inclusion and Cognitive Training for Older Adults

An aged-care service provider wishes to engage its less physically able clients in greater levels of social inclusion, so as to reduce mental health concerns and associated mortality rates. Following a review of the literature, the development team decides that it may be beneficial to explore whether engagement in multiplayer-based casual puzzle video gameplay can foster client social inclusion, support and accountability. Social games, whether competitive or collaborative, can foster interest in future social interactions, online peer attachment, social self-efficacy, online and offline social support, as well as emotional well-being (Chen et al., 2016; Park et al., 2014). Given the fine motor limitations of some of their potential users, the development team decides to provide their clients with inexpensive tablet devices, and develop a social puzzle-based game that allows for collaborative play, competitive play, voice chat and instant messaging. Users are provided with training in the use of their tablet device and gameplay. Staff involved in user-care are also provided training, in addition to education on the utility of this intervention. User scores are displayed in game via leaderboards. Users and staff are asked to complete questionnaire at monthly intervals, so as to track improvements in client emotional well-being and social engagement.

Example 3 - Developing a Game to Measure Problem Gambling

It is essential that video game assessments and interventions be developed in such a way that they effectively incorporate both psychological and game design theory,

rather than simply borrow features from either, if they are to be recognised as immersive, engaging, effective, and valid platforms of delivery within the field of psychology (Bharathi et al., 2016; Landers, 2004; Morford et al., 2014; Turner, Thomas & Casey, 2016). For this reason, there is a need for methodologically sound and psychometrically validated mental health video games (Clough & Casey 2015; Kato, 2013; Kharrazi et al., 2012; Lau et al., 2017; Lumsden et al., 2016; Parson, 2015; Riley et al., 2013; Turner & Casey, 2014). To demonstrate how to undertake this process of piloting and psychometrically validating mental health video games, we provide an example of our recently developed mental health video game: SLOTZ. SLOTZ was developed with the aim to measure gambling severity in hard-to-reach populations.

Purpose

As noted in Rickard and Humphreys (2014) and Turner & Casey (2018), problem and disordered gamblers can be identified via discernible behavioural, neurocognitive and social indicators. To this end, we developed a video game with the intent to incorporate game design and gambling-related neuropsychological theory. Our overall aim was to examine whether game design and neuropsychological theory could be incorporated in the development of a video game-based measure of gambling severity. Psychometric validation of SLOTZ was completed over the course of two studies (Turner & Casey 2018a; Turner & Casey, 2018b).

Piloting

In response to calls for clinicians and researchers to conduct smaller pilot studies earlier in the development process (Clough & Casey, 2015; Lumsden et al., 2016; Turner et al., 2016), we commenced development of SLOTZ via the pilot testing of user engagement and enjoyment. Smaller scale pilot studies afford clinicians and researchers

with greater opportunity to explore the utility, outcomes and underpinning theory of their video games (Turner & Casey, 2018), with larger psychometric evaluations conducted following completion of the piloting stage (Clough & Casey, 2015; Lumsden et al., 2016; Turner, Thomas & Casey, 2016). During the piloting of SLOTZ (Turner & Casey, 2018a), we evaluated participants' levels of immersion, engagement and enjoyment of gameplay.

A game-based measure of problem gambling was created in accordance with game design and neuropsychological theory. Game mechanics suitable to gambling-related neuropsychological theory were incorporated into gameplay, including effortful challenges; chance; performance-based feedback; visual leader boards; progression levels; numerical reward points; and clearly defined success win states. Four sub-tests were developed: a modified pictorial version of the Dot Probe Paradigm to measure attentional bias via longer reactions times to addiction-related stimuli (Brevers et al., 2013; Bruce & Jones, 2004; Koster et al., 2004; Lipp & Derakshan, 2005; MacLeod et al., 1986); a confidence in decision-making assessment based upon the work of Camchong et al. (2007) and Goodie (2005), to measure overconfidence in decision making and metacognition; a decision-making tasks based using principles similar to those depicted in the Iowa Gambling Task (Bechara et al., 2000, Bowman et al., 2005; Brevers et al, 2013; Lakey et al., 2007); and a procedurally generated endless runner level to measure illusory correlations, cognitive flexibility, and common problem gambling-related cognitive biases (Lyons et al., 2013; Sun & Wang, 2010; Xu & Harvey, 2014).

Nineteen Non/Social Gambler and Problem Gambler participants were invited to participate in the immersion and engagement testing of SLOTZ. Prospective

participants were recruited via email, social networking sites and flyers posted across a university campus. Participants were asked to complete pre and post-gameplay questionnaires measuring gambling-related cognitions, demographic information, immersion and qualitative feedback. Participation could occur anywhere participants had access to the internet and on any digital device possessing a web browser. Questionnaires and video game gameplay took approximately 60 to 80 minutes to complete. Participants' immersion and engagement levels were observed to be high, with significant differences observed between SLOTZ immersion scores and immersion scores reported by Jennet et al.'s (2008) Immersion Questionnaire study (10 minutes playing Half Life, a 3-dimensional first-person shooter game).

Results from this pilot study stage indicated that Non/Social Gambler and Problem Gambler participants found SLOTZ gameplay immersive, engaging and enjoyable. Qualitative feedback obtained from participants lead to several changes to SLOTZ gameplay. Transitions between levels were accelerated, as were participants' actions and consequences (e.g., on-screen display of rewards and punishments for participant selections). Four participants reported technical difficulties relating to the modified pictorial Dot Probe Paradigm Sub-Test, with several participants identifying this Sub-Test as being the least immersive, engaging and enjoyable. Subsequently, the modified pictorial Dot Probe Paradigm Sub-Test was replaced with a substantial faster to complete modified pictorial Stroop Task Sub-Test (Ashwin et al., 2006; Bourke & Gormley, 20012; Bruce & Jones, 2004; Ó'Ciardha & Gormley, 2009).

Psychometric Validation

It is recommended that psychometric validation of mental health video games be conducted following the successful completion of game piloting, so as to improve

methodological rigour and empirical support for the game in mention and the field of mental health video games as a whole (Clough & Casey, 2015; Lumsden et al., 2016; Turner, Thomas & Casey, 2016). During psychometric validation of SLOTZ (Turner & Casey, 2018b), we evaluated its test validity (e.g., face validity, content validity, convergent validity, discriminant validity, concurrent validity, predictive validity, etc.) to determine the validity and utility of its use a screening tool for problem gambling.

One hundred and seventy participants were invited to participate the psychometric validation of SLOTZ. Prospective participants were recruited via convenience sampling from social networking sites a university undergraduate recruitment pool, an Australian problem gambling counselling service provider, and flyers posted across a university campus. Participants were asked to complete a pre-gameplay questionnaire measuring gambling-related cognitions and demographic information. Questionnaires and video game gameplay took approximately 60 to 80 minutes to complete. Participation could occur anywhere participants had access to the internet and on any digital device possessing a web browser.

Item reliability, correlational and regression analyses were conducted. Of the 18 Sub-Test variables included in SLOTZ gameplay, nine were retained for final analyses. Overall, three SLOTZ Sub-Test variables were observed to significantly correlate with established measures of gambling severity, with two of these variables found to significantly predict gambling severity scores. Review of SLOTZ Sub-Tests' correlation and regression results provided evidence of face validity, convergent validity, discriminant validity, concurrent validity and predictive validity, demonstrating test validity of SLOTZ video gameplay.

Findings

Several implications arose from our findings (Turner & Casey, 2018a; Turner & Casey, 2018b). Firstly, these studies provide support for the importance of multi-stage evaluation and psychometric validation of mental health video games, as well as the utility of mental health video game assessments. Secondly, our findings indicate that mental health video games can provide low-tech, user-friendly and psychometrically valid platforms for the screening of mental health concerns. Thirdly, similarly designed mental health video games can be targeted at varying populations, including hard-to-reach clinical populations and minority groups. Fourthly, SLOTZ presents a potentially ecologically valid, economical, and wide-reaching measure of problem gambling that is likely to be less mental health and socially aversive to prospective participants. Finally, it has the potential to be further developed to include an intervention component, such as directing users to online or face-to-face treatments, or the incorporation of brief normative feedback for less severe gambling presentations.

Conclusion

By combining game mechanics with psychological theory, mental health video games can be developed in such a way that they are more meaningful, significantly increasing user engagement, social inclusion, social support and therapeutic reach (Chen et al., 2016; Clough & Casey, 2011; McGloin et al., 2016; Park et al., 2014; Turner & Casey, 2018b). Clinicians and researchers are encouraged to turn to the emerging body of research for guidance in the development of mental health video games. Though this task may appear daunting at first sight, clinicians and researchers will need to experiment with emerging technologies and various types of video games if we are to take full advantage of the ever-growing ubiquity of video games in day to day life.

Clinicians and researchers are encouraged to turn to the emerging body of research for guidance in the development of mental health video games. Though this task may appear daunting at first sight, clinicians and researchers will need to experiment with emerging technologies and various types of video games if we are to take full advantage of the ever-growing ubiquity of video games in day to day life.

References

Ashwin, C., Wheelwright, S., & Baron-Cohen, S. (2006). Attention bias to faces in asperger syndrome: A pictorial emotion stroop study. *Psychological Medicine, 36(6),* 835-843. 10.1017/S0033291706007203

Anderson, C. A., Shibuya, A., Ihori, N., Swing, E. L., Bushman, B. J., Sakamoto, A.. . Saleem, M. (2010). Violent video game effects on aggression, empathy, and prosocial behavior in eastern and western countries: A meta-analytic review. *Psychological Bulletin, 136(2),* 151-173. doi: 10.1037/a0018251

Bailey, K., West, R., & Anderson, C. A. (2010). A negative association between video game experience and proactive cognitive control. *Psychophysiology, 47(1),* 34-42. doi: 10.1111/j.1469-8986.2009.00925.x

Baniqued, P. L., Lee, H., Voss, M. W., Basak, C., Cosman, J. D., DeSouza, S., . . . Kramer, A. F. (2013). Selling points: What cognitive abilities are tapped by casual video games? *Acta Psychologica, 142(1),* 74-86. doi: 10.1016/j.actpsy.2012.11.009

Baranowski, T., Buday, R., Thompson, D., Lyons, E. J., Lu, A. S., & Baranowski, J. (2013). Developing games for health behavior change: getting started. *Games Health Journal, 2(4),* 183-190. doi: 10.1089/g4h.2013.0048.

Baranowski, T., Blumberg, F., Buday, R., DeSmet, A., Fiellin, L. E., Green, C. S., . . . Young, K. (2015). Games for health for children-current status and needed research. *Games for Health Journal, 5(1),* 1-12. doi: 10.1089/g4h.2015.0026.

Baranowski, T. (2016). Pokémon go, go, go, gone? *Games for Health Journal, 5(5),* 293-294. doi: 10.1089/g4h.2016.01055.tbp

Batterham, P. J. (2014). Recruitment of mental health survey participants using internet advertising: Content, characteristics and cost effectiveness. *International Journal of Methods in Psychiatric Research, 23(2),* 184-191. doi: 10.1002/mpr.1421

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. Cerebral Cortex, 10(3), 295-307. 10.1093/cercor/10.3.295

Birk, M. V., Friehs, M. A., & Mandryk, R. L. (2017). Age-based preferences and player experience: A crowdsourced cross-sectional study. *CHI PLAY '17 Proceedings of the Annual Symposium on Computer-Human Interaction in Play,* 157-170. doi: 10.1145/3116595.3116608

Bonevski, B., Randell, M., Paul, C., Chapman, K., Twyman, L., Bryant, J., . . . Hughes, C. (2014). Reaching the hard-to-reach: A systematic review of strategies for improving health and medical research with socially disadvantaged groups. *Bmc Medical Research Methodology, 14(1),* 42-42. doi: 10.1186/1471-2288-14-42

Boot, W., Champion, M., Blakely, D., Wright, T., Souders, D., & Charness, N. (2013). Video games as a means to reduce age-related cognitive decline: Attitudes, compliance, and effectiveness. *Frontiers in Psychology, 4,* 31. doi: 10.3389/fpsyg.2013.00031

Bourke, A. B., & Gormley, M. J. (2012). Comparing a pictorial stroop task to viewing time measures of sexual interest. *Sexual Abuse: A Journal of Research and Treatment, 24(5),* 479-500. doi: 10.1177/1079063212438922

Bowman, C. H., Evans, C. E. Y., & Turnbull, O. H. (2005). Artificial time constraints on the Iowa Gambling Task: The effects on behavioural performance and

subjective experience. *Brain and Cognition, 57(1),* 21-25. doi: 10.1016/j.bandc.2004.08.015

Bradford, S., & Rickwood, D. (2014). Adolescent's preferred modes of delivery for mental health services. *Child and Adolescent Mental Health, 19(1),* 39-45. doi: 10.1111/camh.12002

Brand, J., Lorentz, P. & Mathew, T. (2014). Digital Australia. *Interactive Games & Entertaining Association.* Retrieved from http://www.igea.net/2013/10/digital-australia-2014/

Brevers, D., Cleeremans, A., Bechara, A., Greisen, M., Kornreich, C., Verbanck, P., & Noël, X. (2013). Impaired metacognitive capacities in individuals with problem gambling. *Journal of Gambling Studies, 30(1),* 141-152. doi: 10.1007/s10899-012-9348-3

Bruce, G., & Jones, B. T. (2004). A pictorial stroop paradigm reveals an alcohol attentional bias in heavier compared to lighter social drinkers. *Journal of Psychopharmacology, 18(4),* 527-533. doi: 10.1177/0269881104047280

Camchong, J., Goodie, A. S., McDowell, J. E., Gilmore, C. S., & Clementz, B. A. (2007). A cognitive neuroscience approach to studying the role of overconfidence in problem gambling. *Journal of Gambling Studies, 23(2),* 185-199. doi: 10.1007/s10899-006-9033-5

Chen, A., Lu, Y., & Wang, B. (2016). Enhancing perceived enjoyment in social games through social and gaming factors. *Information Technology & People, 29(1),* 99-119. doi: 10.1108/ITP-07-2014-0156

Chu, J. L., & Snider, C. E. (2013). Use of a social networking web site for recruiting canadian youth for medical research. *Journal of Adolescent Health, 52(6),* 792-794. doi: 10.1016/j.jadohealth.2012.12.002

Clough, B. A., & Casey, L. M. (2011). Technological adjuncts to increase adherence to therapy: A review. *Clinical Psychology Review, 31(5),* 697-710. doi: 10.1016/j.cpr.2011.03.006

Clough, B., & Casey, L. (2015). The smart therapist: A look to the future of smartphones and mHealth technologies in psychotherapy. *Professional Psychology-Research and Practice, 46*(3), 147-153. doi: 10.1037/pro0000011

Derboven, J., Van Gils, M., & De Grooff, D. (2012). Designing for collaboration: A study in intergenerational social game design. *Universal Access in the Information Society, 11(1),* 57-65. doi: 10.1007/s10209-011-0233-0

Eggenberger, P., Wolf, M., Schumann, M., & de Bruin, E. D. (2016). Exergame and balance training modulate prefrontal brain activity during walking and enhance executive function in older adults. *Frontiers in Aging Neuroscience, 8,* 66. doi: 10.3389/fnagi.2016.00066

Eichenberg, C., & Schott, M. (2017). Serious games for psychotherapy: A systematic review. *Games for Health Journal, 6(3),* 127-135. doi; 10.1089/g4h.2016.0068

Entertainment Software Association (2015). The 2015 Essential Facts About the Computer and Video game Industry. *Entertainment Software Association.* Retrieved from http://www.theesa.com/wp-content/uploads/2015/04/ESA-Essential-Facts-2015.pdf

Fink, C. (2017). Why Consumer Adoption of VR And AR Will Be Slow. *Forbes.* Retrieved from https://www.forbes.com/sites/charliefink/2017/12/13/why-consumer-adoption-of-vr-ar-will-be-slow/#1cbb8625359f

Fleming, T., de Beurs, D., Khazaal, Y., Gaggioli, A., Riva, G., Botella, C., Banos, R. M., Aschieri, F., Bavin, L. M., Kleiboer, A., Merry, S., Ming Lau, H., & Riper, H. (2016). Maximizing the impact of e-therapy and serious gaming: Time for a paradigm shift. *Frontiers in Psychiatry, 7,* 65. doi: 10.3389/fpsyt.2016.00065

Garcia-Rodriguez, O., Pericot-Valverde, I., Gutierrez-Maldonado, J., Ferrer-Garcia, M., & Secades-Villa, R. (2012). Validation of smoking-related virtual environments for cue exposure therapy. *Addict Behav, 37(6),* 703-708. doi: 10.1016/j.addbeh.2012.02.013.

Gentile, D. (2009). Pathological video-game use among youth ages 8 to 18: A national study. *Psychological Science, 20(5),* 594-602. doi: 10.1111/j.1467-9280.2009.02340.x

Goodie, A. S. (2005). The role of perceived control and overconfidence in pathological gambling. *Journal of Gambling Studies, 21(4),* 481-502. doi: 10.1007/s10899-005-5559-1

Gopinath Bharathi, A.K. B., Singh, A., Tucker, C. S., & Nembhard, H. B. (2016). Knowledge discovery of game design features by mining user-generated feedback. *Computers in Human Behavior, 60,* 361-371. doi: 10.1016/j.chb.2016.02.076

Ijsselsteijn, W., Nap, H., de Kort, Y., & Poels, K. (2007). Digital game design for elderly users. In Proceedings of the 2007 conference on Future Play (Future Play '07). ACM, New York, NY, USA, 17-22. doi: 10.1145/1328202.1328206

Jo Harris, K., Ahluwalia, J., Catley, D., Okuyemi, K., Mayo, M., & Resnicow, K. (2003). Successful recruitment of minorities into clinical trials: The kick it at swope project. *Nicotine & Tobacco Research, 5(4),* 575-584. doi: 10.1080/1462220031000118540

Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human - Computer Studies, 66(9),* 641-661. doi: 10.1016/j.ijhcs.2008.04.004

Johnson, D., Jones, C, Scholes, L & Carras, M. (2013). Video games and Wellbeing: A Comprehensive Review. *Young and Well Cooperative Research Centre*. Retrieved from https://www.youngandwellcrc.org.au/knowledge-hub/publications/videogames-wellbeing-comprehensive-review/

Jones, D. J. (2014). Future directions in the design, development, and investigation of technology as a service delivery vehicle. *Journal of Clinical Child and Adolescent Psychology: The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53, 43(1),* 128-142. doi: 10.1080/15374416.2013.859082

Kahn, J., Duchatmr, P., Rotenberg, A. & Gonzalez-Heydrich, J. (2013). "RAGE-Control": A game to build emotional strength. *Games Health Journal, 2(1),* 53-57. doi: 10.1089/g4h.2013.0007.

Kato, P.M. (2012). Evaluating Efficacy and Validating Games for Health. *Games Health Journal, 1(1),* 74-76. doi: 10.1089/g4h.2012.1017

Kayrouz, R., Dear, B. F., Karin, E., & Titov, N. (2016). Facebook as an effective recruitment strategy for mental health research of hard to reach populations.

Internet Interventions - the Application of Information Technology in Mental and Behavioural, 4, 1-10. doi: 10.1016/j.invent.2016.01.001

Kazdin, A. E. (2011). Evidence-based treatment research: Advances, limitations, and next steps. *The American Psychologist, 66(8),* 685. doi: 10.1037/a0024502

Kharrazi, H., Lu, A. S., Gharghabi, F., & Coleman, W. (2012). A scoping review of health game research: past, present, and future. *Games Health Journal,1(2).* doi: 10.1089/g4h.2012.0011.

Khosravi, P., & Ghapanchi, A. (2016;2015;). Investigating the effectiveness of technologies applied to assist seniors: A systematic literature review. *International Journal of Medical Informatics, 85(1),* 17-26. doi: 10.1016/j.ijmedinf.2015.05.014

King, R., Bickman, L., Shochet, I., McDermott, B., & Bor, B. (2010). Use of the internet for provision of better counselling and psychotherapy services to young people, their families and carers. *Psychotherapy in Australia, 17*(1), 66-74. Retrieved from http://www.psychotherapy.com.au/journal/

King, D., O'Rourke, N., & DeLongis, A. (2014). Social media recruitment and online data collection: A beginner's guide and best practices for accessing low-prevalence and hard-to-reach populations. *Canadian Psychology-Psychologie Canadienne, 55;36;(4;2A;),* 240-249. doi: 10.1037/a0038087

Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective attention to threat in the dot probe paradigm: Differentiating vigilance and difficulty to disengage. *Behaviour Research and Therapy, 42(10),* 1183-1192. doi: 10.1016/j.brat.2003.08.001

Kovess-Masfety, V., Keyes, K. M., Hamilton, A., Hanson, G., Bitfoi, A., Golitz, D., . . . Pez, O. (2016). Is time spent playing video games associated with mental health, cognitive and social skills in young children? *Social Psychiatry and Psychiatric Epidemiology, 51(3),* 349-357. 10.1007/s00127-016-1179-6

Kronenberger, W. G., Mathews, V. P., Dunn, D. W., Wang, Y., Wood, E. A., Giauque, A. L.. . Li, T. (2005). Media violence exposure and executive functioning in aggressive and control adolescents. *Journal of Clinical Psychology, 61(6),* 725-737. doi: 10.1002/jclp.20022

Lakey, C. E., Goodie, A. S., Lance, C. E., Stinchfield, R., & Winters, K. C. (2007). Examining DSM-IV criteria for pathological gambling: Psychometric properties and evidence from cognitive biases. *Journal of Gambling Studies, 23(4),* 479-498. doi: 10.1007/s10899-007-9063-7

Landers, R. N. (2014). Developing a theory of gamified learning: Linking serious games and game design of learning. Simulation & Gaming, 45(6), 752-768. doi: 10.1177/1046878114563660

Lau, P. W. C., Lau, E. Y., Wang, J. J., Choi, C., & Kim, C. G. (2017). A pilot study of the attractive features of active videogames among Chinese primary school children. *Games for Health Journal, 6(2),* 87-96. doi: 10.1089/g4h.2016.0021

Lipp, O. V., & Derakshan, N. (2005). Attentional bias to pictures of fear-relevant animals in a dot probe task. *Emotion, 5(3),* 365-369. doi: 10.1037/1528-3542.5.3.365

Lumsden, J., Edwards, E. A., Lawrence, N. S., Coyle, D., & Munafò, M. R. (2016). Gamification of cognitive assessment and cognitive training: A systematic

review of applications and efficacy. *JMIR Serious Games, 4(2),* e11. doi: 10.2196/games.5888

Luxton, D., June, J., & Kinn, J. (2011). Technology-based suicide prevention: Current applications and future directions. *Telemedicine and e-Health, 17(1),* 50-54. Doi: 10.1089/tmj.2010.0091

Lyons, J., Weeks, D. J., & Elliott, D. (2013). The gambler's fallacy: A basic inhibitory process? *Frontiers in Psychology, 4,* 72. Retrieved from https://www.frontiersin.org/journals/psychology

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95(1),* 15-20. doi: 10.1037/0021-843X.95.1.15

McGloin, R., Hull, K. S., & Christensen, J. L. (2016). The social implications of casual online gaming: Examining the effects of competitive setting and performance outcome on player perceptions. *Computers in Human Behavior, 59,* 173-181. doi: 10.1016/j.chb.2016.02.022

Merikivi, J., Tuunainen, V., & Nguyen, D. (2017). What makes continued mobile gaming enjoyable? *Computers in Human Behavior, 68,* 411-421. doi: 10.1016/j.chb.2016.11.070

Mojtabai, R., Eaton, W. W., & Maulik, P. K. (2012). *Pathways to care: Need, attitudes, barriers.* Oxford University Press. doi: 10.1093/acprof:oso/9780195390445.003.0015

Newzoo (2013). 2013 Global Games Market Report, *Newzoo BV*. Retrieved from http://www.newzoo.com/reports/

Ó'Ciardha, C. & Gormley, M. J. (2009). Comparing two implicit cognitive measures of sexual interest: A pictorial modified stroop task and the implicit association test. (pp. 177-201). Oxford, UK: Wiley-Blackwell. doi: 10.1002/9780470747551.ch9

Park, E., Baek, S., Ohm, J., & Chang, H. (2014). Determinants of player acceptance of mobile social network games: An application of extended technology acceptance model. *Telematics and Informatics, 31(1),* 3-15. doi: 10.1016/j.tele.2013.07.001

Parsons, T. (2015). Virtual reality for enhanced ecological validity and experimental control in the clinical, affective and social neurosciences. *Frontiers in Human Neuroscience, 9,* 660. doi: 10.3389/fnhum.2015.00660

Peterson, T. (2017). How marketers are wrestling with virtual reality's adoption issue. *MarTech Today.* Retrieved from https://martechtoday.com/marketers-wrestling-virtual-realitys-adoption-issue-205285

Rahmani, E. & Boren, S.A. (2012). Video games and Health Improvement: A Literature Review of Randomized Controlled Trials. *Games Health Journal,1(5),* 331-341. doi: 10.1089/g4h.2012.0031.

Ramo, D. E., & Prochaska, J. J. (2012;2011;). Broad reach and targeted recruitment using facebook for an online survey of young adult substance use. *Journal of Medical Internet Research, 14(1),* e28. doi: 10.2196/jmir.1878

Rice, S. M., Goodall, J., Hetrick, S. E., Parker, A. G., Gilbertson, T., Amminger, G. P., . . . Alvarez-Jimenez, M. (2014). Online and social networking interventions for the treatment of depression in young people: A systematic review. *Journal of Medical Internet Research, 16(9),* e206. doi: 10.2196/jmir.3304

Skjæret, N., Nawaz, A., Ystmark, K., Dahl, Y., Helbostad, J. L., Svanæs, D., & Vereijken, B. (2015). Designing for movement quality in exergames: Lessons

learned from observing senior citizens playing stepping games. *Gerontology, 61(2),* 186-194. doi: 10.1159/000365755

Swant, M. (2018). What Needs to Come First for VR to Take Off, Mass Hardware Adoption or Compelling Content? *Adweek.* Retrieved from http://www.adweek.com/digital/what-needs-to-come-first-for-vr-to-take-off-mass-hardware-adoption-or-compelling-content/

Sun, Y., & Wang, H. (2010). Gambler's fallacy, hot hand belief, and the time of patterns. *Judgment and Decision Making, 5(2),* 124-132. Retrieved from http://journal.sjdm.org/

Turner, W. A., & Casey, L. M. (2014). Outcomes associated with virtual reality in psychological interventions: Where are we now? *Clinical Psychology Review, 34(8),* 634-644. doi: 10.1016/j.cpr.2014.10.003

Turner, W., Thomas, B., & Casey, L. (2016). Developing games for mental health: A primer. *Professional Psychology-Research and Practice, 47*(3), 242-249. doi: 10.1037/pro0000082

Uebelacker, L. A., Marootian, B. A., Pirraglia, P. A., Primack, J., Tigue, P. M., Haggarty, R., . . . Miller, I. W. (2012;2011;). Barriers and facilitators of treatment for depression in a latino community: A focus group study. *Community Mental Health Journal, 48(1),* 114-126. doi: 10.1007/s10597-011-9388-7

Unlu, B., Cuijpers, P., van t Hof, E., & Riper, H. (2014). Reaching and recruiting turkish migrants for a clinical trial through facebook: A process evaluation. *Internet Interventions, 1*(2), 74-83. doi: 10.1016/j.invent.2014.05.003

van ’t Riet, J., Crutzen, R., & Lu, A. S. (2014). How effective are active videogames among the young and the old? adding meta-analyses to two recent systematic reviews. *GAMES FOR HEALTH: Research, Development, and Clinical Applications, 3(5),* 311-318. doi: 10.1089/g4h.2014.0005

Venn, A., Dickinson, A., Murray, R., Jones, L., Li, J., Parrott, S., & McNeill, A. (2016). Effectiveness of a mobile, drop-in stop smoking service in reaching and supporting disadvantaged UK smokers to quit. *Tobacco Control, 25(1),* 33-38. doi: 10.1136/tobaccocontrol-2014-051760

Wang, A. I. (2011). *Survey on how Norwegian teenagers play video games.* Paper presented at the 2011 IEEE International Games Innovation Conference, 26-28. doi: 10.1109/IGIC.2011.6115123

Warnick, E. M., Gonzalez, A., Robin Weersing, V., Scahill, L., & Woolston, J. (2012). Defining dropout from youth psychotherapy: How definitions shape the prevalence and predictors of attrition. *Child and Adolescent Mental Health, 17(2),* 76-85. doi: 10.1111/j.1475-3588.2011.00606.x

Wood, S. K., Eckley, L., Hughes, K., Hardcastle, K. A., Bellis, M. A., Schrooten, J. & Voorham, L. (2014). Computer-based programmes for the prevention and management of illicit recreational drug use: a systematic review. *Addict Behav, 39(1),* 30-38. doi: 10.1016/j.addbeh.2013.09.010.

Xu, J., & Harvey, N. (2014). Carry on winning: The gamblers' fallacy creates hot hand effects in online gambling. *Cognition, 131(2),* 173-180. doi: 10.1016/j.cognition.2014.01.002

Turner & Casey, (2018a). Immersion and Engagement Testing of SLOTZ: A Game-based Measure of Problem Gambling. Unpublished manuscript.

Turner & Casey, (2018b). Measuring Problem gambling via Video Game Play. Unpublished manuscript.

Chapter 8. Summary

Summary

Problem gamblers present as an especially difficult population to engage in treatment and intervention (Cunningham et al., 2012; Delfabbro, 2014; Gomes & Pascual-Leone, 2015; Goudriaan et al., 2013; Petry, 2009; Productivity Commission, 2010; Richard & Humphrey, 2014; Wynn et al., 2014). Difficulties with engagement often stem from factors including treatment access issues, stigma, and embarrassment or shame (Bonevski et al., 2014; Cunningham et al., 2012; Gomes & Pascual-Leone, 2015; Venn et al., 2014). This is unfortunate, as problem gambling can be successfully treated via a variety of interventions (Blaszczynski & Nower, 2014; Gomes & Pascual-Leone, 2015; Pallesen et al., 2005; Wynn et al., 2014). Typically, digital technologies are employed in order to circumvent barriers often faced by traditional face-to-face mental health assessments and interventions (Clough & Casey, 2015; Gilbody et al., 2015; Hermes et al., 2016; Jones, 2014; Melville, Casey & Kavanagh, 2010; Postel et al., 2011; Turner, Thomas & Casey, 2016; Turner & Casey, 2018c). The overall aim of this thesis was to explore the role digital technologies can play in the development and delivery of mental health assessment and intervention, with particular focus placed upon the area of problem gambling.

A literature review of existing research on digital delivery platforms led to the identification of a lack of empirically sound research into their development and application within the field of mental health (Kato, 2012; Kharrazi et al., 2012; Lumsden et al., 2016; Rahmani & Boren, 2012; Turner & Casey, 2014; Turner et al., 2016). Though virtual reality technologies presented as a highly efficacious platform for the delivery of mental health interventions, it was determined that concerns regarding their accessibility, affordability, usability, and methodological rigor precluded

them from wider adoption (Fink, 2017; Peterson, 2017; Swant, 2018; Turner & Casey, 2014). Conversely, while mental health video games were observed to possess methodological and theoretical issues, they were found to present a more accessible, affordable, engaging and user-friendly platform for digital delivery of assessments and interventions (Kharrazi et al., 2012; Lumsden et al., 2016; Turner et al., 2016). Given the affective, cognitive, financial, and social barriers that often prevent problem gamblers from engaging in assessment and treatment, video games could be of great benefit, potentially affording them a delivery platform that is easily accessible, confidential, engaging and even enjoyable. Subsequently, a mental health video game assessment for problem gambling was developed.

A Multi-Step Iterative Process for Developing Mental Health Games

Traditional approaches to development within the mental health field are likely to be unsuitable to the development and evaluation of digitally delivered mental health assessments and treatment. The process of literature review and finalisation of a product prior to evaluation would often be prohibitively expensive if it included the development of software and/or hardware (Gulbranson & Audretsch, 2008). Development and evaluation of more novel digital assessments and interventions is thus likely to require a multi-step, iterative process of piloting and validation (Clough & Casey, 2015; Enock & McNally, 2013; Gulbranson & Audretsch, 2008; Jones, 2014; Lumsden et al., 2016; Turner et al., 2016; Turner & Casey, 2018b; Turner & Casey, 2018c). This process would consist of the piloting or prototyping of a product that should be based upon psychological and technology-specific theory, and include key functions of the intended final product (Enock & McNally, 2013; Jones, 2014; Turner et al., 2016). Piloting would then be followed by revision, refinement and empirical

evaluation of the product (Clough & Casey, 2015; Lumsden et al., 2016; Turner et al., 2016; Turner & Casey, 2018b; Turner & Casey, 2018c). This process would continue until the intended final product is realized (Enock & McNally, 2013; Jones, 2014; Lumsden et al., 2016; Turner & Casey, 2018c). A visual depiction of this process is depicted in Figure 4.1.

Future Directions and Limitations

In accordance with the abovementioned process of digital mental health platform development, this thesis reported on the completion of the initial conceptualization, development, piloting (Chapter 5; Turner & Casey, 2018a) and first iteration of revision and refinement of SLOTZ game play (Chapter 6, Turner & Casey, 2018b). Further evaluation would include the incorporation, piloting and refinement of a brief normative feedback intervention into SLOTZ game play. Completion of this process is likely to result in the development of an empirically supported, user-friendly and engaging means of digital assessment and intervention for problem gamblers.

The studies included in Chapter 5 and Chapter 6 have several potential limitations that require further elaboration. Whilst user feedback was sought pertaining to immersion, engagement and enjoyment during the development and piloting of SLOTZ game play, user feedback was not sought during psychometric validation. Further evaluations of SLOTZ and similar game-based instruments should thus incorporate ongoing user involvement, affording users the opportunity to aid in the planning, development and delivery of said instrument. Analyses conducted over the course of development, piloting and psychometric testing of SLOTZ focused upon limited sample sizes (piloting n = 19; psychometric testing n = 166). Further analyses with significantly larger sample sizes are required as to evaluate this instrument's ability

to discriminate between clinical and non-clinical problem gambling or Gambling Disorder cases. Similarly, further analyses with larger sample sizes and a larger proportion of problem gamblers is required in order to determine SLOTZ's test sensitivity and specificity in identifying problem gamblers. Finally, there is a possibility that the gender balance obtained during the psychometric testing of SLOTZ (74.7% female, 25.3% male) resulted in a potentially unrepresentative sample. Whilst this gender balance is commonly observed amongst undergraduate university research participants (Dickson et al., 2012), a large proportion of neurocognitive biases and problem gambling issues are experienced by males. Further analyses would thus benefit from more representative gender balances amongst participants.

Conclusion

Taken together, Chapter 5's (Turner & Casey, 2018a) and Chapter 6's (Turner & Casey, 2018b) findings provide further support for a process of empirically testing digital mental health video assessments and interventions via a multi-step iterative process of pilot testing and refinement (Lumsden et al., 2016; Turner et al, 2016; Turner & Casey, 2018c). Moreover, these findings provide evidence that gambling severity and addiction-related cognitions can be identified and predicted via video game play, demonstrating the utility of video games in mental health assessment and interventions.

Based upon the findings presented in this thesis (Turner & Casey, 2014; Turner et al., 2016; Turner & Casey, 2018a; Turner & Casey, 2018b; Turner & Casey, 2018c), we recommend that clinicians and researchers place focus upon the development of brief personalised digital mental health interventions. As the aims of both digital mental health assessments and interventions and brief interventions are to circumvent barriers to treatment and to reach as wide a population as possible, successful

integration of these two approaches is likely to provide cost-effective, user-friendly and wide-reaching means of screening and ‘first-line’ intervention for addiction-related difficulties.

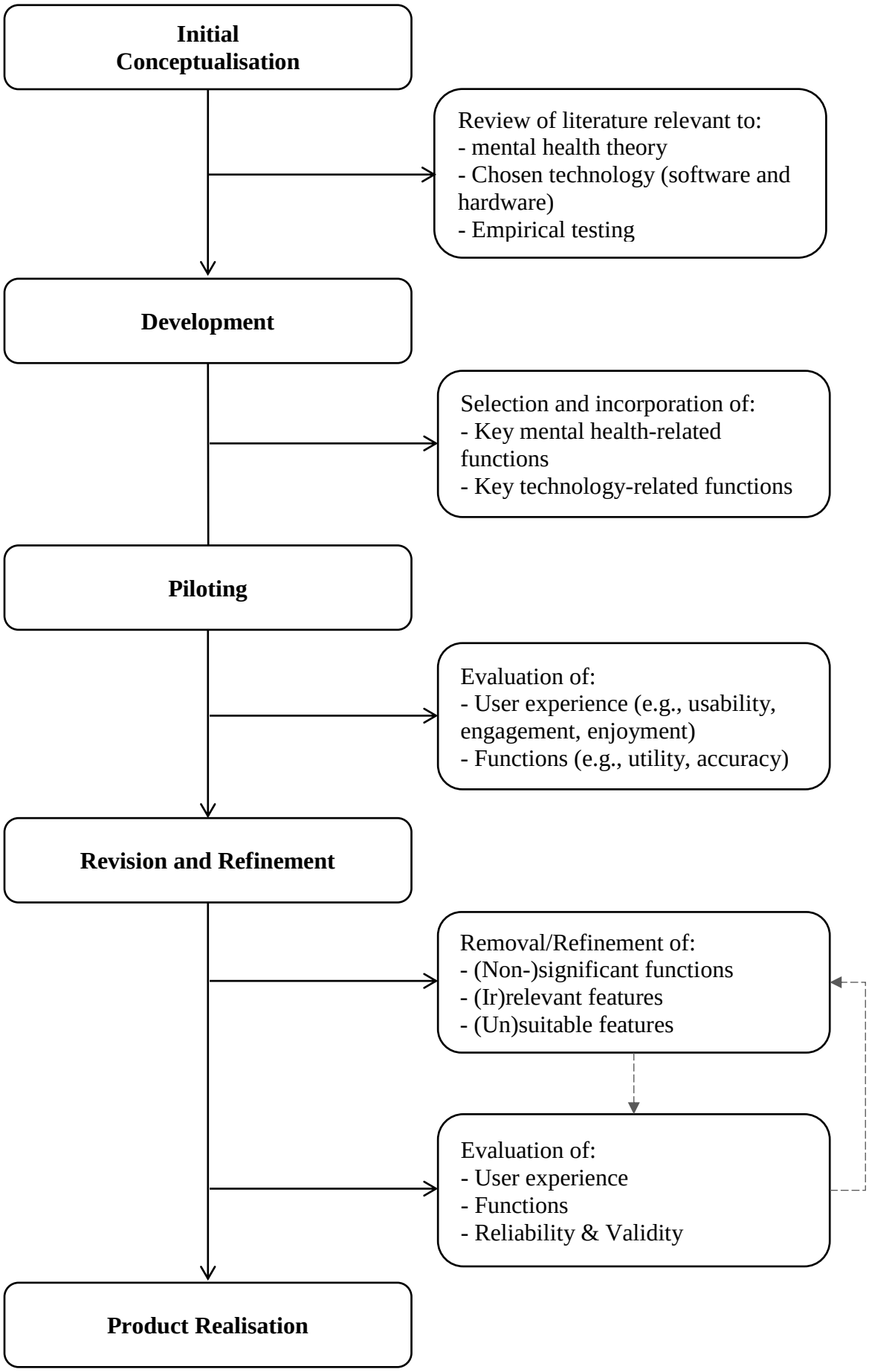

Figure 4.1. Multi-Step Iterative Model of Digital Mental Health Platform Development

References

Blaszczynski, Alex, & Nower, Lia. (2014). Cognitive-Behavioral Therapy: Translating Research into Clinical Practice. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons Ltd.

Bonevski, B., Randell, M., Paul, C., Chapman, K., Twyman, L., Bryant, J., . . . Hughes, C. (2014). Reaching the hard-to-reach: A systematic review of strategies for improving health and medical research with socially disadvantaged groups. *Bmc Medical Research Methodology, 14(1),* 42-42. doi: 10.1186/1471-2288-14-42

Clough, B., & Casey, L. (2015). Smart designs for smart technologies: Research challenges and emerging solutions for scientist-practitioners within e-mental health. *Professional Psychology: Research and Practice.* doi: 10.1037/pro0000053

Cunningham, J.A., Hodgins, D.C., Toneatto, T., & Murphy, Me. (2012). A Randomized Controlled Trial of a Personalized Feedback Intervention for Problem Gamblers. *PLoS One, 7*(2). doi: 10.1371/journal.pone.0031586

Delfabbro, P. (2014). Behavioral Risk Factors in Disordered Gambling and Treatment Implications. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Enock, P. M. , & McNally , R. J. (2013). How mobile apps and other Web-based interventions can transform psychological treatment and the treatment development cycle. *Behavior Therapist*, 36, 56 – 66. Retrieved from http:// www.abct.org/docs/PastIssue/36n3.pdf

Fink, C. (2017). Why Consumer Adoption of VR And AR Will Be Slow. *Forbes.* Retrieved from https://www.forbes.com/sites/charliefink/2017/12/13/why-consumer-adoption-of-vr-ar-will-be-slow/#1cbb8625359f

Gilbody, S., Littlewood, E., Hewitt, C., Brierley, G., Tharmanathan, P., Araya, R., . . . REEACT Team. (2015). Computerised cognitive behaviour therapy (cCBT) as treatment for depression in primary care (REEACT trial): Large scale pragmatic randomised controlled trial. *BMJ : British Medical Journal, 351,* h5627. doi: 10.1136/bmj.h5627

Gomes, K., & Pascual-Leone, A. (2015;2014;). A resource model of change: Client factors that influence problem gambling treatment outcomes. *Journal of Gambling Studies, 31(4),* 1651-1669. doi: 10.1007/s10899-014-9493-y

Gulbranson , C. A. , & Audretsch , D. B. (2008). Proof of concept centers: Accelerating the commercialization of university innovation. *Journal of Technology Transfer*, 33, 249–258. doi: 10.1007/s10961-008-9086-y

Hermes, E.DA., Merrel, J., Clayton, A., Morris, C. & Rowe, M. (2016). Computer-based self-help therapy: A qualitative analysis of attrition. *Health Informatics Journal,* n/a, n/a. doi: 10.1177/2F1460458216683536

Jones, D. J. (2014). Future directions in the design, development, and investigation of technology as a service delivery vehicle. *Journal of Clinical Child and Adolescent Psychology: The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53, 43(1),* 128-142. doi: 10.1080/15374416.2013.859082

Kato, P.M. (2012). Evaluating Efficacy and Validating Games for Health. *Games Health Journal, 1(1),* 74-76. doi: 10.1089/g4h.2012.1017

Kharrazi, H., Lu, A. S., Gharghabi, F., & Coleman, W. (2012). A Scoping Review of Health Game Research: Past, Present, and Future. *Games Health Journal,1(2).* doi: 10.1089/g4h.2012.0011

Lumsden, J., Edwards, E. A., Lawrence, N. S., Coyle, D., & Munafò, M. R. (2016). Gamification of cognitive assessment and cognitive training: A systematic review of applications and efficacy. *JMIR Serious Games, 4(2),* e11. 10.2196/games.5888

Melville, K. M., Casey, L. M., & Kavanagh, D. J. (2010). Dropout from internet-based treatment for psychological disorders. *British Journal of Clinical Psychology, 49*(4), 455-471. doi: 10.1348/014466509X472138

Pallesen, S., Mitsem, M., Kvale, G., Johnsen, B., & Molde, H. (2005). Outcome of psychological treatments of pathological gambling: A review and meta-analysis. *Addiction, 100*(10), 1412-1422. doi: 10.1111/j.1360-0443.2005.01204.x

Peterson, T. (2017). How marketers are wrestling with virtual reality's adoption issue. *MarTech Today.* Retrieved from https://martechtoday.com/marketers-wrestling-virtual-realitys-adoption-issue-205285

Petry, N. (2009). Disordered Gambling and Its Treatment. *Cognitive and Behavioral Practice, 16*, 457-467.

Postel, M. G., Haan, H. A. d., Huurne, E. D. t., Palen, J. v. d., Becker, E. S., & Jong, C. A. J. d. (2011). Attrition in web-based treatment for problem drinkers. *Journal of Medical Internet Research, 13*(4), e117-e117. doi: 10.2196/jmir.1811

Productivity Commission (2010). *Australia's Gambling Industries, Report No. 50*. Canberra: Ausinfo

Rahmani, E. & Boren, S.A. (2012). Videogames and Health Improvement: A Literature Review of Randomized Controlled Trials. *Games Health Journal,1(5),* 331-341. doi: 10.1089/g4h.2012.0031

Richard, D.C. & Humphrey, J. (2014). The Conceptualization and Diagnosis of Disordered Gambling. In D. C. S. Richard, A. Blaszczynski & L. Nower (Eds.), *The Wiley-Blackwell Handbook of Disordered Gambling*: John Wiley & Sons, Ltd.

Swant, M. (2018). What Needs to Come First for VR to Take Off, Mass Hardware Adoption or Compelling Content? *Adweek.* Retrieved from http://www.adweek.com/digital/what-needs-to-come-first-for-vr-to-take-off-mass-hardware-adoption-or-compelling-content/

Turner, W.A., & Casey, L. (2014). Outcomes associated with virtual reality in psychological interventions: Where are we now? *Clinical Psychology Review, 34(8),* 634-644. doi: 10.1016/j.cpr.2014.10.003

Turner, W. A., Thomas, B., & Casey, L. M. (2016). Developing games for mental health: A primer. *Professional Psychology: Research and Practice, 47(3),* 242.

Venn, A., Dickinson, A., Murray, R., Jones, L., Li, J., Parrott, S., & McNeill, A. (2016). Effectiveness of a mobile, drop-in stop smoking service in reaching and supporting disadvantaged UK smokers to quit. *Tobacco Control, 25(1),* 33-38. doi: 10.1136/tobaccocontrol-2014-051760

Wynn, J., Hudyma, A., Hauptman, E., Nicole Houston, T., & Michael Faragher, J. (2014). Treatment of problem gambling: Development, status, and future. *Drugs and Alcohol Today, 14*(1), 42-50. doi: 10.1108/DAT-10-2013-0044

Turner & Casey, (2018a). *Immersion and Engagement Testing of SLOTZ: A Game-based Measure of Problem Gambling.* Unpublished manuscript.

Turner & Casey, (2018b). *Measuring Problem gambling via Video Game Play.* Unpublished manuscript.

Turner & Casey, (2018c). *Levelling up: Considerations for the development and utilisation of mental health video games.* Unpublished manuscript.

Appendices

Appendix A: Demographic Information Item List (Study 3 and Study 4)

Q1. What device did you complete this assessment on?
-Mobile -Tablet -Computer/Laptop -Other

Q2. How many technological devices do you have in your household?
-0 -1-2 -3-4 -5+

Q3. Do you experience any difficulties with your vision?
-Yes -No

Q4. Was your vision corrected during this assessment (e.g., via glasses or contacts)?
-Yes -No

Q5. Have you ever experienced a period of extreme emotional distress or psychotic episode (e.g., auditory or visual hallucinations)?
-Yes -No

Q6. Have you ever experienced a serious neurological or medical condition (e.g., traumatic brain injury and/or a hearing impairment)?
-Yes -No

Q7. What is your current age?
(Open question)

Q8. What is your highest level of education?
-Primary -Secondary -Undergraduate -Postgraduate
-Diploma/Certificate -Trade

Q9. What is your current level of employment?
-Full-Time -Part-Time -Retired -Unemployed -Casual/Temporary

Q10. What sex do you identify as?
-Female -Male -Other

Q11. What is your level of personal weekly income?
-$0-$399 -$400-$799 -$800-$1249 -$1250-$1499
-$1500-$1999 -$2000+

Q12. What is your current marital status?
-Defacto -Married -Separated -Divorced -Single -Widowed

Q13. How often do you need help reading complicated letters, pamphlets or medical notes?
-Often -Sometimes -Rarely -Never

Q14. Are you currently studying?
-Studying Full-Time -Studying Part-Time -Not Studying

Appendix B: Chapter 3 - Meta-Analysis Search Strategy Information

Databases utilised:

Ovid, ProQuest Psychology Journals and ScienceDirect (Psychology)

Year range:

1980 - 2014

Search terms employed:

‘game’ OR ‘virtual’ OR ‘reality’ OR ‘simulation’ OR ‘augmented reality’ OR ‘augmented’ OR ‘virtual reality’ OR ‘VR’ OR ‘Wii’ OR ‘Xbox’ OR ‘PlayStation’

Inclusion criteria:

- Randomised controlled trial design;
- Published in a scholarly journal;
- Focus primarily on psychological or behavioural intervention (as opposed to assessment or education);
- Include one group with clinical or subclinical psychological or neurological disorders, syndromes or distressing behaviours;
- Disorders, syndromes and/or behaviours were required to have been identified via validated, standardised clinical measures or to have been made according to DSM IV-TR criteria;
- Interventions implemented after May/April, 2013 were required to have identified disorders, syndromes and/or behaviours via validated, standardised clinical measures or to have been made according to DSM-5 criteria;

- Include validated measures; and

- Report means and standard deviations of outcome measures.

Appendix C: Participant Information and Consent Materials (Study 3)

INFORMATION SHEET
SLOTZ: A Game-based Measure of Gambling Decision Making

Chief Investigator
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Why is the research being conducted?

Though individuals with gambling-related issues (problem gamblers) frequently report a range of psychological, physiological and social issues, only around one in ten problem gamblers will ever seek treatment. As such, there is a growing need for more active, emotionally engaging, affordable, effective and wide in reach problem gambling assessments.

In this study we are interested in determining whether gambling decision making and gambling related issues can be identified in individuals via a specially designed videogame: SLOTZ. In particular, we would like to determine whether differences in individuals' gambling decision making and the severity of an individual's gambling related-issues can be determined during SLOTZ gameplay. This research is being conducted by Wesley Turner as part of a requirement for the completion of a Doctorate of Philosophy in Clinical Psychology.

You do not have to be experiencing gambling-related issues to participate in this study. Your participation will provide a valuable contribution to the development of easily accessible and confidential measures of gambling decision making, problem gambling and behavioural addictions. It is hoped that this research will increase our understanding of the development of easily accessible and confidential measures gambling decision making, problem gambling and behavioural addictions, as well as our understanding of the reliability, validity and usefulness of game-based psychological measures.

What you will be asked to do

You will be invited to participate in the piloting of a game-based measure of gambling decision making. Gameplay should take approximately 45-60 minutes to complete. You will also be asked to complete four questionnaires that collect information relating to your enjoyment of the game, your level of immersion during gameplay, the way you think about gambling, and whether anything may have influenced your gameplay results or exclude you from analysis, and asked to provide feedback on how you think the game may be improved. These questionnaires should take approximately 15-20 minutes to complete.

The basis by which participants will be selected or screened

To participate in this research you must be over 18 years of age; have an adequate understanding of written English; have adequate or corrected vision; and not be currently experiencing psychotic symptoms or have a history of a serious neurological or medical condition (e.g., brain injury or major sensory impairment).

The expected benefits of the research

Involvement in this research is unlikely to provide any direct or personal benefits to you as a participant. However, your participation will help to improve our understanding of how gambling decision making, problem gambling and behavioural addictions can be measured, as well as our understanding of the reliability, validity and usefulness of game-based psychological measures. Without your assistance we are unable to undertake this important work, so we greatly appreciate your participation.

Risks to you

Participation in this study does not pose any significant foreseeable risks. However, because this research involves administration of measures relevant to problem gambling symptoms, it is possible that you may feel concerned about your gambling behaviour and/or mental health. Should you become concerned about your gambling behaviour and/or mental health, support can be accessed via the National Gambling Helpline (Ph: 1800 858 858; www.gamblinghelponline.org.au) and Lifeline Australia (Ph: 13 11 14; www.lifeline.org.au).

Your confidentiality

All data from this study will be kept confidential. Data collected via SLOTZ gameplay and questionnaires will be located in an Australian-based secure host with a domain validated security certificate. Individual identifying information will not be collected. **Data collected from this research will be reported in general terms only and**

will not involve personal identifying information. Computer records will be password protected and hard copy data will be stored in a locked filing cabinet in the School of Applied Psychology, Griffith University for a period of 5 years and will then be destroyed.

Your participation is voluntary

Participation in this study is voluntary and you are not under any obligation to consent to participate in this research. Non-participation will not involve any penalty or affect any current or future involvement with Griffith University or the School of Applied Psychology. **As data collected during the course of this study will remain anonymous, you will not be able to withdraw consent following assessment completion** (see 'What you will be asked to do' above for more information).

Privacy Statement

The conduct of this research involves the collection, access and/or use of your identified personal information. The information collected is confidential and will not be disclosed to third parties without your consent, except to meet government, legal or other regulatory authority requirements. A de-identified copy of this data may be used for other research purposes. However, your anonymity will at all times be safeguarded. For further information consult the University's Privacy Plan at http://www.griffith.edu.au/about-griffith/plans-publications/griffith-university-privacy-plan or telephone (07) 3735 4375.

Questions / further information

If you would like to obtain further information about this study, please contact Wesley Turner (wesley.turner@griffithuni.edu.au).

The ethical conduct of this research

Griffith University conducts research in accordance with the National Statement on Ethical Conduct in Human Research. If you have any concerns or complaints about the ethical conduct of this research project you should contact the Manager, Research Ethics on 3735 4375 or **research-ethics@griffith.edu.au**.

Feedback to you

A summary of the group findings of this study will be available in an email from the researchers. You can email Wesley Turner (wesley.turner@griffithuni.edu.au) if you wish to receive an overview of the results. Group feedback will be made available from approximately December 2016.

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By participating in the piloting of this game-based assessment, I confirm that I have read and understood the information package and in particular have noted that:

- I understand that my involvement in this research will entail:
  a) Approximately 60-80 minutes of my time.
  b) Completing a game-based measure of gambling decision-making.
  c) Completing four questionnaires relating to my enjoyment of the game played, your level of immersion during gameplay, the way I think about gambling, and whether anything may have influenced my gameplay results or exclude me from analysis.
- I have had any questions answered to my satisfaction;
- I understand the risks involved;
- I understand that there will be no direct benefit to me from my participation in this research;
- I understand that my participation in this research is voluntary and that non-participation will not involve any penalty or affect any future involvement with Griffith University or the School of Applied Psychology;
- I understand that if I have any additional questions I can contact the research team;
- I understand that I am free to withdraw at any time, without explanation or penalty;
- I understand that I can contact the Manager, Research Ethics, at Griffith University Human Research Ethics Committee on 3735 4375 (or research-ethics@griffith.edu.au) if I have any concerns about the ethical conduct of the project;
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- I understand that by beginning this game-based assessment, I have agreed to participate in this study.

Appendix D: Screenshots of SLOTZ Game Play

Figure C.1. Study One and Study Two Title Screen

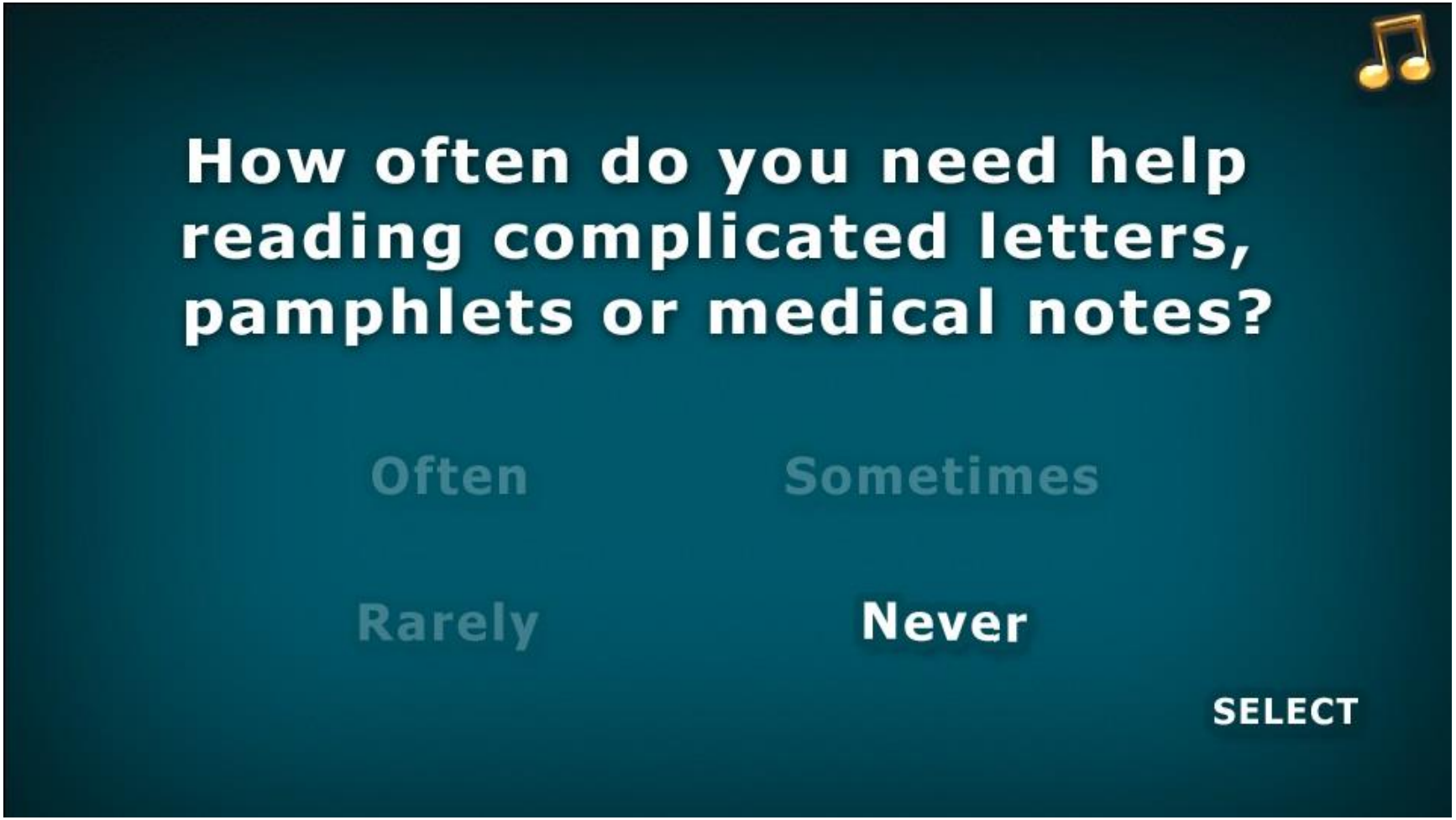

Figure C.2. Example of Study One and Study Two Demographic Items

Figure C.3. Example of Study One and Study Two Gambling Severity Items

Figure C.4. Study One Dot Probe Paradigm Sub-Test

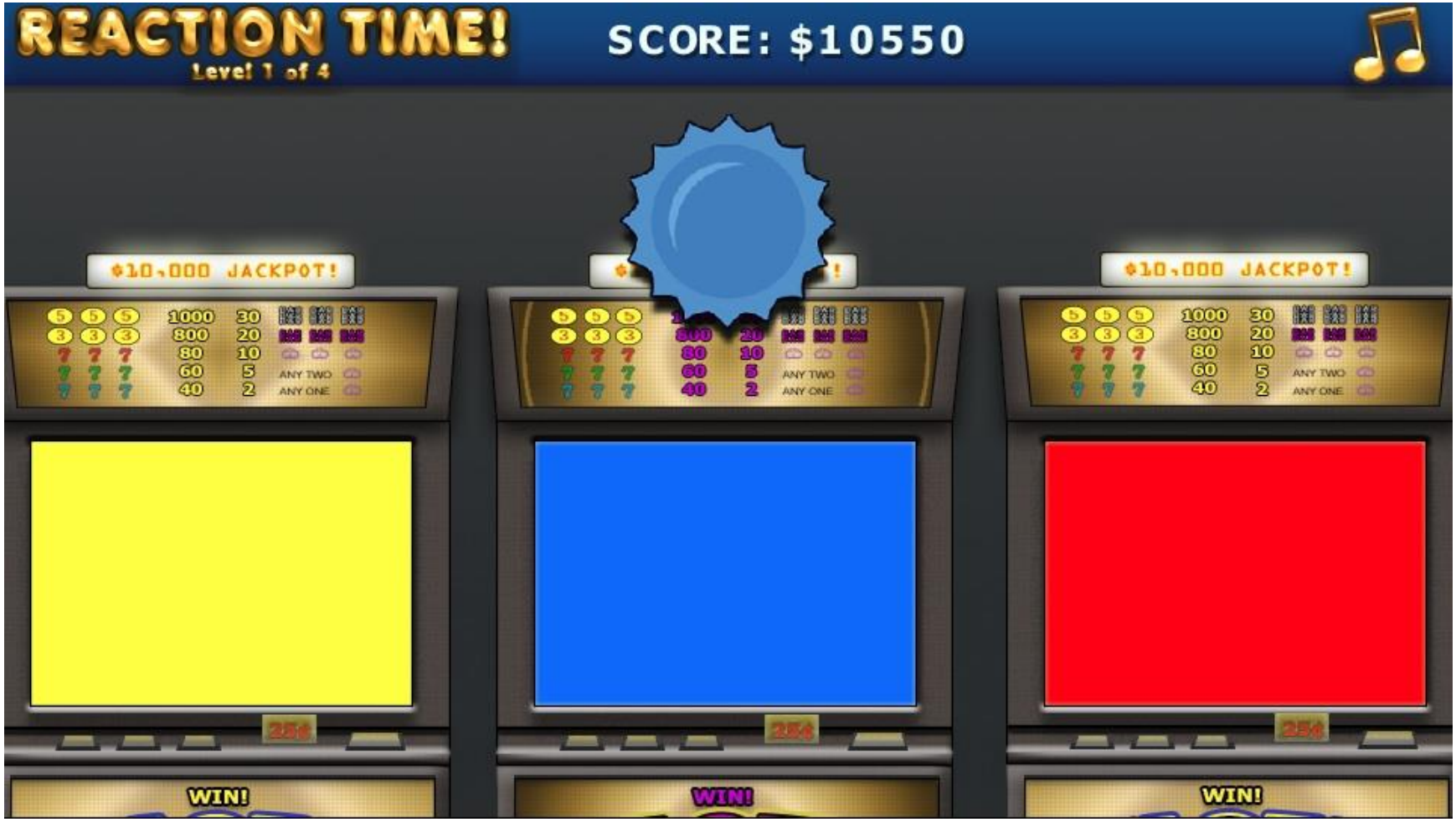

Figure C.5. Study Two Modified Pictorial Stroop Sub-Test

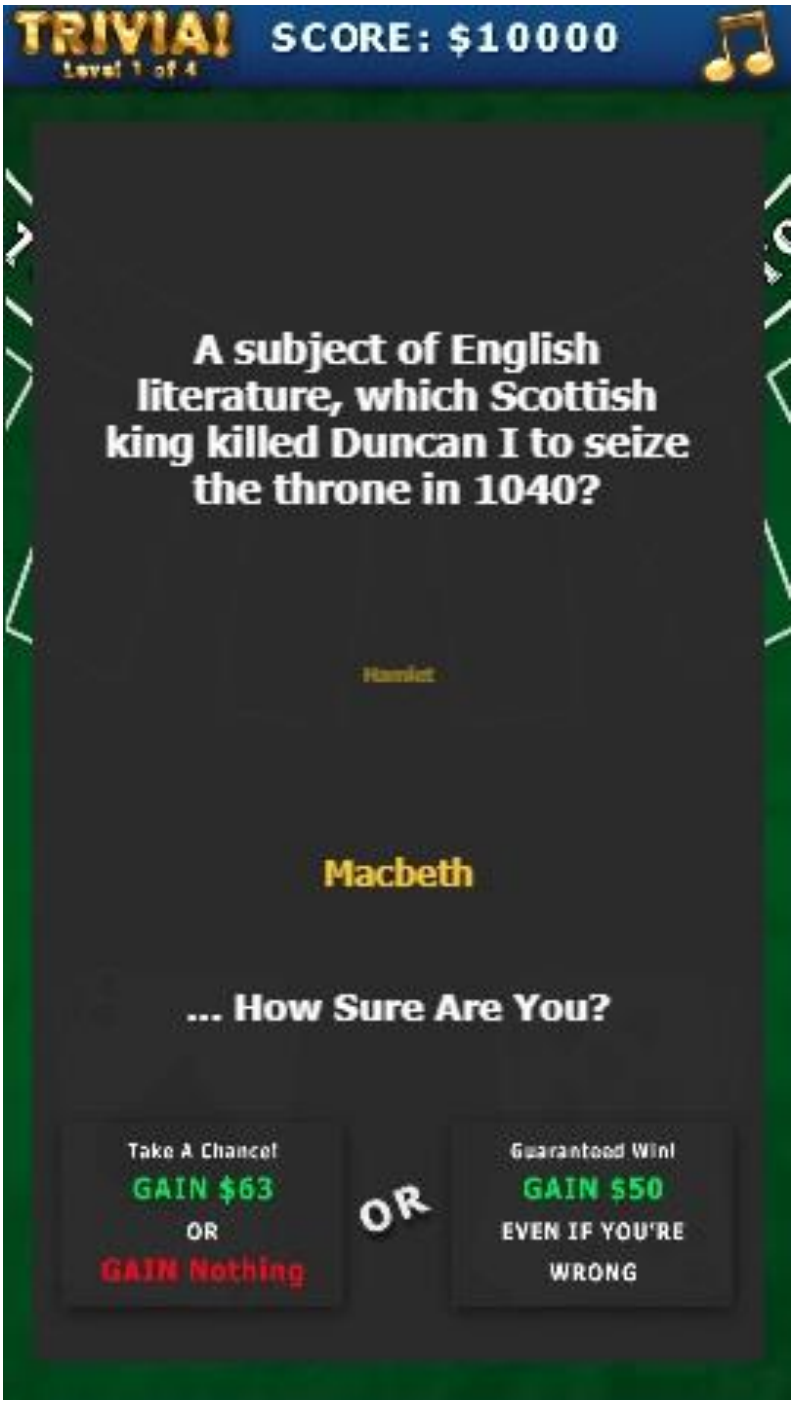

Figure C.6. Study One and Study Two Trivia Sub-Test

Figure C.7. Study One and Study Two Four-Cup Monte Sub-Test

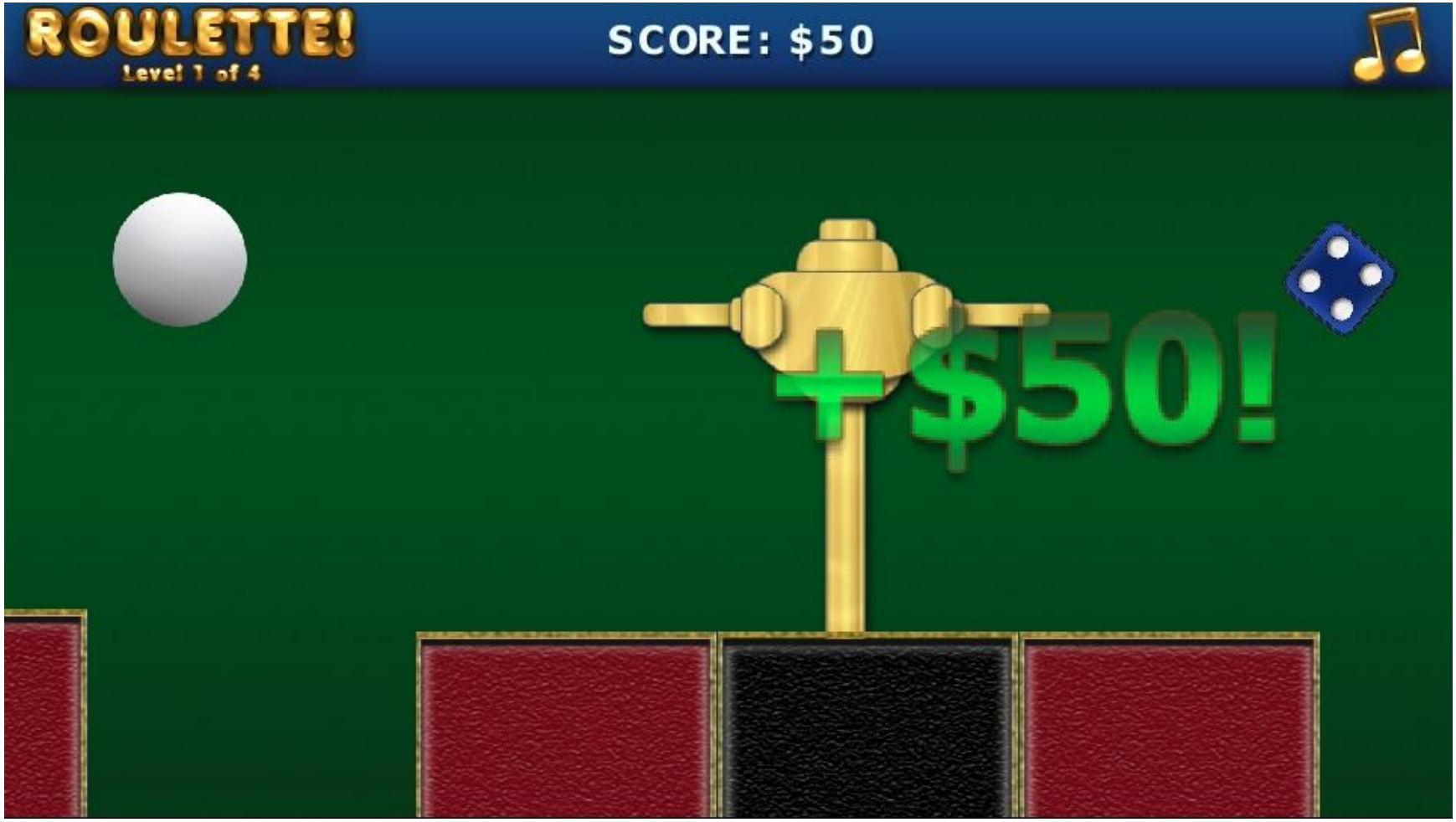

Figure C.8. Study One and Study Two Roulette Sub-Test

Figure C.9. Study One and Study Two Level Transition Screen

Appendix E: Participant Information and Consent Material (Study 4)

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Appendix F: Gambling-Related Cognitions Scale (Raylu & Oei, 2004)

Please indicate (by circling) the extent to which you agree with the value expressed in each statement (1 = strongly disagree; 2 = moderately disagree; 3 = mildly disagree; 4 = neither agree or disagree; 5 = mildly agree; 6 = moderately agree; 7 = strongly agree)

1 - Gambling makes me happier.
2 - I can't function without gambling.
3 - Praying helps me win.
4 - Losses when gambling, are bound to be followed by a series of wins.
5 - Relating my winnings to my skill and ability makes me continue gambling.
6 - Gambling makes things seem better.
7 - It is difficult to stop gambling as I am so out of control.
8 - Specific numbers and colours can help increase my chances of winning.
9 - A series of losses will provide me with a learning experience that will help me win later.
10 - Relating my losses to bad luck and bad circumstances makes me continue gambling.
11 - Gambling makes the future brighter.
12 - My desire to gamble is so overpowering.
13 - I collect specific objects that help increase my chances of winning.
14 - When I have a win once, I will definitely win again.
15 - Relating my losses to probability makes me continue gambling.
16 - Having a gamble helps reduce tension and stress.
17 - I'm not strong enough to stop gambling.
18 - I have specific rituals and behaviours that increase my chances of winning.
19 - There are times that I feel lucky and thus, gamble those times only.
20 - Remembering how much money I won last time makes me continue gambling.
21 - I will never be able to stop gambling.
22 - I have some control over predicting my gambling wins.
23 - If I keep changing my numbers, I have less chances of winning than if I keep the same numbers every time.

Scoring

To obtain the raw subscale scores add values of items for each subscale. To obtain total raw GRCS score, add the five raw subscale scores. To obtain mean subscale scores divide each of the raw subscale scores by the number of items in each subscale. To obtain a total mean GRCS score, add the five means subscale scores. The items that belong to each subscale are as follows:

- Gambling expectancies: 1, 6, 11, 16
- Illusion of control: 3, 8, 13, 18
- Predictive control: 4, 9, 14, 19, 22, 23
- Inability to stop gambling: 2, 7, 12, 17, 21
- Interpretive bias: 5, 10, 15, 20

Appendix G: Problem Gambling Severity Index (Ferris & Wynne, 2001)

Thinking about the last 12 months…

Have you bet more than you could really afford to lose?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Still thinking about the last 12 months, have you needed to gamble with larger amounts of money to get the same feeling of excitement?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

When you gambled, did you go back another day to try to win back the money you lost?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Have you borrowed money or sold anything to get money to gamble?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Have you felt that you might have a problem with gambling?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Has gambling caused you any health problems, including stress or anxiety?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Has your gambling caused any financial problems for you or your household?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Have you felt guilty about the way you gamble or what happens when you gamble?

0 Never **1** Sometimes **2** Most of the time **3** Almost always.

Appendix H: Diagnostic Criteria for 312.31: Gambling Disorder (DSM 5)

A. Persistent and recurrent problematic gambling behaviour leading to clinically significant impairment or distress, as indicated by the individual exhibiting four (or more) of the following in a 12-month period:

1. Needs to gamble with increasing amounts of money in order to achieve the desired excitement.
2. Is restless or irritable when attempting to cut down or stop gambling.
3. Has made repeated unsuccessful efforts to control, cut back, or stop gambling.
4. Is often preoccupied with gambling (e.g., having persistent thoughts of reliving past gambling experiences, handicapping or planning the next venture, thinking of ways to get money with which to gamble).
5. Often gambles when feeling distressed (e.g., helpless, guilty, anxious, depressed).
6. After losing money gambling, often returns another day to get even ("chasing" one's losses).
7. Lies to conceal the extent of involvement with gambling.
8. Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of gambling.
9. Relies on others to provide money to relieve desperate financial situations caused by gambling.

B. The gambling behaviour is not better explained by a Manic Episode.

Specify if:

Episodic: Meeting diagnostic criteria at more than one time point, with symptoms subsiding between periods of gambling disorder for at least several months.
Persistent: Experiencing continuous symptoms, to meet diagnostic criteria for multiple years.

Specify if:

In early remission: After full criteria for gambling disorder were previously met, none of the criteria for gambling disorder have been met for at least 3 months but for less than 12 months.
In sustained remission: After full criteria for gambling disorder were previously met, none of the criteria for gambling disorder have been met during a period of 12 months or longer.

Specify current severity:

Mild: 4-5 criteria met.
Moderate: 6-7 criteria met.
Severe: 8-9 criteria met.