REF2021

Institution: Bournemouth University

Unit of Assessment: 4

Title of case study: The impact of the Sea Hero Quest app on public awareness of, and engagement with, ageing and dementia research

Period when the underpinning research was undertaken: 2013 – 2019

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Professor Jan Wiener	Professor in Psychology	2009 - current
Professor Anthea Innes	Professor in Health and Social Care	2012 - 2015
Dr Sarah Muir	Lecturer in Psychology	2012 - 2019
Dr Shanti Shanker	Lecturer in Psychology	2016 - current
Dr Ramona Grzeschik	Postdoctoral Researcher	2015 - 2017

Period when the claimed impact occurred: January 2016 – 31 December 2020

Is this case study continued from a case study submitted in 2014? No

1. Summary of the impact (indicative maximum 100 words)

Bournemouth University (BU) research enabled the creation of Sea Hero Quest (SHQ), a mobile gaming app that encourages users to navigate complex virtual seascapes. In the process, they provide data on their own wayfinding ability and learn how it is affected by typical/atypical ageing. One of the most successful citizen science projects ever, SHQ reached more than 4,300,000 users in 194 countries, and:
- established the value of BU laboratory research in the real world;
- raised awareness of spatial disorientation in atypical ageing and the importance of research in overcoming it;
- triggered diagnostic innovation;
- provided new commercial domains for gaming developers.

2. Underpinning research (indicative maximum 500 words)

BU's Wayfinding Lab is developing a deep understanding of how ageing, both typical and atypical, affects the cognitive processes involved in spatial navigation. We are using this knowledge in part to develop empirically- based guidelines designed to minimise spatial disorientation in people with dementia. The work has been funded by an ESRC grant of GBP170174 ('Dementia Friendly Architecture') to Wiener.

Research in the Wayfinding Lab uses different methodologies to analyse changes in spatial knowledge and awareness with ageing. From the beginning, we employed three-dimensional virtual environments to pinpoint how age affects participants' use of cues as they learn to navigate through complex spaces. For example, we found age-related deficits in allocentric processing led to shifts in preferred navigation strategies. Older adults showed an unexpected - and suboptimal - shift towards using response-based strategies, and a specific preference for beacon-seeking [R1].

We have further enriched our knowledge of behavioural performance at routing choice points, using eye-movement analysis and computational modelling to gain a more detailed

understanding of wayfinding strategies [R2]. Subsequently, we have shown retrospective route-related recall is also age-sensitive. We trained young and older participants to a route learning criterion, then - away from the simulated environment - tested memory for landmarks, turn sequences, and route identification based on two-dimensional cues. Older adults showed differentially poorer performance on the latter two tests [R3].

More recently, we have focused on individual differences in the performance of older adults, showing that higher verbal and episodic memory abilities were strongly associated with better maintained route learning skills [R4]. We have supplemented this detailed quantitative account by conducting qualitative interviews with older adults living in retirement accommodation. These are designed to capture how memory problems affect their experience of wayfinding [R5]. Their accounts confirmed the difficulties revealed in laboratory studies and underlined the importance of effective landmark design in reducing difficulties associated with ageing.

Laboratory and applied research conducted in the BU Wayfinding group is necessarily limited in terms of external validity because it relies on sampling from relatively small and localised populations. Fortunately, a prestigious team of researchers, including Professor Wiener, came together in 2015 to overcome this constraint on generality. The result was an international project, supported by Deutsche Telephone and Alzheimer's Research UK, to identify the determinants of navigation ability in the global population.

This was achieved through the design of a mobile phone app, Sea Hero Quest (SHQ) [R6]. SHQ comprises a three-dimensional, multi-level game in which users navigate a boat through increasingly complex environments, gaining credits for completing wayfinding tasks. These tasks provide data on the processes that underly spatial navigation. The app also gathers demographic data, allowing researchers to construct a detailed picture of how wayfinding ability is distributed across gender, age, and nationality.

Wiener's expertise in the design of navigation tasks, environments, and experimental levels meant that he played a key role in the research team, ensuring SHQ could track age-related changes in navigational abilities.

3. References to the research (indicative maximum of six references)

R1-6 were all subject to rigorous peer review.

R1: Wiener, J. M., de Condappa, O., Harris, M. A. and Wolbers, T. (2013). "Maladaptive bias for extrahippocampal navigation strategies in aging humans*," Journal of Neuroscience*, 33 (14), pp6012-6017. https://doi.org/10.1523/JNEUROSCI.0717-12.2013.

R2: de Condappa, O. and Wiener, J. M. (2016). "Human place and response learning: navigation strategy selection, pupil size and gaze behaviour," *Psychological Research*, 80 (1), pp82-93. https://doi.org/10.1007/s00426-014-0642-9.

R3: O'Malley, M., Innes, A. and Wiener, J. M. (2018). "'How do we get there?': Effects of cognitive aging on route memory," *Memory and Cognition*, 46 (2), pp274-284. https://doi.org/10.3758/s13421-017-0763-7 .

R4: Grzeschik, R., Conroy-Dalton, R., Innes, A., Shanker, S. and Wiener, J.M., (2019). "The contribution of visual attention and declining verbal memory abilities to age-related route learning deficits," *Cognition*, 187, pp50-61. https://doi.org/10.1016/j.cognition.2019.02.012

R5: O'Malley, M., Innes, A., Muir, S. and Wiener, J. M. (2018). "'All the corridors are the same': A qualitative study of the orientation experiences and design preferences of UK older adults living in a communal retirement development," *Ageing and Society*, 38 (9), pp1791-1816. https://doi.org/10.1017/S0144686X17000277.

R6: Coutrot, A., Silva, R., Manley, E., de Cothi, W., Sami, S., Bohbot, V. D., Wiener, J. M., Holscher, C., Dalton, R. C., Hornberger, M. and Spiers, H. J. (2018). "Global Determinants of Navigation Ability," *Curr. Biol.*, 28, 17:2861-2866.e4. https://doi.org/10.1016/j.cub.2018.06.009

4. Details of the impact (indicative maximum 750 words)

Sea Hero Quest (SHQ) has been, at heart, a citizen science project, designed to achieve three interdependent goals:
- First, it aimed to gain massive quantities of data on how spatial navigation abilities varied with critical demographic factors, thus establishing the external validity of existing research on wayfinding and ageing.
- Secondly, it aimed to immediately raise awareness of the problem of spatial disorientation associated with dementia, and highlight the importance of research in overcoming the disabilities associated with it.
- Third, in the longer term, it aimed to impact on the wellbeing of people with dementia.

These goals could only be achieved by involving the global public, by creating an engaging data-gathering platform that also conveyed persuasive messages about dementia research and participants' contribution to it. SHQ is the tool we developed to achieve these aims (Figure 1).
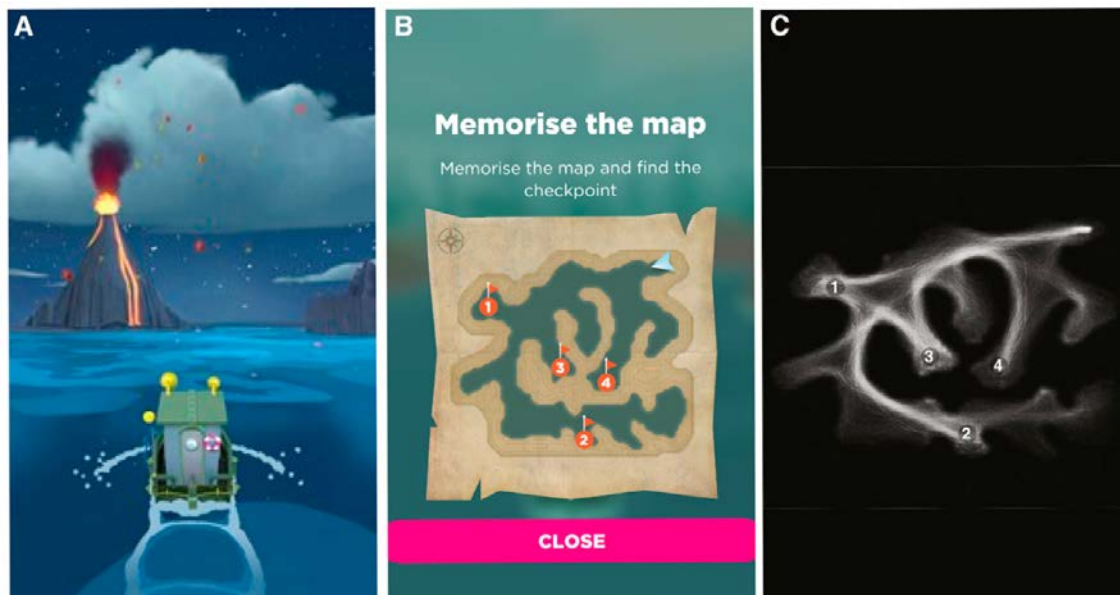

Figure 1: (A) Screenshot taken during navigation, highlighting the visual attractiveness of SHQ; (B) A map presented before navigation, featuring the order of waypoints to visit; (C) Superposition of 1000 trajectories for one level. SHQ requires users to interpret maps, plan and memorize multi-stop routes, monitor progress along and update route plans, and transform birds-eye to egocentric perspectives.

SHQ is one of the largest "citizen science" projects ever conducted, certainly "the largest dementia study in history" [E1], and it has worldwide reach. It has been played by 4,300,000 people, aged 18-90 years, from 194 countries. In 14 months, 2,500,000 participants downloaded and engaged with the game - the equivalent of "more than 176 centuries of experimental research in that field" [E2]. Of these users, 58% provided detailed demographic data. Analyses in R6 are based on at least 500,000 participants.

The unprecedentedly large normative data set, obtained from many diverse nationalities and cultures, is crucial to the longer-term impact of spatial learning research on understanding dementia. We can now be certain that spatial navigation abilities begin declining from the age of 19, becoming more rapid as ageing continues. This "big data" benchmark is already having a significant impact in geriatric medicine, for example, driving the development of SHQ as a new and sensitive differential diagnostic tool for dementia [E3].

SHQ was clearly positively rated by users, with average Apple and Android app store scores of 4.8/5, and 88,694 overwhelmingly positive reviews. To quantify the degree of enhanced cultural understanding of - and attitudes to - dementia, we analysed approximately 20,000 comments. The results demonstrate that active collaborative involvement with the research had produced a clear understanding of the link between navigational performance and dementia, and raised public awareness of dementia issues [E4].

A Google trends analysis further highlights the widespread public impact of SHQ [E5]. It shows a steep increase in searches for "dementia test" coinciding with the release of the app and first results (Figure 2). This demonstrates that SHQ's impact included the triggering of enhanced awareness of diagnostic tools for dementia.
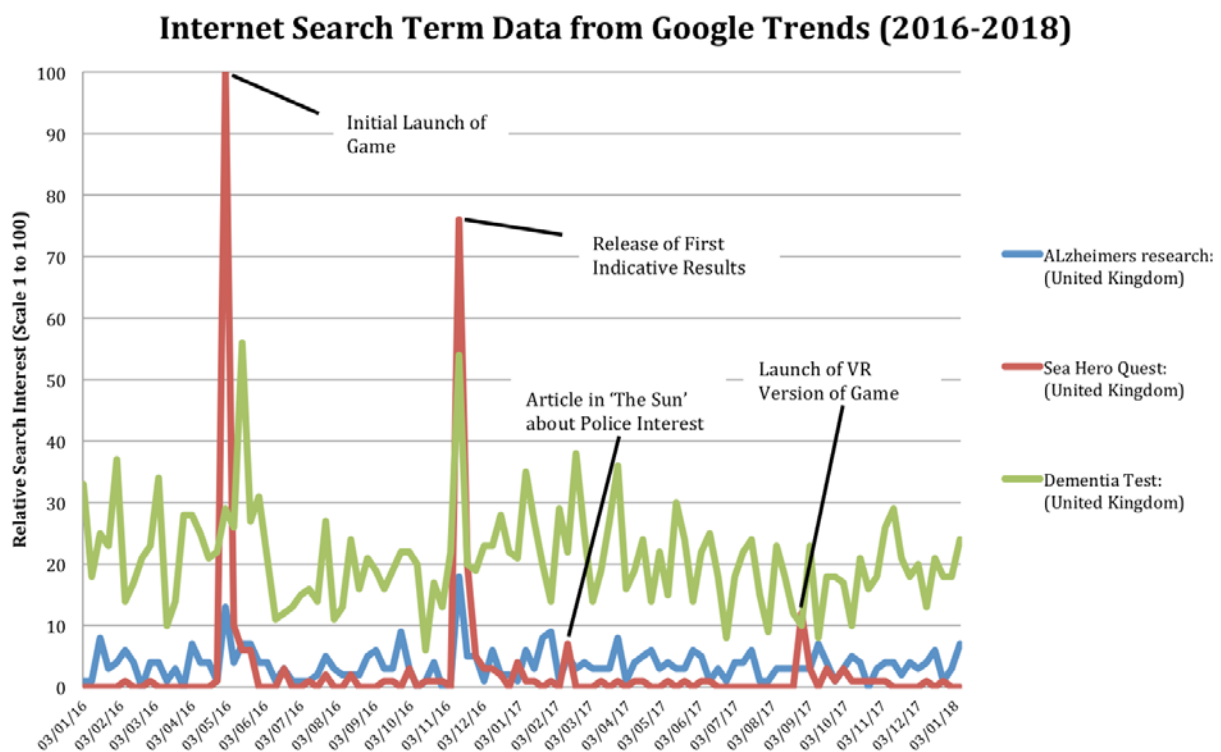

Figure 2: Google Trends analysis of the relative frequency of the search terms "Alzheimer's research", "Sea Hero Quest", "Dementia Test".

Further evidence of the reach and significance of SHQ in terms of awareness and understanding was provided by media analysts, Proud Robinson. They estimate that, globally, the media value of 2,700 items of SHQ coverage was EUR30,000,000 and, in the UK alone, achieved a total reach of approximately 50,000,000 people [E6]. For example, mainstream international tabloid and broadsheet journalists [E7] and broadcasters [E8] provided extensive coverage.

In addition to its impacts on research validity, public awareness, and diagnostic developments, SHQ also had an unexpected but significant commercial impact on the gaming industry. This is marked by the increasing importance of "Games for Good". GLITCHERS, the company that created the software implementation of SHQ, reports it has greatly enhanced its business. The co-founder states: "SHQ has been transformative for [us] … Its high profile, through widespread media coverage and multiple awards, has opened doors … and given the industry confidence in our abilities to deliver innovative, sector-leading projects under complex restrictions and through cross-sector collaborations." [E9]

Moreover, other software house representatives see SHQ as "a landmark in citizen science games", and … "an inspiration for the gaming industry as a whole". The industry has responded to the success of gaming/research collaborations, "with SHQ as a high-profile and very

influential example … by shift[ing] practice towards developing more of these games as policy."
[E10, E1]

SHQ produced a massive data set that is still being analysed. Once done, the results will inform a new-generation citizen-science app.

5. Sources to corroborate the impact (indicative maximum of 10 references)

E1: ThinkCrowd Founder. (2019). Letter to Weiner, 2 October.

E2: Deutsche Telekom. (2019). Letter to Weiner, 24 September.

E3: Coughlan, G., Coutrot, A., Khondoker, M., Minihane, A. M., Spiers, H., Hornberger, M. (2019). "Toward personalized cognitive diagnostics of at-genetic-risk Alzheimer's disease," *Proc. Natl. Acad. Sci. U.S.A.*, 116, 19:9285-9292. https://doi.org/10.1073/pnas.1901600116

E4: Dalton, R.C., Wiener, J.M., Yesiltepe, D., Adams, A., Spiers, H., and Hornberger, M. "Motivational Factors for Participating in Citizen Science Games", under review at *Journal of Citizen Science: Theory and Practice* (Available on request).

E5: Google trends analysis results used for Figure 2.

E6: Media reach data.

E7: Taylor, R. (2017) ALZHEIMER'S AID Sea Hero Quest game app to help police track lost dementia patients by testing their navigation skills, *The Sun* [online], 10 February, Available at: https://www.thesun.co.uk/living/2830063/sea-hero-quest-game-app-to-help-police-track-lost-dementia-patients-by-testing-their-navigation-skills/ (Accessed 05/01/2021)

E8: BBC Breakfast UK (2016) *Experts have designed an app that can help with research into how dementia affects the brain, called Sea Hero Quest* [Facebook] 4 May, Available at: https://www.facebook.com/bbcbreakfast/videos/experts-have-designed-an-app-that-can-help-with-research-into-how-dementia-affec/1321179204562881/ (Accessed 05/01/2021)
Video includes interview with Alzheimer's Research UK.

E9: GLITCHERS. (2019). Letter to Weiner, 16 October.

E10: W2O group. (2019). Letter to Weiner, 21 October.