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# From SnappyApp to Screens in the Wild

## Gamifying an Attention Deficit Hyperactivity Disorder continuous performance test for public engagement and awareness

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**Abstract**— Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental condition that is characterised by three core behaviours: inattention, hyperactivity and impulsivity. It is typically thought that around 3-5% of school aged children have ADHD, with lifetime persistence for the majority.

A psychometric Continuous Performance Test (CPT) had recently been incorporated into an interactive smartphone application (App), SnappyApp, to allow the measurement of the three ADHD symptom domains. SnappyApp presents a sequence of letters of the alphabet in a pseudo-random manner with responses via the device's touch screen. Following a pilot test in the general population where the CPT showed sensitivity to ADHD-related symptoms (self-reported impulsive behaviour related to CPT measures), a new project was begun to convert the App into a game Attention Grabber based on the functionality of the test, focussing on the attention and impulsivity domains.

The Screens in the Wild (SITW) platform is in the process of being employed for public engagement in awareness about ADHD through interactive technology. SITW has deployed a network of four public touch-screens in urban places. Each of the four nodes has a large (46 inch) display, a camera, a microphone and a speaker. The SnappyApp web-app was translated for presentation on to the SITW platform. The browser-based App was redesigned, with the input of a commercial graphics design company, based on an initial proof-of-concept whereby the original App was reprogrammed to present sequences of graphical objects (fruit) and to introduce further engagement features including animations. A shortened video about Adult ADHD and a brief questionnaire were incorporated to form a stand-alone edutainment package.

The earlier design and user testing of SnappyApp is briefly described and details are then provided of the process of gamification to produce Attention Grabber. An evaluation process is described whereby awareness of ADHD and its related symptoms are to be probed. In general, finding out whether and how people engage with interactive screen technology can help in the design of future public engagement and health promotion activities. Ethical considerations are discussed, since public access to this kind of game could potentially raise health anxiety

related to self-interpretation of game performance. This risk is balanced with the need to provide health information.

**Keywords**—healthcare; displays; gamification; m-Health, pervasive and ubiquitous computing

### I. INTRODUCTION

#### A. Urban displays and 'Screens in the Wild'

Over the last 20 years, the use of digital screens in the public realm has been rapidly increasing through advertising but also through public initiatives, such as the BBC Live Sites programme in the UK [1]. However, whilst the medium has become pervasive, expectations about its usefulness have actually decreased so that when people are faced with non-interactive advertising content, if not immediately relevant to them, they don't 'see' urban screens anymore [2]. Research is now concentrated on how best to integrate the medium with public life, for example the social potential of urban screens in supporting local communities and generating collective experiences [3]. This includes suggestions on how to better consider the relationship between content and technology in the engagement of communities [4]. English Heritage together with Commission for Architecture and the Built Environment responded to the challenge posed by urban screens by issuing specific guidance to support their installation [5]. More recently, Davies et al. have argued that this challenge can only be met through the provision of 'Open Display Networks' which are aimed at providing access to non-commercial interactive content [6]. The Screens in the Wild (SITW) project was developed in this context, deploying a network of four interactive, urban screens in the UK over the long term [7]. The nodes include two locations in Nottingham, UK (an Arts Centre and an Independent Cinema) and two locations in East London (within a Business Improvement District and at a volunteer-run community centre). One installation is shown in Fig. 1. From its inception, SITW has developed from content created by the research team to content created by others,

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providing an increasingly open platform, which will continue operating at least until the end of 2014.

One application area for SITW is as a platform for games in the domain of health and well-being. Gamification of health is a broad area including games to encourage healthy behaviours through motivation or explicitly as a form of exercise ('exergaming') and are also described under the banner of 'serious games' that are intended to support therapies and rehabilitation or training (e.g. through simulation). The area of interest in this paper is public awareness of health issues and in particular to address the problem of stigmatisation of people living with mental health conditions. More specifically there is a need to raise public awareness of Attention Deficit Hyperactivity Disorder (ADHD), and Adult ADHD in particular.

A few examples of existing puzzles and games intended for use in awareness-raising in mental health include a website offering a crossword of definitions and a word-square of mental health words from East Dunbartonshire Association for Mental Health [8], a 'Flash' video game from the Talk Out Loud Mental Health Stigma Programme [9] and a narrative-based adventure game Depression Quest [10]. One game, The Mooderator, had previously been produced for SITW whereby people are able to share their mood across four locations.



Fig. 1. Screens in the Wild installation (reproduced with permission)

### B. Adult ADHD and stigma

Attention Deficit Hyperactivity Disorder (ADHD) is a common neurodevelopmental condition that starts in childhood, and for the majority of individuals, persists into adult life [11]. The symptoms of ADHD can include: inattention (difficulty concentrating for long or finishing tasks,

disorganised, easily distracted, forgetful, unable to listen when people are talking), hyperactivity (fidgety, unable to sit still, talking excessively, always on the go, feeling of inner restlessness), and impulsivity (acting quickly without thinking about the consequences, interrupting other people, difficulty waiting turn) [12].

The history of ADHD as a valid and reliable condition has not been without controversy and it has often been perceived as an excuse for poor parenting, a cultural construct, or driven by the US pharmaceutical industry. Progress has been made in the acceptance of ADHD in children, however, despite European wide consensus validating ADHD as a condition persisting into adulthood [13], it remains under-diagnosed and under-treated in adults [14]. Having ADHD as an adult can have significant implications for education, work, independent daily living, and social relationships [15]. The consequences of not diagnosing and treating ADHD in adults appropriately can also result in high rates of substance misuse or offending, with broader implications for health and social care, and wider society as a whole [14].

Research has suggested that stigma of mental health disorders can significantly impact on engagement with treatment and affect mental wellbeing. Mueller et al. identified factors specific to ADHD which include public uncertainty about the validity of ADHD as a diagnosis, perceived dangerousness of individuals with ADHD, and scepticism towards ADHD medication [16]. Public opinion on these issues is likely influenced by media reports which can lack scientific justification [17].

Stigma towards individuals with ADHD can also have wider impact for friends and family through 'courtesy stigma'. Qualitative research carried out by Williamson et al. found that parents react to external expectations put forward by community networks, but that stressors could be lessened through societal stigma reduction [18]. Walker-Noack et al. found that a cohort of young people (age 10-21 years) perceived the general public to be misinformed about ADHD, contributing to social stigma and stereotyping, resulting in a negative perception with regards to having the condition [19]. This is supported by a negative bias found towards adults with ADHD, particularly in academic and work settings [20].

The Government's mental health strategy for England 'No Health Without Mental Health' set out six key objectives for better mental health and improved mental health care, one of which included reducing stigma and discrimination [21, 22]. Aligned to this aim, the Nottinghamshire Healthcare NHS Trust had recently developed a set of resources 'Making Sense of Adult ADHD' designed for use in clinical settings. As part of this resource a film was made to illustrate ADHD from the perspective of five adults living with the condition [23]. These were patients accessing a specialist clinic for adults with ADHD in Nottingham. Bev, John, Joe, Vicky and Scott describe how having ADHD impacted on their childhood, and how it continues to affect their daily lives and those of the people around them.

The original purpose of the film was to raise awareness of ADHD in adults for use in clinical settings: given to newly diagnosed adults to help in engagement with the diagnosis and

treatment, and identify with the condition; and to be informative to clinical staff who may have a role in identifying and treating adults with ADHD. The SITW project was seen as an opportunity to expand the film's use into a public sphere and raise broader public awareness of ADHD in adults. To this end, a condensed version of the film was produced to be combined with a game based on a Continuous Performance Test, as described in the next section.

## II. IMPLEMENTATION

### A. *SnappyApp: Continuous performance Test*

Whereas the most widely accepted method of assessment of ADHD is the clinician's judgement, objective methods are now commonly used in the assessment of ADHD in children and adults. One such measure is the Continuous Performance Test (CPT) which is a neuropsychological test that measures the individual's attention and impulsivity in a sustained task. Typically, a CPT is a computer based programme which involves rapid presentation of visual or auditory stimuli where participants are asked to respond when a given target occurs but remain passive to non-targets. CPTs are a popular adjunct in the assessment of attention [24, 25].

The potential for wider use of CPTs recently led to a project pilot study at the University of Nottingham that was conducted on a non-clinical sample to establish the feasibility and validity of a smartphone application which could be appropriate for monitoring symptoms in a clinical population [26]. The primary aim of the pilot study was to establish whether it was feasible for end-users to conduct a CPT on a phone whilst their physical activity was measured using the in-built motion sensors (accelerometer, gyroscope). The resulting application, SnappyApp, was designed to present a sequence of letters as target stimuli (implementing a form of the 'AX' CPT [25]) and asked the user to respond via the touch screen or a button on the screen of the smartphone (clicking only when an 'X' immediately follows an 'A'). Initially the App was developed to implement the 'AX' test on an Android smartphone platform and this was subsequently converted to an HTML5 web-app.

From a research study that was conducted with SnappyApp, meaningful correlations were found with a self-reported impulsivity measure and with activity data collected from the phone's sensors. Further results from the study from the end-user point of view showed that the task was considered to be easy and not stressful. However preferences were expressed about screen background colour, font size, display of the time, and a number of usability suggestions included choice of user name, addition of a help function, further reminders (by text messaging) and a gamification function (scoring or ranking system for participants) [26].

This latter point raised during the SnappyApp user study introduced the possibility of gamifying the App which in turn contributed to the idea of implementing a game on the SITW platform (which is browser-based so an adaptation of the web-app version of SnappyApp was deemed to be most feasible).

The aims of the public awareness element were determined to be:

- a) Discover to what extent the public engage with the health-related content as part of a community placed multimedia installation.
- b) Increase knowledge/health literacy about ADHD.
- c) Reduce stigma by placing positive messages about ADHD in the community.

Whilst the aim of this project was to raise public awareness of ADHD, the potential for raising health anxiety also needs to be considered, particularly if an individual performs poorly on a CPT. Therefore, a text screen following the game will be carefully worded to avoid judgment of game performance. On the other hand, there is good research evidence that increasing public awareness of physical health problems leads to improvements in public health. For example, Robb et al. measured the impact on health anxiety of providing cancer risk information to patients in a UK general practice setting. They found no increase in anxiety, and suggested that educational materials have good potential to contribute to public engagement with health promotion and disease prevention [27]. The impact of raising public awareness of mental health conditions has received less attention. However, a review by Jorm suggested that if the public's mental health literacy is not improved, this may hinder public acceptance of evidence-based mental health care, and individuals may not receive appropriate support from others in the community [28]. Ethical approval for was obtained via the University of Nottingham Computer Science ethics committee and opinion was also sought from the Medical School ethics committee.

### B. *Attention Grabber: urban screen implementation of an attention & impulsivity game*

The Screens in the Wild platform provides an opportunity to test out the value of public engagement with health information through the interactive multimedia installations in public places. As indicated earlier ADHD was selected for this project in part because ADHD-related interactive resources (Apps and film) are available, which could usefully be deployed across the screens, and in part because there is little existing work aimed at addressing stigma and discrimination related to ADHD. A number of information websites that do exist are targeted primarily at the clinical population, rather than aiming to provide knowledge and awareness for the general population. It is intended that Attention Grabber will be available on the SITW platform for 2 hours each day at each of its four locations and, as introduced above, includes two different media to engage members of the public with ADHD related information:

1. An interactive game – based on the functionality of the CPT test for assessing symptoms of ADHD, focussing on the attention and impulsivity domains.
2. A two minute film with sub-titles, featuring adults living with ADHD – an edited highlight of a longer film which formed one of a number of resources produced by specialist clinicians from the NHS Trust to increase awareness and understanding for adults with ADHD.

The adaptation of SnappyApp to a game for the urban screens can be seen in Figs. 2 and 3.

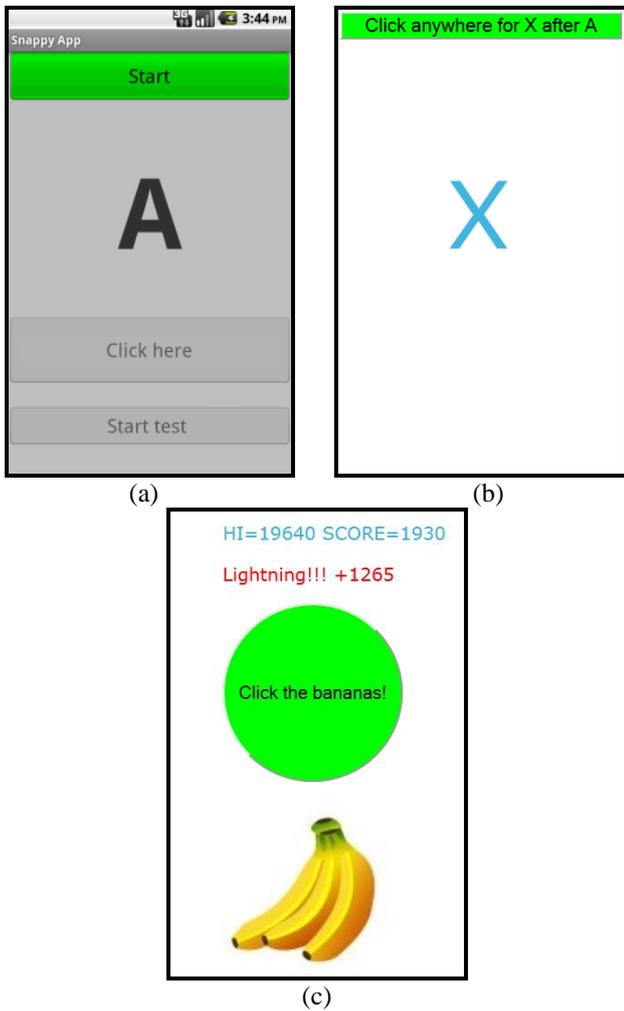


Fig. 2. Incremental development of Attention Grabber (a) Original SnappyApp 'AX' CPT Android App (b) Web-app version of SnappyApp (c) Gamified web-app Attention Grabber

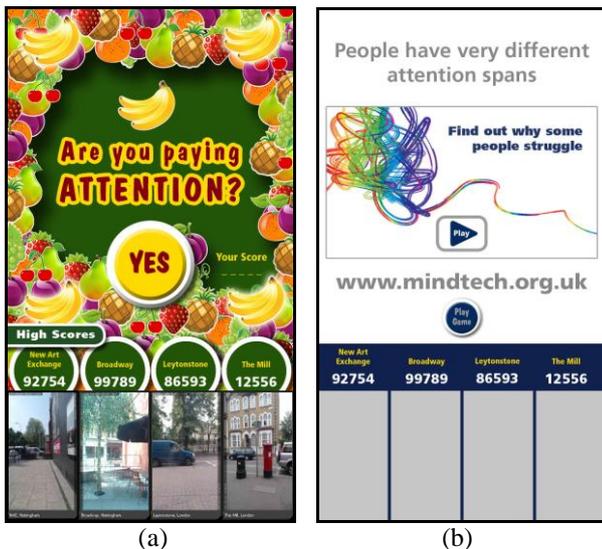


Fig. 3. Design of Attention Grabber for the SITW large screen (a) Redesign and layout with graphical designer's reproduction of 4 video feeds at the bottom (b) Adult ADHD video resource, shown optionally after the game.

The aim of the gamification was to make the attention task easily understandable without additional instruction and to provide some level of motivation that is not present in the CPT and, when combined with the Adult ADHD video, a stand-alone edutainment package for increasing awareness. The new game was designed for use by children or adults and so, as a proof-of-concept prior to translation to the SITW screen format, the App was redesigned with attractive graphics. It also implemented a simpler form of the CPT where the user is asked only to look for a single stimulus (commonly known as the 'X' CPT). The presentation period of the stimuli was maintained at 1.65 seconds but the duration of stimulus presentation was increased to make the game easier (since in the true CPT the stimulus is shown only momentarily). The number of presentations was also reduced to 100 from the original 400 in SnappyApp, therefore reducing overall playing time.

Fig. 2. shows the progression from the original Android SnappyApp to the proof-of-concept Attention Grabber web-app. Instead of letters, different types of fruit were chosen as the stimuli and bananas were chosen as the target 'X' stimulus, since they are a familiar fruit and easily distinguished from other fruit in either shape or colour. Game functions introduced into the web-app included a personal score for the game being played that was accumulated from rewards for reaction time and correct selections, and penalty points awarded for incorrect or missed selections during the test (the latter deducted at the end). The highest score was also saved and shown on the screen to allow the player to compare their performance against this and to motivate them to repeat the game.

Since the SITW platform used the Mozilla Firefox web browser, the gamified version of SnappyApp was developed from its web-app version, Figure 2(b), which had been programmed in Javascript and HTML5. As such, the proof-of-concept design, Figure 2(c), was able to run on any browser supporting HTML5 which includes browsers that are installed on a wide range of PCs, tablets and smartphones.

The graphical look was redesigned for the SITW large screens by a graphic design contractor to make it attractive to passers-by, and will also introduce animation of the text and graphics. Audio was not included in the game since the urban locations of the screens demand that sound is kept to a minimum. The condensed video includes audio but sub-titles are present since the audio may be turned off or set to a low volume at some locations. Additional features include the display of video feeds from the internet (IP) camera at the local site and at the other three remote sites, and high scores to be displayed from all of the locations. Fig. 3(a) shows an impression of the home page of the game screen with four typical views from the cameras at the four locations (as seen when nobody is in front of the screen). A function was included on the server side to allow the high scores to be zeroed by the SITW administrators at any time. Figure 3(b) shows the screen that is accessible as an option at the end of the game to allow the player to view the ADHD video. Alternatively, the game can be replayed without first viewing the video.

### III. EVALUATION PLAN

#### A. Rationale

Evaluating open display networks poses specific challenges. One might usefully split this into evaluating what happens around the screen and what happens in urban space and the affected communities. The user experience around the screen can be framed by previous work that described how people move from observation, to distance interaction, focussed interaction, and then other activities [29, 30] and by the entry and access points enabling these stages of engagement [31]. Capturing this behaviour typically involves a mixed-methods approach combining log and video data analysis with on-the-ground fieldwork. Understanding the wider context can be addressed by drawing on spatial analysis [32, 33] and also by conducting and evaluating community work, where the tensions between multiple stakeholders can be a useful driver for design and scheduling [34, 35].

In the context of public health, using media can have good utility for a number of purposes, including raising public awareness [36], which can potentially be measured. Time to Change is England's largest programme aiming to challenge mental health stigma and discrimination. This ambitious, evidence based, multi-million pound programme uses a multi-modal approach to change public attitudes and behaviours. The programme, now in its second stage, includes social marketing and media campaigns, community activity and events, user-led projects and a network of patient leaders. The programme has an integrated evaluation led by the Institute of Psychiatry [37].

For programmes such as Time to Change, the chosen methods for assessing impact are longitudinal designs which sample the general (or target) population to compare knowledge, attitudes and behaviour before and during/after any campaign [38]. While it is likely that such programmes can produce short term positive effects, the longer term impacts can be harder to discern and sustain [39]. Moreover, the Time to Change campaign has found that even these short term positive effects can be eroded even while the campaigning continues to be active [40]. A limitation of this evaluation method is the inability to determine the exact contribution of any campaign to the changes reported in the follow up studies.

While this current project is significantly more modest in terms of reach and scale, evaluation is required to measure effectiveness of the installation in meeting the aims (as above). Given the nature of the campaign, it was decided to limit evaluation to assessing engagement with the installation and change in knowledge for those people who engage with both elements of the programme; aims (a) and (b). Assessing the impact on stigma for people with ADHD (c) is outside the scope of this project/evaluation since measurable change in the general population is unlikely with this style of campaign.

#### B. Evaluation methods

Interaction data will be collected through the automated logging of completion, progression and interactions via the installation and the Attention Grabber application. These will be stored centrally via the SITW server. The following

outcomes will be analysed across the designated time slots and sites:

1. Number of interactions with Attention Grabber.
2. Number of times the game is completed.
3. Number of times users progress through to the film.
4. Responses to questions embedded in the media at appropriate places (Table 1), plus response rate to these questions compared to number of people interacting with the content overall.

Additional analysis will be performed of recordings of activity in front of the screen via the internet (IP) cameras and video link footage. This will enable a partial assessment of the broad demographics (for example, age and gender) of those interacting with the installation as well as group sizes. Excerpts of these recordings will be selected to illustrate different episodes of interaction identified through the logging data.

TABLE I. SAMPLE QUESTIONS TO BE EMBEDDED IN THE MEDIA

| Questionnaire  |              |          |      |       |
|--|--------------|----------|------|-------|
| Question   | Rating scale |          |      |       |
| Did playing the game make you think about your own attention span? | Not at all   | A little | Some | A lot |
| How much do you know about ADHD?                                   | None at all  | A little | Some | A lot |
| How aware are you that ADHD affects adults?                        | Not at all   | A little | Some | A lot |
| How much has the film increased your knowledge of ADHD?            | Not at all   | A little | Some | A lot |

### IV. CONCLUSIONS

This paper has described the evolution of a game combined with an information film to increase awareness of adult ADHD. This will shortly be launched for public use at the four Screens in the Wilds locations, and is due to run for two hours a day until the end of 2014. The aims of the public awareness project and its evaluation process have been described, and its scope and limitations discussed. The Attention Grabber game will be play-tested before launch and adjustments made to the length of the game or the values of the score and penalties where required. An impression of the game in-situ at one of the SITW screen locations is shown in Fig. 4.

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([www.screensinthewild.org](http://www.screensinthewild.org)), which was originally funded through EPSRC grant EP/I031413/1, is provided by HS, Steve North and Lei Ye at the Mixed Reality Lab. The authors acknowledge the graphic design work (shown in this paper for the SITW version of Attention Grabber) by Crocodile House, Nottingham, who also produced the condensed film, funding for which was raised from a prize awarded to AG and others for the Nottinghamshire Healthcare NHS Trust 'Making Sense' resource for Adult ADHD. The authors wish to thank all of the volunteers who contributed to the testing of SnappyApp and those who were involved in the making of the Making Sense video.



Fig. 4. Graphic designer's impression of Attention Grabber as it may look in-situ, after launch.

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