

# Service-Please: an interactive healthy eating serious game application for tablet computer.

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**While everyone knows that we should eat healthily, translating such information into practice is a major challenge for many of us when it comes to eating well. So despite a huge increase in awareness of the implications of food-choices, obesity levels in the UK continue to increase. In this paper, we present a novel application designed to deliver psychological ‘Approach Avoidance’ training in a serious games format. Developed for tablet computers, gameplay requires players to repeatedly push unhealthy food icons away, and pull healthy food icons towards themselves. The hypothesis for the overall project is that repeated push away gestures will produce an implicit avoidance bias towards unhealthy foods, reducing players’ tendency to consume them. Previous research using a joystick controlled PC training regime has shown success with alcohol choices, however the current project offers the potential for a pervasive game based intervention using a tablet and gestures making such training more readily accessible.**

*Healthy Eating, Serious Games, Pervasive Computing, Tablet Computers, Marmalade, iPad*

## 1. INTRODUCTION

While many of us believe that we are in control of what we choose to eat, it is well established that, consciously or not, we eat more when there is more food available (Wansink and Cheney, 2005). Furthermore, we can be induced to eat beyond the point of fullness with sufficiently appetising food cues (Cornell et al., 1989). Consequently, the high availability of cheap ‘junk’ food in the UK has resulted in a high fat, high salt, high sugar diet that contributes to the prevalence of obesity. In turn, diet related conditions such as diabetes, heart disease, and cancer, place a significant, but preventable, strain on our healthcare system. In 2006-07, diet-related ill health cost the NHS £5.8 billion (Scarborough et al, 2011). A sustainable society is therefore a healthy society, and great strides could be made towards improving population health if individuals made healthier

dietary choices. However, changing dietary behaviour is deceptively difficult. Public health strategy to date has focused largely on education, under the assumption that people who understand the consequences of unhealthy food choice will make healthier choices. Unfortunately, while education increases knowledge about what constitutes a healthy diet, this knowledge, does not lead to changes in actual diet (Hesketh et al, 2005).

Neuroimaging evidence points to similar patterns of brain activity in both substance addicted and obese individuals, strengthening the arguments in favour of food addiction in the explanation of obesity (Gearhardt et al., 2011). Thus the question arises as to whether it is possible to directly influence peoples’ choices through attentional training or approach bias re-training techniques used in alcohol addiction. Recently, it has been experimentally shown in controlled laboratory

studies that individuals who are asked to repeatedly push away pictures of alcoholic drinks subsequently drink less than those who did not (Wiers et al., 2010). It seems that the mere act of repeatedly rejecting a target item sets up a subconscious psychological bias that steers people away from that item in future. So rather than trying to educate and inform the user directly (a method that has little impact on actual behaviour), psychological training may directly influence choice with little or no effort from the individual and could be used to 'nudge' peoples' food choices in a healthier direction.

Seminal work by Wiers et al. (2009, 2010) has established a behavioural effect of avoidance training on learned responses to alcohol related stimuli in both healthy adults and problem drinkers. The Approach Avoidance Task (AAT) intervention typically involved in their research requires participants to perform a picture sorting task on a PC monitor. Participants are asked to use a joystick to 'push away' landscape oriented pictures, and to 'pull toward themselves' portrait oriented pictures. The content of the picture appears irrelevant to participants, but all pictures in the push condition depict alcohol, while pictures in the pull condition depict shape and colour matched non-alcoholic drinks. With sufficient training episodes, subsequent alcohol consumption has been reduced significantly, and this reduction maintained over extended time periods (Wiers et al., 2010). It is argued that addictive behaviour develops through automatic or implicit associations gaining attentional bias, and that training can tackle these biases. However, if these experimental behavioural change techniques are to be useful outwith the laboratory and in food contexts, they must be delivered in a format that is engaging and accessible. With this in mind, the present project had two objectives;

- (i) to build a food focused version of Wiers et al.'s behavioural training paradigm into an enjoyable gaming application
- (ii) to map the perceptual effects observed on PC and joystick to a more accessible touch-screen tablet format

The advent of tablet PC affords an opportunity to align the perceptual and the physical contingencies in the AAT paradigm in a highly popular ubiquitous gaming device tablet format allows for a potentially stronger link to the food item by co-locating the stimulus and the push or pull gesture. The player must actually touch the object in order to push it away. The ability to set a tablet computer flat, in landscape format allows for the object to physically retreat or approach in absolute distance.

## 2. THE SOFTWARE SOLUTION

The game was designed by a multi-disciplinary team comprising: two psychologists, an information scientist, a health economist and an artificial intelligence researcher along with programmers, graphic designers and digital artists. Over a series of group-work sessions, numerous concepts were narrowed down to create a game board that combined and met the scientific objectives within an engaging game. The game was angled in perspective to allow objects placed on it to recede in the push away condition. The Push/Pull gestures were set to travel a minimum distance across the tablet that was equal to the distance travelled by the joystick in the AAT task of Wiers et al. The game format is variable so that in future trials it will be possible to independently manipulate the growth and shrink of the game assets as well as the distance travelled.



*Figure 1: Game concept splash screen.*

### 2.1 Graphic Elements

#### 2.1.1. Food items

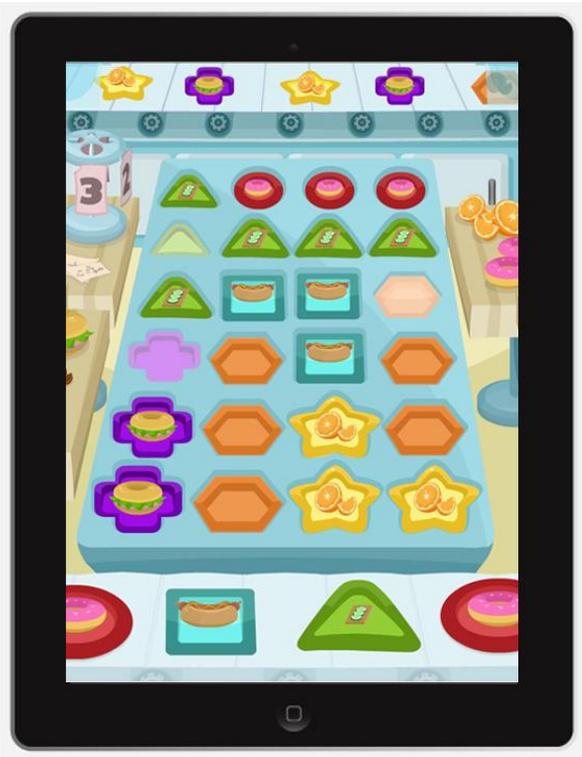
Iconic 'non-photographic' versions of the target healthy and unhealthy foods were chosen to maximise the generalisability of the graphics. In total, eight matched pairs of healthy and unhealthy food items were created (Figure 2).



**Figure 2:** Examples of Matched Healthy and Unhealthy Food types. Healthy items in this figure appear on the top row, with their matched unhealthy items depicted immediately below.

### 2.1.2. Gameboard

Figure 3 demonstrates an image from the game play showing the basic game-board. To emulate Wiers et al's task where targets were sorted based on landscape/portrait orientation and not picture content, the objective of the game is to shift the foods according to the shape of the plates and the foods on the plates seem irrelevant. The grid layout can be pre-programmed within the game to ensure drag distances for objects.



**Figure 3:** Game Layout board.

The game grid includes two conveyor belts that produce foods. The task of the player is to drag individual plates (which have different shapes) and match three in a row on the board. The food

appearance is designed to mimic sushi restaurant layouts where there is a sense of urgency. The player is required to use both belts to solve the task ensuring that they use both the push and pull gestures. Healthy food stimuli are located on the top conveyor belt (necessitating a 'pull') and unhealthy food stimuli on the lower conveyor belt (necessitating a 'push'). A counter on the left side of the grid keeps a running score of the plate matches. The plates must be dragged to the correct location. Misplaced plates smash into pieces and a matching sound effect is played. At the conclusion of the game, the participant is given a score category rather than an actual number. The long-term idea is to create interim 'rewards' after each level, but in the final game, difficulty will increase between levels.

### 2.2 Application Structure

The implementation software is written in C++ and GLSL, using the Marmalade API to allow for the possibility of cross platform development. The application was designed based on the Object-Component Model (Dickheiser, 2006). This model operates by representing in-game objects as the same common base class and "bolting-on" components for any object specific functionality such as rendering, interface and control script components. This structural model is highly modular and automated, and allows agile and robust modification of in-game objects. The structure described is ideal for representing the integral plate and food objects in the application, which may need to have their colours and images modified at run-time to allow for differing experimental criteria. Future extension of the application engine is also simplified by the abstracted nature of this model.

The OpenGL ES 2.0 API was used to implement the view transformations required to give the impression of perspective needed for the "push-pull" mechanic. A modifiable perspective controller object controls the use of perspective transforms in all areas of the application through a globally applicable normalised perspective factor. By changing the value of the perspective factor in the controller, the perspective mechanic can be modified to allow for changes in the relative scale of objects based on their perceived distance from the view point at the base of the screen. The delivery belts for healthy food items can be swapped from top to bottom to enable control conditions within experimental protocols.

The software stores time taken to drag the object, the X-Y start and end-points, the colour of plate, the food type, the accuracy and the drag time. Total game time is also stored. Data is saved on the device in a file stamped with the time the data was collected. This format allows for the anonymised

collection of data in public spaces and events such as in science festivals. It is important that the application can be released without the necessity to pre-programme participant details.

### 2.3 User trials.

Preliminary user trials (n=21; age range 20-25) indicate that average game duration for a single level is 1.01.6 minutes (SD 19.9 secs). There was no significant difference between drag times for top and bottom belts (t=.75, P =.464), table 1.

**Table 1:** Average Drag Times for Correct and Incorrect Food Selections (top & bottom)

Food Type	Average Drag Time (Secs)	
	Correct	Incorrect
Healthy (top)	1.029	.835
Unhealthy (Bottom)	1.038	.618

There was no significant difference between correct drag times from top and bottom (t=-.078, p=.94); see table 1. Drag error rate for the bottom belt was 11.1% and for the Top belt 21.43%, meaning the top belt was used slightly more (because correct drags complete the game). Total number of correct drags required to solve the game is always 12 each from top and bottom. Overall, oranges, cakes and strawberries were dragged the fastest, but these differences were not significant.

### 2.4 Summary

Overall feedback from the first prototype of the application has been positive; both in terms of the gameplay and the healthy eating focus of the application. However, the user trials indicate that an additional instruction splash screen is required prior to the game play to ensure participants are equally aware of both conveyor belts in the game from the start.

### 3. FUTURE WORK

Future studies will assess the impact of gameplay on subsequent dietary behaviour. In initial tests participants will be asked to play repeated levels of the game to ensure 20 minutes total game time enabling direct comparison with laboratory studies of the original paradigm. Additional feedback will be required to make the game sufficiently rewarding to encourage participants to play for the required number of repetitions. The participants will then be asked to participate in a seemingly unrelated consumer rating study where they are asked to make consumer judgements on a range of products. Amongst the products being rated will be a selection of food items depicted in the game (e.g. sweets and crisps) and each raters' consumption of

these foods during the rating task will be recorded. If the behaviour change techniques built into the game do implicitly reduce players desire to consume unhealthy foods, we would expect to see a measurable reduction of their intake during this rating task. Comparison with the belts-swapped version of the game serves as an internal control condition in the experimental design.

There is increasing recognition that many of the problems we face as a society (e.g. obesity, climate change, crime) come down to the behaviour of individuals and so there is a real push to fully exploit research from the behavioural sciences in order to facilitate real world behaviour change. The recent House of Lords Science and Technology Select Committee report on Behaviour Change (2011) begins by stating that behaviour change underpins the development of effective and efficient policies in all areas of concern to the UK. This neatly illustrates the scale of the potential impact of this project. If we can demonstrate that the approach can be successfully brought out into the wild in one domain (healthy eating) the same techniques could then be adapted to other areas of national economic interest (e.g. climate change). By launching the refined game on popular mobile computing platforms for free we will be able to open up this research. Games are undoubtedly popular among children - 99% of boys and 96% of girls between the ages of 8 and 12 play electronic games on a regular basis each week (Todays Gamers (2009) and this figure will only increase in future, so there is a significant opportunity to utilise this technology to nudge people's dietary choices in a healthier and more sustainable direction.

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