

Chapter for **Breaking Convention book**

## **YourBrainOnDrugs.net - Using smartphone games to research recreational drug use**

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**Main Text (3660 Words)**

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### **Introduction**

This chapter describes the YourBrainOnDrugs.net research project (1). We are developing a smartphone application to track drug and alcohol use in the real world. It links psychological and sociological researchers directly with ordinary users. The aim is that to create a win-win scenario where researchers can have access to large numbers of participants and can provide the public with real-time feedback on how the drugs they take affect their cognitive function and their emotional state. The users are provided with a smartphone application that is fun to use and lets them track their consumption of alcohol and other drugs. It has a mood tracker and a series of simple games that measure reaction time, coordination, memory and cognitive measures. We want to give the public instant, honest feedback, in the hope that this gives them new ways of telling how drink and drugs affect them. Our first version tracks just alcohol but will be adapted to recreational drugs in the future.

Openness and honesty are a key foundation of the project. All data collected will be anonymous but available. All the software we are developing is available free with an open source license. All our progress and our research will be documented on the internet and provided freely with creative commons licensing. YourBrainOnDrugs.net is

an independent non-profit, scientific and social project that aims to empower drug users with personalised data about the real effects of drugs on our daily lives. The rest of the chapter will describe the motivations behind the project, explain why openness is central to the undertaking and describe our first prototype the Boozerlyzer drinks tracking application which is available on Android smartphones (2).

## **Motivations**

Two complementary objectives drive this project. First, we want to build a tool that is useful to drug-users, that educates and informs their drug taking. Second, genuine engagement from users should allow us to collect better data and conduct research in ways that have never been possible before now. Both are premised on the fact that the current recreational drug landscape is complex and fast changing. In the past three years over 100 new recreational drugs appeared on the EU market (3-4). In the past year, 1,700 new medicines and drugs were licensed in the UK. Many of these are psychoactive and some are liable to be abused. Psychopharmacologists and drugs professionals have a full-time job trying to keep up with the pace of change. Scientific research is lagging far behind casual self-experimentation. The two need to be better connected.

## **Meeting challenges in drugs and alcohol research**

Even before the advent of Spice, Mephedrone and the rapidly changing roster of other 'research chemicals', laboratory research into drugs and alcohol use has always been affected by problems.

### **Laboratories are sterile**

Recreational drugs research has a problem with 'ecological validity' (5). The lab is too far removed from the living room or the lounge bar. Scientists need to carefully control their experiments to be able to rule out alternative explanations. But in doing so they create a situation too artificial to compare to the real world.

### **Speed**

Laboratory based research happens too slowly. Before research can take place, funding and ethical approval must be secured and pilot work carried out. The

experiments themselves are liable to be slow and labour intensive. The peer review systems means it can take several years for results to be published, during which time data are unlikely to be shared for fear of competition. If any of those 100 new substances were particularly dangerous, it is going to take a long time for that information to filter through normal scientific channels.

### ***Complexity***

Consuming single drugs in isolation is very much the exception. Drinking a vodka-redbull makes you a poly-drug user. Researchers are still trying to understand how alcohol and caffeine interact (6). As other drugs are added to the cocktail the picture becomes even more complicated. Using very large and very diverse samples, such as we hope to get from our data, are a possible way around this. Certainly our data will be messy and uncontrolled but if there are any consistent effects the large size of the sample means that they should rise above the noise.

### ***The missing millions***

Most drug research misses the bigger picture in other ways too. Research funding and political policy leads to a focus on problem users ignoring the 'missing millions' of non-addicted, non-problematic recreational users (7). Only around 10% of casual drug users develop problems but while research focuses on this group, it will be difficult to change the political discourse to reflect the majority experience. Taking our study out of the laboratory should let us reach that wider constituency.

### **Entertaining, educating and informing recreational drug users**

People must be motivated to take part in our project. To achieve this it must have clear personal value to them. Over 50,000 people have downloaded a simple NHS drink unit counter (8) so we believe that there is a wide interest in tracking consumption. Moreover this in itself is a useful tool; drink and drug diaries are already widely used in therapeutic settings to help reduce consumption (9). But in the face too overt a health message many people will be put off. Likewise it may be difficult to interest people in the effects as well as the amounts. Here drinkers may already assume they understand how alcohol affects them, while recreational drug users might be doubtful that something as

rich as a psychedelic trip could be quantified. We have to overcome these sources of skepticism. For this we have turned to computer games.

In her book, *Reality is Broken*, Jane McGonigal (10) explains how game designers have found a winning formula for engaging people in complex and demanding tasks. These principles can be coopted for social and health purposes. For example, Nike Plus has been a highly successful 'gamification' of jogging (11). By adding competition, targets, rewards and social and gaming elements to running, they have encouraged people to continue with their training and made it more entertaining. By including lots of game elements in our application, making it fun to use in a social setting and tracking high scores we hope to draw in and hold people's engagement long enough for them to benefit from self-awareness that can come from self-tracking.

## **Open source, open science, open data and open minds**

Central to this project is the idea of openness. This takes many forms.

### **Open source**

All the software we use was given away freely by the people who wrote it. More than that they foster a community surrounding the projects they work on being open and letting anyone participate. This anarchy is carefully organised and works incredibly well. We have been beneficiaries of this open source software and are running our project on the same lines. All the code for our applications is freely available (12). Anyone can adapt and reuse it for their own purposes.

### **Open science and open data**

By making our data completely anonymous we can make it completely open. By making it open to anyone who is interested, we are kept honest. We cannot massage our data to suit any agenda. By making our data completely free, we open up and speed up the research that can be carried out with this data making it more valuable (13). To this end we endorse the Panton Principles developed by the Open Knowledge Foundation (14).

### **Open minds**

While we make no secret of the fact that we are strongly opposed to the blanket prohibition of drugs currently in place, we are not seeking to prove that all drugs are all

good. We believe the truth is more nuanced than that and that more data is required, in order to allow people to make their own minds up. This is an uphill battle. Lots of good research is being done into the scientific, economic and social effects of drugs and drug prohibition. But, ironically, it is the impeccable academic credibility of this research that weakens its impact. Because ivory tower research doesn't connect with the grassroots, governments have long been happy to short-cut the process and decide policy on purely populist or ideological grounds. We believe that evidence based research is essential to deciding policy sensibly and that providing users with direct access to personal data will empower them to lobby for change.

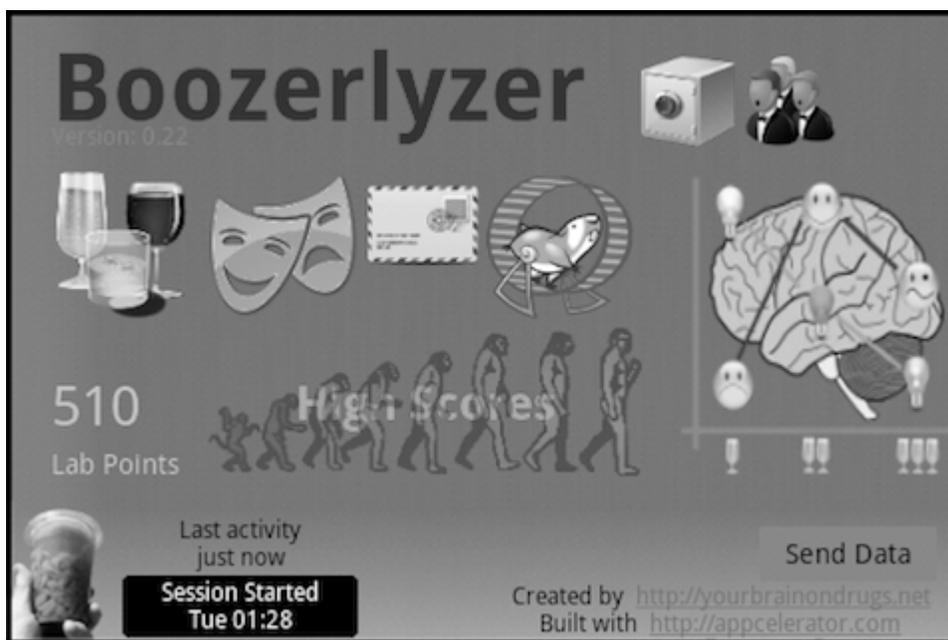


Figure 1 The main screen for our Boozerlyzer alcohol tracking application.

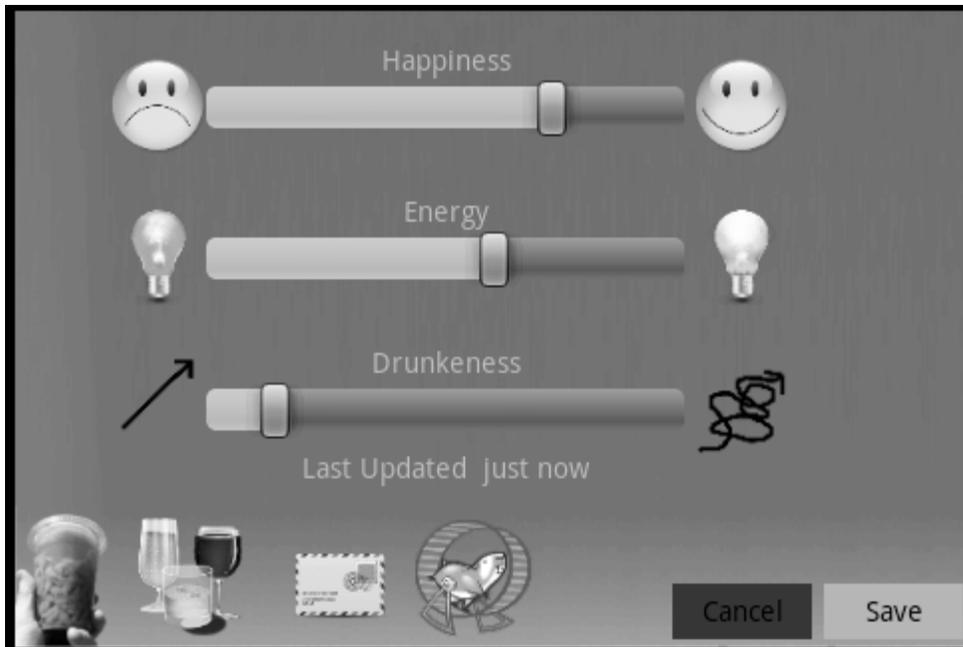
## The Boozerlyzer – our first application

In this section we describe the Boozerlyzer drinks tracker. It is a free application for Android phones (2). Although this version of the app features just alcohol, it will be relatively easy for us to adapt it to allow people to track drug use too in a recreational or medicinal context. Tracking drug use raises more issues and has more serious consequences (for example, if our data is not properly anonymised) so we are taking our first steps and making our first mistakes with alcohol.

The application tracks consumption and also measures cognitive and emotional effects that might normally be somewhat obscured. From the homescreen (Figure 1) users can launch screens that allow them to enter what they have drunk, how they are feeling and make comments. A group of simple games test the user's reaction times, coordination, memory and other cognitive and emotional factors. The user receives feedback on their performance in the form of high scores, graphs and timelines. Users also accumulate 'Lab Points' and are rewarded with achievement badges the more they use the application. This is intended to encourage participation and remind users of the scientific purposes of the project.



Figure 2 The drinks entry screen tracks drinks consumed in a particular session.



**Figure 3** The self reporting screen allows users to record their current level of happiness, energy and their own estimate of their drunkenness.

## **Self reporting**

### ***Doseage***

The dosage screen is shown in Figure 2. Users can record drinks as they consume them, entering the drink type, strength and volume. The application gives them a running total of how many drinks consumed in the current session, measured in standardized 'units' of alcohol. It informs them of equivalent number of calories which this represents and calculates their approximate blood alcohol at that time, based on their height, weight and gender (15). It also keeps a running total of units in the last week, month, year.

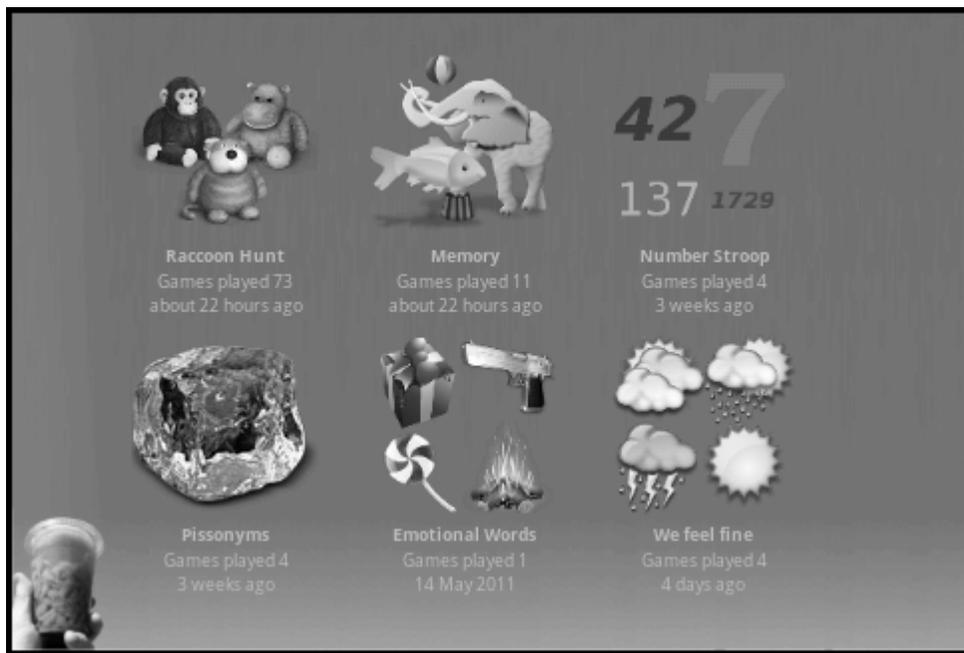
### ***Emotion and drunkenness***

Equally important is a record of how the user is feeling. The screen shown in Figure 3 is accessed by pressing the comedy and tragedy masks icon. This allows the users to quickly and easily mark their current emotional state and make an estimate of their current level of intoxication, each on a sliding scale. Subjective estimates will vary considerably but will show consistency for a given user. Happiness-sadness and high-low energy are the two primary dimensions of mood (16-17). Using these two

dimensions allows us to capture a wide range of mood states and their variation on simple and universal axes.

### ***Free text self-reporting***

Clicking on the envelope icon leads to a messaging window where users can record short comments. With this tool we hope to be able to capture a more qualitative type of data and also to provide the user with a means of annotating their experiences. This richer, more experiential data is an interesting adjunct to our alcohol research but would be an essential prerequisite for researching recreational drug use. When we adapt the application as a psychedelic “trip tracker”, the ability to record subjective experiences and report salient aspects of set and setting are central to capturing the breadth and complexity of drug experiences.



**Figure 4** The game selection screen shows the available games, how often they've been played and how recently.

### **Using games to measure cognitive function**

A range of games measure various aspects of cognitive function and emotion in a way that is quick, fun and informative. Figure 4 shows the game menu. Currently there are six different games. The application has a modular structure allowing new games to be

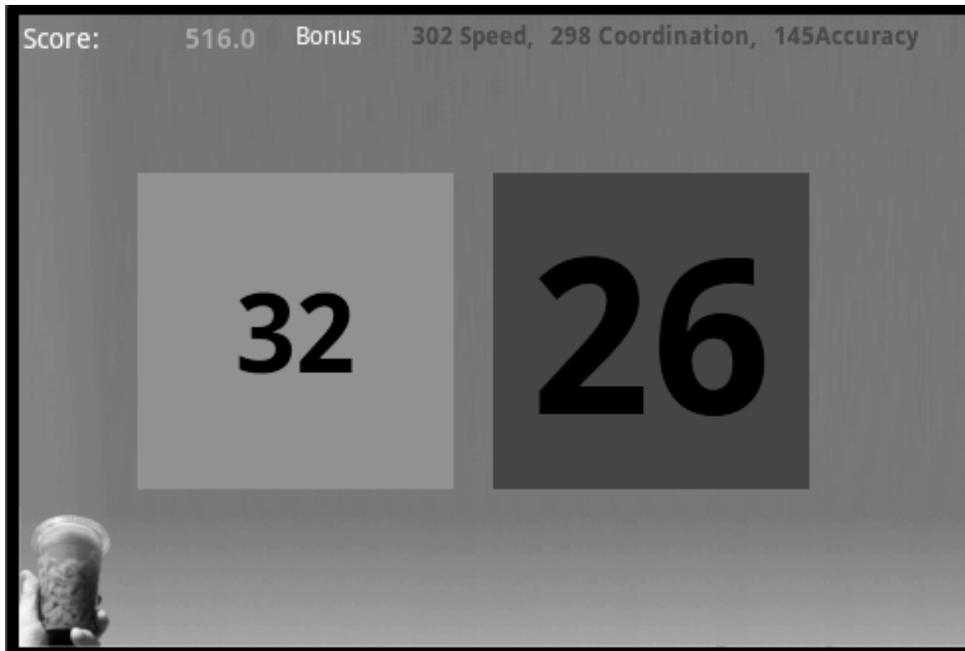
added easily. Each of the games is short, simple and self-contained. The application has three games that measure cognitive functions. All are based on standard laboratory tasks, but they are adapted to make them more fun and quicker to complete.

### ***Raccoon Hunt***

In this game cartoon animals appear one by one at six different locations on the screen and start to shrink. The object of the game is tap on the animals before they disappear. As the game progresses the animals disappear faster and bonus points are awarded for how quickly and how accurately the icons are pressed. Approximately 15% of the time the animals appear upside-down and player must tap anywhere else on the screen. The player must exercise cognitive control to inhibit their tendency to tap the target, this ability is known to be affected by alcohol (18). The game finishes after 5 mistakes. Furthermore, the starting level of difficulty is not adjusted so players familiar with the game must demonstrate persistence to reach the bounds of their ability. Thus, the game tests reaction time, coordination, inhibition and concentration.

### ***Memory Game***

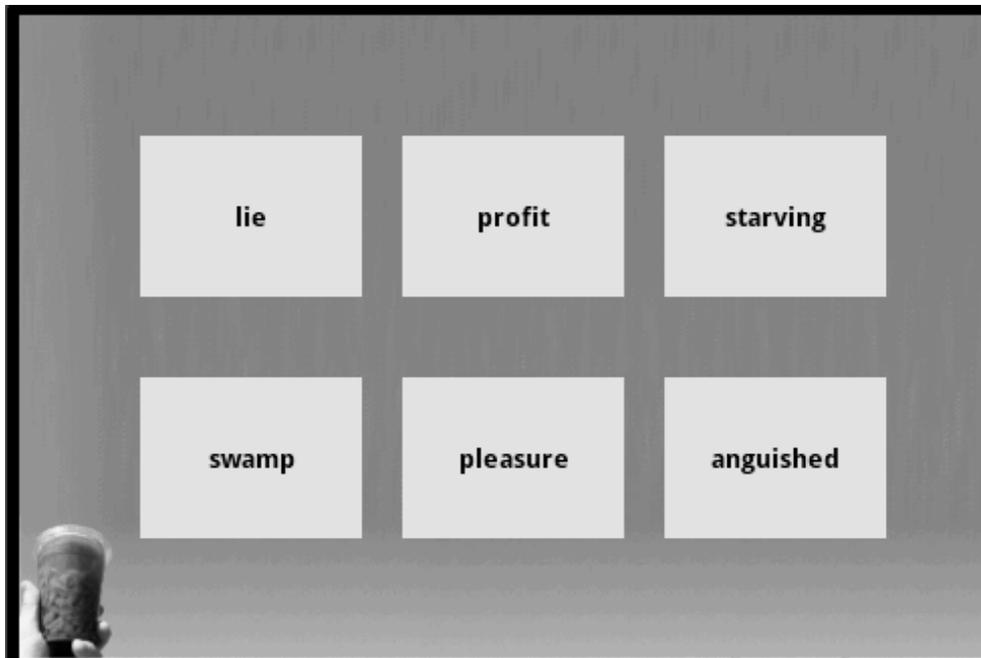
This game tests working memory, the ability to hold multiple items in mind at the same time. Nine fruits appear randomly and sequentially in 9 random locations on a grid. If either the same fruit or the same location is repeated the player must press the corresponding 'match' button. Otherwise they press the 'no match' button and the next item is presented. Bonuses are awarded for speed, coordination in pressing the buttons and avoiding mistakes. This is a version of the dual N-back task which is the only task that has ever been shown to transfer of performance improvement to unrelated tasks (19).



**Figure 5** In the numerical Stroop game two numbers appear on the screen and players to tap the numerically larger number, ignoring font size.

### ***Number Stroop***

The numerical Stroop test is a classic psychological task used to study speed of processing, executive functions and working memory (20). Our version of the task is shown in Figure 5. At each step two numbers are presented and the player must click on the *numerically* larger value ignoring the font size. Half the time, the number and size information will coincide, half the time they will be in conflict (as in Figure 5) which makes people slower to respond. The difference in response speed between congruent and incongruent trials is called the Stroop effect. It is a good measure of speed of processing that is sensitive to cognitive load. It has the useful property that it is not reduced by repeated practice. It is an ideal task to probe the effect of intoxication on cognitive function. As the game progresses the numbers get larger in quantity and the presentation rate increases. The game ends when the player makes 5 mistakes in any 10 trials. As before, bonus points are awarded for speed and coordination.



**Figure 6** In the emotional words game participants must pick the word that best appeals to them from six alternatives.

### **Other measures**

The other three games are variations on a word selection task (Figure 6). Over a number of rounds the player must choose one word from a set of six. There is no time limit, no score and there are no 'right' answers. But in some cases feedback is given at the end of the game. In all cases we surreptitiously record reaction times and how coordinated the user is when tapping the screen. The players do not get any direct feedback on these measures.

### ***Pissonyms***

In this game the words are a set of 200 synonyms for drunkenness. Five randomly selected words plus the option 'sober' are presented on each of four rounds. The player has to select the word that is closest to 'their current level of drunkenness'. Each word is internally ranked in terms of severity and the player is given feedback of their average rating and this is compared to their person estimate from Figure 3. This game is primarily a fun social task that users can share with their friends. Similarly, as we collect data we will be able to adjust our word ratings to get a scientific ranking of all

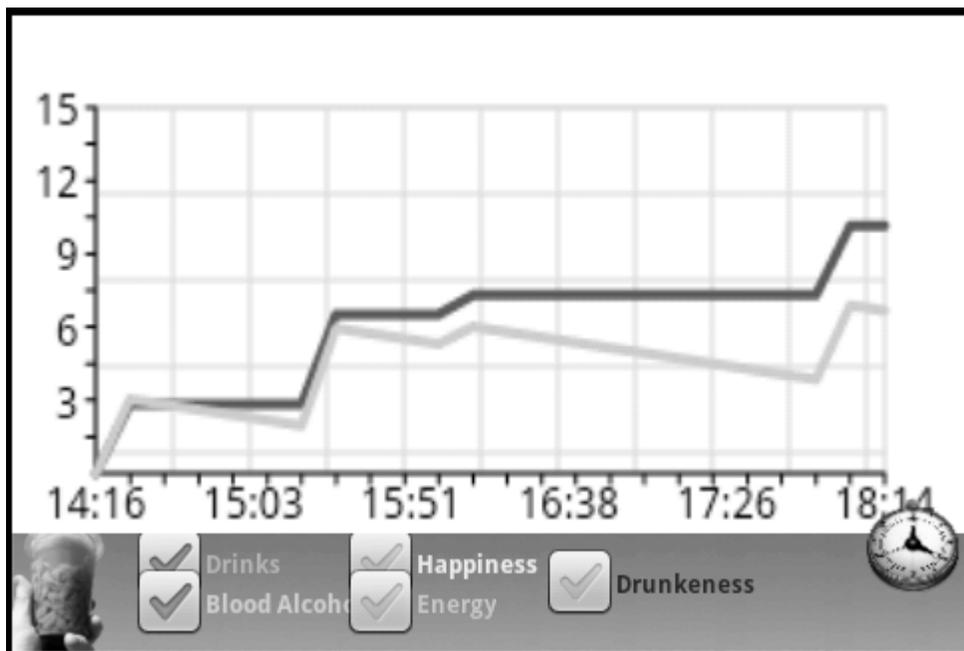
words for drunk. This will be published on our website as a means of drawing attention to the project.

### ***Emotional words***

In this game choices are randomly drawn from a set of 2000 emotional words. The words can be positive, negative or neutral and each word has a set of standardized affective ratings (21). In particular each word has scores for happiness and energy. Averaging each of these scores for the words chosen gives us an indirect measure of the person's mood to compare to their own subjective assessment from Figure 3.

### ***We feel fine***

Words are drawn from the list of approximately 8000 feelings and emotions generated by the We Feel Fine project (22-23), an automated website that scours blog posts for sentences that start 'I feel' or 'I am feeling'. No feedback is given to the user and the game has no direct scientific purpose but adds variety to the application.



**Figure 7 Charts provide feedback on how alcohol and emotions interact over the course of a single drinking session or longer**

**High scores and other rewards.**

Computer games can themselves be addictive. High scores are integral part of game design that allow users to keep track of their achievements and provide rewards to keep them playing. We aim to use this to our advantage. Where applicable, games have a scoring mechanism and keep track of a player's high-scores. Each action in the Boozerlyzer earns a small number of lab points and as players accumulate more of these points, they are rewarded by moving up a chain of laboratory species. Using the networked database of all users' scores we can create global high scores for each game and for overall accumulated lab points, further encouraging usage of the game and commitment to the project.

## **Charts and Analyses**

The first version of the Boozerlyzer is limited to plotting data over time. But the charting abilities of application make it possible to display a range of analyses.

### ***Data over time***

Figure 7 illustrates the simplest chronological plot, showing volume of drink and corresponding blood alcohol concentration over a single session. This plot can also show happiness, energy and self-estimated drunkenness. The time-scale can be changed to show the past week or month. We are also developing ways to show meaningful averages of these values over time.

### ***Plotting intoxication***

By plotting game scores against blood alcohol concentration or personal estimates of drunkenness, we can show the effects of intoxication. We aim to show users how alcohol affects memory, concentration, reaction time and coordination. For the individual user this data will necessarily be very noisy but using scatter plots and statistical regression lines we will help users make sense of their data.

### ***Demographic comparisons***

When data from all our users is combined, we can get a much clearer picture of what our tasks are measuring. This will allow us to improve future versions of the games and give individuals more accurate personalized feedback. It also permits us to show how they compare to other people of same age, gender or nationality. Showing a heavy

drinker quite how extreme their consumption is could well influence their future behaviour in positive ways.

### **Changes and challenges for future versions**

The Boozerlyzer is under constant revision. The first version was released in November 2011 and has several hundred test users. Based on their experiences and reactions to the application, it is going through many further iterations. The highest priorities will be simplify and streamline the user interface and to increase the range of charts and analyses available in the application. We hope to add geolocation data at a sufficiently coarse grained resolution that individual users can never be identified. This will require some scaling of resolution based on population density. Beyond these we would like to make the emotional tracking a lot richer. Likewise a single dimension for intoxication is limited. Both within the drinking / drug taking experience and also for capturing the hangovers and comedowns.

The single most important feature of an application that tracks illegal drug use is anonymity by design. It must be impossible for us or anyone else to identify individual users of the app from the data we collect. This is formidable technical challenge but must be done right. When extended to all recreational drug classes, dosage entry becomes much more complicated. It will be far more difficult to accurately capture the strengths and potencies of various herbs, pills, potions and powders. Even creating an exhaustive list of intoxicants is difficult. Nevertheless, some information is better than none and we would expect to see a fair degree of internal consistency within the data of any one user. Just as we plot blood alcohol concentrations, we foresee the possibility of calculating the appropriate dose-response and half-life curves. These would necessarily be approximate but tracking the time course of the effect is a particularly important consideration for psychedelics. While for many of the newest research chemicals this information does not exist yet.

### **Ethical and legal considerations**

This research must abide by the ethical and legal restrictions normally placed on psychological and health research (24-25). However, as a truly global research project

and one that addresses illegal drug use, the obligations are even more formidable. In fact, data protection requirements and drug laws vary so hugely between jurisdictions that it is impossible to conduct traditional research. For this reason, compulsory anonymity is a necessary part of our system.

Our system is designed so that we could not identify individual users even if we wanted to. We encrypt all data sent by the phones to our site. As the data comes from the phone onto our servers we throw away any information that could individually identify a given user. But it is important that users control their own data. We use public/private key cryptography to give your data a unique and unbreakable one-way key allowing individuals to delete their data if they don't want us to have it any more.

## **Concluding remarks**

Current research does not capture the positive drug experiences of the missing millions of non-problematic drug use and does not provide direct useful information directly to users. The YourBrainOnDrug.net project aims to address both of these issues. We hope that it can provide a useful new dataset and a new perspective of everyday drug use, by studying it as it happens and in a way that engages users in a positive, non-judgmental way.

## **Author Biography**

Caspar Addyman has a BA in mathematics from Cambridge, and a BSc in psychology and PhD in developmental psychology from Birkbeck, University of London. He is a Postdoctoral Research Fellow at Birkbeck's Centre for Brain and Cognitive Development studying infant perception and cognition. Before becoming an infantologist he spent eight years writing trading software in the City. He finds babies a lot more rewarding to work for than bankers. He never drinks the same drink twice in a night and dances without spilling a drop.

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