
Building Resilience through Emotionally Responsive Gaming:

Findings from a biofeedback video game trial at St Angela's Ursuline School

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1. Executive summary

Introduction

Youth mental health is a priority issue, with almost 10% of children and young people in the UK living with a diagnosable mental health disorder. Research indicates that emotional regulation problems are a risk factor for the development of a range of common adolescent mental health problems. There is, however, a shortage of effective, preventative, mass-scale mental health interventions for adolescents, and even fewer directly targeted at the risk factor of emotional regulation.

In response, BfB Labs developed an emotionally responsive biofeedback video game that trains, prompts and rewards players to effectively control their emotional state. We trialed the game with St Angela's Ursuline School, in Newham, London and this report details the results of that trial.

Background to the intervention

The game BfB Labs designed uses a sensor to record and give feedback on the player's heart rate pattern (a measure called Heart Rate Variability, or HRV) which is a physical indicator of the player's emotional arousal levels (e.g. stress, anxiety, excitement). It then rewards the player for using breathing exercises to modulate their levels of emotional arousal.

The game is a mobile card game based on a fantasy world championship, and is played on an Android tablet. Within the game, the better the player is able to master their emotions, and stay cool under pressure, the better they do in the game.

Evaluation objectives & design

The evaluation had three main objectives: to evaluate whether the game was able to teach young people people to breathe diaphragmatically and practice this regularly, to evaluate whether the game was effective at improving emotional regulation in young people and to assess how acceptable the intervention was to young people and school staff.

To address these objectives BfB Labs conducted a trial in which 30 students were randomly selected to play the game in lesson for an hour a week for seven weeks and physiological, survey and qualitative data was collected.



Results

Participants learned and practiced diaphragmatic breathing

The data indicates that the game effectively encouraged the key therapeutic behaviour of diaphragmatic breathing. Over three quarters (80%) of the test group also reported they had improved at using the breathing technique and some participants had begun to experiment with their breathing speed, demonstrating engagement in the technique, and that a clear connection had been made between correct technique and the physical impact that had on their heart rate pattern (HRV).

The majority of participants demonstrated improved emotional regulation skills

HRV data captured during play showed that the game encouraged participants to regulate their emotions through diaphragmatic breathing, thus raising their HRV, and sustaining this raised level. This ability to sustain their HRV level also increased over the trial period. Nearly three quarters (73%) of participants felt they had got better at staying calm and focused whilst playing the game and one in three participants in the test group had already used the breathing technique outside of the game, mostly for situations which required the management of feelings of pressure, stress or anxiety.

The game broadly appealed to both students and staff

The game appealed to the test group, with 43% of the players saying they would recommend the game to a friend, and only 17% of participants actively disliking the game. Considering this was a randomly selected group of participants with varying levels of game enthusiasm and experience these percentages are encouraging. School staff were also enthusiastic about the game feeling there was a large need in schools for tools like this one that help young people to build emotional regulation skills.

The trial also highlighted areas that need to be improved. These included support for teaching and practising the correct breathing technique for those struggling to master it, and also an easily accessible on-boarding process to teach the rules of the games to those less familiar with digital gaming in this genre. Finally, participant feedback also showed a desire for customisation and more progression within the game.

Conclusion

In all, the trial shows that BfB Labs' biofeedback video game is a product that has the potential to teach young people the skills they need to manage their emotions effectively, in an engaging, age-appropriate, culturally relevant way. As such, it provides the basis for further development of the product, making the product more widely available to individuals and schools, and further testing, including with young people with behavioural difficulties.





2. Introduction

Youth mental health is a priority issue

Young people's mental health is a major public health concern in the UK, and around the world.^{1,2} Mental health problems account for more years of healthy life lost than any other single source of illness³, costing the UK around £70 billion every year (roughly 4.5% of GDP) in lost productivity at work, benefit payments and health care expenditure.⁴

These problems start early in life, with half of all cases of mental health disorders starting by the age of 14, and three quarters starting by the age of 24.^{5,6} Around 10% of children and young people in the UK aged 5-18 have a diagnosable mental health disorder⁷, with conduct disorders being the most common problem, experienced by 6% of young people, followed by anxiety disorders (3%), hyperkinetic disorders such as attention and hyperactivity disorders (2%) and depression (1%).⁸

Children and young people who experience mental health problems are at a greater risk of suicide, substance misuse, anti-social behaviour, early pregnancy and committing criminal offences⁹ and are more likely to have poor educational achievement, with negative consequences for career development and earnings. The mental health problems young people experience also often persist into adulthood,¹⁰ with poor mental health in childhood and adolescence being associated with poor health and social outcomes in adulthood.

Mental health problems also exacerbate inequalities. Major national reviews have found that children and adults from households in the lowest 20 per cent of household income are three times more likely to have common mental health problems than those in the richest 20%,^{12,13} and nine times as likely to have psychotic disorders.¹⁴ This evidence indicates that the relationship between mental illness and poverty represents a vicious cycle that multiplies and sustains consequences and costs.^{15,16}

1 Collishaw, S., Maughan, B., Goodman, R. & Pickles, A. (2004) Time trends in adolescent mental health. Journal of Child Psychology and Psychiatry 45(8):1350–1362. **2** Patel, V., Flisher, A., Hetrick, S. & McGorry, P. (2007) Mental Health of Young People: A Global Public-Health Challenge. The Lancet 369(9569):1302–13. **3** Royal College of Psychiatrists (2010) No health without public mental health: The case for action, Position Statement PS4/2010. London: Royal College of Psychiatrists. **4** OECD (2014) Mental Health and Work: United Kingdom **5** Kim-Cohen, J., et al. (2003) Prior juvenile diagnoses in adults with mental disorder: developmental follow-back of a prospective-longitudinal cohort. Archives of General Psychiatry 60(7):709–17. **6** Kessler, R. et al. (2005) Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. Archives of General Psychiatry 62(6):593–602. **7** Green, H., McGinnity, A., Meltzer, H., et al. (2005). Mental health of children and young people in Great Britain 2004. London: Palgrave. **8** Green, H., et al. (2005). Mental health of children and young people in Great Britain 2004. London: Palgrave. **9** Fergusson DM, Horwood LJ, Ridder EM (2005) Show me the child at seven: the consequences of conduct problems in childhood for psychosocial functioning in adulthood. Journal of Child Psychology, 46, 837–849. **10** Fergusson DM, Woodward LJ. (2002) Mental health, educational, and social role outcomes of adolescents with depression. Archives of General Psychiatry 59(3):225–31.



Emotional regulation is a key target for preventative interventions

Recent research indicates that emotional regulation problems are a risk factor for the development of a range of common adolescent mental health problems. Emotional regulation problems are associated with externalising disorders such as conduct disorder, as well as internalising disorders such as withdrawal, anxiety and depression.^{17,18} Poor emotional regulation is also linked to problems such as substance abuse and eating disorders.¹⁹ Conversely, individuals who have healthy emotional regulation strategies tend to experience better social functioning, more positive emotions, and higher levels of wellbeing.²⁰

Emotional regulation is therefore an important target for preventative interventions that aim to reduce the incidence of mental health disorders across the population, and there is a strong argument for preventative interventions that build emotional regulation skills in adolescents.²¹

What is Emotional Regulation?

There are multiple competing definitions of emotional regulation, but in this report, emotional regulation is defined as the set of processes involved in monitoring, evaluating and modifying emotional reactions to accomplish one's goal, or meet the demands of one's environment.²²

For example, if a person feels butterflies going into a test, to respond in the most beneficial way

possible they need to a) be aware that what they feel is caused by nerves, b) evaluate how justified these nerves are and c) use techniques, such as deep breathing, to reduce the nerves they feel.

There is a need for youth-focused preventative interventions

There is, however, a shortage of effective, preventative, mass-scale mental health interventions for children and adolescents²³ and even fewer interventions directly targeted at the risk factor of emotional regulation.

While there is evidence that school-based social and emotional learning programmes can improve resilience to mental health problems, their effectiveness varies and depends heavily on the quality of implementation within the school environment.²⁴ They also generally require extensive and intensive training for staff members.²⁵ Furthermore, interventions that do exist, such as mindfulness or Cognitive Behavioural Therapy (CBT), can feel quite culturally distant from young people's lives, limiting young people's engagement with them. There is therefore an urgent need for affordable, easy-to-implement interventions that target transdiagnostic risk factors such as emotional regulation in packages that appeal to young people.

In response to this need, BfB Labs developed a biofeedback game geared towards 10-14 year olds, which encourages the regular practice of diaphragmatic breathing exercises, shown to be an effective technique

11 Royal College of Psychiatrists (2010) No health without public mental health: The case for action, Position Statement PS4/2010. London: Royal College of Psychiatrists. **12** Green H, McGinnity A, Meltzer H, et al. (2005) Mental Health of Children and Young People in Great Britain, 2004. Office for National Statistics, London: The Stationery Office **13** McManus S, Meltzer H, Brugha T, et al. (2009) Adult Psychiatric Morbidity in England, 2007: Results of a Household Survey. Health and Social Information Centre, Social Care Statistics, London **14** Marmot M et al, Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post 2010. The Marmot Review, London, 2010 **15** Murali, V. & Oyeboode, F. (20014) 'Poverty, social inequality and mental health', in *Advances in Psychiatric Treatment*, 10(3):216-224. **16** Friedli L, (2009) Mental Health, Resilience and Inequalities. Mental Health Foundation, World Health Organisation, Geneva, Switzerland **17** Berking, M. & Wupperman, P. (2012) Emotion regulation and mental health: Recent findings, current challenges, and future directions. *Current opinion in Psychiatry* 25(2):128-34 **18** Kim, J. & Cicchetti, D. (2009) Longitudinal pathways linking child maltreatment, emotion regulation, peer relations, and psychopathology. *Journal of Child Psychology and Psychiatry* 51(6):706-716 **19** Berking, M. & Wupperman, P. (2012) Emotion regulation and mental health: Recent findings, current challenges, and future directions. *Current opinion in Psychiatry* 25(2):128-34 **20** Kim, J. & Cicchetti, D. (2009) Longitudinal pathways linking child maltreatment, emotion regulation, peer relations, and psychopathology. *Journal of Child Psychology and Psychiatry* 51(6):706-716 **21** John, O., Gross, J. (2004). Healthy and unhealthy emotional regulation: Personality processes, individual differences, and life span development. *Journal of Personality* 72(6), 1301-1304. **22** This definition is drawn from Thompson, R. A. (1994). Emotion regulation: A theme in search of a definition. *Monographs of the Society for Research in Child Development*, 59 (2/3), 25-52. and Hilt, L., Hanson, J., and Pollak, S.D. (2011). Emotion Dysregulation. In B. Brown and M. Prinstein (Eds.), *Encyclopedia of Adolescence*, vol. 3, Elsevier, pp. 160-169. **23** McGorry, P. (2013) Prevention, innovation and implementation science in mental health: the next wave of reform. *The British Journal of Psychiatry* 202: s3-s4 **24** Weare, K. & Nind, M. (2011). Mental health promotion and problem prevention in schools: what does the evidence say? *Health Promotion International* 26(suppl 1): i29-i69. **25** Weare, K. & Nind, M. (2011). Mental health promotion and problem prevention in schools: what does the evidence say? *Health Promotion International* 26(suppl 1): i29-i69.





to help people regulate their emotions. The game ultimately aims to be an easy-to-use, effective way of helping young people learn key skills to promote their mental health and wellbeing. To explore its impact on emotional regulation, and understand how young people, parents and school staff respond to it, we ran a trial in a school in East London, with 30 young people regularly playing the game. This report describes how the game works, and explains how we tested it and what we found.



3. Background to the intervention

How the game works

The game uses breathing to help regulate emotions

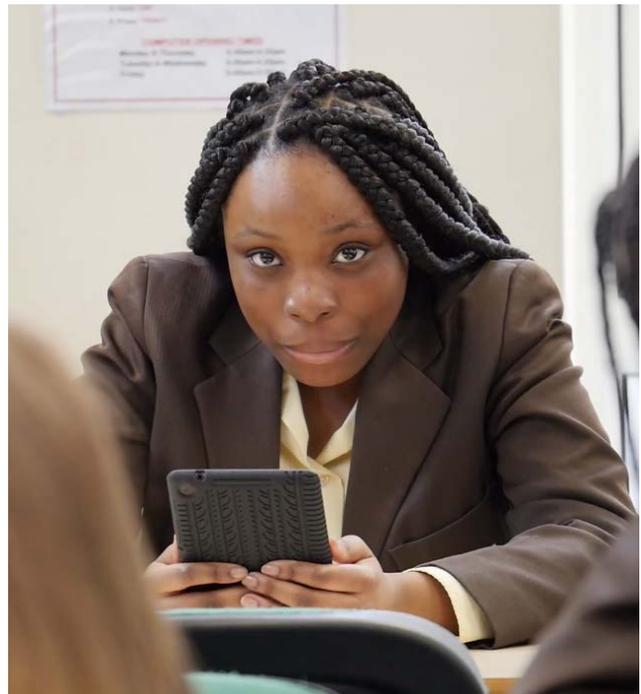
Deep, regular breathing is a simple physiological technique that can help to regulate emotions; an easy-to-understand way to regain control in situations of stress and anxiety.

One type of breathing which has been found to be particularly effective in reducing stress and managing anxiety is diaphragmatic breathing, where the diaphragm contracts and air is drawn into the bottom section of the lungs.^{26,27} The calming effect of diaphragmatic breathing occurs because the breath activates the parasympathetic nervous system, the system that calms the body down by promoting the “rest and digest” response, and counters the “fight or flight” response.^{28,29}

This breathing technique has been promoted in connection with stress reduction by institutions such as Mind³⁰, Bupa³¹ and the NHS.³² These recommendations are supported by substantial evidence that regulating the physical movement and speed of the breath can directly reduce physical stress reactions in the body.³³

The game uses HRV to measure emotional regulation

The game uses a measure derived from the player’s heart rate, called heart rate variability (HRV) to check whether the player is using breathing to regulate emotions. HRV is the variation in the length of time



²⁶ Gilbert (2003). Clinical applications of breathing regulation: Beyond anxiety management. *Behaviour Modification*, 23(5), 692-709. ²⁷ Hazlett-Stevens & Craske (2008). Breathing retraining and diaphragmatic breathing techniques. Ch.10 in *Cognitive Behavior Therapy: Applying Empirically Supported Techniques in Your Practice* / Edited by William O’Donohue & Jane E. Fisher. Wiley. ²⁸ Harvey, J. (1978). Diaphragmatic breathing: A practical technique for breath control. *Behaviour Therapist*, 1, 13-14. ²⁹ Ballentine, R. (1976). *Science of breath*. Glenview, IL: Himalayan International Institute. ³⁰ Mind (2012) Relaxation from http://www.mind.org.uk/information-support/tips-for-everyday-living/stress-guide/how-to-relax/#.VFyWj_SsV0U ³¹ Bupa (2014) Stress from <http://www.bupa.co.uk/individuals/health-information/directory/s/hi-stress?tab=FAQs> ³² NHS (2014) Relaxation tips to prevent stress from <http://www.nhs.uk/conditions/stress-anxiety-depression/pages/ways-relieve-stress.aspx> ³³ McCaul, K., Solomon, S. & Holmes, D. S (1979). Effects of paced respiration and expectations on physiological and psychological responses to threat. *Journal of Personality and Social Psychology*, 37(4), 564-571 ³⁴ Schwartz, M. (1987). *Biofeedback: A Practitioners Guide*, New York: Guilford.



between each heartbeat. The heart rate speeds up with each in-breath and slows down with each out-breath. When a person practises regulated diaphragmatic breathing, this speeding up and slowing down of the heart rate increases significantly, increasing their HRV. When the person stops doing diaphragmatic breathing their HRV decreases again, making HRV a useful proxy measure for diaphragmatic breathing.

In addition to responding to breathing, the heart rate also responds to emotions, with stress causing a high heart

rate and a low HRV. Thus, HRV reflects both the player’s breathing, and their emotional state.³⁴

By capturing the player’s HRV data via a heart rate monitor, the game can assess if, and how effectively the player is both breathing and regulating their emotional state, and reward them accordingly. The player then sees the reward (or lack of it) and can alter their technique and emotional regulation strategies to try to get a better score.

Diagram 1: The BfB Labs biofeedback loop



Because HRV is affected by both breathing rate and mental state, showing HRV on screen helps the player make the connection between how stressed they are,

the effect the stress has on their body, and how they can use regulated breathing to regain equilibrium.





4. Game Design

BfB Labs' biofeedback video game is a digital card duelling game based on a fantasy world championship, in which players are challenged to marshal their courage, stay focused under pressure and win magical matches against fellow



spellcasters. The game is played on an Android tablet which wirelessly receives data from a heart rate monitor worn, in this trial, around the player's chest. The better the player is able to use the breathing technique to keep calm under pressure (resulting in higher HRV), the higher the score they get and the greater chance they have of succeeding in the game.

The version of the game used for the trial was composed of three sections:

1. *Ranked Matches, in which the player competed against their opponents by casting cards against them.*

- In this trial the player played against the computer AI. Each round of every match contained:
- Choosing cards - where the player selected the cards they wanted to buy
 - The Breathing Phase - where the player needed to take 6 breaths following a breathing pacer. The player would then be given a number of points based on their HRV level during these 6 breaths. Their HRV level was determined by both their breathing technique and how well they could keep calm and focused whilst breathing.

- Buying cards - the player used the points they earned in the breathing phase to buy the cards they wanted.
- Playing cards - The earned cards were then played against their opponent.

2. *The Proving Grounds, in which the player was able to build their skills in diaphragmatic breathing.* In this optional section the player was given breathing-based challenges. If a player succeeded they won new and exclusive cards to add to their deck to use in their Ranked Matches.

3. *The player's Spellbook, that displayed all of the cards the player had in their deck.*

The game also had a ranking system. At the end of every match each player was given a rank, based on the number of matches won, which added a competitive motivation to practice their breathing technique and increase their chance of winning matches.

Why a video game?

By embedding breathing and emotional regulation into the main game mechanic, the product draws on several distinctive benefits of video games. Firstly, they are ubiquitous among young people, with 80% of people under 15 reportedly playing some form of digital game,³⁵ giving the product a wide potential reach. Secondly, skill development is already a central part of video games, with structured, progressively harder challenges making them good training vehicles. Finally, video games are "sticky" and encourage regular play. By embedding the breathing into gameplay the practice of diaphragmatic breathing and emotional regulation becomes part of the challenge and enjoyment of the game, incentivising continued practice.





5. Evaluation objectives and research questions

In our school trial, we aimed to test the game with young people to understand its impact on emotional regulation and its appeal to the target audience. The evaluation had three main objectives.

Firstly, we wanted to evaluate whether the game was able to teach young people how to breathe diaphragmatically, and to practice this technique regularly. Secondly, we wanted to evaluate whether the game was effective at improving emotional regulation in young people aged 10-14 over a seven-week period of use, compared to no treatment. Finally, we wanted to assess how acceptable the intervention was to young people aged 10-14, and their parents and school staff.

We used the following research questions to explore these issues:

1. To what extent did participants practise diaphragmatic breathing during the gameplay period?
2. Does regular use of the game improve participants' emotional regulation abilities?
3. Does the game prototype appeal to the target audience of 10-14 year olds, and their teachers?





6. Evaluation design

To evaluate the game, we conducted trials in two secondary schools. Due to IT and data collection challenges in one of the schools, the interventions and the data available to analyse them were different in the two sites, so we have reported on each school trial separately. This report is on the trial that took place at St Angela's Ursuline School, Forest Gate, London.

Samples and sample selection

St Angela's is a voluntary aided girls school in Forest Gate, London. Thirty Year 8 students (aged 12 - 13) were randomly selected from the year group of 191 students to play our game once a week for seven weeks.

The game version

The version of the game used in this trial was the most recent Beta version that BfB Labs had been developing and testing over the last three years.³⁶ The Beta version had full functionality in the main areas of the game and some high quality artwork and graphics so that it felt more like a "proper" game than a Beta prototype, but had basic navigation and no multiplayer functionality.

Set-up and play of the game during the trial

All students in the year had a weekly hour-long PSHE lesson. The 30 selected students were put into a class together and played our game during this PSHE lesson for seven weeks.

The first half of the initial play session consisted of an introductory presentation in which BfB Labs staff explained the game and equipment, and taught the diaphragmatic breathing technique. The following hour-long sessions consisted only of playing the game. In the final seventh session the last 10 minutes of the session was spent discussing in groups what the students had learned through playing the game. At least one member of the BfB Labs staff was present at each of the play sessions for any game or technical support needed.

Consent

As the participants in the pilot were under 16, parental consent for participation was needed. Letters were sent out to the parents of students in the test group who were given two opportunities to opt their child out of the trial.

³⁶ For results of the other trials conducted please see BfB Labs' website: www.bfb-labs.com



Data collection methods

We used a number of different data collection methods.

- We collected live heart rate and gameplay data whilst the participants were playing which was securely sent to a central database.
- We collected feedback on the game participants using tailored surveys developed by the BfB Labs research team.
- We also conducted four focus groups with participants from the test group. The participants were selected based on timetable availability rather than engagement in the game.
- Finally, we received informal feedback from the lead teachers throughout the trial.

A more detailed explanation of each measure is given in the relevant section below.

Data protection

To protect the identity of the young people involved in the trial, BfB Labs produced unique logins and passwords to access the game and these were given to the participants by their teacher. This meant that BfB Labs only ever had data linked to usernames, and were not able to link the data or usernames to the participant's true identity. All the heart rate and gameplay data was saved on a password-protected and encrypted server.





7. The trial in action

During the roll-out of the trial in the school we encountered a few challenges which led to some change in the planned trial design.

The first challenge was that the school IT network was highly protected making it difficult to connect the tablets to the school wifi. Despite working closely with the school's IT department and conducting a numerous tests and adaptations before the trial, these difficulties continued into Session 1 and 2, meaning participants struggled to log onto the game in these sessions. This resulted in a reduced average per session play time for the first two sessions and also in frustration from some of the participants.

To resolve the issue we created an off-line version of the game, played from Session 3, and a BfB Labs team member manually downloaded all game data between each session. Whilst the offline version of the game worked well, being offline meant the automatic ranking system in the game didn't function. Instead, ranks were calculated by BfB Labs in between each play session and

read out to the class, changing some of the competitive motivation the ranking system built into the game. The early technical difficulties were discouraging for the players, and meant that engagement had to be rebuilt in subsequent sessions.

To compensate for lost play time in Session 1 and 2 we ran an additional play session at the end of the trial bringing the total number of sessions to seven rather than the six originally planned.

Alongside IT challenges, we also had survey difficulties that arose from fitting a trial into a school term structure. We had hoped to capture emotional regulation data through a validated scale both before and after the trial, but due to the very busy end of term period it was difficult for the survey to be given to all students post-trial before the school holidays. As a two week holiday could substantially influence a young person's views of their emotional regulation abilities, we decided not to collect this data after the holidays.





8. Results

Player numbers

The thirty participants in the test group all received a login and played the game at least once. 83% of the test group attended at least five out of the seven play sessions, with 100% of the test group attending at least four sessions.

8.1: To what extent did participants comply with the diaphragmatic breathing protocol?

In order to understand the overall impact of the game, it was essential to understand how effective it was in encouraging the key therapeutic behaviour, diaphragmatic breathing. To do this, we assessed how long participants played for, how much of their playing time they spent in the integrated and voluntary breathing stages of the game, and the extent to which they were able to master the correct breathing technique to enable themselves to regulate their emotions and raise their HRV.

Heart rate and gameplay data:

The game digitally captured data on how long the player played, the amount of time they spent doing the breathing technique, and how well the player did the technique. This data was sent from the game to an online database each time a player played the game. The variables taken from this data included:

- **Number of sessions played by the participant**
- **Length of time in the Breathing Phase:** The Ranked Match section was composed of two sections, the Match Play section where the player is playing cards against their opponent and breathing naturally and the Breathing Phase section where the player is prompted to take a number of diaphragmatic breaths for which they get a score. We collected data on how long players spent in the Breathing Phase per session and over the total trial period.
- **Length of time in the Proving Grounds:** We collected data on the number of players that entered the Proving Grounds (a section with breathing challenges) and the mean minutes they spent in the Proving Grounds across the trial.
- **Feedback survey:** We developed a feedback survey given to participants in the test group once the trial had finished. This included questions on their breathing technique.
- **Qualitative data:** We conducted four focus groups, with a total of 20 participants at the end of the trial. Discussion topics included their knowledge and experience of the breathing technique before and during the trial.



Analysis

For the quantitative data we ran exploratory descriptive statistical analysis using the SPSS analysis package and Excel. The qualitative data was analysed against a thematic framework to show patterns within and across groups, a method used for all the qualitative analysis in this report.

Results

Participants spent an average of 4hr 30m min playing the game over the course of the trial, an average of 39 minutes per session.³⁷ 21 minutes of each session was spent, on average, in the Breathing Phase where they

were following a breathing pacer attempting to raise their HRV to gain points. This equates to each participant spending just under half (44%) of their gameplay in the Breathing Phase suggesting the game created a good balance between gameplay and practice of the breathing technique.

In addition, the trial players spent an average of 51 minutes over the course of the trial in the Proving Grounds, the optional section of the game where the player could complete challenges in which they had to alter their HRV level through breathing and emotional control to win new cards.

Table 2: Gameplay and breathing data

	Measure	Unit
Time spent playing	Average time a participant spent playing the game in the trial	270m (4hr 30m)
	Average time a participant spent playing the game per session	38m 36
Time in Breathing Phase	Average time a participant spent in Breathing Phase over the trial	120m 12s
	Average time a participant spent in Breathing Phase per session	21m 6s
Proving Grounds data	Average amount of time a participant spent in the Proving Grounds across the trial	50m 43s

³⁷ Sessions were an hour long, however, due to continued difficulty of accessing the school's WiFi there was substantial loss of play time at the start of the trial. See Section 7: *The trial in action* for further information.

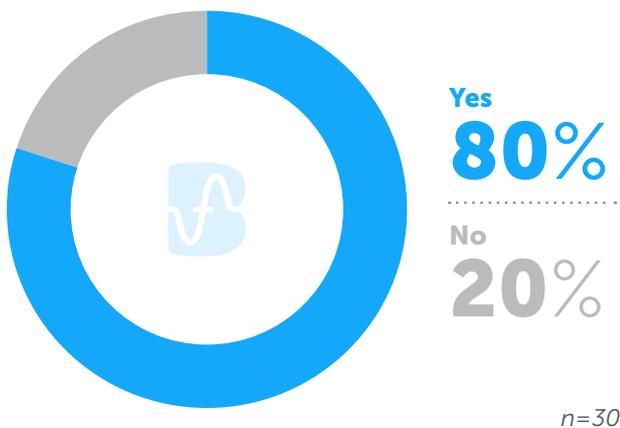


Players felt they had improved their breathing

In the feedback survey, 80% of the test group reported that over the trial they had improved their breathing technique, with 37% feeling they had got a lot better.

Graph 1: Percentage of participants that improved their breathing technique

Over the six weeks you played the game did you get better at doing the belly breathing?



Nearly all of the participants in the focus groups had experimented with the breathing speed throughout the duration of the trial, mostly increasing it, and many participants singled this feature out as an element of the game they particularly liked. Such experimentation demonstrates that the game was encouraging players to think about and explore the relationship between breathing and heart rate.

Section Summary

An aim of the game was to encourage the key therapeutic behaviour of diaphragmatic breathing. The data indicates that it was successful in this aim, with participants spending a just under half of their game-play in the Breathing Phase, where they would be prompted to practice the diaphragmatic breathing technique. They also spent time in the Proving Grounds, an area where practice of the technique was the core activity. Finally, participants reported having improved their technique over the trial, and experimented with their breathing speed showing they had made the connection between breathing and increased HRV levels (score in the game).

8.2 Does regular use of the game improve participants' emotional regulation abilities?

Having established that the game encouraged participants to practise diaphragmatic breathing, we wanted to find out whether this translated into an improved ability to regulate emotions. We were able to measure this through a combination of physiological data (collected through the game), survey data, and qualitative data.

Measures and data collection

Emotional regulation physiological data: We measured the amount of time participants had a significantly elevated HRV levels. This was defined as an HRV level 100% above the participant's own baseline level, corresponding to the emergence in the heart rate data of a clear and distinct pattern associated with elevated HRV. As described in the Background section above, raised HRV is a sign that the player is both doing diaphragmatic breathing (which raises HRV) and also managing to remain in a calm state of mind (thus not suppressing HRV). Consequently, the amount of time spent over a personalised HRV threshold can be seen to demonstrate the player is regulating their emotions as well as monitoring the extent to which diaphragmatic breathing is being practiced.

- **Feedback survey:** The feedback survey we gave to the test group at the end of the trial included questions on the players' emotional regulation skills.
- **Qualitative data:** The focus groups included discussions on feelings during the trial, and use of the technique outside of the trial.

Analysis

The quantitative data was explored through descriptive statistics to understand data trends.

The qualitative data was analysed as described above.



Results

The majority of participants demonstrated improved emotional regulation

The majority of participants were able to regulate their emotions during game play. Sixty percent of participants were able to double their HRV level and keep it at this elevated level for over 40% of the time they were in the Breathing Phase, and 10% of participants were able to keep their HRV at this elevated level for more than 60% of the time. This shows both adherence to the breathing protocol and that the most participants were able to regulate their emotions sufficiently (staying calm and focused throughout the Breathing Phase) for the breathing to have an effect on their HRV.

There was a general trend of improvement in physiological markers of emotional regulation in the game. In the first session of the trial, participants spent an average of 37% of their breathing time with an elevated HRV. By session seven, this had increased to 44%. This indicates both that participants were improving their breathing technique, but also that they were improving their ability to remain calm under pressure.

Emotional regulation in the game varied greatly among participants

These averages mask a large range in the starting points of all of the players. Some initially struggled to achieve an elevated HRV (a level 100% above their baseline) and didn't manage to elevate their HRV at all in the breathing phase, but by Session 7 they had improved to spending 15% of time at this elevated level. This is a low percentage but a significant improvement from 0.

At the other end of the spectrum some students spent 96% of their time in the breathing phase with an elevated HRV in their first session peaking at Session 6 with 100%, and falling back down to 68% in Session 7. The feedback survey supports the general trend of improvement, with 73% of participants feeling they had got better at staying calm and focused whilst playing the game during the trial.

Graph 2: Percentage of participants who felt they got better at staying calm and focused

Over the six weeks you played the game did you get better at staying calm and focused whilst playing the game?

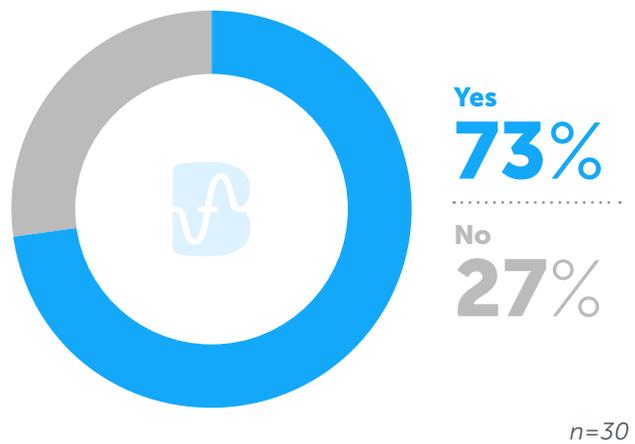


Table 3: Physiological emotional regulation data

Measure	Unit
Average time a participant spent with an elevated HRV level across the trial	50m
Average time a participant spent with an elevated HRV per session	9m 6s
Average % of Breathing Phase spent with an elevated HRV	42%
Percentage of participants able to spend at least 40% of Breathing Phase with elevated HRV levels	60%
Percentage of participants able to spend 60% of Breathing Phase with elevated HRV levels	10%



The game provide a pressured context in which to practice

The improvement in time spent with elevated HRV levels happened within the context of game play, which was not an emotionally neutral experience. Within two of the focus groups participants explained that they found it hardest to get a high score (a raised level of HRV) when they felt under pressure within the game. This pressure came from both seeing other people near them doing well, putting pressure on their own performance, and also when they moved from the training section of the Proving Grounds, into the match sections where their performance led to winning or losing a game.

“In the proving grounds you are more relaxed. But when you’re in the match there is more tension on yourself saying “oh, I need to beat this person”

Focus group participant

The technique produced a variety of feelings

In previous game testing, both user testing and trials, players have commented on the relaxing and calm feeling the breathing technique induced in them. Within the St Angela’s focus groups positive feelings of being calm and relaxed were used by participants to describe how they felt when doing the breathing technique however, unlike in other tests, these were also juxtaposed with more negative words related either to tiredness or to frustration.

Words related to tiredness indicate that some of the participants weren’t correctly using the technique as the breathing should be comfortable and not lead to “over breathing” or tiredness.

The feelings of frustration were generally attributed to two main issues. The first was that some participants found it difficult to pick up the rules of the game. As the game had originally been designed for young people familiar with games and gaming, the introduction and explanation of the rules may not have been comprehensive enough for those who never played games. The second issue was the breathing score, with some participants feeling that their score didn’t reflect their improvement in technique. The lack of change

in the score may have been due to poor technique, but may also have been due to the sensitivity of the breathing metric not being sharp enough to capture very small changes, an area of focus for future development. The feelings of frustration may also have been compounded by the IT issues that occurred in Session 1 and 2 (see Section 7 for details).

These findings have driven further investment in developing in-game instruction around the breathing technique that ensures it is learned correctly by the player, and supports those who struggle to pick it up by scaffolding their learning. They have also led to a focus on creating a simple and accessible on-boarding process to teach the rules of the game within the game itself, and, as mentioned above, further work on the sensitivity of the metric.

The participants had understood they could use diaphragmatic breathing as an emotional regulation technique

When asked about diaphragmatic breathing in the focus groups a number of participants had heard of it before the trial but mostly in the context of sports or singing, and not as a tool for emotional regulation. Only one girl had heard of it as an emotional regulation technique and had been taught the technique by her parents as she suffered from panic attacks. Consequently, the examples given by girls who used the technique outside of the game demonstrates that the game had raised an awareness that the breathing technique could be used to regulate emotions.

The link between the impact of emotions on heart rate had also been made by the end of the trial. This was evidenced when participants gave advice on how to get the best Magic Score (HRV level) in which they emphasised the need to remain calm and relaxed:

“When you are breathing think of calm things because if you think of problems and things like that, your breathing would start to go up because you are starting to get yourself stressed..Just have calm thoughts, flowers or kittens”.

Focus group participant



The emotional regulation technique had been used outside of the game

The feedback survey showed that a third of students in the test group (33%) had already applied the technique of diaphragmatic breathing outside of the game, mostly to deal with challenging emotional situations. The situations in which the participants had used the techniques included:

- **When experiencing physical pain:**

“The other day I was going to get my eyebrows done and it really hurt, and I was just like let me really deeply belly breathe now, and it stuck in my head, even though i thought it wouldn’t...and it helped a bit.”

Focus group participant

- **When provoked in an argument:**

“When you are in an argument I don’t feel right, I sometimes feel like i’m in a different planet, on a different world. The things that go through my head, And when I did belly breathing I calmed down, came back to earth.”

Focus group participant

- **When under pressure, for example in class or in a test at school.**

- **When feeling upset**

- **When doing sports, to regain their breath in running and basketball**

Within the focus groups some girls had also told other friends and family about the technique, for example when their family members were getting stressed by a situation.

“When [my mum] was going she was freaking out because she thought I might not reach there in time. She was about to scream and I was like “Mum you need to calm down and then breathe” and when she did it she felt relaxed.”

Focus group participant

Section Summary

The data demonstrates that this game was able to encourage participants to regulate their emotions sufficiently (overcoming pressures experienced in the game) for their breathing technique to raise their HRV and sustain this raised level. The game also facilitated an improvement in the amount of time this elevated HRV could be sustained, indicating improvement in both breathing technique and emotional regulation.

The qualitative data also indicates that the game had taught the participants an emotional regulation technique, with some of the girls using this technique already within the trial period to deal with emotionally charged situations.

8.3 Does the game prototype appeal to the target audience of 10 - 14 year olds, and teaching staff?

For the video game to be a successful tool in building emotional regulation it has to both train young people in these skills but also, crucially, it has to be appealing enough for the player to want try the game, and play repeatedly. The greater the appeal, the greater the likelihood of repeated play, building up the skills of emotional regulation through diaphragmatic breathing.

Measures and data collection

Feedback survey: The feedback survey we gave to all test group participants at the end of the trial included questions on their engagement with the game.

Focus groups: The groups included discussions on their enjoyment of the game, which aspects they enjoyed most, the integration of the breathing into the game and improvements they would make.



Informal discussion with teachers: Throughout the trial we had informal discussions with teachers involved in running the sessions around the engagement of students and impact of the game. We also discussed the appeal of the game for them as a tool to use in a school setting.

Analysis

The survey and qualitative data was analysed as described in the sections above.

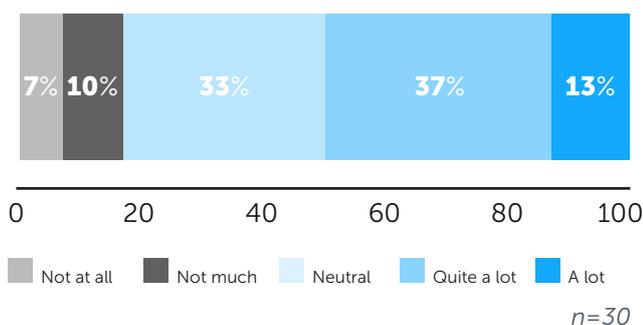
Results

8.3.1 Appeal of the game for participants

The test participants were randomly selected and therefore included a variety of girls with various levels of game-play experience and enthusiasm for gaming. Although game-playing is seen as ubiquitous among young people, there were a small minority within the focus groups who didn't play any digital games. Within this diverse group, only 17% said they didn't enjoy playing, whilst 50% said they enjoyed the game, and 43% said they would recommend it to a friend.

Graph 3: Participants' enjoyment of the game

How much did you enjoy the game?



8.3.2 What was particularly liked in the game

There were a number of elements of the game that were particularly enjoyed by participants. These were:

- **The uniqueness of the game**

In the game the player has to use their whole body, not just use fingers on a controller. There was discussion about feeling like they were more involved in the game because of the "whole body" element.

"I liked how it was unique....there is a meaning..it's not like every other game, it's a different experience"

Focus group participant

- **The game taught valuable life skills**

The skills taught by the game - remaining focused under pressure - were mentioned a number of times as one of the elements liked by the participants who appreciated the usefulness of the skill in their future life.

"I liked the concentration . . . Cause it's helpful in everyday stuff as well, so it teaches you to breath properly and stay in control."

Focus group participant

- **The demonstration of a link between mind and body**

Some participants enjoyed that the game linked together the elements of mind and body.

- **The ability to change the speed of the breathing pacer**

The players were able to change the speed of the breathing pacer, which nearly all of the players had done.

- **The game made players earn their achievements**

As the game involved both mind and body there was no way to cheat the system and earn points if they weren't doing the technique correctly. This brought an element of fairness to the game, and satisfaction in achievement.

"In some games they give you the stuff, but in this game you have to be able to work for it."

Focus group participant

- **A selection of game mechanisms**

A number of gameplay mechanisms were liked including the different types of cards, and their individual actions on the board as well as the the mechanism that allowed players to win new cards through breathing challenges.



- **Ranking**

IT issues meant that the live ranking element of the game did not function. However, the rank could be calculated after the session and read out at the following session. This element of competition was enjoyed and was clearly a motivator for some of the players to focus on the game.

8.3.3 Areas participants felt could be improved

A number of themes also emerged around elements of the game that were universally felt to need improvement.

The first of these were certain in-game design elements that arose as a result of the game being in beta version. For example, there was a strong desire for more customisation in the game, such as being able to choose your own character and pick display themes. Similarly there was a desire for more progression in the game, moving to different levels or duelling with different characters. Both of these will be built into future versions of the game. Similarly, all glitches in the game, that appear as a result of an iterative game development process, will have been identified through additional rigorous testing and removed in alpha versions.

Another area that was felt to have room for improvement was instructions in the game. As discussed above, not all of the participants played games on a regular basis and so didn't instinctively understand the game. Although we gave a presentation with the rules, and provided a rule booklet, information in this format was clearly not absorbed by everyone. As a result we will be introducing an in-game tutorial in the next version of the game.

Finally, the participants didn't like wearing the heart rate monitor around their chest. Some felt it to be uncomfortable and involved quite a bit of effort to put on - including going to the toilets to get changed. We had expected this feedback, and had been using the chest strap as it provided the most accurate reading of heart rate at the time. Post-trial, however, we will be using an ear clip heart rate monitor that provides sufficient levels of accuracy as well as being more convenient to put on.

8.3.4 Elements of the game that divided opinion

Although there was consensus on some areas of the game, others divided opinion. The areas that prompted most difference was the integration of breathing in the game, the use and enjoyment of the Proving Grounds section in the game, and the magic theming of the game.

Breathing in the game

There were those in the group who enjoyed the integration of breathing into the game, and, as discussed above, participants liked that the integration both taught them a skill and meant that they couldn't cheat in the game.

However, another group of participants in the focus group found the breathing itself to be quite frustrating and thus were quite negative towards having it integrated in the game. Frustration came both from the setup of the equipment with the heart rate monitors which they found annoying and which some girls had trouble connecting to the game, and also from not being able to master the breathing technique leading to feeling dispirited. It is difficult to disentangle the extent to which each element contributed to the frustration. However, we will be acting on this finding to improve the in-game teaching of the breathing technique and also the support available for those who are struggling to learn the technique.

The Proving Grounds

In this section of the game, players would complete breathing challenges to earn new cards exclusive to the Proving Grounds. Challenges started easy and increased in difficulty and included tasks such as raising HRV levels to increasingly high levels and maintaining HRV at a particular level. This section of the game polarised players who tended to either have really enjoyed it, or hardly spent any time there.

For those who really enjoyed it they liked it both because it provided the opportunity to win new cards but also because it offered the opportunity to practice and improve their breathing technique which they saw would help them in the Ranked Matches.



“When I first started I didn’t really bother to go on the Proving Grounds, I just went straight to the Ranked Matches. And then i realised I wasn’t getting enough points and I went to the Proving Grounds in the last few sessions, practiced and then I became better.”

Focus group participant

For those who didn’t spend much time there they explained they had gone into the Proving Grounds but had found the challenges too repetitive. For others, the challenges had been too difficult for them and so they gave up.

This polarisation has shown us that there is a desire to practice the breathing technique and this practice can be further incentivised with techniques such as winning cards. Any breathing challenges do, however, need to be varied enough to maintain engagement. They also need to be suitable for those who struggle with the breathing technique without proving too easy for others who pick up the technique first time. This is something we will be working on for future versions.

The magic theming of the game

The opinions in the focus groups echoed the survey results which showed there was a split between those who liked the magic theme (50%) and those who didn’t (33%) with 17% being neutral.

This diversity of opinion reflects the wider game environment in which no game has universal appeal, with different people favouring different types and themes of games. In line with this, those focus group participants who didn’t like the magic theme explained that they felt it was a bit too young for them. In contrast, other focus group participants particularly liked the magic theme, enjoying the world it created. This game is the first in a range of games to be developed by BfB Labs with future games encapsulating different styles and game-play and appealing to different target audiences.

8.3.5. Appeal of the game for school staff

As part of the trial we spoke to staff involved and interested in the project. This included the Deputy Head of the school and the Librarian, both of whom had been involved in the setup of the trial. We also spoke to the Learning Support Unit (LSU) Manager who manages the support of children with particular emotional and behavioural needs. The LSU manager hadn’t been involved in the trial but was interested in the game and its potential applications in her department.

The staff interviewed felt that there was increasing pressure on young people today

The consensus among the staff was that adolescence was a difficult time for young people, citing hormonal changes, stresses due to academic, social and emotional pressures. There was also consensus that the digital world was further compounding these pressures and raising them to new levels, with young people now being continuously in touch and on show through social medial platforms. Within this context of increasing pressure, staff felt that training in emotional regulation was needed more than ever by young people.

“I think that the need is even greater than ever to help students with their emotional control.”

Fidelma Boyd, Deputy Headteacher,
St Angela’s Ursuline School

The game was seen as a particularly innovative and appropriate solution

Staff were impressed with the game and felt that there were three elements of the intervention that made it particularly appropriate for use with young people in the school context. First, it is accessible and easy to use. Second, as a video game it is relevant to the young people who were familiar with digital games, and also associated them with fun. Finally, it gives both the player and the school the opportunity to monitor play and progress through the online database which captures all players’ data. This is something that other interventions tend to lack, with teachers having to rely on self-reports of practice from students.



The staff felt the game was enjoyed by most of the participants

From observations of the sessions, the staff felt that the girls had been enthusiastic about the game, although it was noted that some girls were quite chatty in the sessions. Outside of the game, the staff also reported being asked by participants when the next session was going to be, which the staff interpreted as engagement in the sessions.

The game was versatile and could be used in different school settings

A final advantage of the game highlighted by the staff was its versatility. The Learning Support Unit Manager explained how it could be used both in the classroom context, as in the trial, but also on a one-on-one basis for students coming to the Learning Support centre:

“If [a student] was relocated from a lesson where they were really angry with the teacher to sit and play a game, it would be a “treat” but they would also learn to control their anger at that time which would be really beneficial to us as staff and them as students.”

Kim Evans, Manager, Learning Support Unit

She also explained that along with controlling anger it could be used in sessions she ran with students that have anxiety issues and panic attacks as it is a fun, familiar way to learn a technique to help, whilst leaving the young people feeling like they have had a treat.





9. Conclusions

BfB Labs' biofeedback game was designed to address the need for preventative interventions that help young people build skills of emotional regulation, providing protection against the development of common mental health issues and their consequences.

This evaluation demonstrated that the game sessions were effective in teaching most young people the breathing technique and encouraging regular practice. Although a few students continued to struggle with the technique, eighty percent of participants felt that they had improved their technique during the trial and most participants had experimented with breathing speed, with some spending considerable amounts of time in the Proving Grounds completing breathing-based challenges - another indication of breathing technique practice.

The game also proved to be effective at improving emotional regulation in young people over the seven-week trial period with players showing an improvement across sessions in the amount of time they could sustain elevated HRV levels (indicating emotional regulation). Participants also felt that they had improved their emotional regulation skills, with nearly three quarters of participants (73%) feeling they had got better at staying calm and focused whilst playing the game and a third (33%) having already used this technique outside of the game context in situations that were emotionally charged.

Finally, the game was generally well received, with only 17% saying they hadn't enjoyed playing the game and some participants particularly liking the fact that the game taught them a life-skill. It was no surprise that there was not universal appeal of the game, something that no game achieves, but feedback on the elements of the game which weren't liked will inform the development of the next set of games that are planned to be developed.



From a staff perspective the game was seen as a unique and innovative way to help young people cope with the increasing pressures they were seen to be experiencing. The use of the game was also seen to extend beyond class-based activities and was seen as a useful intervention to use in one-on-one sessions with young people who struggle with regulating their behaviour and emotions.

The trial also highlighted a number of areas which will directly inform future development of the game such as the need for stronger teaching and support of the breathing technique within the game and the need for a clear and simple on-boarding process to explain the gameplay itself, the latter a particularly valuable feature for players who are less familiar with games in general. Work on these areas has already begun, along with changes and development of game-play aspects based on participant feedback.

In all, the trial shows that BfB Labs' biofeedback video game is a product that has the potential to teach young people the skills they need to manage their emotions effectively in an engaging, age-appropriate, culturally relevant way. As such, it provides the basis for further development of the product, making the product more widely available to individuals and schools, and further testing, including with young people with behavioural difficulties.





For more information about the project, please visit our website: <http://www.bfb-labs.com>

If you would like to discuss the project with us, please contact BfB Labs' Lead Researcher Naomi Stoll at Naomi.stoll@bfb-labs.com

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