

Can Biofeedback Technology help Young Children “Learn” to Relax in School?

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Abstract: Research over the years has identified a number of stresses and anxiety periods for children during compulsory education (5–16 years). The current study focuses on infants (5–6 year olds) entering the education system. It explores children’s perceptions of ‘relaxation’ and learning, and it evaluates the use of biofeedback technology in helping young children ‘learn’ to relax. This technology gives users awareness of physiological functions such as heartbeat. In this study, biofeedback technology was used as a method for enhancing children’s relaxation, thereby possibly contributing to their self-regulation and enjoyment of learning. By asking the children themselves, the study evaluates a specific software and approach. This research reports on the first pilot study to use HeartMath™ with young children in school. The findings are relevant to young people and educators, as it contributes to an understanding of how a new technology may be applied in new contexts as well as the possible outcomes of this application.

Keywords: Biofeedback Technology, Relaxation, Classroom Stress, Learning, Enjoyment

Introduction

CHILDREN’S SOCIAL LIVES are increasingly mediated by new technologies, and within schools, these technologies are becoming used to support the learning of curriculum topics. Some technologies utilise social feedback between groups of children (Ravenscroft and McAlister, 2005), whilst others provide computer feedback on an individual learners performance using an educational programme (Pea, 1985). However, new technologies also have the potential to give a different form of feedback, namely giving a child feedback on their own emotional state, through the measurement of a physiological function. This *biofeedback* technology has been used for several decades in clinical settings, but has only recently become affordable and ubiquitous enough for educationalists to begin to consider its use with the classroom.

Biofeedback technology gives a user external and immediate psycho-physiological feedback about a selected internal biological function. Heart rate monitoring technology is the focus of this research. This area is typically researched in adults in clinical and performance sport settings. Indeed, heart rate monitors have become a commonplace technology for runners and endurance athletes. However, the use of heart rate biofeedback with children is under researched (Conley et al, 2011), and the use of biofeedback in school classrooms is at a very early stage of exploration (Roberts, Hampton and Kerr, 2009)

There is evidence, from non-technology based research, that children learning to control their heart rates via breathing control, as part of developing ‘mindfulness’ (Jones, 2011), gain benefits in terms of relaxation, reduced stress and increased ability to regulate their at-

tention. Work with teenagers found improved psychological well-being through, and following, this type of training (Huppert and Johnson, 2010). Relaxation and stress management are not traditionally part of the curriculum for young children; yet, contemporary investigations suggest that young children's school experience are not necessarily stress free (Byrne et al, 2011). Such approaches may be difficult to implement with very young children, and it is here that newer biofeedback technologies may have a particular relevance.

One of the strengths of biofeedback technology is that it can use children's biological states to control devices that children find engaging. For example, as a child's level of relaxation changes, the behaviour of an onscreen character or object responds accordingly. This has allowed children to learn to relax through control of PlayStation® type games and controlling the behaviour of avatars in virtual worlds (Sheehy, 2010). HeartMath™ is a biofeedback technology in which children wear a non-invasive ear clip to monitor their arousal levels and which gives feedback in the form of pictures or control of pictorials displayed on a laptop. It would therefore appear to have potential for use with very young children. Recording the average heart beat through the pulse detected in the ear provides a method of recording heart rate variability (HRV) coherence. McCraty et al (2004) argue that a more coherent pattern of heart rhythms can produce an increase in positive emotions and therefore by monitoring HRV through visual feedback, users can train and improve their level of HRV coherence. A positive emotional state and balanced flow of sympathetic and parasympathetic nervous systems associated with coherent HRV is also advocated by Lipsenthal (2004). From a health perspective Lipsenthal (2004) also states HRV patterning can result in enhanced cortical functioning. This area is still under research. HeartMath™ can operate in two main modes: a calibration activity; which is where the user views a rhythmic breath counter and a range of graphs denoting the users' 'live' performance. The second option is in game mode; where the user continues to regulate their breathing, but as they do so, the images on the screen change either in terms of colour, appearance or movement. Figure 1 provides an example of the screenshots available for the calibration and different games. In total five games are available including one where the user can insert their own library of pictures. Participation in these games and the calibration activity can be at three levels of challenge: low, medium and high. In addition, accompanying music can be switched on or off and the time duration of the activity can be pre-set.



Figure 1: Screenshots of the Calibration Screen and Three of the Games from HeartMath™

This research reports on the first pilot study to use HeartMath™ with young children in school. The research is concerned with gaining children's perceptions about 'relaxation' and their experience of using this technology. In effect, the underlying belief is that children have a right to be involved in decisions which affect, and potentially influence, their lives (CRC, 1989). To paraphrase McIntyre et al. (2005), it cannot be claimed that we are seeking to develop technologies for the benefit of young people if we do not consider their views about what is beneficial to them. This is particularly relevant for young children in relation to new and assistive technologies where their voices are typically not heard (Wright et al, 2011).

Methods

The aim of the study was to observe the process of implementing biofeedback technology in an educational setting by gaining some insight into children's perceptions on 'relaxation' and evaluating the level of engagement by the children. We were also keen to explore the support staff's views on using this type of technology.

In exploring the initial implementation of this technology, a qualitative approach has been recommended (Savenyen and Robertson, 1996). Focus groups (Sheehy and Bucknall, 2007) along with questionnaires were utilised to 'elicit the perceptions, motivations, concerns and opinions of the participants' (Gibson 2007, p474). Informal interviews with the class teaching assistant were used to explore their perceptions of introducing this new educational practice. In addition quantitative data, average heart beat and a coherence ratio, by the biofeedback software were analysed.

The research complied with the British Educational Research Association Ethical Guidelines (2011) and clearance was obtained through the University of Northampton's ethics committee.

Letters of invitation to participate in the research were sent out by the school to all children in a Year 1 class at an Infants school in England. Twenty seven per cent were returned duly signed. The sample group consisted therefore of 5 boys and of 3 girls with ages ranging from 5–6 years. The research was carried out in three distinct stages: preparation, participation and feedback.

Preparation

Supplemented with written guidelines, a teaching assistant at the school was trained in setting up and using the biofeedback software with the children. The teaching assistant facilitated a preliminary focus group discussion with the children to explore their perceptions of the 'being and feeling relaxed'. As part of this activity, the children were asked to draw a face that looked relaxed and one that was not relaxed. Each child also completed a smiley face statement questionnaire about their experience at school. The statements were read out to them in a group and they coloured in the face that best matched their feeling about the statement.

Participation

An introductory activity with a low level of challenge allowed the children to become familiar with the technology. After discussion with the teaching assistant it was felt that the time

for each session should set at two minutes. Whilst sound is an option available in Heart Math™ in terms of soft relaxation music, for practical reasons, the school opted to switch this feature off. Data output from the software per session was recorded as average heart beat rate measured in ‘beats per minute’ (BPM) and a coherence ratio.

Seven of the children were present for all 10 sessions (5 calibration and 5 game mode). One child (Child B) was absent for three of the five days. After each session, the children were asked questions about their experience using a smiley chart (see table 3) as well as three interview questions which were 1) Was there anything you noticed or felt? 2) Which game did you play? 3) Did you prefer the calibration activity or the game and why?

Feedback

At the end of the study, the researchers interviewed the teaching assistant to obtain her views on the administration and training aspects of the project. Most of the parents of the participating children also requested feedback at the time of giving consent and this was provided through the school, on request.

Results

Feeling Relaxed is Feeling Happy

















During the focus groups, the children defined ‘feeling relaxed’ as “feeling happy and calm” and the opposite of relaxed as “grumpy and sad”. These perceptions were re-iterated by the children in their drawings. All eight children drew a happy face for relaxed and a sad face of someone who was not relaxed. In addition, two of children shared that when they are relaxed their breath is deeper and they are smiling. They also stated when they are not relaxed they “feel weird and they might cry”. This suggested they saw relaxation as a more desired state and were aware of how their emotions might impact on them physically.

In discussing what things at school makes them relaxed the children listed play, having fresh air and “choosing activities”. Conversely, lessons they don’t enjoy do not make them relaxed, suggesting that for them relaxation was synonymous to enjoyment. Interestingly some of the children thought that feeling relaxed helps to improve their learning, however none of the relaxation producing activities they identified were classroom or academic based.

Feelings about School Vary with Individual Children

The pre-participation school experience questionnaire elicited a range of responses from the children thus denoting a mixed experience for most children.

Table 1: Responses from Pre-participation Questionnaire

	Child A	Child B	Child C	Child D	Child E	Child F	Child G	Child H
	Boy	Boy	Boy	Boy	Girl	Girl	Girl	Boy
Coming to school makes me feel								
When I think about school I feel								
I enjoy learning	dis-agree	agree	agree	agree	Agree	agree	dis-agree	don't know
I feel relaxed at school	dis-agree	don't know	agree	agree	Agree	agree	agree	agree
I have lots of friends at school	agree	agree	agree	don't know	Agree	agree	don't know	don't know
I feel I can talk to my teacher about any problems I have	dis-agree	dis-agree	agree	dis-agree	Agree	agree	dis-agree	agree
I wish I didn't have to come to school	agree	agree	dis-agree	don't know	Agree	agree	dis-agree	dis-agree

As table 1 indicates the children's responses to school are not always positive ones and there is variation between the children in their response profile. Interestingly all the girls in the study commented on how coming to school makes them happy. In comparison only 3 of the 5 boys expressed the same opinion. 75% of the sample group shared they felt relaxed at school; whilst only 50% felt they could talk to the teacher about any problems they had and 38% wished they didn't have to come to school.

Average Heart Rate and & coherence data was recorded on the following number of occasions:

Table 2: Number of Recorded Output Data Points from the Biofeedback Software

Child	Calibration	Game
A	5	5
B	1	2
C	5	5
D	4	5
E	4	6
F	5	5
G	4	5
H	6	4
Total	34	37

The study was conducted over 5 days and on each day children took part in a calibration activity and a game activity (as indicated by Child A in table 2). To keep the data output separate from both these activities the children had to switch user names between activities. It is possible; therefore, that in the case of Child E & H, this was omitted on one occasion and in the case of Child D & G, one session was not recorded. Child B was absent for three out of the five days.

Figures 2 and 3 denote the software output of average heartbeat (BPM) for each child in the calibration activity and in the game. There is variance across the days. The range of BPM during the calibration and game activity is approximately 61 to 110. It is interesting to note that Children C, D & H had a high coherence ratio during the game mode indicating a higher level of relaxation and supporting their preference as recorded in table 3. Child A was consistent across both activities.

Figure 2: Average heart rate (BPM) of the children over the research period - calibration activity

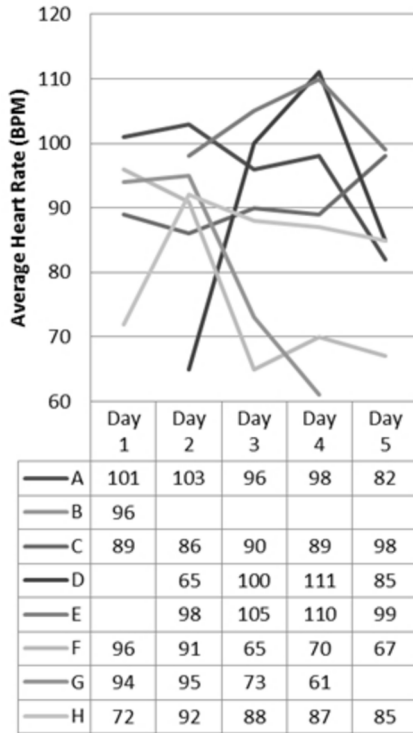
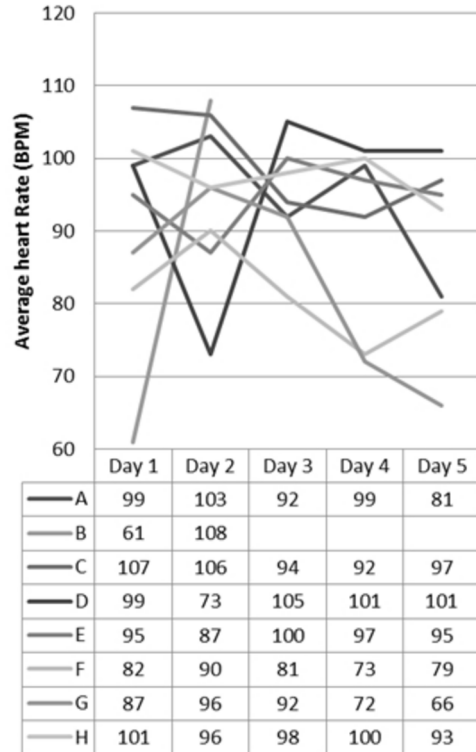


Figure 3: Average heart rate (BPM) of the children over the research period - game activity

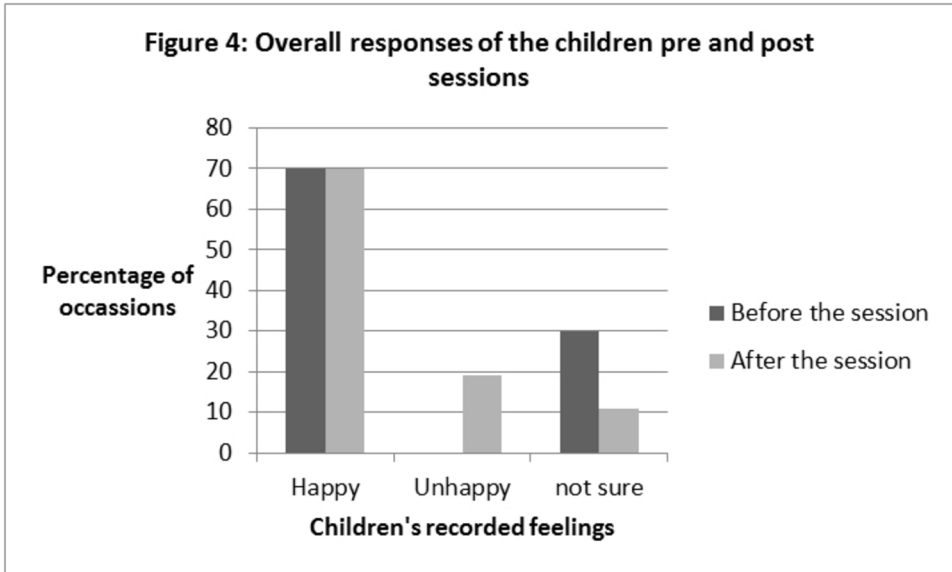


The coherence ratio data recorded for each child varied daily. However, over the five day period, most children had shifted from low coherence on day 1 to medium or high on the subsequent days. Child E & Child F, in particular, had improved significantly to a high level of coherence. This change was noted in both the calibration and game activity. However, most children demonstrated a preference for the game activities, as recorded in Table 3. Overall the children said that they enjoyed 87% of their sessions, reported non-enjoyment for 8% and 'not-sure for 5% of their sessions. All the children demonstrated a preference for the 'Moon Game' as they 'liked the way the bubbles changed colour'. On two occasions, two children expressed a liking for the visual fluctuation of the bar graphs in the calibration activity. The teaching assistant reported that as the children become more used to using the software, they appeared to be more confident in using it.

Table 3: Data from the Post Session Questionnaires

Child	Feelings before the session /5	Feelings after the session /5	Did you enjoy the session /5	Which games did you play?	Preference Calibration or Game	Any comments
A	4 😊 1 😊	2 😊 1 😊 2 😊	1 😊 4 😊	Moon Game	4/5 Moon Game	Liked the baby and the lights changing colours
B	1 😊 1 😊	2 😊	1 😊 1 😊	Moon Game		Absent for three days Calibration because I liked the graph go up and down
C	5 😊	1 😊 4 😊	1 😊 4 😊	Moon Game	2/5 Moon game	Liked the bubbles change colour and the lines go up and down
D	2 😊 3 😊	2 😊 3 😊	2 😊 4 😊	Moon Game	5/5 Moon game	I didn't want to stop Moon game—because the bubbles changed colour and it made me laugh
E	2 😊 3 😊	2 😊 3 😊	5 😊	Moon Game - tried rainbow game	3/5 Moon game—1/5 both 1/5 calibration	I wanted to carry on I wanted to play all day Moon game was fun, nice & calm Calibration—liked zig zag on the screen
F	2 😊 3 😊	1 😊 4 😊	5 😊	Moon Game	4/5 Moon game 1/5 both	Fun watching the bubbles change colour, relaxing,
G	3 😊 2 😊	5 😊	5 😊	Moon game	4/5 Moon game 1/5 Calibration	Moon game—liked changing bubbles Calibration—liked it because it was going up and down
H	5 😊	5 😊	5 😊	Moon game	5/5 Moon game	Liked the blow bubbles & changing colours

Figure 4 identifies an apparent ‘increase’ in unhappiness following the biofeedback session. However, this is because the children were unhappy that their session had finished and did not want to stop. (See additional comments by Child D & E in table 3).



Feedback

The teaching assistant indicated that by day 3, the children were able to independently use the software i.e. opening up their name, clicking start and taking part. It was also reported that the training and guidelines provided prior to the trial were adequate, although it may have been useful to build additional practice time into the trial for the children. The children were given the option of all five games, but most chose the moon game.

Discussion

The purpose of this study was to examine and evaluate the use of biofeedback technology in a school with young children. From the data, it can be seen that the ‘school experience’ varies for each child and children correlate the ‘experience’ of relaxation with ‘happiness’ i.e. a positive emotion. Putwain (2008) describes the education system in England as a ‘test-conscious’ culture; thereby increasing the stress and anxiety a childhood experiences in school (Denscombe 2000; Connor 2001; Connor 2003). Landson (2006) filmed a reception class in a primary school in Bath and reported on some of the stresses they experience upon entering school. These included adjusting to routines, following instructions, the size of the setting and making friends. Whilst the girls in this study confirmed they enjoyed coming to school, a significant number of boys felt the opposite and approximately 50% felt they could not talk to the teacher if they had a problem. The Education Act (2004) set out the parameters for the ‘Every Child Matters’ agenda in which ‘excellence and enjoyment’ were identified

as one of five desirable outcomes of educational practice. Therefore in a system where assessment is a driver for provision is it possible to ensure children's experiences in school are less stressful? The principles underpinning 'assessment for learning' (Mansell et al 2009, p10) support an education assessment system that 'fosters motivation' and 'helps learners know how to improve'. A development area for this research would be to see how the use of biofeedback technology over longer periods of time might be transferred to the classroom environment to enhance the learning experience of young children by providing them with a stronger resilience (Roberts et al 2009) to stress through HRV coherence training. This research is currently under development as part of an ongoing doctoral thesis (Devi, unpublished).

Play is a form of learning and 'critical to self-regulation and children's ability to manage their own behaviour' (Singer et al, 2006). Based on their research with adults and children and on their perception to and of play, Keating et al (2000, p441) argue that play can 'stimulate and extend' learning. The adult population of their sample group also reported play as a 'building block or a foundation upon which to develop future learning' (Keating et al, 2000). Indeed cognitive development can be seen as beginning with play (Manning and Sharp, 1977; Cass, 1971 and Bruner *et al.*, 1976). In the current study the children engaged initially in 'directed play' with a choice of game. Over time, the children developed a sense of independence as well as increased coherence. This made their learning a 'relaxing' and enjoyable experience for the children. This is in contrast to only 75% of the sample group who said they enjoyed coming to school. In the current study children were given the 'choice' of game. Feedback would also suggest they would have liked autonomy over the time length of engagement. This raises questions about what is the optimal 'learning time' and 'engagement time' for a learning activity in school.

Whilst, the use of information and communication technology (ICT) is encouraged from a young age (DCSF 2008), some researchers would challenge the effectiveness and merits of the use of computer technology with young children (Cordes & Miller, 2000; Oppenheimer, 2003 and The Alliance for Childhood, 2004). Our small scale study challenges this view and suggests that biofeedback technology has great potential in education and warrants further research. This study has served to demonstrate the ease with which this can be incorporated into the daily routine in schools. It has also shown how children as young as 5 can access this type of technology and that engaging in this type of activity is an enjoyable experience. It provides them with a sense of autonomy and independence. What is required is to examine the impact of engagement back into the classroom in terms of transferable skills.

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