Mind, the Gap

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Abstract. Training is needed to exercise our most important organ: the brain, exploit its full potential and sustain it for our later years. Does a gap exist in our capacity for learning, a gap between what our brain could potentially achieve and what we are currently prepared to accept? The 'prototype' follows an ambitious undergraduate Computer Science student as he gets drawn into psychophysiological experiments that explore brain-training, involving image recognition, cognition, subliminal delivery, and imagined movement. Such technology has great potential for promoting and assessing learning and possibly exploring under performance or dysfunctional learning. However, as with all technology that enhances the human, there is potential for unintended use that we should be mindful of.

Keywords: Brain computer interface · Immersion · Stimulation · Brain-training · Enhancement · Subliminal learning · Brain-washing

1 Introduction

Our mind is our intellect, our ability to think and reason. In his book exploring the human mind, Professor Robert Winston [1] states, "*With the help of science we can now begin to understand the extraordinary complexity of the brain's circuits: we can see which nerve cells generate electricity as we fall in love, tell a lie or dream of a lottery win. And inside the 100 billion cells of this rubbery network is something remarkable: you.*" However, eminent neurosurgeon, Henry Marsh recently stated that we understand more about the universe than our own consciousness [2]. As scientists and educators, we need to further understand the mind and its underlying hardware, the brain. If we do not train our bodies, then such neglect is obvious by sight; quantified by metrics, such as body mass index. Labels to describe poor conditioning are in everyday use: sedentary, obese; this has led to new terms in our vocabulary such as 'diabesity'. But what happens if we neglect our brain, if we under-stimulate the mind. At the developmental stage (i.e. early years and school) will the brain ever reach its full potential? Peer judgement on intellect is less obvious but 'measures' such as Intelligent Quotient (IQ) and examination grades are widely used by society and subsequent labels can be harsh and detrimental to the individual. If a person fails to achieve a pass in an examination then there may be many contributing factors beyond intelligence: motivation, appropriate learning and teaching, even social class and proper nutrition. And what of people with special educational needs, such as Attention Deficit Syndrome (ADS) or dyslexia? Such needs often go undiagnosed leading to inappropriate teaching

C. Allison et al. (Eds.): iLRN 2016, CCIS 621, pp. 102–112, 2016.
DOI: 10.1007/978-3-319-41769-1_8

environment and support. As we mature into adulthood then surely we can achieve even more if we continue to stimulate and train our brains. How does advancing age affect our intellectual abilities: can brain-training reduce the incidence of forgetfulness, cognitive decline, even the onset of dementia? These are significant societal questions as the ageing demographic rises.

But how can we measure learning in real-time? This paper investigates the possibilities of brain computer interface (BCI) technology [3] for image identification and extrapolates this to learning[1]. It takes the viewpoint that the brain is under-utilized and would benefit from increased stimulation, in an immersive environment. However to be beneficial, we need to measure and quantify changes in brain activity. Visual Evoked Potentials (VEP) [4] and Cognitive Event-Related Potentials (ERP) [5] can be measured in neurophysiology laboratories. Could this technology be translated into mainstream learning in the future, to human enhancement? The public is equally fascinated and suspicious of emerging technology. This is particularly true of BCI devices, which are seen as clinical and invasive, the stuff of medicine or even science fiction [6]. One well-known myth of BCI is that it can be used for 'brain-washing'. *Or is it a myth?* This prototype addresses BCI for learning application in immersive education. Adoption of such technology could throw up unanticipated consequences. Technology such as Oculus Rift can provide appealing and stimulating immersive environments; eye-tracking can provide an objective measure of eye gaze on a computer screen; combined this powerful technology can be linked to user engagement. But there is a gap, how do we as teachers know that a student has *really* understood a topic? We should mind the gap.

2 Rationale for a Prototype

The fictional work is motivated by the mystical lyrics of the 1971 David Bowie song, *Quicksand* [7]. The 2016 release of the his last record *Blackstar* and accompanying videos[2], featuring a preacher and his 'blind' followers, reignited interest in Bowie's fascination with the occult (evidenced in his *Station to Station* album, 1976), magician Aleister Crowley and the Golden Dawn cult [8, 9]. The visual imagery was particularly poignant, as it provided many subliminal indicators to Bowie's imminent death, which duly occurred on 10th January 2016, 2 days after the album release. So this prototype is an investigation of BCI and learning; homage to a *guy that's been*. It weaves a make believe web, linking characters: Crowley (a persona projected onto the research Psychologist), poet W.B. Yeats and renaissance artist Michelangelo[3], all with reported interests in mysticism and cults. The prototype blurs what is currently possible with BCI technology; crossing the line from the human being in control, through to shared autonomy and to eventual brain-washing, with human subservient.

[1] This step takes us beyond the current state-of-the-art, into the realms of sci-fi prototype.

[2] Two controversial videos, "Blackstar" and "Lazarus" were recorded as Bowie contemplated his final act, whilst battling liver cancer.

[3] Yeats referred to Michael Angelo [misspelt] in his poem, *Under Ben Bulben.*

There are many gaps. The title of this paper refers to the 'gap' between what a human brain and mind can currently achieve and what maybe possible. However it could also refer to the gap that neuroscience currently has in understanding the complex brain, the scientific gap in our knowledge.

3 Fictional Story – The Golden Dawn Experiment

"Mind the gap"[4]. I'm on the subway in London waiting for a tube. "Mind the gap". I'm headed for the *Villa*. I'm not sure whether the journey will end in enlightenment or oblivion. The tube arrives. "Mind the gap".

"I'm closer to the Golden Dawn,
Immersed in Crowley's uniform of imagery" [7]

3.1 Cats and Dogs in the Psychophysiology Laboratory

{A few days earlier}

"This is the future of education?" I pondered as I made my way to the Psychology Department. I had replied to an intriguing email from an organisation called, 'ORMEN: Operations and Research for Mental Enhancement Network'. It sought student volunteers to take part in a pedagogy experiment called 'Golden Dawn'. I had finished my exams at last and had time on my hands. The information provided was not very specific:

The focus of this special track will be to explore the possible ways immersive-reality technology might change future education.

I had achieved good grades in my Computing degree so far and I was particularly interested in research into human computer interaction, so I fulfilled the inclusion criteria. I was also interested in the fee of £10 per hour-long session, which would definitely be worth it, if I was selected for continued participation throughout the day. On arrival, I filled in some run of the mill 'consent' paperwork, which I probably should have read more closely and found myself in a laboratory with a couple of dozen others, presumably like-minded cash-poor undergraduates.

I was seated in front of a computer, with a keyboard, mouse and a set of virtual reality (VR) glasses, under starters orders. An announcement was made on the screen. "`You will see some images on the screen. All you have to do is count the number cats and dogs. Ignore the other images`". The screen flickered into life in front of me. Images were presented sequentially. Each time a dog or cat appeared, I pressed left or right mouse button as appropriate, and as fast as I could. It was easy, not much to this Psychology at all, I thought. After about thirty minutes the experiment ended and a message on the screen appeared that I could proceed; I should continue to be seated. There was the movement of chairs and some

[4] 'Mind the gap' is an audible warning provided on London's tube network and railway stations. Announcer Phil Sayer died in April 2016, aged 62.

people left the lab, presumably they had difficulty distinguishing a cat from a walrus, a dog from a duck, either this or they were happy with their tenner and were heading to the pub for lunch.

A further announcement: "`This is an immersive test. Put on the glasses. You will see some interesting images. All you have to do is count the number cats and dogs`". I was always a 'techie', so this really appealed. The glasses flickered into life and the cats, dogs and other strange creatures, some mystical, again appeared, but this time in glorious 3D. I felt a bit disorientated as bizarre lifeforms flew past me, and lingered behind, above and below. A few more targets were visible to me in the periphery of my vision, and with the VR I could *turn and face the 'strange'*; the count went up. I was dizzy and probably needed a glass of water, but somehow I felt I couldn't ask for one. At the end of this session, I was again successful. It was just like being on The Krypton Factor[5], I thought. A few sighs from around the room and the number of participants was again reduced.

A third session followed, this time in the dark, pitch black and eerie. Fainter images were interspersed with the brighter easier identified targets. They must have been there all the time, and I hadn't spotted them. There is something to this Psychology.

"I'm torn between the light and dark
Where others see their targets in divine symmetry" [7]

Still I was retained in the diminishing group of participants. In the next session, the speed of delivery was increased. Was that a cat? I thought I saw 10 dogs or was it 11? Maybe there were a few I missed? Now my mind was working overtime. A bit surprised this time, as I again got successful feedback. This brought us to lunchtime; a free lunch, yet another bonus.

At lunch I was directed to a table with four other 'select' participants and our tutor, a Dr. Crowley. She put us at ease straightaway, and praised us for our vision and quick reactions. We were disarmed. We discussed the motivation for volunteering. The others were definitely motivated by research, as of course was I (although in truth, I was feeling a bit out of my depth). We were asked about our interests. With the others responses were quite high-brow, art and poetry; for me it was seventies pop music and David Bowie in particular. "Interesting", posed Crowley. "That's my era, seems too dated for you". "I got into Bowie, from my mother's old vinyl collection. It keeps my memories of her alive", I said. "Interesting" was again the sparse comment. She was probably a fan, I thought. Crowley informed us that we were the top performing participants. She suggested that we could continue with this mundane pedagogy work in the afternoon or undertake some 'real' research. Of course this was like a red rag to a bull. Perhaps we had already been psychologically profiled, I pondered. Swept along by ego, I plumped for the real research. That made five of us.

[5] The Krypton Factor was a 'serious' game show in the UK which pitted contestants in physical and mental challenges.

3.2 A Sublime Afternoon

We were directed down a labyrinth of corridors to a smaller electrophysiology suite in the bowels of the building. The rest of the participants went back to the original lab to 'play' with the computer gadgets. Our group was then prepared for the afternoon experiments, which involved the acquisition of our 'select' brain electrical activity in response to visual stimulation. I had read articles on this type of Brain Computer Interface (BCI) experiment [10]. This was exciting work, at the forefront of Computing and it could be a real benefit to humanity. People who had peripheral neural dysfunction or 'locked-in' syndrome could benefit from it as an assistive technology. This was Psychology and Computer Science in sweet harmony. I was definitively in the right group, with the elite. Instead of pressing a button to signify a response, the researchers could study my brain patterns in real time to check my brain's response to the visual stimuli. Crowley had a couple of lab assistants. They expertly applied electrodes to our scalps. After a little bit of tweaking, a bit of scraping and a tiny bit of boring, which provided some mild discomfort, and a fair bit of hair gel, we were ready. I enquired about the paperwork for this research, but I was reassured that I had already given my consent in the morning. I couldn't recall this bit but hey, this was real research.

A familiar announcement was made. "`This is an immersive test. Put on the glasses. You will see some images. All you have to do is count the number cats and dogs. We will do the rest`". The lights went down and my anticipation rose. Then…what a let-down! The same images were presented, cats, dogs and an array of animals some real, others mystical, some bright, others faint. What was worse, for the next two hours we had to endure three more sessions, some presented faster, others slower, but an overdose of feline and canine targets. At about 4 pm it was over. The helpers took off the electrodes. My scalp stung due to the alcohol solution that dissolved the electrode gel, and my brain hurt through overuse. I was disoriented, practically seeing stars. Well that should be about £80, not bad for a day's work, I consoled myself. I assumed that we would be leaving, then but there was one more session - a test. I had overdosed on exams already.

3.3 Testing Times

We five donned the goggles again. Our instructions were familiar. "`You will see multiple choice questions. All you have to do is choose a, b, c, or d on the keyboard`". An image flashed. It was Irish Nobel laureate, William Butler Yeats. I identified him correctly, most people would. Second question: Where was Yeats born? I quickly answered, *c: Sandymount in Dublin*, although I'm pretty sure it was Sligo. Where did Yeats study? I answered, *a: Erasmus Smith High School*, completely guessing now. Oh dear!, I never really studied poetry at school. Questions continued: Complete the verse: *We rode in sorrow, with strong hounds three*. I choose option, *d: Bran, Sceolan, and Lomair*. In all I answered 20 questions, and then time was up.

We then awaited feedback from Crowley and we all hoped that the test results wouldn't influence our payment, in any way. Results from the tests; we had ALL scored either 19 or 20 out of 20. I looked around puzzled, at my colleagues. They all

must be from the English department, studying poetry, I thought. I offered some explanation to my tutor. "Lucky guesses by me, I said". But Crowley retorted, "PJ, can you finish this poem?

"Proof That There's a purpose set
Before the secret working mind:…."

"…*Profane perfection of mankind;*" [11], I replied, before I could even think. I was facing the *strange* indeed, it couldn't be a guess. "You're an expert on W.B. Yeats", she said. I liked being called an expert, but I was now definitely in some surreal zone, head spinning, not really sure what was happening. Crowley continued to the group, "You will receive payment as you leave. I would like you all to come to a session tomorrow. Remuneration will again be provided. Can you make it?" My four colleagues confirmed straight away, as did I, actually before giving it any thought. But another £80 in the bank was all to the good.

On my way back to my apartment, my head was filled with the poetry of Yeats. Funny, thoughts of computing, science or old seventies tunes normally swirled through my brain. Today, I knew everything Yeats, but how? After some rest and gathering of my wits, I guessed that I was in the middle of some sort of subliminal study. I wanted to ask some probing questions about this, but I felt inhibited. And why didn't the others ask, anyway?

3.4 The Next Day: Michelangelo

The next day followed a similar a pattern. This time we five elite were looking for *daffodils* and *roses*, but I soon realized that this was totally unimportant. After a day of electrophysiological recording, we were tested again. I had developed significant expertise in the art of Michelangelo; works, many with subliminal meaning that I could readily identify during the end of day test. I was able to confirm that the depiction on the ceiling of the Sistine Chapel of *The creation of Adam* provided an anatomical illustration of the human brain in cross-section; *Separation of Light from Darkness* gave a ventral view of the brainstem [12]. Then we all received another invitation for day three.

Firstly, expertise on W.B. Yeats and then an appreciation of the works of Michelangelo: not bad for a Computing second year. I revised my television quiz aspiration upwards to *Mastermind*[6] contestant; I'll take Yeats in the first round and Michelangelo in the semi-final, I mused. This subliminal learning was powerful stuff. Should I persist or should I question it? Would I be removed from the study and relinquish the easy money? But my thirst for this easy knowledge was also growing more powerful. I could be an expert on composers, artists, potentially anything. Computing next please, I thought. Imagine, final year would be a breeze; no late nights, no popping pills to stay awake and enhance brain-power.

[6] Mastermind is the regarded as one of the more demanding television quizzes, usually for the more esoteric and intellectual.

Day three, and I didn't have to ask. When we arrived Crowley was there to brief us. "We have a new 'network' experiment, cutting edge research this time", she stated. "I guess you are all wondering what's going on". After a pause, to check our complete acquiescence with the process, she continued, but this time with much more passion and feeling. "The brain is very powerful, it takes up 20 % of the body's energy resource. It can process 11 million bits of information each second. But most people use less than 10 % of its capacity. Our research, the Golden Dawn project, is addressing this shortcoming. If we all use even 50 % of our brain-power, humanity will enter a renaissance, a golden dawn of enlightenment. We will reach a higher level of wisdom, people with less able brains can be identified, and defects rectified. We can discover the genes responsible for intelligence." After a pause, she calmed a bit. "As you may have deduced we have been stimulating your brains with images that are not readily perceptible to you. We know the response of your brain to an image you are searching for. We know that you have searched for it because we have monitored your gaze with the glasses. We know much about your interaction in the Golden Dawn experiment. If we get this same response to an image that you haven't looked at, we know that your brain has detected it, but you probably are unaware that you have seen it; the image may have been too faint or may have been too fast. All the same, because of the untapped power of the brain, you have still noticed it and can recall it."

"But why…", I thought to interrupt. Crowley pre-empted, "You haven't asked questions because in the experiments, we keep telling you not to, it's a frequent stimulus you don't perceive – we call it the *Don't Ask* stimulus! It's in the form of a white star" No need for me to finish then. "Your brain can detect an image long before you can press a button. You five have the most reliable visual perception. But sometimes, even one of you will miss a stimulus. This is unacceptable if we are to capture the knowledge". "We need volunteers for the next study. Who's in?" We all said "yes". Did we have any choice? I guessed there was probably a *Say Yes* stimulus too. I didn't ask.

3.5 Big Lou – A 'Real' Brain Neural Network

My appetite for knowledge was becoming more powerful; it was a drug. Crowley was right, think of what we could achieve, and we five were in the vanguard, we could become 'versatilists' of all knowledge. The next day, we were prepared as normal, nothing new. The experiments started again. This time I identified targets of colourful "fish" and cuddly "rabbits". But what would I learn? What would be the real test? I sought more expertise.

When I took the test, I realized that we were subconsciously straying into somewhat uncomfortable territory, immersed in a genre of violent video games. I was now identifying future crime scenes and potential perpetrators. This wasn't *Finding Nemo* meets *Bright Eyes*; it was *War Games* meets *Minority Report*. And something new was happening in the controlling computer. The potentials from our brains had been joined together by an Artificial Neural Network into a fuzzy decision-making brain network, linked to a cognitive computer called 'Big Lou'. If I didn't identify a scene, then one of my colleagues almost certainly did. This increased the reliability of ensemble identification to 100 %, and then I was then re-trained to rectify the error. This was indeed a

powerful network for decision making, tapping into the brain's unused potential, into a network of brains. And we could learn from each other to perfect learning strategies. The potential for this intelligent cognitive computer was enormous.

At the end of this session, Crowley called me aside. "PJ, you are the best of the group and you have learned even more from the other four. You no longer need them. You can proceed beyond research. *Operations* Golden Dawn needs you. You have been selected for the next phase. It is located in the *Villa* in London. You will meet my colleague, Tom. Will you go?" I wanted to ask what the operations were, what the villa was for, but I couldn't. I should have stopped then, but I couldn't. I needed to learn more. All the information derived from the study would be used for good to help people enhance their learning, wouldn't it? "Yes", I said. Of course I did.

3.6 A Spider's Web in the Villa of Ormen

I had been given a plane ticket to London Heathrow, further directions and a letter of introduction, by Crowley. I travelled on the underground tube on the Piccadilly line to Gloucester Road and then the District line to Temple. "Mind the gap, mind the gap". I could hardly wait. I was driven for new knowledge, my mind now possessed by some thirsty demon as I progressed from station to station. Eventually I arrived at my destination, somewhere near Blackfriars Bridge. I looked for a sign for 'Operation and Research for Mental Enhancement Network', but there was nothing, a cloak of secrecy. The building was old, built in gothic style, very atmospheric.

A doorman, possibly a security guard, checked my letter of introduction and I was ushered in to a dark corridor illuminated by a solitary candle. I met Crowley's colleague, who introduced himself as Tom. He was evidently a military type, loud, quite pleasant but not to be messed with. "Call me Major", he said. I was informed that I was here for my inaugural competition, which would begin in the morning. I would need rest, as this 'track' would be mentally tiring; I would be staying on the premises. The building was eerie, silent save for the hum of vespers or chanting. I guessed there could be a religious service in an adjoining room or maybe the sound could have been in my head. I couldn't really tell anymore.

In the morning after breakfast with the Major and three colleagues, I was briefed on the purpose of the track, which would be held in a CAVE. A number of candidates were being 'interviewed' to join the Golden Dawn elite; I was effectively in a play-off, with others from around the globe. There would be only one recruit, the others would be eliminated; their journey would be at an end. I now realised I was really in a nerdy version of *X-factor*[7]. I found out that the CAVE was a Computer Assisted Virtual Environment, a distributed, interactive games venue. The Villa housed the UK's node. There was a global labyrinth of CAVES, all connected to 'Big Lou'. Instead of putting on a VR headset and experiencing an environment in 3D, I was in it! The electrodes were again expertly applied to my scalp. This time I also donned a smart shirt, with

[7] X-Factor is an entertainment show requiring considerably less intellectual ability, but possibly a modicum of singing talent.

sensors and actuators to measure heart rate and galvanic skin response, and constrict upon command.

The Major was the BCI expert, he instructed me in imagined movement [13], whereby simply the thought of moving a finger would enact a motor response, a 'trigger' potential. He told me that each time there was a shoot-out, the candidate with the slower trigger would feel a sharp tightening in his chest. The feedback was realistic, important for motivation. Each Golden Dawn candidate had three lives. Anyone losing a third life would be eliminated.

I entered my CAVE pod. `This is an immersive test. You will see some images of assailants. All you have to do is identify them and use your trigger to eliminate them. We will do the rest`". I was in the middle of something resembling *Call of Duty*, engulfed by swarms of strange assailants but four were familiar; the Major and his band of brothers in avatar form. Presumably I was visible to them as well, in this vast virtual world. The other assailants were easily dealt with; their reaction times couldn't match my brain's neural response and reaction. In the end only five remained, four against me. I spotted the Major hiding by a boulder, he hadn't seen me. I knew I could take him out if I acted fast.

Then from the CAVE's audio came the strumming of familiar chords of a guitar. I became distracted. A familiar song consumed all my thoughts. I smiled momentarily. *"Oh Man! Look at those cavemen go. It's the freakiest show"*. Vivid memories took over. I could visualise my hero, the *Starman* arm in arm with Ronno, singing on *Top of the Pops*, glitter, make-up and knee length boots; and he was pointing at me. I moved closer. Only then could I see that it was really the Major in disguise and he was pointing a laser weapon, not his finger. I had been tricked. It was a brain-to-brain shoot-out, but my trigger potential wouldn't work. My chest tightened, and I struggled for breath, convulsing zombie-like.

Minutes later, I re-spawned. The computer knows I like David Bowie. I won't fall for Big Lou's tricks next time. But I was now in a new augmented reality, a psychedelic planet of wonderful colours; it must be Mars. Combat renewed. This time space creatures attacked, spider-like in appearance. After a prolonged bout of seventies-style 'Space Invaders' that I easily won, it was down to me versus the Major and his band. I was drained and disorientated when someone else entered the game. The image and voice were unmistakable to me; I could see my mother walking along an arid landscape arguing with a drugged-up clown and his followers. She had come to help me. She had always put my education first and nurtured my love of music. I needed to say "Hello", to say "Thanks". Up close, and then I realised that it wasn't my mother, it couldn't be, she had morphed back into one of the band. Distracted, I had been hit from behind. Duped again, I waited for the smart shirt to take its toll. The constriction was longer and painful, I didn't know if I would make it, breathing was laboured, my heart rate fell; this was pretty real. Eventually the constriction eased and Lazarus-like I was back in the CAVE. By now I was mentally exhausted, the demon within all but gone. I knew the next contest would be my last. I couldn't match the cognitive computer.

I didn't have to wait long. I was transported back to a virtual Villa of Ormen. I heard the faint murmur of chanting, just as I had heard the previous night. I could see the blind followers, convulsing in unison to the chants. I didn't want to join this strange band of thought-controlled brothers. I wanted knowledge but there is no free lunch.

I left the safety of the villa and ventured outside, prepared to take on whatever strange elements this planet could throw at me. This time I was not pitted against alien creatures but fast moving colliding geometric shapes; pentagrams, hexagrams and 12-pointed stars that whizzed by in 3D, like a scene from Star Wars. White stars with *Don't Ask* and *Say Yes* messages abounded, frequent indeed. I needed to navigate right, left, up or down to avoid them and survive. This was more difficult than a simple trigger. And there was no Major or band to be seen, they were gone, only a slumped spaceman remained, his fate already decided by then. And then it arrived, a Blackstar, try as I might I couldn't avoid it. I knew it was the end. My death waits here. Prolonged constriction followed by blackout.

"I'm sinking in the quicksand of my thought
And I ain't got the power anymore" [8]

I recovered to find the Major looking down on me in the (real) Villa. "We had high hopes for you, PJ. The data shows that you spotted targets in good time. But you hesitated, that's fatal. 'Big Lou' must have tricked you. You have been eliminated. You must leave the competition." I didn't want to go to the next round. This was already far too 'real' for me. I shuddered to think what the next round would entail.

I was now on the underground to Heathrow, going back to Belfast, knowledge demon banished. The final track was indeed over.

3.7 Conclusion

So where are we now? There are implications for science and implications for society. As BCI advances out of dedicated labs there is the opportunity to use it as a tool for self-quantification, to provide feedback for therapy, and to measure learning [14]. However with such a close coupling between brain and software then the technology can potentially impinge on the autonomy and the self-efficacy of the individual, possibly even moving towards brain-washing. Rapid visual stimulation has emerged as a viable BCI paradigm [15]. Magicians and mentalists (performers) are well aware of the power of 'suggestion'. And we know the detrimental effect that social media can have on young or easily influenced people. Stricter ethical procedures for controlling such research could become necessary [16]. The blurring of the interface between man and machine, and the possibility of harvesting knowledge to produce self-aware robots is a topic that is exercising the leaders in Computing Science. Stephen Hawking, Elon Musk, Steve Wozniak and others have warned that AI can potentially be more dangerous to humans than nuclear weapons. Hawking stated: "humans, limited by slow biological evolution, couldn't compete and would be superseded by AI" [17].

So was the Golden Dawn project the future of learning through interactive games or preparation for some dystopian version of future combat? Could a real brain (or cognitive computing) network be used for enhancing learning or for the enactment of 'Star Wars', in association with autonomous drones and humanoid robots (e.g. Atlas from Boston Dynamics). BCI can be used for human enhancement and conditions that inhibit learning can be addressed. This is the bright future of education. But there could be a darker side. Images are powerful, be they of bygone pop stars, Hollywood

blockbusters or propaganda preying on the accepting mind. Could BCI be used for learning or could it be used as a form of brain-washing. This is indeed a big gap. Mind the gap.

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