

FocusOn:

An Intervention to Reduce Stress, Improve Your Health and Advance Your Business

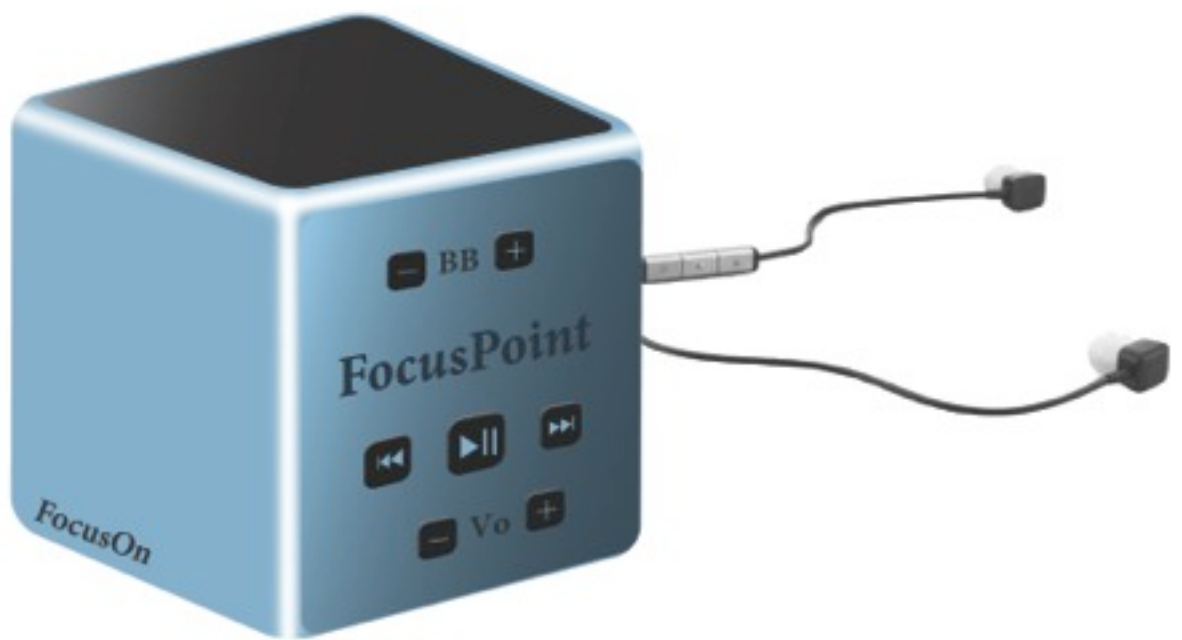
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Abstract:

This report analyzes the journey from meta-theme to concept of the design project FocusOn. The first chapter begins with an exploration of what stress is and the effect that it has on mental and physical health. It examines the transition between positive and negative stress and considers some plausible causes of this. In the second chapter, the design brief is then refined to specify that the most appropriate environment for intervention is an open-plan office. The merits of this choice are discussed showing that a solution in this space not only addresses the impact of increased productivity and decreased stress levels on an individual, but also the difference this can make on a larger scale, to the output of a business. In the following chapters an examination of current designs, leads to an exploration of novel designs that were under consideration. As the merits and faults of these designs are evaluated, other methods of solving similar issues, particularly through the concept of entrainment, are addressed. The benefits of using this method are evaluated, which leads to an analysis of various ways to introduce them to the chosen environment. The FocusOn system includes the FocusPoint device, a tool that uses the concept of brainwave entrainment through binaural beats to create a more individual, comfortable environment to increase employee productivity. This system is a valuable tool for both lower-level employees and senior managers of businesses, as it decreases negative symptoms and sparks a series of meliorations.

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Introduction:

The topic of stress was chosen as the theme for this design project due to its great, yet often overlooked, importance in modern life. Most people are conscious of stress and some of the impact that it has on their wellbeing, but generally, they are unaware of how extensively it affects their minds, bodies, and behavior. During the research into the most influential triggers of stress, it was discovered that work, particularly in impersonal, open plan offices, can cause major problems. A brief was constructed, research was conducted and initial ideas were generated. This led to current design solutions being examined and as many of these solutions have been successful in relation to their particular problems, a specific direction where intervention could have the greatest impact was established. As it became evident that stress prevention, rather than management, would be most influential, and that increasing productivity in more direct ways would be possible, the concept of brainwave entrainment was explored. The previously specified design brief was revisited with the newly acquired knowledge of entrainment and this led to the development of the FocusOn system, and specifically, the FocusPoint device.

Chapter 1: What is stress?

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“I promise you nothing is as chaotic as it seems. Nothing is worth your health. Nothing is worth poisoning yourself into stress, anxiety, and fear.”

– Steve Maraboli (Maraboli 2009)



There are many definitions of the word stress. In physics it is a measure of the amount of force applied to an area; as a verb it applies emphasis to a specific item or action; in the 15th century it began as an abbreviation for ‘distress’. All of these descriptions can be related to the medical state of stress; an individual person feeling the pressure of various forces, competing for emphasis, that can eventually cause distress. It is an evolutionary trait that has been developed as a vital tool for the continuation and progression of human life, however, if this state is persists, it can have detrimental effects on the mind and body (Brock University 2010, Health and Safety Executive, Livingstone Booth 1982). Historically, stress has not been considered a major problem in society, or even a topic for research, with the majority of books mentioning the topic having been published within the last 100 years, as shown in Figure 1 below (Google Books 2013). However, since the discovery of the stress syndrome by Hans Selye in the 1930’s, it has become a major factor in biomedical research (Arnetz & Ekman 2006). As modern life becomes more demanding, fast paced, and fueled by the overstimulation provided by a variety of technological advancements, stress levels are rising and the importance of research on the topic and design of interventions is becoming progressively more evident (Arnetz & Ekman 2006).



**Figure 1: Usage of the Word “Stress” in Published Works vs Time
(Google Books 2013)**

Stress is a biological response to potentially threatening stimuli, such as the sighting of a bear. This response consists of the hypothalamus, a small region

at the base of the brain, sending signals to the adrenal glands to release the hormones adrenaline and cortisol (Mayo Clinic 2010). Adrenaline increases heart rate, elevates blood pressure, triggers muscle stimulation and increases the amount of energy available for immediate use (Mayo Clinic 2010). Cortisol, which is the primary stress hormone, increases blood sugar levels, enhances the brain's ability to use these sugars, and increases the amount of bodily repair substances that are available (Mayo Clinic 2010). In order for the benefits of the high-stress state to be possible, cortisol also signals parts of the body that are nonessential for fighting or fleeing to cease functioning as normal (Mayo Clinic 2010). This occurs in order to conserve energy for the vital systems such as the brain and muscles of the limbs to function at a higher level and includes altering the normal responses of the immune system and suppression of the digestive and reproductive systems (Mayo Clinic 2010, Arnetz and Ekman 2006)). It also causes parts of the brain to make adjustments to mood, motivation, and fear (Arnetz and Ekman 2006, Livingston Booth 1982, WebMD 2012). This fight-or-flight response can be helpful, to motivate fighting or fleeing from the bear, or developing an alternative solution to avoid future threats, but if a person is kept in this high-alert state for too long, they become fatigued mentally and physically (Brock University 2010).

When is stress not such a bad thing?

Stress is a response that humans have developed in order to make them perform at their best when it is necessary. The type of stress that encourages productivity and motivation to face challenges is called eustress and it is a vital tool in the progression of society (Livingston Booth 1982). Eustress is also responsible for the feeling of accomplishment at completing a task (Brock University 2010). Without the threat of potentially negative consequences if the task were not completed, the satisfaction of completing it would also cease to exist. It also provides the motivation to care for others and keep oneself living happily and successfully (Brock University 2010). Selye identified stressors as the triggers that produce a stress reaction and if exposure to them is continuous, and therefore the body never gets a chance to return to an unstressed state, a negative stress state is created (Livingston Booth 1982, Priest & Welch 1998). A graph of this phenomenon can be viewed in Figure 2 and is referred to as the

human function curve or the stress-performance curve, as it indicates the relationship between productivity and prolonged stress.

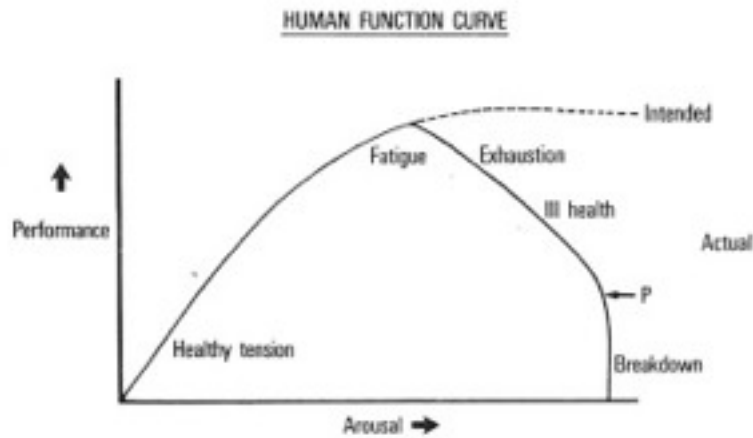


Figure 2: The Human Function Curve (Livingston Booth 1982 p.26)

Why is stress a problem?

Stress is a part of everyday life for most people. It helps them stay alert, know when something is wrong, and can motivate them to do their best work (Livingston Booth 1982, Mayo Clinic 2010). However, it can also have severe detrimental effects on a person's psychological, and physiological wellbeing (Arnetz & Ekman 2006, Mayo Clinic 2010). When a stress-inducing threat passes, the body is able to reset itself and regain normal hormone levels and system functions but when the stressors remain present, the body remains in its altered state (Case & Waterhouse 1994, Mayo Clinic 2010). This causes the body to become exhausted as it is working harder than it should for an extended period of time and normal bodily function in areas such as the brain, heart, and digestive system cannot be restored. 43% percent of adults suffer from extreme adverse effects due to stress (WebMD 2012). Although stress affects everyone differently, and is often caused by many different triggers, no one can persist in a state of stress without consequences.

Many adults will suffer from an emotional disorder at some point in their lives and these are often caused by untreated stress states (O'Hara 2007). These commonly begin with adverse psychological reactions to short term stress such as anxiety, lack of motivation or focus, memory impairment, irritability, and sadness, and these can often result in social withdrawal, substance abuse, and changes in eating habits (Arnetz & Ekman 2006, Livingston Booth 1982, WebMD 2011). If these temporary effects are left untreated, and the presence of stressors continues, they can cause lasting issues such as clinical depression, anxiety disorders, and chronic substance abuse (Arnetz & Ekman 2006, Livingston Booth 1982, WebMD 2011). If an individual is in a position of power, stress can also inhibit his or her ability to lead. It can cause a loss of confidence and self-assurance, and also a loss of confidence in subordinates and an inability to delegate tasks efficiently (Livingston Booth 1982). In daily life, these psychological issues are the dominant concern when one considers his or her own stress levels but there are also serious physical symptoms of persistent stress.

Due to the body continuing to produce stress hormones and remain in a state of heightened alert, there are many direct and indirect physical consequences. As a direct result of increased adrenaline levels, hypertension, raised heart rate, high blood pressure, cardiovascular disease, heart attacks, and other issues such as problematic sleeping can occur (Arnetz & Ekman 2006, Columbia Center for Psychiatry 2011, WebMD 2012). As a direct result of the change in blood sugar due to raised cortisol levels, diabetes can result (Arnetz and Ekman 2006, Mayo Clinic 2010). Many other physical ailments including headaches, muscle tension and/or pain, skin problems, digestive problems, asthma and arthritis can also be triggered by stress (Dimsdale 1984, Mayo Clinic 2010). Being in this state can also exacerbate preexisting conditions such as eczema, migraines, hair loss, and weight problems (Dimsdale 1984, Livingston Booth 1982). A depletion of the immune system leaves the individual vulnerable to viruses and infections, and has even been found to increase the likelihood of developing cancer (Priest & Welch 1998). These physical symptoms of chronic stress also cause more potential damage as they often lead to a vicious cycle of increasing stress levels (Figure 3) (Priest & Welch 1998). The symptoms are often difficult to treat without a decrease in exposure to stressors and as this

would cause great disruption to the individual's life, are therefore viewed as unsolvable problems to the sufferer (Arnetz & Ekman 2006)



Figure 3: The Impact of Stress Symptoms Creates a Vicious Cycle of Increasing Stress

Why does stress affect people differently?

Stress affects all people in different forms and intensities depending on various factors including personality, past experiences and medical history (Lindquist & Cooper 1999, Livingston Booth 1982). Correlations between individuals' personality traits and the specific physiological effects that they are most likely to experience have been observed. For example if a person is ambitious, stress is most likely to affect his or her heart, resulting in heart disease, hypertension, and heart attacks but a person who is more phlegmatic is more likely to develop obesity in response to high stress levels as their major response is likely to be overeating (Livingston Booth 1982). Often, an experience or event becomes a stressor unexpectedly such as the experience of this London worker: "For me it was a new boss. I found myself crying 'cause I couldn't keep up suddenly. Stress is where you can't cope, there's too much and you don't know what to focus on any more" (Health and Safety Executive). Also, a person's ability to deal with stress is often partly due to the quantity and intensity of stressors in various parts of their lives. If each part of their lives such as work, friends, and family are each mildly stressful, the mind and body will not often get a chance to recover and this will have an impact on the degree of unexpected stress that they are equipped to handle (Lindquist & Cooper 1999, Mayo Clinic 2010).

Why are stress interventions so important *now*?

At the general meeting of the British Society of Medical Psychology in 1900, stress was discussed as one of the major causes of a dramatic increase in mental disorder cases (Arnetz & Ekman 2006). One doctor pointed out that “If, then, it is a disease in which the danger lies in stress, we must see many people whose nervous systems will go to pieces unless they can be taken away from the stress in which they are living, whether that be on the stock exchange, or in any other professional occupation where the nineteenth century pressure is very great” (Arnetz & Ekman 2006). Soon after this statement was made, research was conducted and the link between overstrain and fatigue was established (Arnetz & Ekman 2006). Fatigue represents the limits of the individual’s physical and mental capabilities and previously had not been considered a medical issue in itself, but simply as a symptom of depressive mental conditions (Arnetz & Ekman 2006). In the past century the changes that were causing the increase in illnesses when this statement was made, have continued and accelerated, causing a greater threat to the health of the population (Arnetz & Ekman 2006, Priest & Welch 1998).

In the mid 1980’s it was discovered that an ailment was impacting the lives of many young professionals, in high-stress environments (Arnetz & Ekman 2006). This was named Chronic Fatigue Syndrome and often results in infection due to a stress-weakened immune system (Arnetz & Ekman 2006). Symptoms may include muscle and joint pain, feverishness, persistent headache, and memory, concentration and sleep problems; but the main concern is the fatigue itself (Arnetz & Ekman 2006). It often makes all forms of exertion, including work, or even conversation, seem impossible (Arnetz & Ekman 2006). These detrimental effects of stress on the workforce, particularly as it begins with those who have only recently entered it, will not assist our society in progressing towards a brighter future.

Another reason that office stress is such a vital issue to address now is the increasing necessity of sustainable design. Although many buildings are now being designed to incorporate “green” ideals, they only function at the most sustainable level if they are in use by as many people as possible. If an office is not a constructive workplace for its employees, they will seek workspace in other places, and the energy consumed by the office building, even if it is

minimal, will not be as efficient on a per capita basis (Myerson). Also, if the employees are working from home instead of being in the office this decreases the sustainability further as they will then be consuming additional energy in that location, for lighting, computer charging, internet, etc. With increasing stress levels and decreasing energy resources, it is incredibly important that interventions in the office environment are addressed as soon as possible.

Conclusion:

Stress plays an important role in keeping our society progressing. It encourages us to complete tasks to the best of our ability, avoid negative situations, and provide assistance to those around us. However, if one experiences overexposure to a stressful environment, it can have detrimental effects on the psychological and physiological wellbeing of the individual. The transition from eustress to a negative stress state can be sudden as one unexpected stressful event presents itself and the individual reaches his or her limit of coping. A stress state can be entered unconsciously and this threat becomes much larger if an environment contains unproductive stressors such as noise, insufficient or excessive lighting, or constant disruptions to focus such as one would find in an open-plan office.

Chapter 2: Does Your Office Make You Less Productive?

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“When you ask people where they get their best work done... you almost never hear people say the office. Business are spending all this money on this place called the office, yet people don't do work in the office. Why is that happening?”

-Jason Fried (TED 2010)



Introduction to stress in the workplace:

According to a recent survey, documented by the Wall Street Journal, job pressures are the second biggest cause of stress after financial worries (Schellenbarger 2012). Why is this? Many studies have attempted to find the answer to this troubling question, and these have resulted in many possible conclusions. These include workload and managerial issues, but also environmental stressors such as noise, light, disruptions and distractions (Australian Government: Comcare 2008, Crayon 1993). The effects that these high stress levels have on the output of a company are tremendous. Stress has been proven to lower productivity, and, since stress impacts health, it is estimated that “51% of sickness absence [in the United States] is in some way stress related” (Kompier 1999 p.1)

It is estimated that the cost of workplace stress to firms is about 10% of the GDP of the UK (O’hara 2007). This is not only due to the decreased productivity caused by sickness and absence, but also the increased costs for the company such as health insurance (particularly in the US) and treatment of stress-related problems (Kompier 1999). In the UK these issues are responsible for between 40 and 90 million lost working days per year with as much as 40% of all absences and 50% of long-term absences being stress-related (Priest and Welch 1998, O’Hara 2007, NHS 2013). Studies have shown that an increase in stress directly correlates to a decrease in personal productivity and that generation of quality work is primarily a result of lower stress levels rather than workload (Halkos & Bousinakis 2010, Imitate & Ahmad, Priest & Welch 1998). It can then be deduced that with lower stress levels, employees will produce higher quality work, in less time, even if their workloads increase. Due to the fact that stress causes low morale, and increased accidents, it can cause a company to have high personnel turnover, which decreases loyalty to the firm and creates an ever-changing environment (Priest & Welch 1998).

What causes stress in the workplace?

Sound affects humans physiologically, psychologically, cognitively, and behaviorally at all times, even when they are unaware of it (TED 2012). For example, in a retail setting, customers are much less likely to make purchases if they find the shop to be a stressful environment and therefore inappropriate and accidental sound in these locations causes sales to decrease by approximately

28% (TED 2009). This is also a major issue in an office environment, where noise related to open plan spaces causes productivity to decrease by approximately 66% (TED 2009). It can also make employees less willing to help others (TED 2012). It also hinders absorption of information as “studies indicate that noise may lead to a more superficial processing of text when reading and thus to impaired comprehension of the text” (Witterseh & Wyon 2004). This was shown in an experiment performed in 1979 that “investigated performance of a proofreading task in two different noise conditions, and showed that subjects read significantly fewer words in the loud noise than in the soft noise” (Witterseh & Wyon 2004).

The excess sound in this environment can be caused by a variety of factors including computers, air conditioning, printers and photocopiers, phones, voices and movement (Carayon 1993, TED 2009). This leads the listener’s hypothalamus to indicate that he or she is under threat and this triggers a stress response. Over time, this consistent “threat” is inaudible to the individual, but is still causing their body to react as if it is in danger. There is a similar reaction to both excessive and insufficient lighting (TED 2009, Witterseh & Wyon 2004).

In a 1980 survey it was found that 70% of office workers identified lighting as one of the major issues that affects their work (Kempier 1998). Insufficient lighting can lead to health issues such as eye-strain and musculoskeletal strain, particularly in the back, as a result of poor posture in order to reach a closer view of pertinent material under poor light (Priest & Welch 1998). It increases the chance of errors being made and often makes people work slower. The issue of insufficient lighting is often solved by the introduction of overhead fluorescent lights. These are also dangerous to health as the flickering associated with this type of lighting triggers a stress response. This reaction is caused by the eyes and brain interpreting the flickering as movement from an unknown source, and considering it a threat (Knez & Enmarker 1998, Wynn Jones 2002). Also, the brightness of fluorescent lights combined with their signature “humming” can also contribute to headaches, depression, sleep disorders, and carbohydrate cravings (Wynn-Jones 2002).

The phenomenon of excess lighting, known as over-illumination, also has an effect on the body’s circadian rhythms which control the timeline of sleep, as it promotes the body to continue processing as if it is daytime for much longer than is appropriate. This causes the individual to enter a state similar to jet lag

and can have drastic effects if normal rhythms are not reestablished (National Institute of General Medical Sciences 2013). These rhythms consist of physical, mental and behavioral changes that include sleep-wake cycles, hormone release, body temperature alterations, and more (National Institute of General Medical Sciences 2013). If circadian rhythms become unbalanced, then sleep becomes disrupted, and without proper rest, the body cannot renew itself and therefore stress symptoms become exaggerated (Occupational Safety and Health Council 2013). Unhealthy changes to these rhythms can also lead to obesity, diabetes, depression, and other mental health issues (National Institute of General Medical Sciences 2013, Occupational Safety and Health Council 2013).

Lighting and sound in an office space are often disregarded as stressors as they do not directly interfere with the productivity of a worker, however, overexposure to these stimuli can have many adverse effects on the human body. The environmental influences of noise and lighting cause the individual to feel threatened through evolutionary instincts, but a stress-state can also be triggered by the disruptions caused by interactions with coworkers and technological communication devices such as smartphones and computers.

Thought-based work, such as that performed by designers, engineers, and writers is a phase-based process (TED 2010). This means that as a person focuses on a task, it is necessary that they are able to ascend between phases in order to develop a greater understanding of the problem they are trying to address. If this focus is interrupted, the employee cannot return to the last task that they were involved in, they must take some time to reassess the information and reestablish their thought process. This is very unproductive and can lead to wasted time and increasing levels of stress. Some major distractions include communication devices such as phones, and computers. In a study of 36 individuals, holding various positions in various fields, including engineers, financial analysts, and project managers, it was found that the average amount of time that a person spends using a device before switching to another one is just over two minutes (Robinson & Mark 2006). Although these are often viewed as the biggest causes of distraction, they have the benefit of being voluntary disruptions. These activities can be initiated by the individual at a time that is convenient for them. Other interruptions, such as those from coworkers, are more disruptive as they can occur during a period when that individual requires focus. Due to the impact of these various interruptions, several experts in the

field have noted that a day at work is no longer a “work-day” but a series of “work-moments” and the length of these moments is out of the control of the workers individually (Robinson & Mark 2006, TED 2010). In the same study of 36 individuals it was found that, on average, a person spends just over ten minutes at a time focusing on a single project (Robinson & Mark 2006). This is an incredibly inefficient way of working and does not allow people to ascend the phases of focus.

What current solutions are there for managing stress in the workplace?

It is valid to assume that in response to the detrimental effects that office-based stress has on a company’s output, the economy in general, and not to mention the health of individuals, there must be extensive research into how to reduce the cause of these problems. However, most research examines stress as an issue affecting individuals, rather than a symptom due to an environmental influence (Kompier 1999). This is partly due to the fact that psychology inherently studies individuals in a subjective manner, but it is also hindered by the fact that it is difficult for researchers to conduct experiments when they are often considered “a nuisance” to the productivity of the office (Kompier 1999). The outcome of research into the problem being performed in this way is that the solutions are addressed in the same, individualistic, subjective manner, if they are addressed at all.

Stress management activities generally focus on secondary (helping those who are already showing signs of chronic stress by becoming ill) and tertiary (treatment activities, such as counseling, for those who already have serious stress-related problems) prevention of stress-related symptoms (Kompier 1999). There are several reasons why primary prevention has not been seriously addressed as a vital asset to a company and these include that senior managers often blame their employees’ stress levels on their personal lives and that the environment of an office changes constantly, making it difficult to produce hard scientific research on the subject (Kompier 1999). Another obstacle of both research on, and treatment of stress-related issues is the taboo surrounding the concept of mental health issues, regardless of their intensity.

Stress management in the office is a difficult issue to address due to the controversial nature of addressing mental health. Although most people will have to deal with periods of excessive stress periodically, and several mild to

moderate mental health issues can stem from this, treatment for these conditions is often stigmatized in the UK. In 1995 The Psychiatric Bulletin reported that ignorance and stigmatism surrounding these issues had resulted in 28% of employers stating that would only occasionally, or never, employ individuals who were open about suffering stress (Priest & Welch 1998). For the subsequent mental issues these numbers get worse as a 2007 research report published by the Guardian states that 38% of employers would not employ someone with a history of mental illness (O'Hara 2007). Of the 20% of companies that reported having a formal stress-management program, only 14% felt that it was effective (O'Hara 2007). This research made it evident that a novel stress-prevention solution would need to be subtle, and fit easily into current workplace trends and routines in order to be adopted easily, and without stigmatization.

Within an open plan office environment, many accidental stimuli trigger the body into feeling threatened and therefore entering a stress state. Inappropriate noise and light levels cause cortisol and adrenaline levels to rise, inducing a heightened stress state. Consistent disruptions of work result in lower productivity levels and therefore less happy and satisfied employees. It is also a major issue that often, raised stress levels in office workers are only addressed after they have already become health issues, and are only treated on an individual basis. The disapproval surrounding these issues also makes it difficult for employees to seek help as it could affect their future employment. In order to truly influence the levels of stress produced due to the environment of an open plan office, the individual experience should be considered within the context of the office design.

Chapter 3: How can the office be improved?

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It is amazing what you can get used to. Your place of work may be disorganized, poorly lit and lack ventilation, and the longer you ignore these factors the more your stress levels will rise. Whether you work at home, in an office or factory, stress can bring a variety of problems.

-Janette Peel (Peel 2009)



(Willimott)

As more companies such as Google, Facebook and Yahoo, begin to discourage or ban office alternatives such as working from home and telecommuting, there is a greater necessity for making the provided office environment as inspiring and motivating as possible (Cain Miller & Rampell 2013). Some of the major issues involved with working in a, now standard, open plan office include sound, light, and disruptions. There are several solutions available to assist in reducing the effect each of these issues, individually, have on employees. These solutions aim to dissuade individuals from making the transition from healthy eustress to demotivating stress.

How can sound levels be improved?

Current solutions to the problem of excess noise in the workplace include masking the noise, using certain materials to absorb it, and use of new designs to remove its audibility. Pink noise is a signal that contains frequencies similar to that of human speech and is considered to produce an equivalent background noise to that developed by neurons within the brain (Lewise & Lemieux 2003). “Masking has generally been found to be an unsatisfactory way of dealing with unwanted noise” (Australian Government: Comcare 2008) but is commonly used as the primary solution to this problem.

The best way to minimize excessive noise is to isolate the sources such as photocopiers and printers preferably while incorporating use of sound-absorbing materials such as melamine foam (Humphrey & Farmer 1989, All Noise Control). Also, separating conversation dependent tasks from areas where individual work must take place is important. Designating separate work areas for meetings or independent concentration, which Li Edelkoort calls ‘annexes,’ is a growing workplace trend that could be invaluable to the productivity of a firm (The Way We Work Today 2012). However, this solution is only compatible with companies that have the space, resources, and willingness to isolate certain tools and activities. Without using a sound masking technique through an entire office, it is possible to deflect an employee’s ears away from stressful noise.

Headphones, particularly those with noise canceling capabilities, and physically noise isolating earphones, have become as normal to see in use in an office as a stapler or a computer. Sales of these devices rose an estimated 41% between 2008 and 2012, with many of them ending up in open plan offices (Shellenbarger 2012). Their popularity has grown rapidly because they are fairly

easy to incorporate into one's working routine, and can also be viewed as a good investment by the consumer as they can also be used for various activities outside the office such as commuting, exercising, and traveling by airplane. Headphone use within the office has become a controversial topic with many researchers and workers arguing that they decrease collaboration, conversation, and apparent approachability of the user (Kreamer 2012). Alan Henry, a writer for Lifehacker.com, swears by headphone use as the only way to allow him to focus in such a distracting environment (Shellenbarger 2012). In order to communicate his availability with colleagues, he has a system of responses to being approached. If he does not have time to be disrupted, he will only remove his headphones from one ear, if he does have time, then he will remove them from both ears (Shellenbarger 2012). This system provides a subtle indication of Henry's availability for discussion without either party feeling discourteous. A possible alternative to individual, isolating noise cancelation is the use of a similar concept on a larger scale.

SoundAcoustic's Sonic Cube records the sound in its vicinity in real time, and then through a series of algorithms, generates and plays back an "harmonic output" that replaces the noise with more soothing sounds (Future Acoustic, Pavlos). In contrast to generic pink noise masking, this output reacts to the specific sounds of its environment, making it much more effective. This uses similar technology to noise canceling headphones, but instead of playing the opposite frequencies to the noise, it plays complementary frequencies that are controlled by the user (Pavlos). This means that the stressful noise is less noticeable and users are more in control of their environment. This is valuable because it has been shown that being in control of one's aural environment may even make individuals work harder (Workplace Woes 2012).

How are disruptions kept to a minimum?

Disruption to an individual during periods of work requiring focus is one of the biggest issues blocking productivity in an office environment. This includes conversations with coworkers, and electronic communication alerts such as those from computers and smartphones. Solutions to these problems include cubicles, individual use of headphones and working from home. The use of cubicles began in 1964, when they were designed as part of a set of modular office furniture (Musser 2009). They had been designed as part of a system that

would provide a variety to office spaces. However, corporations only took advantage of the space-saving options rather than those intended to improve comfort (Musser 2009). Due to the impersonal, isolating nature of these designs, current workplace trends are now moving away from cubicle use, as it is believed to inhibit collaboration (Kesling & Hagerty 2013). This means that larger groups of people are now working in close proximity without any physical division between them. This includes groups of employees who must be able to converse with each other, and individuals in need of quiet in order to focus on a particular piece of work. This has therefore increased the rationale for use of headphones within the workplace.

Headphones are very valuable assets to an individual in a large, loud, open plan office. They provide them with a controllable sound environment and protect their ears from the excessive noise around them. However, their use is not currently an ideal solution as the functionality is also dependent on what sounds the headphones are providing, and the quality of the headphones. If the headphones are of low quality, they do not remove any of the external noise, they simply add more, often louder, sounds to distract from background noise. This does not cause a decrease in the body's stress response to noise, but rather causes an increase, as the other noises have not been eliminated, they have simply been overshadowed by a more imminent "threat."

What novel designs could be introduced to improve to office environment?

During this investigation of stress and productivity in office environments, in order to progress towards a discovery of the most appropriate point for invention, a brief was constructed. The design solution would improve productivity and satisfaction, thus reducing negative stress, through a technological device that would increase the sustainability of the office by encouraging its occupancy. This would have to fit in with current office work techniques in order to enable use and would encourage more amicable feelings towards work, particularly within the office. Some novel designs include a combination, business and personal phone, electrochromic glass cubicles, and computer application based tools for enhancing focus.

Through interviewing individuals it was found that major disruption to a worker who is trying to focus is interruptions from both business and personal phones. Being constantly aware of the whereabouts and alerts from these

devices inhibits focus and decreases productivity. The design solves this issue by providing a docking station for both devices and combining their alerts in one convenient location (Figure 4). It contains settings for placing either or both devices on silent, and forwards all calls to one handset through Bluetooth technology. This gives the user control over which device they want to be alerted by and when, such as personal calls during a lunch break and business calls afterwards. It also provides the ability to leave the user undisturbed when focus is required.



Figure 4: A Combination Business and Person Phone Docking Station

Another novel concept for this application is the use of electrochromic material as cubicle walls. These materials are transparent in a ground state, but when a current passes through them, they become translucent or opaque. If one of these materials, in glass or plastic form, was used as the walls of a cubicle, they could provide adjustable amounts of privacy for the user. If an individual is open to collaboration, the walls may remain transparent, but if the user requires a period of time to focus with minimal distractions, the walls may become opaque. Another way to achieve this effect would be to use a semi-transparent material that appears opaque when in direct light as tabletop spotlights could provide the adjustable opacity (Figure 5). Also, in this design, sound could be addressed

through the shape of the cubicle walls, if the walls are essentially one body, curved towards the user, this will minimize the amount of external noise that can reach them. This design could potentially cause issues of reflected noise when the user, for example, takes a phone call, however, this issue could possibly be addressed through specific placement of sound absorbing materials.



Figure 5: A Desk “Cubicle” with Adjustable Opacity

As this idea development continued, parallels were drawn with different environments and activities, for example, athletes training to perform sprints. Even though these events are brief, athletes, such as runners, often view this short burst of exertion as being broken down into segments. Tom Green, US Olympic athlete and trainer, defines these segments of the 100m dash as: the start (15m), acceleration phase (5m), transition phase (20m), maximum velocity 1 (20m), maximum velocity 2 (20m), and speed maintenance (20m) (Green 2003). This can be used as a metaphor for the mental phases that an individual experiences when focusing on a piece of work: a sprint of focus. If this individual is interrupted during this cycle they may never reach their second level of maximum velocity or productivity.

In order to achieve the concept of a sprint of focus, it is important to decrease individually approached distractions. This could be accomplished

through the use of a computer program, which would lock the user out of certain computer functions. The user could set the amount of time to be dedicated to focusing, and what functions they would like deactivated. For example, these could include the ability to visit certain websites, check email, and open games. The user would then be locked out of these activities until the allotted time passes or a conscious decision is made to choose to deactivate the lockout by stating that the task is complete (Figure 6).

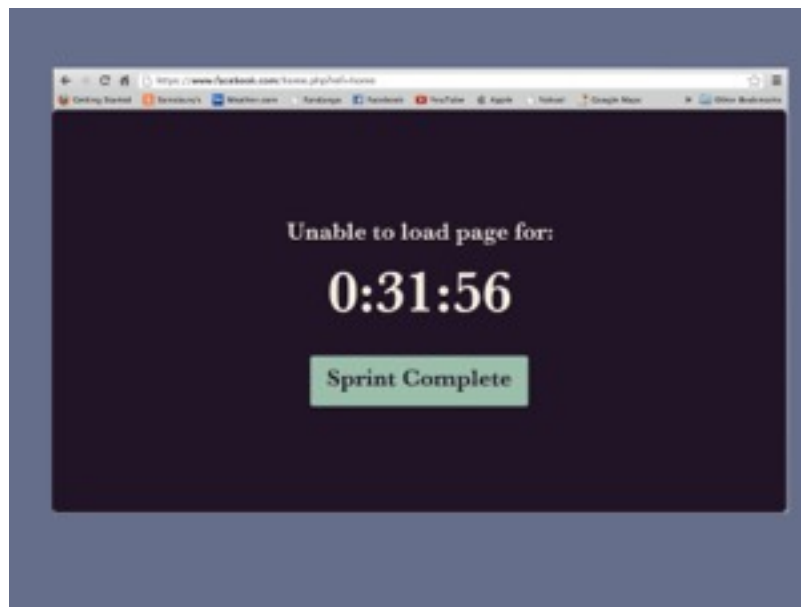


Figure 6: “Sprint of Focus” Computer Lockout

There are many stress-inducing issues with the current design of many open-plan offices. This environment is conducive to raised cortisol and adrenaline levels leading to many health problems for individuals and losses for companies. Current solutions to these issues address them individually rather than as one larger subject, and can even sometimes make the problems worse. Some novel concepts could also work well in solving individual issues but research into experimentally proven systems to increase performance and focus and decrease stress is needed in order to complete the design brief to a higher level. This was the reason for progressing this investigation towards using a new form of intervention, from the evolving field of entrainment.

Chapter 4: Entrainment

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“My life didn’t please me, so I created my life” - Coco Chanel
(Goodreads)



(Brainwave Entrainment 2012)

What is entrainment?

Entrainment is the process of causing a rhythmically oscillating body to synchronize with another and often refers to the process of encouraging brainwaves to synchronize with an outside force (Evans 2007, Merriam-Webster 2013). The most common forms of brainwave entrainment are audio, visual, and a combination of the two. In the words of David Vernon, “when an auditory and/or visual stimulus is presented to an individual, this incoming sensory information is relayed to the various regions of the brain via the thalamus (2009). Entrainment occurs when the electro-cortical activity of the brain mirrors the frequency of the incoming stimuli” (Vernon 2009). This means that with the use of specific stimuli, the brain can be coordinated towards a specific higher level of focus, and/or away from a level of stress. This can be a very powerful tool for increasing productivity and health.

Audio entrainment:

Creating brainwave entrainment through audio stimuli is a popular technique that is often used for assistance with learning disabilities. It has been successful in treatment of various problems including Dyslexia, Attention Deficiency Disorder and Attention Deficit/Hyperactive Disorder, but has also been proven to have beneficial effects on people without these problems (Mind Alive Inc., Evans 2007). The use of specific entrainment audio stimuli is considered to increase performance in memory, creativity and attention spans, as well as cause improvements in overall mood (Vernon 2009, Kennerly 2004, Lane & Kasian 1998). Other entrainment techniques are also used to encourage relaxation and sleep.

The sound-wave frequencies that are accepted as entrainment inducing frequencies, known as cortical rhythms, are between 10Hz and 20Hz (Vernon 2009). These frequencies are below the level that is audible to humans and thus audio entrainment is achieved through the use of “binaural beats.” These beats are produced when different single tones are played in each ear. The difference between these “carrier frequencies” creates a “phantom beat” that the brain creates in response to alternate stimuli in each ear (Vernon 2009, Padmanabhan & Hildreth 2005). These phantom beats cause brainwaves to synch and entrainment to occur. This has been proven through studies in which a subject’s brainwaves are measured using an electroencephalograph (EEG) and the

response evoked by these binaural beats on the electrocortical activity of the subject becomes evident (Kennerly 2004).

There are different frequencies of binaural beats that have different effects on the brain and therefore to create certain ideal responses, the correct stimulus must be used. For the purpose of increasing memory performance, creativity, attention and mood, beta frequency binaural beats should be used (Lane &Kasian 1998, Vernon 2009). An experiment performed by Richard

“Binaural beat audio is the independent presentation of two discrete tones to each ear. Each pure tone is of a different frequency but the subject hears only one tone, an amplitude-modulated third tone created by the brain’s synthesis of the two independently presented tones.”

-Richard Kennerly, University of North Texas

Kennerly with a group of students demonstrates the enhancement effect this stimulus has on memory (2004).

In this experiment, one

group of students listening to music with underlying beta binaural beats, and the other group listened to the same music without the added frequencies (Kennerly 2004, Vernon 2009). After 15 minutes of listening to these stimuli, the group listening to the music with the added entrainment performed significantly better on three quarters of the memory tasks performed (See Figure 7) (Vernon 2009).

Beta binaural beats have also been proven to increase creativity such as in an experiment performed by Chok C. Hiew PhD (Vernon 2009). This experiment was performed to prove the validity of the commercial product Hemi-Sync and consisted of testing the performance of individuals when subjected to different audio stimuli (Vernon 2009). After listening to either binaural beats or relaxation instructions and ocean sounds, the groups were then asked to make a list of various unconventional uses for a brick (Vernon 2009). The group that had been listening to the entrainment frequencies generally produced a much more varied list exhibiting a “greater level of creative flexibility” (Vernon 2009). Both memory and creativity improvement can be linked to an increase in attention.

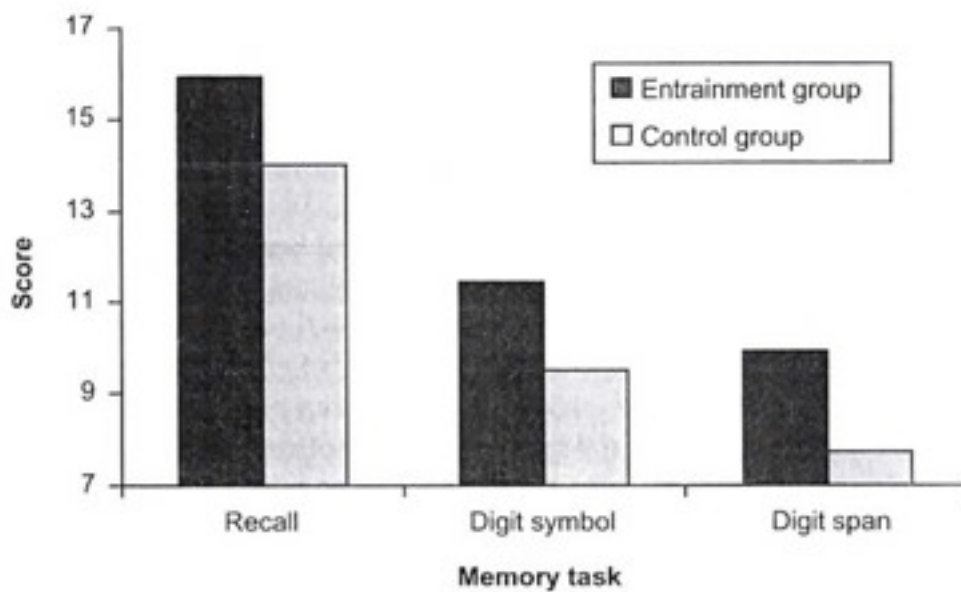


Figure 7: Results of Kennerly's Experiment Testing Beta Binaural Beats' impact on Memory (Vernon 2009)

In another study performed at the Department of Psychiatry at Duke University, the effect of various frequencies of binaural beats on the attention spans of a group of participants was tested (Lane & Kasian 1998, Vernon 2009). This experiment consisted of the participants performing an attention task, whilst listening to tapes that played pink noise, the same tones used for masking noise in offices. Some of these tapes contained beta, theta, or delta binaural beats and the participants were told that these sounds were only used to help them block out external noise. Participants performed a 30-minute visual vigilance test, and also completed a questionnaire in order to determine any changes in mood (Lane & Kasian 1998). During this experiment, even though the participants were unaware of entrainment stimuli that they were listening to, they proved to have greater focus whilst listening to beta frequency binaural beats, but less focus and more confusion and fatigue whilst listening to delta and theta frequencies (Vernon 2009). Also, those who had been listening to the beta-frequency beats reported a less negative mood (Lane & Kasian 1998). This study demonstrates that this kind of entrainment can be used not only for assistance in

improving focus and productivity but also, in decreasing the likelihood of eustress needlessly transitioning into distress.

Visual entrainment:

Visual entrainment consists of a subject observing flickering light, usually with eyes closed (Vernon 2009). This type of stimulus has been quite successful in producing an entrainment response, however, there are some risks involved. This particular form of brainwave entrainment engages the user entirely as it requires them to cease all other activities. The stimulus of a flashing light has been proven to induce seizures in those with epilepsy and in one known case, this kind of entrainment has also produced a seizure in an individual with no history of epilepsy and who has not experienced another seizure since this experience (Vernon 2009).

Audio-visual entrainment:

A combination of audio and visual entrainment is most commonly used for treatment of various disabilities including autism, but some tests have shown it to be less effective than either treatment individually (AutismToday.com, Vernon 2009). This can most likely be attributed to the fact that the audio and visual stimuli would be competing to entrain the brainwaves and thus would decrease the ability of either to be primarily successful. Even though this competition occurs, those influenced by the combined entrainment stimuli still performed better than those who had not (Vernon 2009).

How is brainwave entrainment currently used?

Audio entrainment is currently used in the treatment of various learning disabilities. It is also available in various forms to encourage relaxation and enhance memory. A company called Mind Alive has been producing audio-visual entrainment devices such as the DAVID Delight Pro, which apply audio-entrainment stimuli through headphones, as well as visual-entrainment stimuli through a pair of glasses containing LEDs in the lenses (see Figure 8) (Mind Alive Inc., AutismToday.com). These devices have been marketed as treatment for many issues including ADD, Chronic Fatigue Syndrome, and Seasonal Affective Disorder (Evans 2007, Mind Alive Inc.). As mentioned earlier, the combination of audio and visual entrainment has been shown to be less

successful than a singular stimulus, but a combination can be valuable when treating one of these conditions, as they require the user to be entirely removed from their daily concerns, and distractions. Binaural Beats are marketed for use as study aids, during meditation and to improve general cognitive function (Bapna, Brain Evolution System, MindAlive Inc.).



Figure 8: MindAlive's DAVID Delight Pro Audio-Visual Entrainment Device.

Brainwave entrainment has been shown to assist in increasing human performance in memory, creativity, and attention. It can be performed using various stimuli, most often audio, visual, or a combination of the two and has been shown experimentally to have successful results. Particularly in audio entrainment these results have been exhibited even when the subject is not aware of the impact the stimulus should have on them and as undertones of other music. Listening to the entrainment frequencies in binaural beats has been proven to increase the performance of many aspects of productivity that would greatly benefit many office-based companies, but has not yet been adopted generally as a solution to workplace overstimulation and stress.

Chapter 5: FocusOn

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“Stress might be one of the most fruitful areas in which to apply innovative new thinking and paradigms in order to not only improve mechanistic understanding, but to enhance our ability to implement new knowledge into society and improve overall public health.”
-Arnetz and Ekman 2006



The FocusOn system combines several features in order to provide the user with the greatest level of focus, productivity, and stress prevention. It consists of an audio device, FocusPoint, and complementary software, which incorporate entrainment, and conditioning in order to create a controllable environment for the user to work in. It also assists in communication between coworkers, and helps limit disruptions to more convenient times. It fits into current working routines, but improves the user's experience greatly. This will be a valuable asset to employers as increased productivity will increase output and decreases in physical stress levels will decrease costs associated with this problem.

How does FocusOn work?

The FocusOn system consists of an integrated combination of concepts that increase job performance by lowering the impact of unnecessary stress, and increasing focus and productivity. The primary object in this system is the FocusPoint device. This is an audio device, provided with a pair of noise-isolating earphones, which can be updated on a user's computer. It uses entraining beta binaural beats to assist the user in achieving these goals, as audio entrainment has been proven to increase memory, creativity, and attention. These beats will be combined, at a level controlled by the user, with music that he or she would normally listen to whilst working. This combination is used to encourage incorporation into normal routine and would allow users to constantly update their FocusPoint with their current musical choices. Also, as this device would be provided by their employer, users would be less likely to feel guilty, or antisocial, for use of headphones in their workplace, when required. The ability for users to include their own music was initially designed for the purpose of encouraging adoption, however, during testing of the concept an interesting discovery was made.

If the binaural beats are combined with music that the user traditionally works to, the performance is actually better than with music or entrainment alone. This could be due in part to the psychological theory of classical conditioning. This theory states that if a particular stimulus is consistently present in conjunction with an activity or event, then the stimulus will automatically put a subject in the state of mind associated with that activity or event. This theory was discovered and initially tested by Ivan Pavlov during an

experiment that he performed on a group of dogs. He would hit a tuning fork just before every feeding. After the dogs had been trained to associate this sound with food, simply ringing the bell would instigate the dogs salivating in anticipation of being fed. This theory can be applied to the findings of this project testing due to the fact that a subject who is used to listening to a specific song or type of music, is likely to be inclined to enter a focused, work-oriented state of mind when in the presence of this stimulus. This discovery increases the benefits of this device and the aesthetics have also been designed to promote stress prevention and provide additional user features.

The exterior of the small desktop device would be made from a matte-finish injection-molded plastic to provide a pleasing visual and tactile experience. It also has rounded corners to increase this effect, make it more desirable to carry in a pocket, and reduce the possibility of damage. It would be available in light shades of blue, green, and violet as these hues are generally accepted as having calming and stress-reducing effects (Color Affects). The exterior of the device would also provide a subtle indication to surrounding colleagues, of whether the user has time to be disturbed.

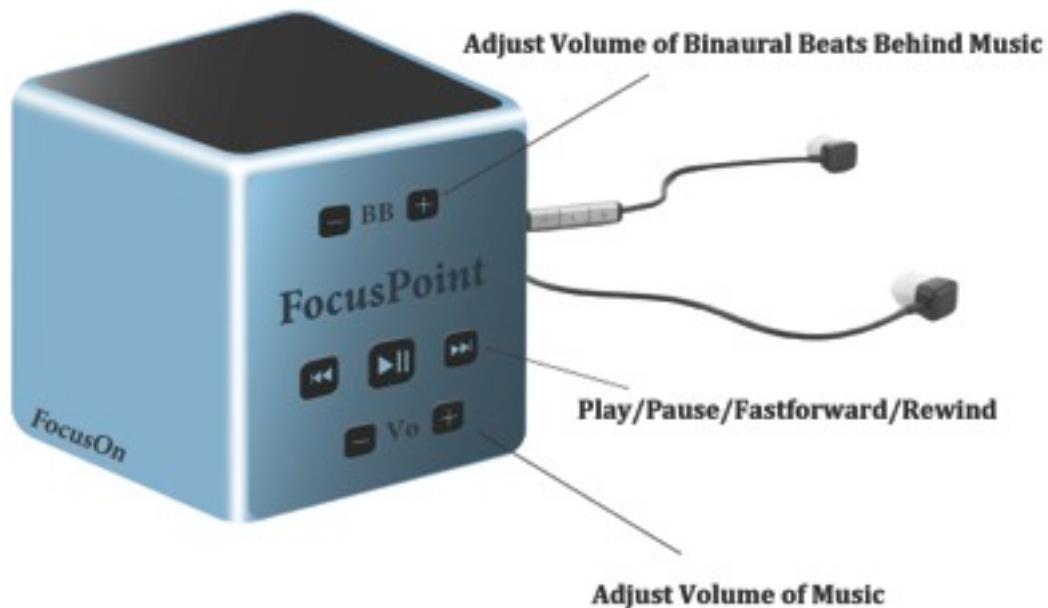


Figure 9: FocusPoint with black “do not disturb” indicator facing up

As the device is shaped as a cube, it is stable on all sides, apart from where the audio controls and headphone port are located. Inspired by Alan Henry's aforementioned subtle indication to colleagues of whether he is available, a simple color-coded system is incorporated to allow the user to nonverbally communicate with those around them. If they are focusing on a particular task and do not wish to be disturbed, this would be shown by placing the device on a desk or table with the black surface facing up (see Figure 9). If any of the remaining colored sides is facing up, the user is not in a particular mode of focus and may be approached for conversation.

Other aspects of the FocusOn system include a computer application that would allow employees to track their usage of the FocusPoint. This would allow them to monitor the correlation between their use of the device and their productivity levels. This would also allow the user to activate different specific frequencies of beta binaural beats at different times and learn which frequencies work best for them. The computer software would also enable the user to pick which binaural beats will play behind which uploaded songs (see Figure 10). Use of these features would be optional and thus would not demand extra work from the employees, however, they would increase the value of the FocusPoint if they were specifically activated by an individual.

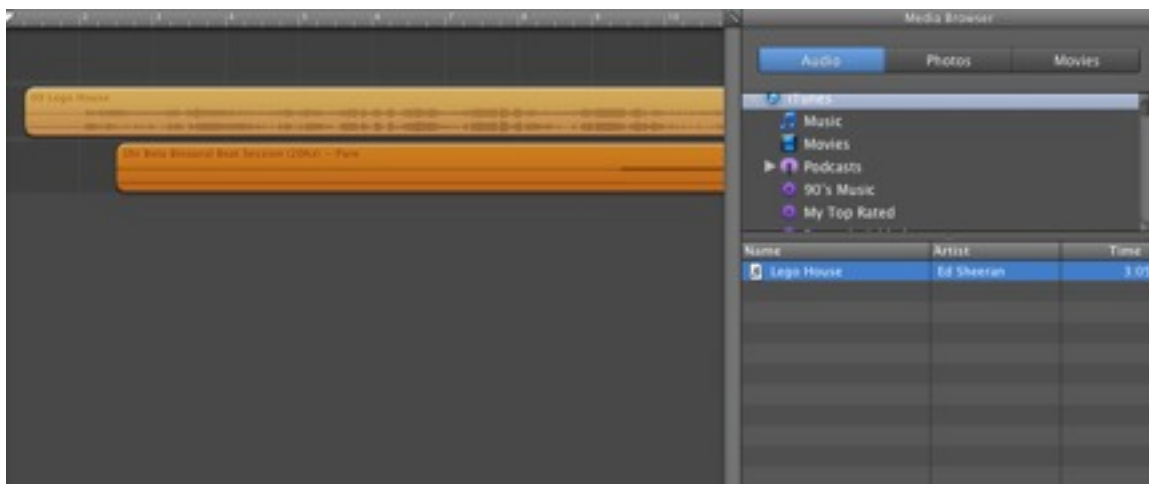


Figure 10: Computer software would allow the user to combine binaural beats with their own music more manually in order to encourage exploration of different frequencies

How will use of this system improve working in an office?

One of the major benefits of this system is that it puts the users in control of their own individual environments without disrupting the current office space or their colleagues. Being able to control one's own environment is vital to decreasing stress as an atmosphere that a user feels is uncomfortable and uncontrollable, becomes a much more influential stressor. With use of this device, collaboration and group work is able to thrive in the same space as individual focus, without either party feeling neglected. It provides a way for employees to produce more work of higher quality, while also keeping them healthier. This system is beneficial to a company as it would reduce environmental and workload stress and therefore treatment of the ensuing issues, and would increase productivity. This would result in higher output and thus profit, and lower stress-related costs.

How will this system be purchased?

Their managers would provide this system to the employees of a company, as this would encourage use by not requiring an initial investment from the user, and being inherently accepted for workplace use. Companies would purchase this system for their employees due to the increase in productivity and decrease in stress-related losses that it would provide. It would also improve relationships between colleagues, as it would lower the instances of inappropriate interruption. Improved relationships, decreased stress levels, and a more controllable environment will provide employees with a more desirable working space and encourage loyalty. This will decrease personnel turnover, and the associated costs of training new employees.

How would FocusOn progress in the future?

In the future this system could expand to include more thorough stress tracking. As many fitness tracking devices such as Fitbit, Nike +, and Up increase in capability and popularity, they will soon be used more widely to track stress levels. A collaboration between one of these devices and the FocusPoint, would allow users to visualize the impact of the FocusOn system, as well as understand more about their own habits. Another addition to this system would be the introduction of the complementary SleePoint device. This would be similar to the

focus point in that it would overlay binaural beats with other tones. In this case, the other sounds would most likely be calming sounds such as ocean waves, and rainforest sounds such as those available in current “white noise” sleeping devices (The White Noise Machine Company 2010). This device could not be developed currently without requiring the consumer to use headphones and thus would be mainly applicable for public sleeping environments such as trains and airplanes. As advancements are made in the field of projected sound, binaural beats will be able to be played more accurately through the use of speakers than they would be today and this would be more appropriate for use in a home bedroom setting (Emery 2010). This device would use theta and delta frequency binaural beats as these have been shown to encourage sleep and reduce mild anxiety (Lane & Kasian 1998, Padmanabhan & Hildreth 2005). They have been used to treat insomnia and, similarly to the FocusPoint, overlaying them with other sounds would not decrease their effects, but would promote use by creating a more desirable listening experience for the consumer (Padmanabhan & Hildreth 2005).

The FocusOn system has been designed to decrease the impact of unnecessary chronic stress. The mental, physiological, and behavioral symptoms that result from this condition also impact the output of companies and can even cause them direct expense. FocusPoint is a device that will assist users in performing at their best, more consistently, and will lower the influence of stressors including those from unnecessary noise and disruption. Providing employees with their own personal, controllable environments, through the use of this system will be an invaluable asset to companies as it will decrease their stress-related expenditure and increase their productivity and output.

Conclusion:

The analysis of stress and focus in the workplace provides the foundation on which the FocusOn system was constructed. Inspired by the drastic impact that stress can have, both physically and mentally on an individual, an investigation into areas for intervention was launched. It then became evident that the workplace, specifically an open-plan office, would be the ideal location for a design intervention as stress initiated here has a dramatic effect on many parts of society. It injures not only individuals but also, the companies themselves, as there are many costs associated with having stressed employees. The FocusOn system has been designed to decreased the instances and impact of workplace stress in order to improve individual lives, and our society.

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