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(54) **Title**: A BIOFEEDBACK, STRESS MANAGEMENT AND COGNITIVE ENHANCEMENT SYSTEM

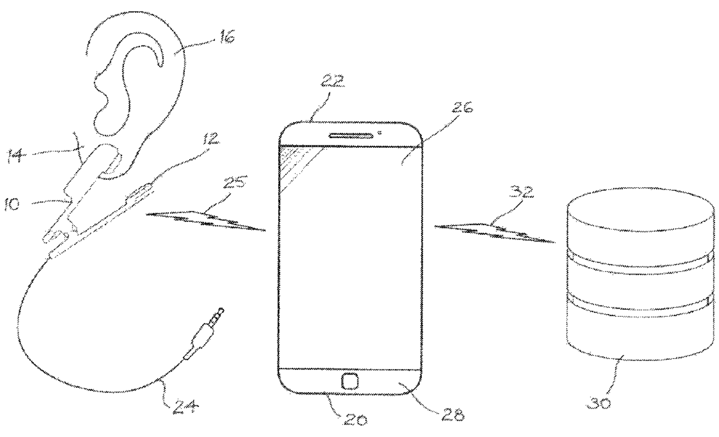

Fig.1

(57) **Abstract**: A method and a system is provided for enabling a person to continuously self-monitor their stress levels so that, when they monitor an unacceptable stress level, they can provide biofeedback to control that stress level. The system includes a sensor (12) attached to the person which detects or otherwise measures stress levels. The sensor (12) is configured to be attached to the person for a continuous period over which their stress levels are to be self-monitored, and to continuously transmit a signal indicative of the stress level at that time during the period. The system also includes a mobile computing device (20) which includes executable software and receives the continuously transmitted signal from the sensor (12). Electronic means are included for causing the visual display of the stress levels to the person during the period. The visual display (26) displays to the person the monitored stress levels to enable the person to provide biofeedback to control or manage any stress levels which are unacceptable.

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A BIOFEEDBACK, STRESS MANAGEMENT AND COGNITIVE ENHANCEMENT SYSTEM

Technical Field

This invention concerns a type of biofeedback system applied to human stress management, and cognitive performance measurement and enhancement. Aspects of the invention include a biofeedback device, a mobile computing device, biofeedback and game software, a server computer and a method for implementing the system.

Background Art

Biofeedback devices have been used for some time to provide an external means of measuring and visualizing internal biological and physiological processes within the human body, such as brainwaves, heart function, breathing, muscle activity, skin moisture and skin temperature. These devices rapidly and accurately feed back such information to the subject. The presentation of this information — often in conjunction with conscious changes in thinking, emotions, and behaviour — supports desired physiological and psychological changes. Over time, these changes can endure without continued use of such an instrument.

Biofeedback is a process that enables an individual to learn how to deliberately change physiological activity for the purposes of monitoring and improving personal physical and psychological health and/or cognitive performance. In particular, it is known in the field of neuroscience that conscious control of the breathing process in a subject can result in a degree of control over the level of physiological and psychological stress experienced by the subject, in such a way that as the level of stress is reduced through deliberately controlled breathing, there is a corresponding increase in cognitive capacity and capability in the subject.

A further aspect of the background art is the distinction between physiological and psychological stress. Physiological stress is caused by an excess of sensory stimulation (factors external to the human body); psychological stress is caused by self-worry and anxiety – it is a self-inflicted state. The root cause of both types of stress is the engagement of the 'fight or flight' response. A leading indicator of the level of both physiological and psychological stress in a subject is the variability in heart rate measured over a time period. A low variability in the heart rate over time is indicative of a high level of stress in the subject, while a large variability in the heart rate over time indicates a low level of stress. Thus the presentation to the subject of their physiological or psychological stress level (measured as heart rate variability) allows them to lower their level of stress and optimise their level of cognitive performance by regulating their breathing accordingly.

In one known biofeedback system (www.heartmath.com) a light sensor attached to a subject's ear lobe or finger detects pulses of the heart through "blood pulse oximetry" (www.oximetry.org/pulseox/principles.htm) and feeds the heart pulse signal to a hardware processing device. In turn, the hardware processing device is connected to a computing device such as a laptop computer, and associated software causes the display of the subject's heart rate and heart rate variability. The subject is thus able to immediately assess the effects of conscious attempts to affect the heart rate by deliberately altering various physiological processes, such as the breathing rate and breathing depth.

In another known system (http://www.azumio.com) the subject places their finger over both the camera and light source on a mobile computing device, which has an installed software application to measure heart rate variability. The light source is then enabled, providing a degree of reflected light from the subject's finger back to the camera. The variation in light intensity detected by the camera is indicative of the subject's heart rate (blood pulse oximetry). The heart rate variability is thus able to be computed and subsequently shown on the display of the mobile computing device. As in the prior example, the subject is able to assess the effects of conscious attempts to affect the heart rate by deliberately altering various physiological processes, such as the breathing rate and breathing depth.

A further aspect of the background art relates to phenomena observed in neuroscience where the human brain becomes "locked on" in the physiological stress response state, due to the generally increased amount of brain stimuli humans are subjected to in modern information-based economies. In this state of existence humans are largely unaware of the persistent state of stress. The brain treats all stimuli as something to be examined for 'threat' potential. When too much stimulus impinges on the brain at any one time, its ability to discern 'threat or non-threat' is compromised. Therefore the brain enters a state of overload and treats the stimuli as a threat and so the neurological mechanism known as the 'fight or flight' response becomes locked on. In effect the brain becomes addicted to old thought patterns (and subsequent repetitive behaviours) because it is unable to attain access to the higher cognitive processes in order to do something new or different. Hence cognitive performance is sub-optimal in this situation. These hidden phenomena present clinically as repetitive behaviours, inability to change behaviour despite a desire to do so, and consistent anxiety or feelings of unease.

A yet further aspect of the background art relates to the psychological effects of playing computer games (also known as "video games" or "mobile apps"). It is widely acknowledged that there is a high level of pleasure experienced by many subjects in the playing of such computer games, which causes the subjects to desire to play the games on a regular basis. It will be shown that exploiting the pleasurable properties of playing computer games are an important aspect of the invention.

Summary of the Invention

In a broad form, the invention is a biofeedback method and system suitable for measuring the pulse rate of the human heart, and optionally, the nature of the subject's breathing as well (breathing rate, breathing depth, breathing type - chest or diaphragm - collectively known as the "breathing profile"), along with a stress analysis and management system.

Accordingly, a first aspect of the present invention resides in a method for enabling a person to continuously self-monitor their stress levels so that, when they monitor an unacceptable stress level, they can provide biofeedback to control that stress level, the method comprising:

attaching to the person a sensor for detecting or otherwise measuring stress levels, the sensor configured to be attached to the person for a continuous period over which their stress levels are to be self-monitored, and to continuously transmit a signal indicative of the stress level at that time during the period,

providing a mobile computing device including executable software for receiving the continuously transmitted signal from the sensor, and including electronic means for causing the visual display of the stress levels during the period, and

displaying to the person the monitored stress levels to enable the person to provide biofeedback to control or manage any stress levels which are unacceptable.

A second aspect of the present invention resides in a system for enabling a person to continuously self-monitor their stress levels so that, when they monitor an unacceptable stress level, they can provide biofeedback to control that stress level, the system comprising:

a sensor attached to the person which detects or otherwise measures stress levels, the sensor configured to be attached to the person for a continuous period over which their stress levels are to be self-monitored, and to continuously transmit a signal indicative of the stress level at that time during the period,

a mobile computing device which includes executable software and receives the continuously transmitted signal from the sensor, and including electronic means for causing the visual display of the stress levels to the person during the period, and

a visual display which displays to the person the monitored stress levels to enable the person to provide biofeedback to control or manage any stress levels which are unacceptable.

Preferably, the stress levels are indicated by the variation in the heart pulse rate of the person, and the sensor is a heart pulse sensor.

In a more preferred form, the heart pulse sensor comprises a light sensor device, such as an LED light sensor device or an infra-red sensor device.

Alternatively, the heart pulse sensor may comprise one or more electro-cardiogram (ECG) sensor devices.

The biofeedback method and system comprises, in a preferred embodiment, a mobile computing device that transmits an electronic signal via wired or wireless means to an LED light emitter device which is part of an LED light sensor device, and that receives an electronic signal via wired or wireless means from a corresponding LED light receiver device which is also a part of the LED light sensor device and is matched to the emitter device and placed in close proximity to it. In one implementation, this is a small peg-like clip in situ on the ear lobe or finger of the subject. In another implementation, this is a small wireless (e.g. Bluetooth) device placed in situ around or over the ear with a clip on the ear lobe, or worn on or around the wrist, chest, upper arm or other suitable location on the body, whereby the LED light receiver device detects LED light from the LED light emitter device which has passed through a blood vein or artery under the surface of the skin. Based on the variation in the intensity of detected LED light signals, the computing device is able to cause the display of the rate of heart beats of the human subject on a visual display. Heart rate variability over a period is then derived from this measurement and can also be displayed. Other heart pulse sensing technologies may optionally be employed, such as electro-cardiogram (ECG) pulse rate detection utilizing one or more ECG sensor devices. In the first instance, this heart rate variability measurement provides a notification or an alert to the subject that they are stressed. In the second instance, this measurement provides direct feedback to the subject about the effectiveness of their attempts to deliberately regulate their heart rate through control of their breathing.

In another aspect, the invention can include analysis of signals derived from a microphone embedded in, and connected to, the mobile computing device, such signals being collected as the subject inhales and exhales. The microphone detects the breathing rate, breathing depth and breathing type that are indicative of the breathing profile of the subject. These signals can be analysed by the mobile computing device to determine or measure the breathing profile of the subject, which information can then supplement the heart rate measurement to provide direct and improved feedback to the subject. In the first instance, this breathing biofeedback provides a means for the subject to better measure their efficacy in regulating or controlling their breathing correctly, as a means to reduce or otherwise control their stress level.

In a further aspect, the invention provides a method for collecting data and creating statistics related to the biofeedback information produced by the subject's use of the system of the invention, the method comprising the steps of:

collecting usage data from the subject (such as frequency and duration of use, ability of the subject to control stress through breathing);

transmitting said data to a remote server (computer) and storing said data in a database;

collating, analysing and presenting said data in various formats.

In a further aspect, the invention provides a method for collecting and analysing other data and information which is not produced directly by the biofeedback system but which is relevant for a complete understanding of the sources of stress in the subject's life, the method comprising the steps of:

providing an interface or other means of collecting or harvesting social media data such as calendar or diary events, appointments, meetings, Twitter feed messages, Facebook and similar postings, Instagram and similar postings and other social media or electronic messages;

using electronic or other sensors built in to or attached to the mobile computing device to collect information or data, or otherwise accessing information available from web sites or other information sources, related to the environment around the subject, such as ambient noise level, light intensity, ambient activity level, geo-spatial orientation, or the type of physical activity being undertaken by the subject;

using electronic or other sensors built in to or attached to the mobile computing device to collect information or data related to aspects of the subject's sleep, such as but not limited to quality, type of sleep, brain pattern, depth, duration, intermittency;

using information and data entered by the subject, or otherwise collected or harvested from third party information sources including apps installed on the mobile computing device regarding the subject's diet (food types, calorific intake, food intake frequency and regularity and other related information);

using electronic or other sensors built in to or attached to the mobile computing device to collect information or data related to aspects of the subject's health and exercise or activity patterns and behaviours;

providing a display of the subject's stress level over time;

plotting said social media data and events on the said display of the subject's stress level over time;

plotting said environmental data and events on the said display of the subject's stress level over time;

plotting said sleep data and events on the said display of the subject's stress level over time;

plotting said diet data and events on the said display of the subject's stress level over time;

plotting said health and exercise data and events on the said display of the subject's stress level over time;

correlating the occurrence of increased (or decreased) stress levels with the said social media, environmental, sleep, diet and health and exercise data and events;

analysing, grouping, filtering and sorting ("processing") the said correlated data;

providing a graphical or text summary of the said processed correlated data.

In a yet further aspect, the invention provides a method for implementing a biofeedback stress management and cognitive enhancement training system, the method comprising the steps of:

receiving heart pulse rate signals and optionally breathing signals from the human subject, and analysing these signals in software structured as a computer game, which executes on the same mobile computing device as the biofeedback measurement software;

the progress of the subject through the computer game is determined partly or wholly by their ability to consciously control their physiological processes (e.g. breathing rate, breathing depth, breathing type (chest or diaphragm)), and therefore heart rate variability;

other aspects of the game may be influenced by the subject's control of these physiological processes;

other physiological processes may be used to influence the subject's control over aspects of the game.

In a still further aspect, the invention is software for implementing the methods described above.

It is an advantage of the invention that any mobile computing device equipped with either an audio input/output connector jack or a wireless interface (e.g. Bluetooth wireless technology or similar) may be used (such as an iPhone, iPad, Android or "Windows Mobile" mobile computing device). This creates ubiquitous availability for a wide range of end users without relying on a specific hardware platform.

It is a further advantage of the invention that no separate hardware processing device is required. The light sensor device or electro-cardiogram sensor device may connect directly to the aforementioned audio connector jack or wireless interface, with no intermediate hardware processing device required. This provides a high convenience factor at a low cost. Some other systems require a separate hardware device.

It is a further advantage that breathing efficacy can be monitored with the same mobile computing device, via direct audio detection of exhalation and inhalation, which provides improved biofeedback information in the context of this invention. Other systems provide only heart rate variability biofeedback, without the additional step of measuring inhalation and exhalation directly.

It is a further advantage of the invention that the subject can make continuous or semi-continuous use of the biofeedback system specifically because it is based on a mobile computing device, designed to be carried continuously or worn continuously by the subject, and because the means of monitoring the subject's heart rate is both unobtrusive and convenient. The subject is therefore able to continuously monitor their psychological condition and cognitive performance regardless of their location, activity or the time of day. Because humans are generally unaware of whether or not they are in a state of physiological (or psychological) stress, this advantage means it is possible to effectively counteract the deleterious effects of repetitive or continuous exposure to stress creation situations. This means the system utilisation is high, with a corresponding high degree of effectiveness in counteracting stress. Other systems which do not provide continuous monitoring are not effective in counteracting stress, because they are often not used at the time when the subject actually requires their use (i.e. when they are stressed) as the subject is usually unaware of their own stressed state.

It is a further advantage of the invention that the subject can undertake a cognitive improvement process without the monotony of a rote learning regime, by using associated computer game software (otherwise known as a "mobile app") which incorporates the biofeedback information. The elements of game design incorporated in the software cause the subject to desire its use, rather than to consider its use as a chore. With regular practise by the subject, the expected outcome can be greater cognitive capacity and capability in the subject on a permanent basis.

It is a further advantage of the invention that the known pleasurable properties of playing a software game are exploited to cause the subject to desire its use on a regular and ongoing basis. Hence the intent of the software game (which is to train the subject in correct breathing technique in order to reduce stress and thereby increase cognitive performance) is disguised by the pleasurable properties of playing the game. It is through this pretext that the subject then undertakes the requisite regular practise of the breathing technique in order to ensure the success of the training.

It is a further advantage of the invention that the progress of the subject through the software game is determined by the subject's ability to control aspects of their body physiology, such as breathing rate and breathing depth. This adaption of the game parameters to suit the subject's physiological control ability creates an optimum environment for training the subject in correct breathing technique, and hence maximises beneficial outcomes for the subject. Other systems do not provide a software game which has the biofeedback data coupled with the subject's progress through the game.

It is a further advantage of the invention that the correlation between stress data and the data taken from social media, calendars, environmental conditions, sleep patterns, diet, health and exercise and other inputs can guide the subject in learning which life events, situations and environments create stress, increase stress and decrease stress, and therefore the subject is able to take actions or make decisions to reduce the specific sources of stress, as desired. It should be emphasized here that this functionality is only made possible by the continuous self-monitoring of the subject's stress levels, as elucidated above. Other systems where the stress level monitoring is not continuous are not effective in this respect.

Brief Summary of the Drawings

In order that the present invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings, in which:

Figure 1 is a schematic diagram of a stress level monitoring and biofeedback system according to a first embodiment of the present invention,

Figure 2 is a Stress Correlation Chart plotting over time (a) a person's stress level as measured by the system of the present invention, (b) the degree of correlation between the person's calendar events and the person's stress level, and (c) the degree of correlation between the person's general health and the person's stress level,

Figure 3 is a schematic diagram of a stress level monitoring and biofeedback system according to a second embodiment of the present invention,

Figure 4 is a schematic diagram of a stress level monitoring and biofeedback system according to a third embodiment of the present invention, and

Figure 5 is a schematic diagram of a stress level monitoring and biofeedback system according to a fourth embodiment of the present invention.

Detailed Description of the Invention

A first preferred embodiment of the system of the present invention comprises the elements arranged as shown in Figure 1.

As illustrated in Figure 1, an ear clip 10 contains an embedded heart pulse sensor 12 which comprises an LED light emitter device on one side of the ear clip and an LED light receiver device on the other side of the ear clip. The ear clip 10 is placed over the lobe 14 of the ear 16 using the spring action of the ear clip to ensure close physical coupling between the heart pulse sensor 12 and the ear lobe. Close physical coupling is required to ensure LED light passes through the ear lobe 14 from the emitter device to the receiver device within the heart pulse sensor 12. Although an LED light sensor device is used in this embodiment, it will be appreciated that an infra-red sensor device or other suitable light sensor device may alternatively be used.

The mobile computing device 20 generates high frequency audio signals and transmits these signals in the form of electrical energy from its audio jack 22 into the sensor cable 24. The signals energise the emitter device in the heart pulse sensor 12 where the signals are converted into LED light, and this LED light is passed through the ear lobe 14. As the human heart pumps blood through the ear lobe 14, variations occur in the intensity of received LED light energy at the receiver device in the heart pulse sensor 12. The received LED light energy is converted back to electrical energy by the receiver device in the heart pulse sensor 12 and passed through the sensor cable 24 and then through the microphone input in the audio jack 22 into the mobile computing device 20.

Software installed in the mobile computing device 20 amplifies, filters and processes the received heart pulse signal using mathematical algorithms in order to calculate the heart pulse rate. It is then a simple computing process to derive the heart rate variability from this result and show this on the mobile computing device (MCD) display 26 in the form of a graph or digital number format.

A further function of the software installed in the mobile computing device 20 is a data analysis function. The data analysis function causes the display of information on the MCD display 26 which guides the subject to breathe in such a way as to regulate their heart rate variability. The information indicates whether the subject's breathing rate should be decreased, increased or remain the same, whether the subject should breathe deeper, shallower or with the same depth, and whether the subject should breathe with more, less or the same amount of chest movement and more, less or the same amount of diaphragm movement (collectively referred to as the "breathing profile"). Factors involved in the calculation and presentation of this information include the subject's age and sex.

An extra function of the software installed in the mobile computing device 20 is to provide a method for determining the breathing profile of the subject. The mobile computing device 20 uses the integrated microphone 28 to directly and accurately measure the breathing profile of the subject. The subject places the microphone 28 a short distance from their mouth, and as they breathe the microphone measures the nature of their exhalations and inhalations. The software in the mobile computing device 20 uses the data analysis function to calculate the subject's breathing profile. The MCD display 26 is then used to display to the subject, in plain text and graphics, indications or suggestions to modify their breathing profile to try and attain a profile closer to the ideal, which would then result in an optimal outcome for stress relief for the subject.

The mobile computing device 20 communicates with a remote database 30 using standard mobile device communication technologies via a wireless internet connection 32.

The remote database 30 has an associated software program which processes data residing in the database, and which controls the data sent back to the mobile computing device 20 from the database. User statistics for the following variables are stored in the database 30: Frequency and time of use of the software installed in the mobile computing device 20; how quickly or slowly the subject makes progress in learning to breathe effectively; age of the subject; sex of the subject; approximate location of the subject when the software is used by the subject; other variables as are able to be collected or determined. Over a period of time the aggregate data can be used to analyse and understand the health and well-being trends of large groups of people, as an aid in determining government, public or private health and well-being policies, programs and activities, or for other analyses and purposes.

An extra function of the software installed in the mobile computing device 20 is that it is able to interact with other installed software, or with data residing either in the memory of the mobile computing device 20 or in the personal user account of the subject, which may exist in a real or virtual location remote from the mobile computing device (for example in the "iCloud" service provided by Apple).

The software installed in the mobile computing device 20 may provide an interface or other means of collecting or harvesting social media events and data, such as calendar or diary events, appointments, meetings, Twitter feed messages, Facebook and similar postings, Instagram and similar postings and other social media or electronic messages. These events and data are plotted on a calendar or time scale shown on the MCD display 26, along with the subject's stress history (as determined by the invention).

In another embodiment, electronic or other sensors built in to or attached to the mobile computing device 20 collect information or data related to the environment around the subject ("environmental information"), such as ambient noise level (via the microphone 28), light intensity (via a camera or light sensor), ambient activity level (whether the subject is situated in a busy environment with other people or moving objects, via a camera), geo-spatial orientation (via a gyroscope, accelerometer or other suitable orientation sensor), and the subject's type of physical activity (whether stationary, moving gently, vigorously, fast, slow or other classification, via an accelerometer or GPS or other suitable activity sensor). The software installed on the mobile computing device 20 analyses, groups, sorts and filters this environmental information and the result is plotted on the said calendar or time scale shown on the MCD display 26, along with the subject's stress history.

In yet another embodiment, electronic or other sensors built in to or attached to the mobile computing device 20, or third party mobile apps installed on the mobile computing device 20, collect information or data related to the sleep patterns of the subject. Such information may include, but is not limited to, sleep times, sleep regularity, sleep quality, sleep depth, sleep and wake cycle timing, sleep interruptions, brain wave patterns and other related information. The software installed on the mobile computing device 20 analyses, groups, sorts and filters this sleep information and the result is plotted on the said calendar or time scale shown on the MCD display 26, along with the subject's stress history.

In still another embodiment, information and data entered by the subject, or otherwise collected or harvested from third party information sources, including mobile apps installed on the mobile computing device 20, are collected regarding the subject's diet. Such information may include, but is not limited to, food types, calorific intake, food intake frequency and regularity and other related information. The software installed on the mobile computing device 20 analyses, groups, sorts and filters this dietary information and the result is plotted on the said calendar or time scale shown on the MCD display 26, along with the subject's stress history.

In a further aspect, electronic or other sensors built in to or attached to the mobile computing device 20 collect information or data related to aspects of the subject's health and exercise or activity patterns and behaviours. Such information may include, but is not limited to, the existence of specific health issues or conditions (for example diabetes), specific health events (such as the occurrence of a heart attack), health assessment events (such as a doctor's visit), exercise patterns (such as time of day a workout is performed and its duration), type or classification of exercises performed (such as walking, running, bicep curls, bench press, aerobics class, karate), calorific burn, and frequency and duration of exercise. The software installed on the mobile computing device 20 analyses, groups, sorts and filters this health and exercise information and the result is plotted on the said calendar or time scale shown on the MCD display 26, along with the subject's stress history.

In this way, the software installed on the mobile computing device 20 is able to correlate the occurrence of increased (or decreased) stress levels with the said social media events, environmental information, sleep information, dietary information, and health and exercise information, and to highlight this correlation to the subject. The strength of the correlation between the stress levels and each of the various causal factors mentioned above is rated by the software and displayed on a scale, so that the subject is able to determine which causal factors have the greatest contribution to stress creation or stress alleviation. The subject is thus able to understand which events, environmental factors, and lifestyle factors create or increase or alleviate stress the most, and consequently the subject has the possibility to manage the said factors which create or increase stress the most and to beneficially reduce their impact.

This correlation functionality is illustrated in Figure 2, which represents one implementation of the software displayed on the screen of the mobile computing device

20. The Stress Correlation Chart 40 has a time scale on one axis, which may use units of minutes, hours, days, weeks, months, years or any other desired time unit. The other axis has a dual-purpose axis with a unit of "percentage". Other relevant units may be used. The Stress plot 42 shows the subject's stress level over time, expressed as a percentage (%). The Calendar plot 44 shows discreet calendar events represented as dots, taken from the said social media and personal calendar data and events. The Calendar plot 44 shows the degree of correlation between the said calendar and social media events and the subject's stress level, also expressed as a percentage. Thus in the instance shown in Figure 2, there is a 90% correlation between the calendar event at time 12:00 shown on plot 44 and the subject's 20% stress level shown on plot 42. This could be interpreted as meaning that the particular calendar event at time 12:00 lowered the subject's stress level. Conversely, the calendar event at time 9:00 shown on plot 44 reveals an 85% correlation with the subject's relatively high stress level of 55% shown on plot 42. This could be interpreted as meaning that the particular calendar event at time 9:00 increased the subject's stress level. The subject's Health plot 46 shows in this instance a 100% correlation between the subject's general health and the variation in stress levels, with the calendar events as the primary variable.

Other correlation data can be plotted against the subject's stress level, such as the said social media events, calendar events, and health, exercise, dietary, sleep and environmental information. Any combination of these may be correlated with stress and with each other, and plotted as described. In this way, the subject may become beneficially aware over time of the said events and lifestyle factors which increase or decrease their stress levels. The subject then has the information required to beneficially make lifestyle changes as desired.

It should be appreciated that the method shown in Figure 2 is only one of many possible ways of showing the stress correlation with the subject's data. Enhancements to the displayed information may include, but are not limited to: Identifying with a symbol or icon the source or identity of each calendar event shown on plot 44; using colour to indicate highly correlated events and data on plots 42, 44 or 46, or using various colours to indicate degree of correlation or other variable.

Referring to Figure 1, the software which performs this correlation function preferably resides on the mobile computing device 20 but can alternatively reside on a remote server or computing platform, which exchanges raw and processed data with the database 30. In this instance, the display of the data can occur on any remote computing device able to access the data on the database 30.

In a preferred embodiment, the executable software installed in the mobile computing device 20 comprises software to play a computer game or elements of a computer game incorporated into the structure of the software. The computer game presents a challenge or series of challenges to the subject in such a way that the ability of the subject to overcome the challenges is dependent on the efficacy of the subject in controlling his/her breathing profile, as measured by the invention.

One embodiment of these challenges is a series of "worlds" or "levels" in the game, where there are specific obstacles to overcome or puzzles to solve; as these are overcome or solved the subject makes progress towards the next world or level in the game, where the obstacles or puzzles are more complex and therefore more difficult to solve or overcome. In this way the subject is motivated to regularly play the computer game by a sense of progress, with constant challenges and rewards.

A further function of the game software is to provide instructional feedback to the subject in order to assist with the control and optimisation of the subject's breathing profile (thereby lowering stress and increasing cognitive ability). This feedback is provided in response to the stress levels indicated by variation in heart pulse rate of the subject. The game software provides either visual or verbal (or both) clues or instructions to direct the subject to change their breathing profile (e.g. to breathe deeper or shallower, or slower or faster, or with more diaphragm movement (less chest movement) or some combination of these variables). In this way the game software adapts the pace of learning to the measured capabilities of the subject, in order to provide improved learning outcomes.

An alternative embodiment of the system of the invention comprises the same elements as previously described and shown in Figure 1, with the exception of the sensor cable 24, which is replaced by a wireless connection 25 (e.g. Bluetooth or other wireless signal transmission technology).

Referring to Figure 3, a further alternative embodiment of the system of the invention comprises the same elements as previously described and shown in Figure 1, with the exception of the ear clip 10, LED light heart pulse sensor 12 and sensor cable 24, which are replaced by an electro-cardiogram sensor (ECS), or other heart pulse sensing technology, embedded in a suitable electrically conductive skin coupling 50 or housed in a device which affords a close skin coupling, such as a wrist band or chest strap. The ECS and skin coupling 50 are preferably held in constant contact with the human body by containment within a wrist band, whose circumference can be adjusted to ensure a comfortable fit while maintaining a firm pressure against the skin. The ECS in the skin coupling 50 detects heart pulses by measuring small electrical signals in muscles, which are indicative of the heart pulse. In this embodiment, the ECS and skin coupling 50 are connected to the mobile computing device 20, preferably by a wireless connection 25. In many ECS applications, more than one ECS will be required to obtain accurate heart pulse measurements. It should be appreciated that the ECS and skin coupling 50 can be replaced by an LED light heart pulse sensor 12 similar to the one previously described and shown in Figure 1, or by any other suitable light sensor device. In this instance, the LED light is transmitted from an LED light emitter device in the wrist band into the skin of the wrist, and is reflected back to an LED light receiver device contained within the wrist band.

Referring to Figure 4, a yet further alternative embodiment of the system of the invention comprises a mobile computing device 52 attached to, or embedded in, eye glasses 53 or another head-wearable device. The heart pulse sensor may be embedded in the mobile computing device 52 because the mobile computing device has close proximity to the human ear 16. Alternatively, an ear clip 10 containing an embedded heart pulse sensor 12 can be placed over the ear lobe, as shown in Figure 4, and can continuously transmit a signal indicative of the stress level to the mobile computing device 52, or indeed the heart pulse sensor could reside in a skin coupling 54 in close proximity to the mobile computing device 52, such as between the mobile computing device and the skin.

In the system illustrated in Figure 4, the eye glasses 53 are designed to provide the subject with a form of augmented reality ("AR"), whereby the mobile computing device 52 connected to the eye glasses provides situation-context-aware information to the subject, based on information captured by a camera 56 and input from the subject. In this scenario, heart pulse rate information could be used to supplement the augmented reality information in such a way that the cognitive performance of the subject could be improved, based on his/her current surroundings and situation (geographic, spatial, social, physical and other contexts). An example of this is where, under normal circumstances, (without the AR input from the glasses) the system of the invention might prompt the subject to breathe with a certain profile because it detects an increased stress level, but additional information from the AR camera 56 dictates that the breathing profile should be different. In this way, multiple sources of information (not just the heart pulse rate) contribute to the recommended breathing profile computed by the software in the mobile computing device 52, resulting in a better cognitive performance outcome for the subject than would otherwise be the case.

An extra function of the computer game software installed in the mobile computing device 52 connected to the eye glasses 53 is to provide real-world information in the computer game. For example, the camera 56 on the eye glasses could capture pictures which become the background to the game. In another example, the subject's current surroundings and situation (elements of the current geographic, spatial, social, physical or other contexts) could be included in real time as part of the game.

Referring to Figure 5, a still further alternative embodiment of the system of the invention comprises a mobile computing device 60 attached to, or embedded in, the underside of a wrist watch 62 or in the band of the wrist watch, or in another arm-wearable device. The heart pulse sensor may be embedded in the mobile computing device 60 because the mobile computing device has close proximity to the human skin, enabling an embedded heart pulse sensor to easily detect the heart pulse. The heart pulse sensor could alternatively reside in a separate skin coupling 64 in close proximity to the mobile computing device 60, for example, placed on the human skin on the wrist or forearm.

CLAIMS

1. A method for enabling a person to continuously self-monitor their stress levels so that, when they monitor an unacceptable stress level, they can provide biofeedback to control that stress level, the method comprising:

attaching to the person a sensor for detecting or otherwise measuring stress levels, the sensor configured to be attached to the person for a continuous period over which their stress levels are to be self-monitored, and to continuously transmit a signal indicative of the stress level at that time during the period,

providing a mobile computing device including executable software for receiving the continuously transmitted signal from the sensor, and including electronic means for causing the visual display of the stress levels to the person during the period, and

displaying to the person the monitored stress levels to enable the person to provide biofeedback to control or manage any stress levels which are unacceptable.

2. The method of claim 1 wherein the stress levels are indicated by the variation in the heart pulse rate of the person, and the sensor is a heart pulse sensor.

3. The method of claim 2 wherein the heart pulse sensor comprises a light sensor device.

4. The method of claim 3 wherein the light sensor device is an LED light sensor device.

5. The method of claim 2 wherein the heart pulse sensor comprises one or more electro-cardiogram (ECG) sensor devices.

6. A system for enabling a person to continuously self-monitor their stress levels so that, when they monitor an unacceptable stress level, they can provide biofeedback to control that stress level, the system comprising:

a sensor attached to the person which detects or otherwise measures stress levels, the sensor configured to be attached to the person for a continuous period over which their stress levels are to be self-monitored, and to continuously transmit a signal indicative of the stress level at that time during the period,

a mobile computing device which includes executable software and receives the continuously transmitted signal from the sensor, and including electronic means for causing the visual display of the stress levels to the person during the period, and a visual display which displays to the person the monitored stress levels to enable the person to provide biofeedback to control or manage any stress levels which are unacceptable.

7. The system of claim 6 wherein the stress levels are indicated by the variation in the heart pulse rate of the person, and the sensor is a heart pulse sensor.

8. The system of claim 7 wherein the heart pulse sensor comprises a light sensor device.

9. The system of claim 8 wherein the light sensor device is an LED light sensor device.

10. The system of claim 7 wherein the heart pulse sensor comprises one or more electro-cardiogram (ECG) sensor devices.

11. The system of claim 9 wherein the LED light sensor device comprises an LED light emitter device and an LED light receiver device, wherein the LED light emitter device receives an electronic signal via wired or wireless means from the mobile computing device, the LED light emitter device being in close proximity to the LED light receiver device which is attached to a location on the body of the person at which there is a blood vein or artery under the skin at that location, such that, when the LED light emitter device receives the electronic signal from the mobile computing device, the LED light emitter device emits LED light which passes through the blood vein or artery and is received by the LED light receiver device, and any variations in the energy intensity of the LED light are detected by the LED light receiver device which converts the variations in the energy intensity to the continuously transmitted signal, and wherein the mobile computing device is configured to cause the visual display of the heart pulse rate on the visual display.

12. The system of claim 11 wherein the LED light emitter device and the LED light receiver device are parts of a spring clip which is attached to an ear lobe or a finger of the person.

13. The system of claim 10 wherein the or each electro-cardiogram (ECG) sensor device comprises an electrically conductive device which measures electrical signals in muscles that are indicative of the heart pulse of the person, and any variations in the

heart pulse of the person are detected and converted to the continuously transmitted signal, and wherein the mobile computing device is configured to cause the visual display of the variability of the heart pulse rate on the visual display.

14. The system of claim 13 wherein the electrically conductive device is part of one or more skin couplings which are worn on or around a wrist, chest, upper arm or other location of the body of the person.

15. The system of claim 11 wherein the mobile computing device receives the continuously transmitted signal via wired or wireless means from the sensor device.

16. The system of claim 6 wherein the mobile computing device is connected to eye glasses.

17. The system of claim 6 wherein the stress levels are controlled by the breathing profile of the person.

18. The system of claim 17 wherein the breathing profile is measured by a sensor, and the sensor is a microphone connected to the mobile computing device.

19. The system of claim 18 wherein the microphone detects the breathing rate, breathing depth and breathing type that are indicative of the breathing profile of the person, and the mobile computing device is configured to indicate to the person modifications to the breathing profile which will reduce the stress levels.

20. The method of claim 1 wherein the executable software comprises software to play a computer game, the method further comprising:

providing hardware to enable the person to play the computer game and to provide biofeedback during the playing of the computer game to control or manage any stress levels which are unacceptable, the biofeedback being provided in response to the stress levels indicated by variation in heart pulse rate of the person, wherein the progress of the person through the computer game is determined partly or wholly by their ability to consciously control their physiological processes, such as breathing rate, breathing depth, breathing type, and therefore heart rate variability.

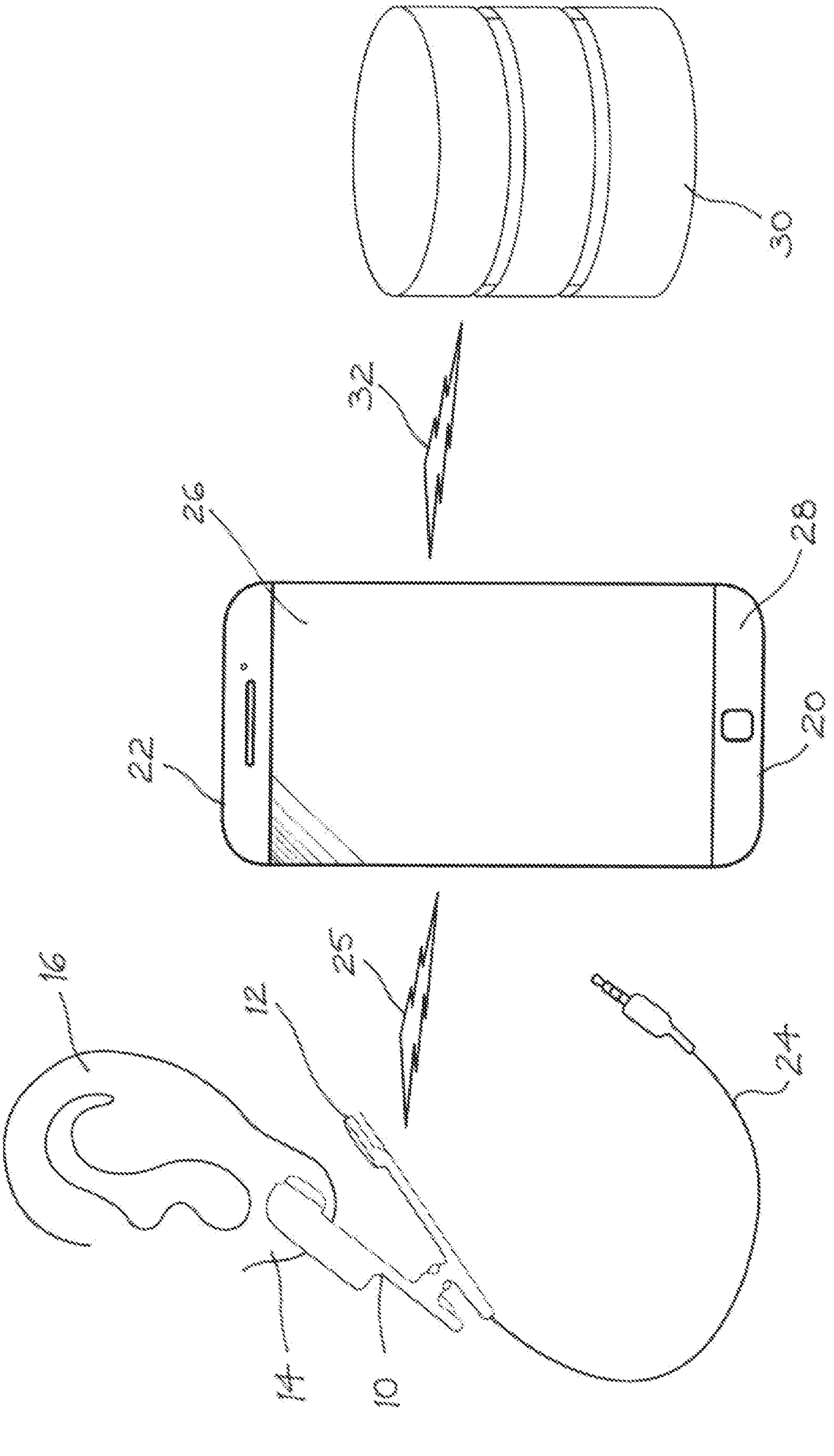
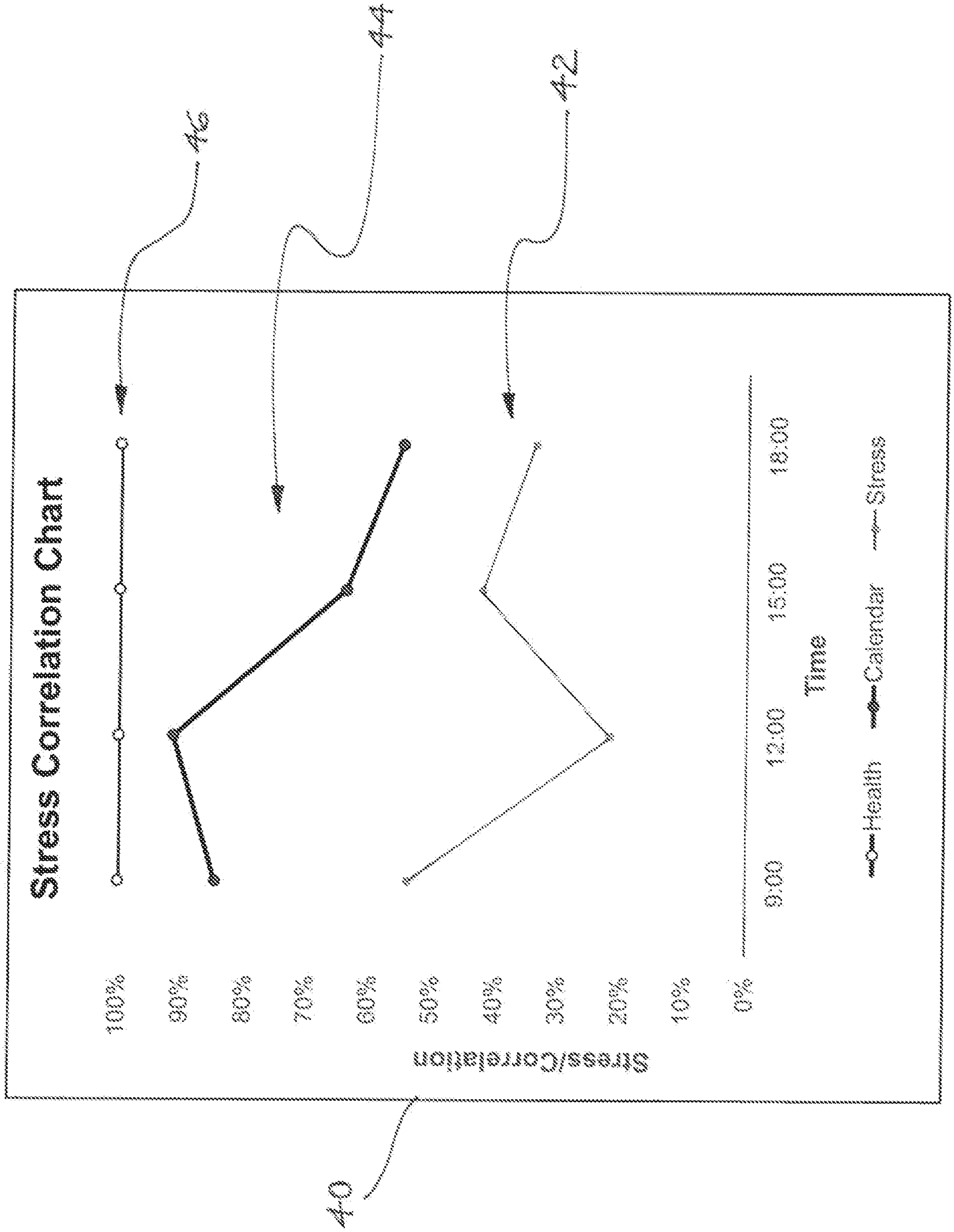


Fig.1



Stress Correlation Chart
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Stress/Correlation
9:00
12:00
15:00
18:00
Time
Health
Calendar
Stress
40
42
44
46

Fig.2

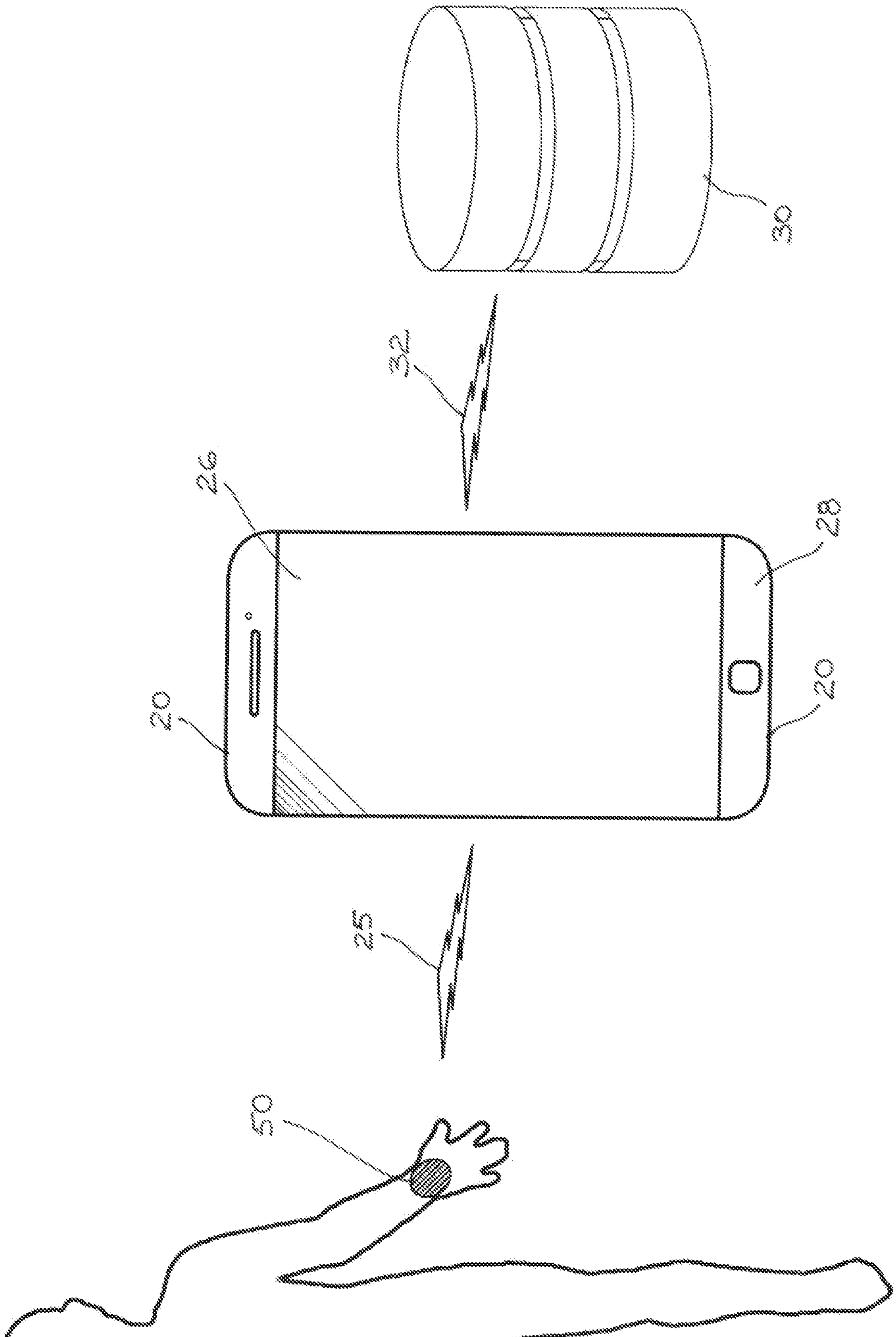


Fig.3

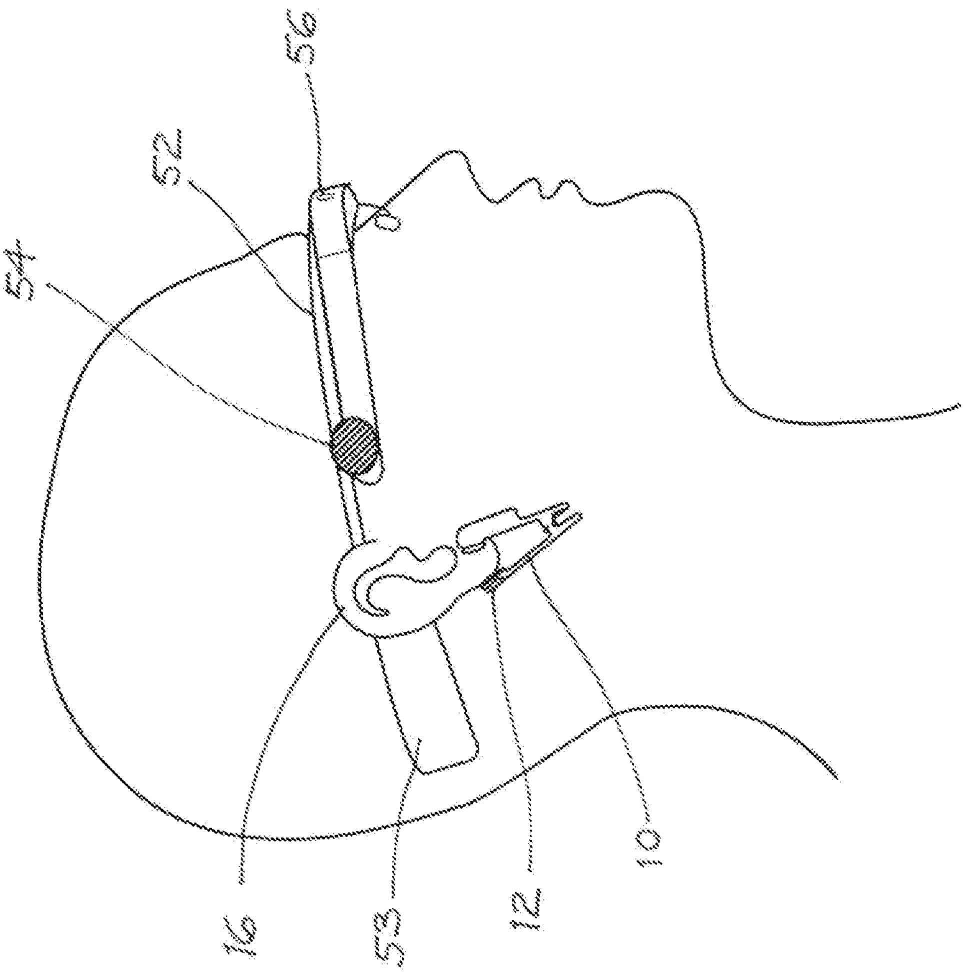


Fig.4

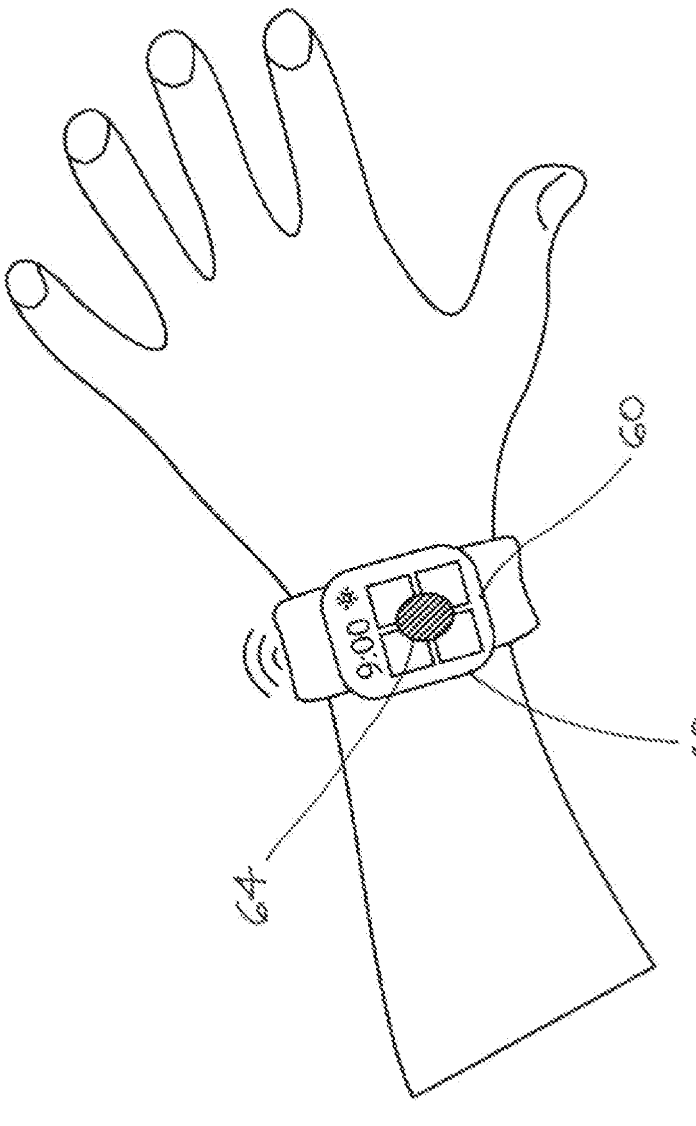


Fig.5

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2014/001173

A. CLASSIFICATION OF SUBJECT MATTER

A61B 5/04 (2006.01) A61B 5/08 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Databases: EPODOC, Espace and Google Patents

CPC: A61B5/04, A61B5/6802, A61B5/08, A61B5/02, A61B5/024, A61B5/486

Keywords: Koonung Heights Pty Ltd, Biofeedback, Regulate, Control, Monitor, Stress, Anxiety, Electrocardiogram, ECG, Heart, Detect, Measure, Wifi, Wireless, Mobile, Game, Video, Player, LED, Light Emitting Diode and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 April 2015	02 April 2015
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	**Authorised officer** Ian Carroll AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832277

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	US 2013/0158423 A1 (KAPOOR) 20 June 2013	
X	Abstract; Figures 3,5; paragraphs [0012,0027,0039-0041, 0044, 0047, 0071-0072 and 0081]	1-3, 5-8, 10, 13-14 and 17-19
Y	paragraphs [0027,0039-0041]; Claim 1	4, 9, 11-12, 15-16 and 20
	US 2012/0229270 A1 (MORLEY et al.) 13 September 2012	
Y	paragraph [0029]	4, 9, 11-12 and 15
	US 2011/0009193 A1 (BOND et al.) 13 January 2011	
Y	paragraphs [0030 and 0137]	16 and 20

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2014/001173**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2013/0158423 A1	20 June 2013	US 8855757 B2	07 Oct 2014
		US 2015057512 A1	26 Feb 2015
US 2012/0229270 A1	13 September 2012		
US 2011/0009193 A1	13 January 2011		

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.