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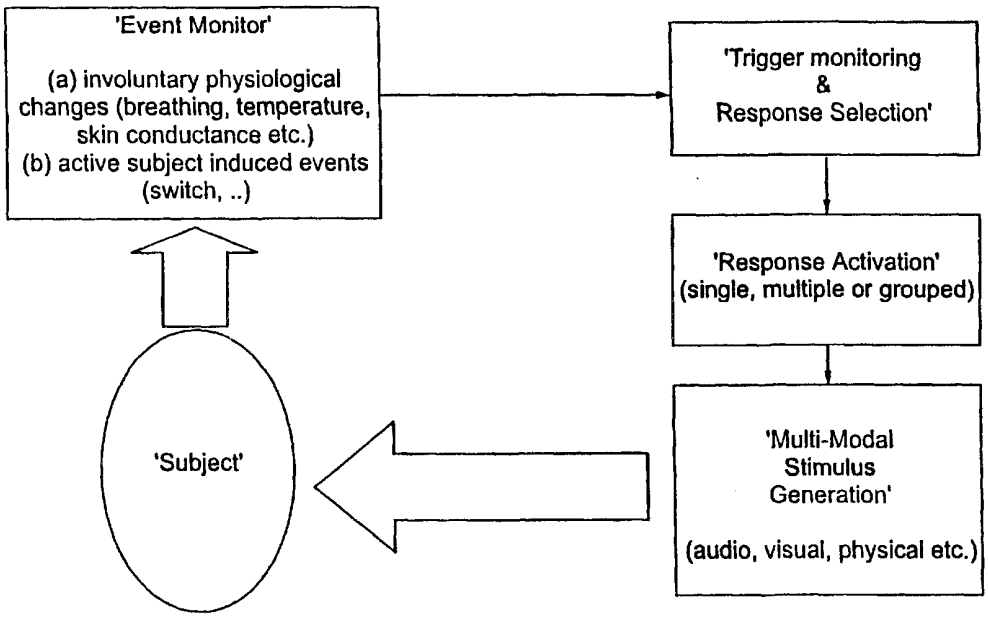

(57) Abstract

A device and associated method for production of an artificial sensory stimulus to elicit a response in a subject, the device including a stimulus production means for producing a sensory stimulus in the environment of the subject which stimulus is discontinuous and has at least two different sensory modalities, the different modalities produced so as to be perceived by the subject to be generally spatially coincident.

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A DEVICE AND A METHOD FOR PRODUCTION OF AN ARTIFICIAL SENSORY STIMULUS

The present invention relates to a device and a method for production of an artificial sensory stimulus to elicit a response in a subject, a use of the device and method and kit of parts forming the device.

In recent years there has been much research into alternative ways of affecting body processes without the use of prescription or generally available drugs. For example, acupuncture, acupressure, hypnotherapy, aromatherapy and many other treatments have been proposed for alleviation of chronic pain or asthma. These two conditions are linked to the respiratory system and many of those methods have been found to be ineffective in alleviating the symptoms.

Another area of recent research is cot death or sudden infant death syndrome, which is also linked to the respiratory system. Known methods of combating cot death include monitoring heart or respiration rate of the infant thought to be at risk with an alarm system activated to warn the parents if either of these fall outside a range of acceptable values. Of course, such methods are dependent on the parents' response and have no direct effect on the infant being monitored.

A further research area concerns improvement of motor co-ordination and skills in children and/or adults, and the provision of devices such as training aids and toys having such purpose. Such research is particularly appropriate to children and sufferers of cerebral palsy and other motor disorders such as Parkinson's disease.

Additionally, there has been research into methods of stimulating comatose patients to awaken them from the comatose state. However no known method is entirely satisfactory.

Another condition associated in particular with the respiratory system is extreme tiredness caused by long-term concentration and/or jet lag or other factors. Some individuals, such as long distance drivers, air traffic controllers, pilots, system monitoring engineers and watch-men have a job which requires long term concentration without movement. The effect of this is often respiratory slowdown and drowsiness, which may lead to sleep. Both the sleeping state and the motor reflex often produced by sudden awakening may be extremely detrimental to performance of people working in these conditions.

There is a need to overcome all the above problems, which is not satisfied by the prior art. In particular, there is a need to develop a means to produce a stimulus which elicits an enhanced response in the subject. The above problems are solved by the present invention.

In its broadest aspect there is provided according to the present invention a device for production of an artificial sensory stimulus to elicit a response in a subject comprising a stimulus production means for producing a sensory stimulus in the environment of the subject wherein the stimulus has at least two different sensory modalities, and wherein the stimulus productions means is adapted to produce such different modalities such that at least two modalities are perceived by a subject to be generally spatially coincident.

By the present invention it has been found that a wide variety of conditions/problems such as those described above may all be alleviated by a device producing at least bimodal sensory stimuli.

Whist the invention is not limited to any particular theory, our research has shown that the provision of a stimulus with at least two different sensory modalities, when perceived by a subject to be generally spatially coincident, produce a significantly enhanced response. The effect seems not to be merely additive, but to stimulate intersensory interactions within the relevant parts of the brain of the subject which produce a qualitatively enhanced brain response. The effect of the stimulus on, for example, involuntary or voluntary motor responses may thus also be dramatically enhanced. Where a stimulus comprising more than two modalities is used, at least two of those modalities, and preferably all of those modalities, are so produced as to be perceived by a subject to be generally spatially coincident

Research has hitherto focused on the processing of single stimulus modalities, and on improving the effectiveness of the subject response to such single modality stimuli. The present invention exploits the unexpected and surprising enhanced effects of stimuli having two or more modalities perceived by the subject to be spatially coincident, to produce a significantly enhanced subject response.

Research suggests that it is the subject's perception of the spatial coincidence of the different modes of stimulus which is critical in producing the enhanced sensory effect. In many instances, the stimulus production means will be configured to generate stimulus signals of at least two different modalities which are generally physically spatially coincident in that the device may comprise a single stimulus producer capable of producing a stimulus of at least two different modalities or may comprise at least one separate stimulus

producer for at least two different modalities located generally adjacent in space. At its simplest, all stimulus producers for each modality will be located generally together in space. For example, when an audio visual stimulus is used, apparatus for generating light and sound may be superimposed.

However, the skilled person will appreciate that in this art, a perception by the subject that the two modalities of stimulus are perceived to be generally spatially coincident does not necessarily require spatial coincidence of the individual stimulus producers. Accordingly, in the alternative, the device will be adapted to produce in the subject perceived spatial coincidence of physically separated stimulus generators in that the device comprises at least one separate stimulus producer for at least two different modalities, wherein a stimulus producer for at least one modality is located distant in space from a stimulus producer for at least one other modality but said stimulus producers are adapted and configured to produce in a subject a perception of spatial coincidence of their respective stimulus signals. For example, in an audio visual embodiment, audio signal generators may be spaced remotely from a visual signal generator but produce a perception of spatial coincidence through interference effects. Examples relating to other stimulus modalities will be in the knowledge of those skilled in the art.

The device may employ a single stimulus producer for each modality or a single stimulus producer for more than one modality or may employ a plurality of stimulus producers for some or all of the modalities. In devices employing more than one stimulus producer for each modality and/ or in devices employing more than two modalities, combinations of physical spatial coincidence and perceived spatial coincidence of physically separated stimulus producers may be envisaged.

The sensory stimulus may be directly in or acting directly on the subject or may be remote from the subject in the subject's sensory environment.

The response may be the desired result itself and the sensory stimulus production means may be adapted to elicit such a predetermined desired response. Alternatively or additionally, the sensory stimulus production means may be adapted to elicit an intermediate stage response, wherein the direct response to the stimulus is a voluntary, involuntary or conditioned response which itself acts as a stimulus (as a sole stimulus or an additional reinforcing stimulus) for a desired final response. Both intermediate and final response may be desired results, or the intermediate may serve only as a stimulus for a desired further response, and several intermediate stages may be envisaged. For example a motor response may be the stimulus (as a sole stimulus or an additional reinforcing stimulus) for a further respiratory response, the respiratory response being the desired end result.

Whether the stimulus produces a final response or an intermediate response, the stimulus production means preferably comprises means adapted to elicit a motor response in a subject, such as a voluntary motor response or an involuntary motor response such as a respiratory response. The stimulus production means thus comprises means to produce non-motor and especially non-respiratory related sensory stimuli (such as audio-visual stimuli) adapted to elicit in particular a motor response in a subject.

Again without being limited to this theory, research has shown that non-respiratory related sensory stimuli can impact body functions such as respiratory control, temperature, skin resistivity and control of involuntary and voluntary motor functions in general. For example, sensory input will normally affect respiration in the form of increased airflow. The same input is

likely to change skin temperature. This would seem to be generally true of discontinuous stimuli.

However, a conditioned response to a sensory stimulus may be a decreased airflow. For example, hyperventilation may be alleviated by sensory stimulus in the form of increased inspiratory resistance, often involving use of a small diameter tube through which the subject breathes. If the same sensory stimulus is produced each time the breathing tube is used, this leads to a conditioned response of decreased airflow rate to the stimulus.

Alternatively, or additionally a conditioned or learned response may be a non-respiratory response, for example a motor response in the form of a finger tap. Our studies have shown that a bimodal stimulus is followed by an increased peak airflow rate in the subject's breathing. When a stimulus is also followed by a voluntary response (such as a finger tap) the involuntary response of increased airflow rate is emphasised.

Conditioning may lead to an improved motor response with better co-ordination and/or faster reaction time and need not also involve a respiratory response. For example, sufferers of cerebral palsy may show an improvement in general motor co-ordination if trained with a conditioned motor response to a sensory stimulus. If a voluntary or conditioned response follows the stimulus, then training using the response may also be used to enhance the speed or accuracy of motor response.

Reference herein to an artificial sensory stimulus is to any sensory stimulus, which is not generally present in the environment around the subject. The sensory stimulus may be produced by the subject, for example, by flicking a switch or cognitively, i.e. by direct brain activity, or may be produced automatically or by a third party.

Reference herein to a sensory stimulus is to any sensory stimulus or combination of sensory stimuli. These may be, for example, sound, taste, smell, electromagnetic radiation (usually in the form of visible light), touch or other sensations to the body of the subject.

Reference herein to a response in the subject is to an involuntary and/or voluntary response. The response may be, for example, increased or decreased body or skin temperature, heart rate, adrenaline flow or brain activity, a voluntary or conditioned motor movement, such as the tap of a finger or movement of any other part of the body, or an involuntary motor movement such as respiratory response such as increased or decreased breath airflow rate. The response may also comprise a combination of different responses, which may be voluntary and/or involuntary.

The stimulus production means may produce any duration of stimulus which has the desired effect of response, but preferably the stimulus production means is adapted to produce a stimulus which is discontinuous and more preferably is adapted to produce a stimulus of short duration. It has been found that stimuli of longer duration have no additional effect on the response, as the subject becomes used to the stimulus signal. In particular, the stimulus production means may produce a single finite duration stimulus or may produce a series of discrete, regularly or irregularly pulsed finite duration stimuli. Different modalities may be produced to the same or different patterns.

Preferably the stimulus production means is adapted to produce a stimulus of duration of between 25 milliseconds and one second. More preferably, the stimulus for production means is adapted to produce a stimulus of duration of

between 50 ms and 250 ms optimally between 75 and 200 milliseconds. These short duration stimuli are sufficient to elicit a response.

The stimulus production means produces stimuli of at least two different sensory modalities. For example, a stimulus comprising combination of sound and visible light frequencies produces an enhanced effect. The stimuli may be temporally discreet or overlapping. Preferably, at least two, and more preferably all, modalities are temporally coincident. Different stimuli may also have different characteristics of length, frequency, intensity etc.

If a series of stimuli is produced, these may differ or be identical. Preferably the stimulus production means is adapted to produce one or more series of discrete identical stimuli.

The device may further comprise activation means to activate the stimulus production means.

The time between activation of the stimulus production means and production of the stimulus may be any suitable variable or non-variable time. For example, if a third party manually activates the device, a random length of time between activation and production may give an enhanced effect. A constant length of time would be more favourable for activation by a subject, especially if the response comprised a number of different responses, including at least one voluntary response.

Preferably the activation means is adapted to activate the stimulus production means within a standard time of activation. This is generally the case for automatic activation. Alternatively, the activation means is adapted for voluntary user activation, either by the subject or by another practitioner, or the device further comprises subject monitoring means, and the activation

means is in data communication therewith and is configured to activate the device in response to signals received from the subject monitoring means.

The stimulus production means may produce any two or more modalities of sensory stimulus, which are adapted to elicit a response in a subject. For example the stimulus production means may produce an acoustic signal, electromagnetic radiation, a fluid flow (such as gas) to the subject or the stimulus production means may be tactile for example producing an electrical signal or may be a taste or smell sensation.

Where the stimulus production means produces electromagnetic radiation or an acoustic signal, it may produce any wavelength or range or combination of wavelengths, which is found to elicit a response, for example an involuntary or conditioned response, or be suitable for voluntary responses. Preferably, the stimulus production means produces a single wavelength or narrow range of wavelengths, such as a red or green light from a light source.

Where the stimulus production means produces an acoustic signal, any known means to produce such a signal may be contemplated. Preferably the stimulus production means comprises an acoustic signal generator, a frequency modulator, a loud speaker and preferably a signal storage means. With this arrangement the frequency may be modulated to provide an optimum stimulus in differing circumstances. A preferable acoustic signal will be within the audible frequency range. A preferable acoustic signal will be broad band noise, particularly where one or more spatially discrete auditory stimuli are used. The generation and use of such signals, and suitable devices, are the subject of GB patents 2303235 and 2318662 incorporated herein by reference.

Where the stimulus production means produces electromagnetic radiation this may be non-visual electromagnetic radiation such as infra red or ultra violet

radiation. Preferably, the stimulus production means uses visible electromagnetic radiation.

Any visible electromagnetic radiation may be provided, so that any light emitting device may be suitable for use in a device according to the present invention. Preferably, the stimulus production means is a light emitting diode. Such a component is simple and economic to produce.

A tactile stimulus production means may comprise a contact member adapted to contact a subject; the member transmitting stimuli derived from production means. For example any one of motion into contact with the subject, temperature, vibration, and electrical or taste stimuli may be contemplated. A combination of any of the aforementioned stimuli and possibly also other forms of stimulus may permit enhancing effects.

In one arrangement the stimulus production means may be moveable. Thus the stimulus production means moves the contact plate into contact with the subject for tactile stimulation. The contact member may be of any suitable construction such as a plate, point, or sphere. Preferably the contact member is in the form of a plate.

The stimulus production means may be provided with temperature control means. For example, temperature control means may comprise a heating or cooling element. This construction allows the tactile stimulus production means to have an enhanced effect on the subject.

In another advantageous construction, the stimulus production means is adapted to vibrate. The stimulus production means in this construction may be held in contact with the subject or may come into contact with the subject during vibration.

In another advantageous construction the stimulus production means comprises a wire or other electrically conducting part adapted to carry an electrical current, the electrical current carrying portion being held in contact with the subject. This arrangement allows tactile stimulus via an electrical current.

For a device in which the stimulus production means produces a fluid flow to the subject, the stimulus production means may be any which creates the desired effect. Any fluid or mixture of fluids may be contemplated for flow to the subject. Preferably a gas or mixture of gases is used. In one embodiment, the gas comprises air. Alternatively, oxygen may be used. Advantageously, the stimulus production means is a piston and cylinder arrangement adapted to blow gas towards the subject. This simple construction may be employed with cooled or heated gas for enhanced effect.

The stimulus production means may be a combination of any of the various means defined herein to provide a combination of stimuli of at least two different modalities. Preferably, the stimulus production means produces at least two stimuli of different modalities selected from the group comprising aural, visual and tactile stimuli. These are found to produce particularly enhanced effects on response.

In a device as hereinbefore defined any suitable activation means may be provided to activate the stimulus production means. For example, the activation means may be manual, automatic or may receive signals from another integrated or separate system, adapted for example to monitor the condition of the subject.

In one advantageous construction, the activation means receives signals from a subject monitoring means comprising brain activity and/or heart rate and/or respiratory rate monitor and is preferably adapted for activation when the rate falls outside or within a pre-set range of value. This construction is particularly suitable for use of the device to prevent cot death or drowsiness leading to sleep or treat coma patients. In this embodiment the device preferably comprises a warning means such as a visual and/or audio alarm, to alert the parents or other carers to a possible dangerous situation.

Additionally or alternatively the activation means may comprise a manually operated switch. Such a construction is suitable for use as a test or for manual production of a stimulus by the subject having a conditioned or learned response such as a finger tap and slowing of the breathing rate.

In another preferred arrangement the activation means may be a timing element adapted to activate a stimulus production means at random or regular time intervals.

Alternatively or additionally, the device may comprise deactivation means which must be operated to switch off the sensory stimuli and/or user response means designed to be actuated by the response of the subject, in response to the stimuli. The user response means may be designed to be actuated by an involuntary user response, either directly or via suitable monitoring and control means, or by voluntary response, for example cognitively, i.e. by direct brain activity, or by voice actuation or mechanical actuation. For example the user response means may be a mechanically actuated switch. The user response means may be combined with means to display, assess or reward user performance in operating the response means, so that the device is adapted for use as a response learning aid, and in particular as a device to

develop a conditioned response to a stimulus or as a training aid for motor coordination.

The device as hereinbefore defined may be of any suitable shape and size: in one preferred embodiment it is portable and therefore suitable for use with subjects at different locations. More preferably it is a hand held device and is optimally of smooth outer shape and easily stored.

In a preferred embodiment, which is particularly suitable for use in preventing cot death, the device may, for example, be provided with a mounting attachment for mounting on a fixed surface, such as a wall, or bed. The device may also be provided with carrying attachments.

The device as hereinbefore defined may comprise additional components for improved ease of use. These may include a casing, preferably of durable rigid material, mains power connection and/or battery housing and/or connection, on/off switch and other suitable components.

It may be further provided with input means such as sockets for connection to another system such as an alarm, heart rate and/or respiratory monitor or it may comprise the system.

In one preferred embodiment, the device is in the form of a toy, for use with handicapped, ill or healthy children or for adult therapy. The toy may be, for example, in the form of a toy doll such as a clown which is suitable for training with children. The activation means may be either automatic or, alternatively, a switch, such as push-button switch in a suitable form, for example the clown's nose. The stimulus would generally be an audio and/or visual signal, for example an LED in the clown's nose.

The child can be trained to respond to the stimulus by a motor response. If the response is made within a certain accuracy or delay, the child may be rewarded, for example by a further, possibly different audio and/or visual signal.

In a further preferred embodiment, the device as hereinbefore defined comprises a pocket device with a casing, which opens to reveal the activation means and stimulus production means. Such a device is suitable for the alleviation of pain in conjunction with conditioning using inspiratory resistance as hereinbefore described.

In a further aspect of the present invention there is provided a method for production of an artificial sensory stimulus to elicit a response in a subject comprising producing a preferably discontinuous and preferably short duration artificial sensory stimulus in the environment of a subject, wherein the stimulus has at least two different sensory modalities and the different modalities are so produced as to be perceived by a subject to be generally spatially coincident.

In the method, the response may be adapted for combating respiratory slow down or control of involuntary or voluntary motor functions. The method makes use of the device as hereinbefore defined.

The method may include a method for instructing conditioned response.

The method corresponds to the means as described above and has the same advantages.

In one preferred embodiment, the method comprises the steps of: in a learning stage producing an artificial sensory stimulus having at least two modalities as

above defined and instructing the subject in an appropriate voluntary response and/or combining the stimulus with a set of conditions for producing an involuntary response, such that the response becomes conditioned, and in a final stage producing the artificial sensory stimulus and eliciting at least one learned or conditioned response.

Both stages may also elicit an involuntary response, which may be emphasised by the voluntary, conditioned or learned response.

For example, the combination of a stimulus and a learned response of a finger tap may be used in combination with inspiratory resistance, for example a small diameter breathing tube through which the subject breathes in the learning stage. The method steps of the learning stage are repeated until a conditioned response of a lowered airflow rate is achieved. In the final stage, the use of the breathing tube may be omitted.

In another embodiment the learning stage merely involves instructing the subject in the use of the device. This may be in the form of written or oral instructions, provided as part of the device or separately from the device.

In a further aspect, the present invention also relates to the use in the environment of a subject of a preferably discontinuous and preferably short duration artificial sensory stimulus having at least two different sensory modalities so produced as to be perceived by a subject to be generally spatially coincident to elicit a response in a subject.

In a further aspect, the present invention also relates to the use of a device or a method as hereinbefore defined, preferably in prevention of sudden infant death syndrome or drowsiness or in training in motor co-ordination or in

alleviation of chronic pain or asthma or to awake coma patients from their comatose state.

In a further aspect of the present invention also relates to a kit of parts forming the device as herein defined.

The invention will now be illustrated in non-limiting manner with respect to the figures.

Figure 1 is a graph showing mean airflow against time for a subject under four different conditions;

Figure 2 is a graph showing means subject reaction times for a subject under two different conditions;

Figure 3 is a block diagram showing the relationship between the subject, events and stimuli;

Figure 4 is a sketch diagram of a preferred embodiment of the device;

Figure 5 is a sketch diagram of an alternative preferred embodiment of the device;

Figure 6 is a sketch diagram of a further preferred embodiment of the device.

In Figure 1 is shown a comparison of dead space breathing for a single subject under four conditions and illustrates airflow rate profiles for a single breath. The subject sat in a comfortable chair while breathing through a wide bore tube (to raise respiratory drive) and a one-way respiratory valve connected to a pneumotachograph.

Four conditions were studied: no stimulus, an audio stimulus, a visual stimulus and a combined audio and visual stimulus. Airflow rate profiles from individual breaths were averaged to obtain mean airflow.

The graphs show the involuntary response of increased airflow to a sensory stimulus. The combination of a combined audio and visual stimulus increases the response.

Figure 2 shows a comparison of reaction times (RT) for a group of subjects (n=28) responding to 16 different visual and spatially coincident audio visual targets with an arm reaching task.

In the study, response times were recorded and student paired t-tests for means were calculated. Results are tabulated in table 1 and represented by the bar charts of Figure 2, and show that mean response times to audio visual stimuli were significantly faster than mean response times to visual stimuli alone (734ms and 897ms respectively with p-value = 0.00 at 5% significant level).

Table 1 - Mean Response Time (ms) For Both Sensory Conditions

	Visual RT	Audiovisual RT
Mean	896.54	733.81
±SEM	170.71	61.33
Min	640.00	633.33
Max	1393.33	876.67

The table and the representation in Figure 2 show the voluntary response of reaching to a sensory stimulus. The combination of a coincident audio and

visual stimulus reduces the reaction time therefore enhancing the speed of the reaching response.

Figures 1 and 2 together illustrate that the enhanced effect is produced both in relation to involuntary and in relation to voluntary motor response.

The block diagram of Figure 3 shows the relationship between the subject, events and stimuli in a preferred device. The subject is stimulated in one of a number of possible ways, such as audio, visual or physical stimulation. The voluntary and/or involuntary response of the subject is monitored and the output fed to a processor that determines when to trigger which stimulus in a subsequent phase.

The sketch diagram of Figure 4 illustrates a hand-held battery-powered version of the device. The device (1) comprises a casing (2) having an integral lid (3), which is shown in an opened position. The stimulus is produced by LED (4) and/or speaker (5). A push button (6) activates the stimulus once or in multiple sequence when pressed. There may be a compartment (10) for accessories or medication. A voluntary finger tap on the button (6) or other part may activate a further signal or stimulus. Conventional circuitry is employed.

In the following, numerals which have been used before in Figure 4 will also be used to designate the parts corresponding to those already described.

The sketch diagram of Figure 5 illustrates a version of the device suitable for use with infants. The casing comprises mounting attachment (7) for mounting to a cot or wall and a socket (8) for a mains lead. The device comprise a respiratory monitor and connection between this and the infant, as well as a

stimulus production means in the form of an acoustic signal generator and loud speaker (9). Activation means receive signals from the respiratory rate monitor. Immediately or alternatively if the respiratory rate monitor shows no improvement after the stimulus has been produced a suitable number of times the device may emit an alarm from the in-built loudspeaker (9) or transmit the alarm to another station over wires or electromagnetic signals. Conventional circuitry is employed.

The sketch diagram of Figure 6 illustrates a hand-held battery-powered toy version of the device containing conventional circuitry. The device (1) comprises a casing (2) in the shape of a clown having a push button in the form of the clown's nose to activate the stimulus. The stimulus is produced by LED (4) and/or speaker (5). The child responds by pressing the clown's abdomen. Speaker (5) emits a congratulatory sound when this is achieved within a selectable time limit.

CLAIMS

1. A device for production of an artificial sensory stimulus to elicit a response in a subject comprising a stimulus production means for producing a sensory stimulus in the environment of the subject wherein the stimulus has at least two different sensory modalities, and wherein the stimulus productions means is adapted to produce such different modalities such that at least two modalities are perceived by a subject to be generally spatially coincident.

2. A device in accordance with claim 1 wherein the stimulus production means is configured to generate stimulus signals of at least two different modalities which are generally spatially coincident.

3. A device in accordance with claim 2 wherein the stimulus production means comprises at least one separate stimulus producer for at least two different modalities located generally together in space.

4. A device in accordance with one of claims 1 to 3 wherein the stimulus production means comprises at least one separate stimulus producer for at least two different modalities, wherein a stimulus producer for at least one modality is located distant in space from a stimulus producer for at least one other modality but said stimulus producers are adapted and configured to produce in a subject a perception of spatial coincidence of their respective stimulus signals.

5. A device in accordance with any preceding claim wherein the stimulus production means comprises means adapted to elicit a motor response in a subject.

6. A device in accordance with claim 5 wherein the stimulus production means comprises means adapted to elicit a respiratory response in a subject.

7. A device in accordance with any preceding claim wherein the sensory stimulus production means is adapted to elicit a predetermined desired response.

8. A device in accordance with any preceding claim wherein the sensory stimulus production means is adapted to elicit an intermediate stage response wherein the direct response to the stimulus is a voluntary, involuntary or conditioned response which itself acts as a stimulus for a desired further response.

9. A device in accordance with claim 8 wherein the sensory stimulus production means is adapted to elicit a motor response which serves as the stimulus for a further respiratory response.

10. A device in accordance with any preceding claim wherein the stimulus production means is adapted to produce a single finite duration stimulus.

11. A device in accordance with any of claims 1 to 10 wherein the stimulus production means is adapted to produce a series of discrete, regularly or irregularly pulsed finite duration stimuli.

12. A device in accordance with any preceding claim wherein the stimulus production means is adapted to produce a stimulus of short duration.

13. A device in accordance with claim 12 wherein the stimulus production means is adapted to produce a stimulus of duration of between 25 milliseconds and one second.

14. A device in accordance with claim 13 wherein the stimulus for production means is adapted to produce a stimulus of duration of between 75 and 200 milliseconds.

15. A device in accordance with any preceding claim wherein the stimulus production means is adapted to produce the stimuli of the at least two different sensory modalities to be temporally coincident.

16. A device in accordance with any preceding claim wherein the stimulus production means is adapted to produce one or more series of discrete identical stimuli.

17. A device in accordance with any preceding claim further comprising activation means to activate the stimulus production means.

18. A device in accordance with claim 17 further comprising subject monitoring means, and wherein the activation means is in data communication therewith and is configured to activate the device in response to signals received from the subject monitoring means.

19. A device in accordance with any preceding claim wherein the stimulus production means is adapted to produce an acoustic signal.

20. A device in accordance with claim 19 wherein the acoustic signal is broad band noise.

21. A device in accordance with any preceding claim wherein the stimulus production means is adapted to produce visible electromagnetic radiation.

22. A device in accordance with claim 21 wherein the stimulus production means comprises a light emitting diode.

23. A device in accordance with any preceding claim wherein the stimulus production means comprises a tactile stimulus production means comprising a contact member adapted to contact a subject; the member transmitting stimuli derived from production means.

24. A device in accordance with any preceding claim wherein the stimulus production means is adapted to produce at least two stimuli of different modalities selected from the group comprising aural, visual and tactile stimuli.

25. A device in accordance with any preceding claim further comprising deactivation means which must be operated to switch off the sensory stimuli and/or user response means designed to be actuated by the response of the subject, in response to the stimuli.

26. A device in accordance with claim 25 wherein the user response means is adapted to be actuated by voluntary user response.

27. A method for production of an artificial sensory stimulus to elicit a response in a subject comprising producing an artificial sensory stimulus in the environment of a subject, wherein the stimulus has at least two different sensory modalities so produced as to be perceived by a subject to be generally spatially coincident.

28. A method in accordance with claim 27 comprising the steps of: in a learning stage producing the said artificial sensory stimulus and instructing the subject in an appropriate voluntary response and/or combining the stimulus with a set of conditions for producing an involuntary response, such that the response becomes conditioned, and in a final stage producing the said artificial sensory stimulus and eliciting at least one learned or conditioned response.

29. The use of an artificial sensory stimulus having at least two different sensory modalities so produced as to be perceived by a subject to be generally spatially coincident to elicit a response in a subject.

30. The use of a device in accordance with one of claims 1 to 26 or a method in accordance with claim 27 or 28 in the prevention of sudden infant death syndrome or drowsiness or in training in motor co-ordination or in alleviation of chronic pain or asthma or to awake coma patients from their comatose state.

31. A kit of parts forming the device of one of claims 1 to 25.

32. A device for production of an artificial sensory stimulus to elicit a response in a subject substantially as hereinbefore described with reference to the drawings.

33. A method for production of an artificial sensory stimulus to elicit a response in a subject substantially as hereinbefore described with reference to the drawings.

34. The use of an artificial sensory stimulus in a manner substantially as hereinbefore described with reference to the drawings to elicit a response in a subject.

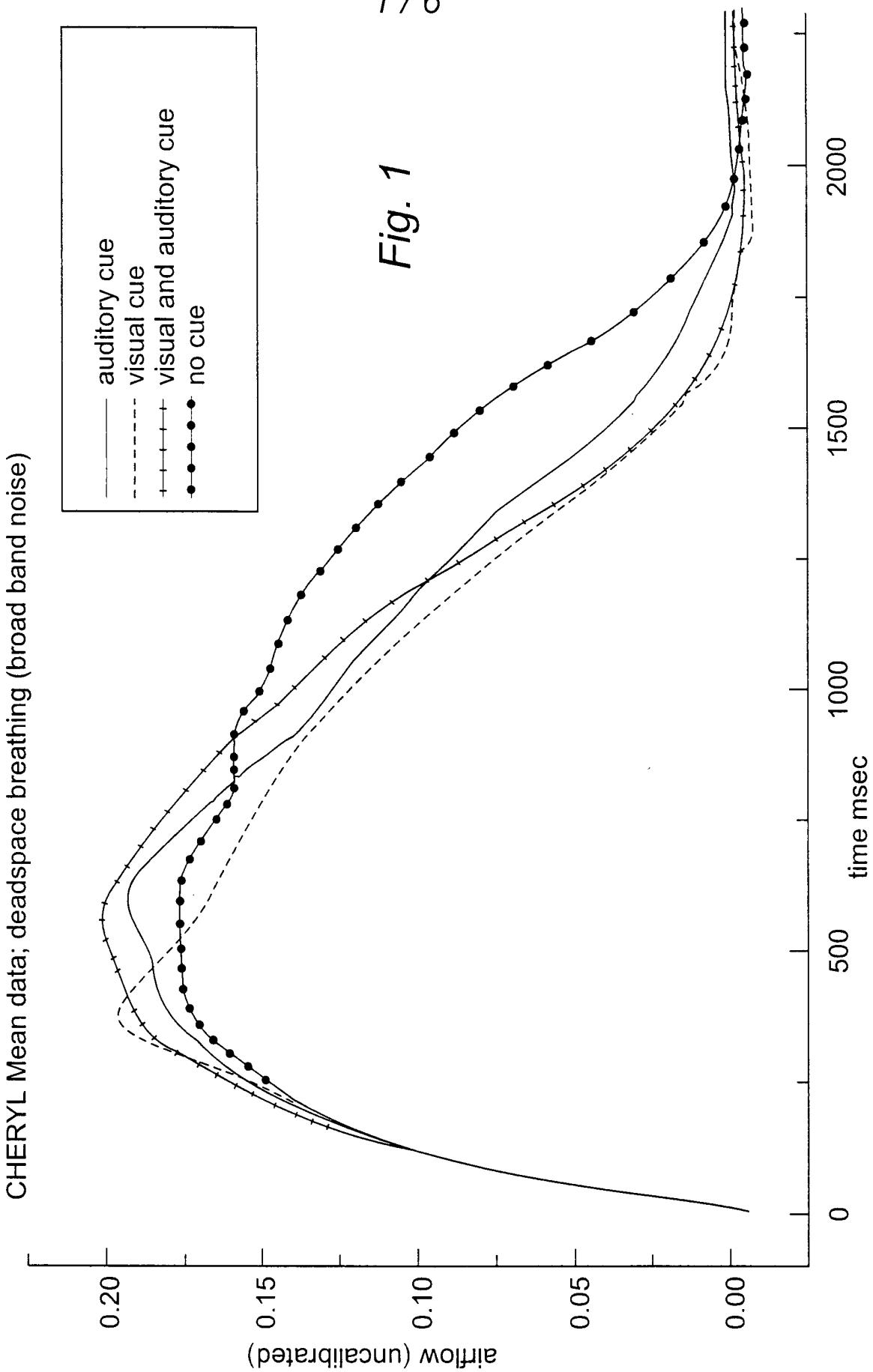

CHERYL Mean data; deadspace breathing (broad band noise)
auditory cue
visual cue
visual and auditory cue
no cue
airflow (uncalibrated)
0.20
0.15
0.10
0.05
0.00
0
500
1000
1500
2000
time msec

Fig. 1

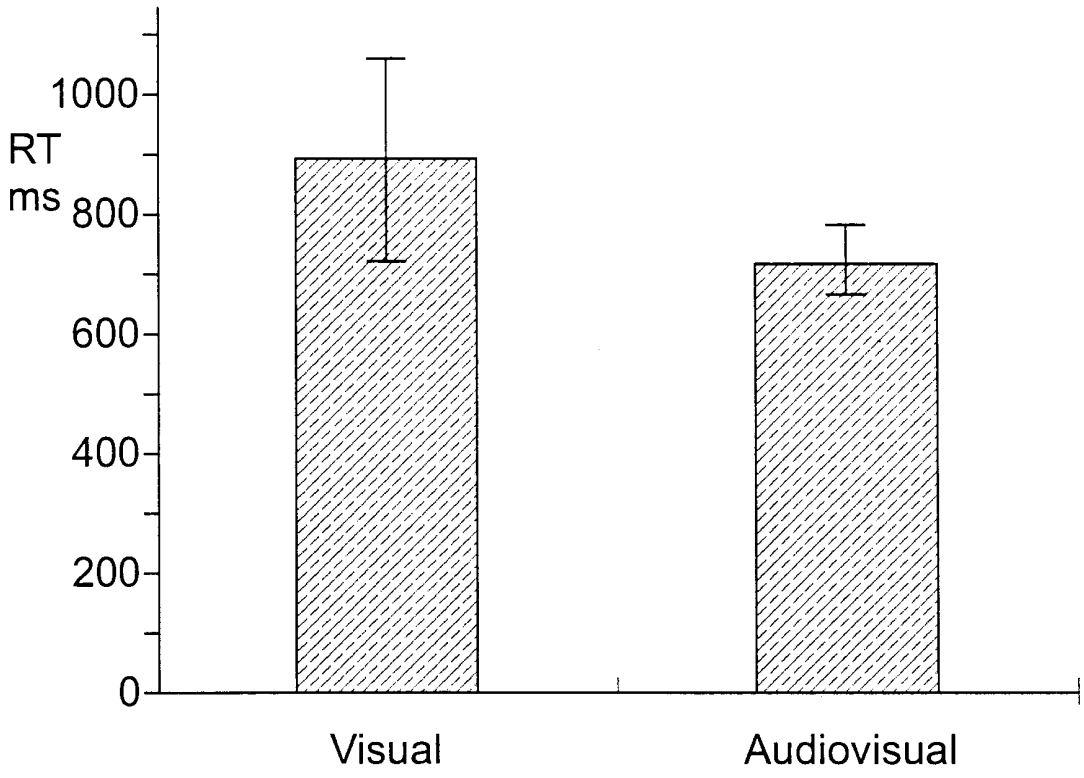


Fig. 2

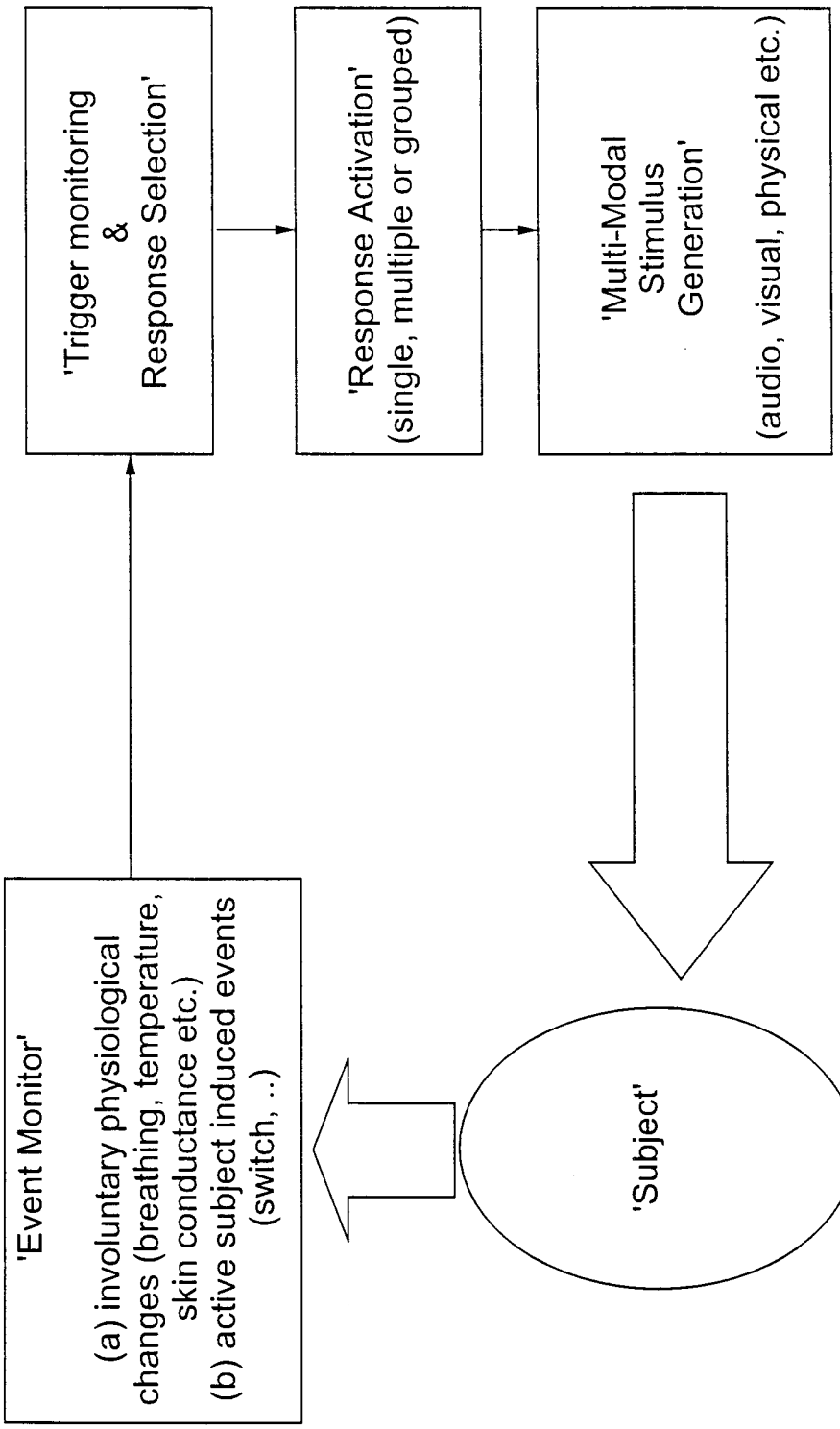

'Trigger monitoring
&
Response Selection'
'Response Activation'
(single, multiple or grouped)
'Multi-Modal
Stimulus
Generation'
(audio, visual, physical etc.)
'Event Monitor'
(a) involuntary physiological
changes (breathing, temperature,
skin conductance etc.)
(b) active subject induced events
(switch, ..)
'Subject'

Fig. 3

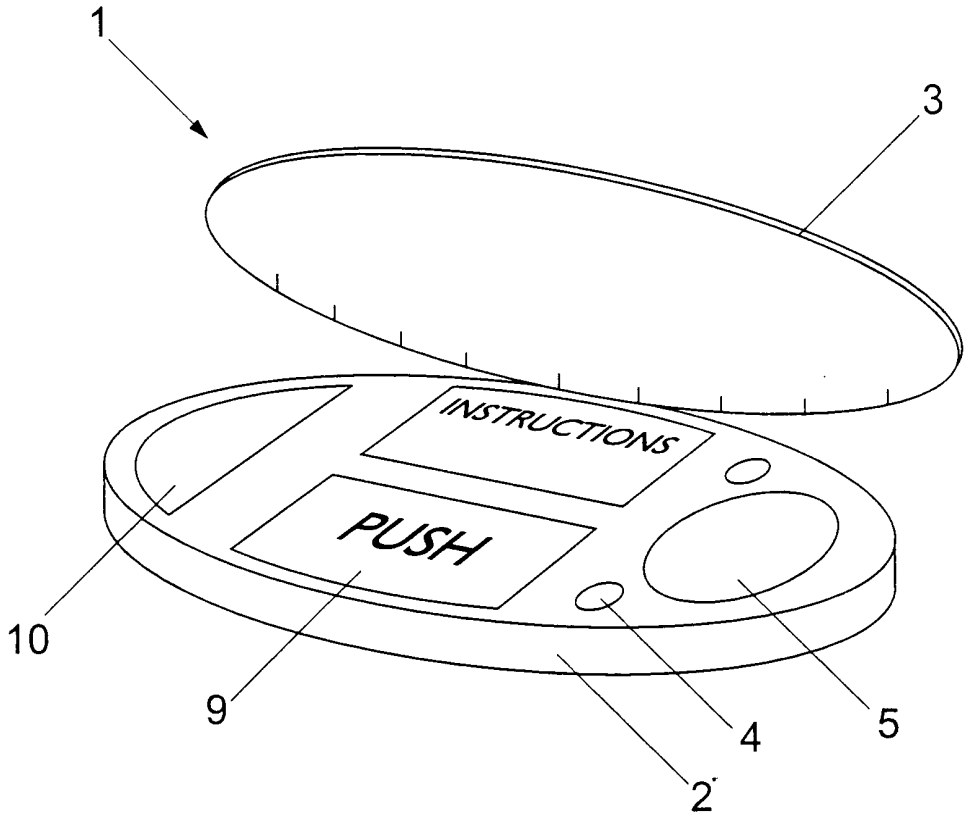


Fig. 4

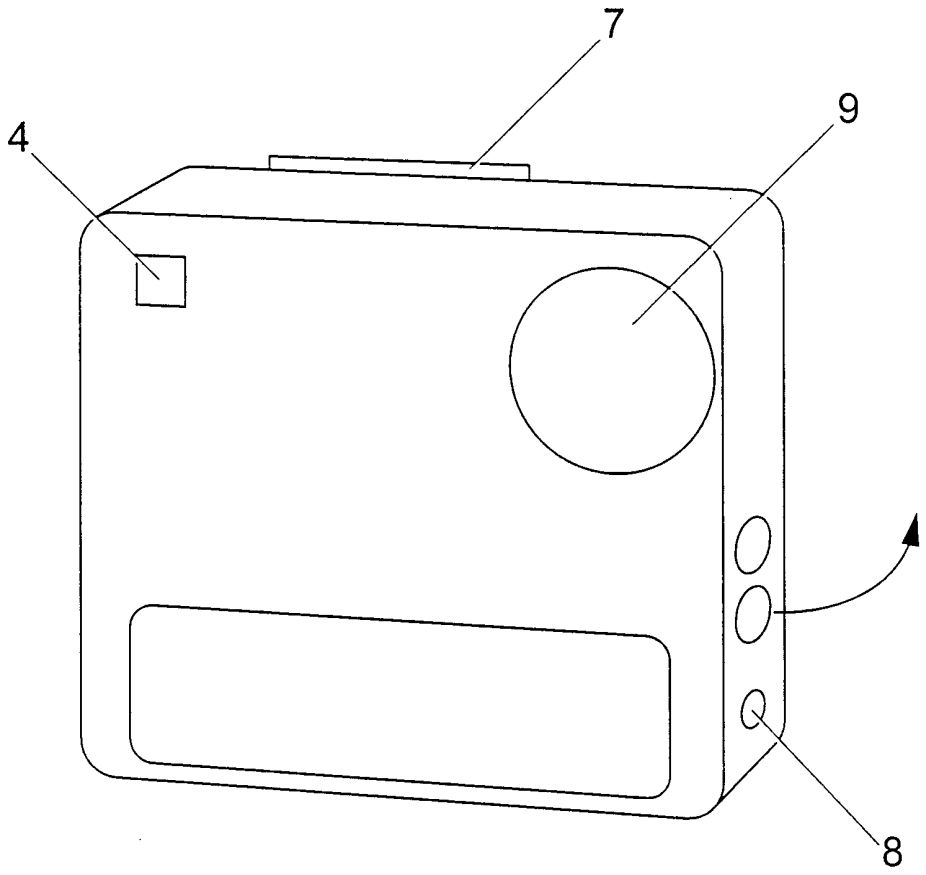
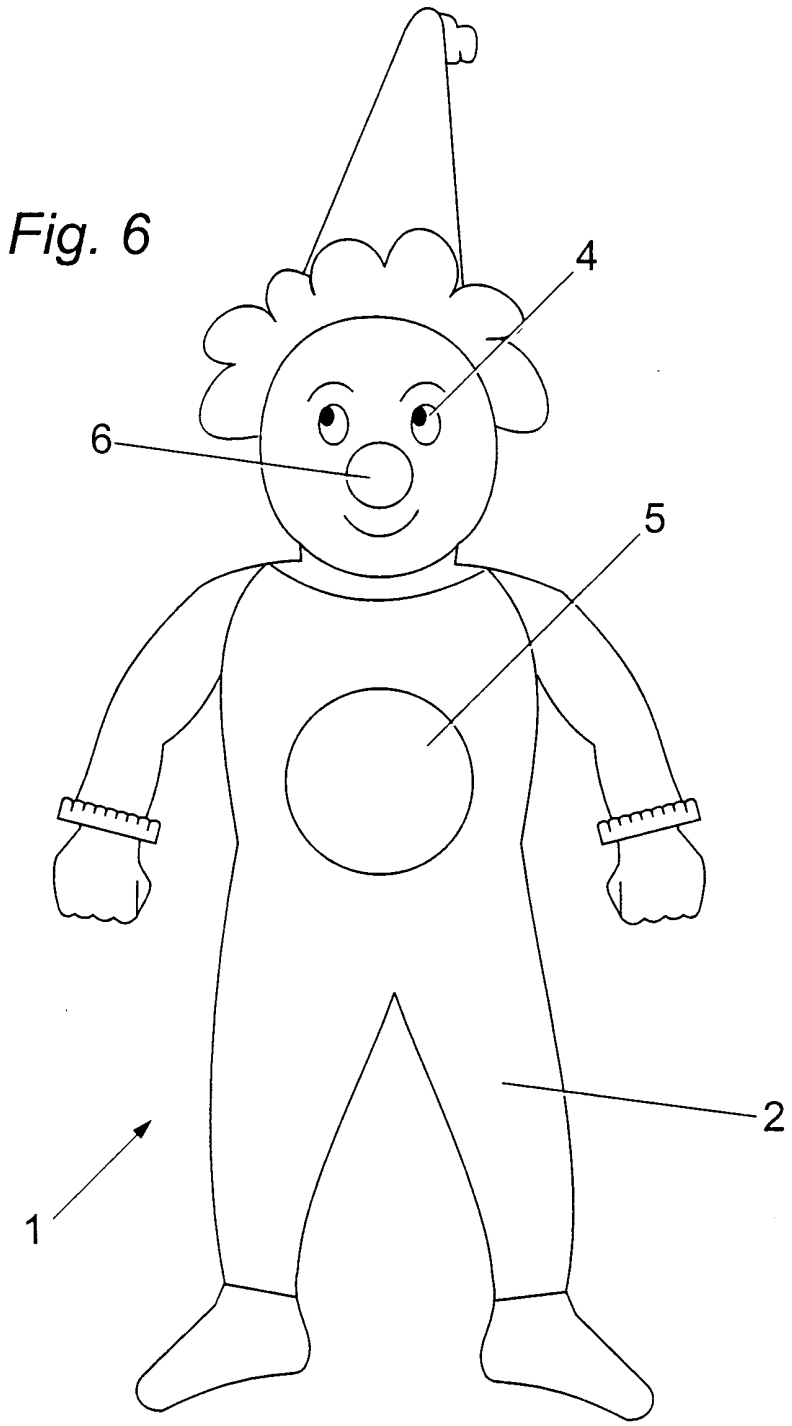


Fig. 5

Fig. 6



INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/GB 00/01470

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/113 A61H31/00

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)
IPC 7 A61B A61H A63B

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 28093 A (ST.ELIZABETH'S MEDICAL CENTER OF BOSTON) 19 September 1996 (1996-09-19) page 5, line 26 -page 7, line 31 page 9, line 6 -page 18, line 16 page 21, line 14 - line 32 figures 1,2	1,27, 31-33
A		2,3,5-7, 10-12, 15-21, 23-25, 28-30

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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
11 August 2000	21/08/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Chen, A

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INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/GB 00/01470

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A		2,3,5-7, 17-19, 23-26, 28-30
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter. ›nal Application No
PCT/GB 00/01470

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