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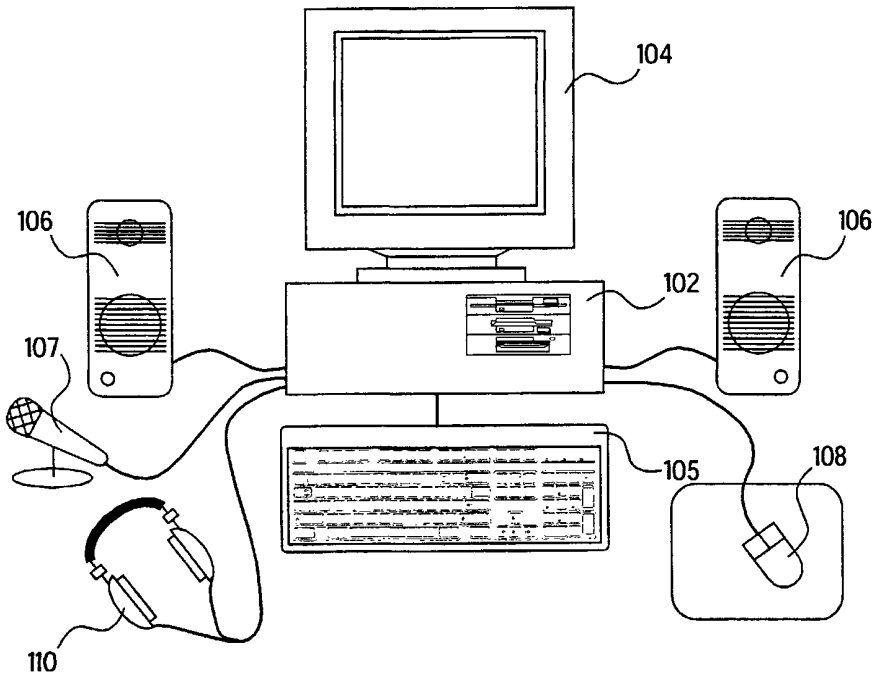
(54) Title: NETWORK BASED DYSLEXIA TREATMENT METHOD AND APPARATUS



(57) Abstract: A system (200) for the remote administration of an individually based and thus more accurate treatment method for large numbers of cerebellar-vestibular impairments such as dysmetric dyslexia with the use of common computer workstations (202, 204) coupled to a server (206) or host over network such as the Internet.

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Network Based Dyslexia Treatment Method and Apparatus

Field Of The Invention

The present invention relates to individualized methods and apparatus for the on-line and thus remote treatment of large numbers of individual subjects for neurological conditions such as dyslexia and related cerebellar-vestibular system (CVS) disorders.

Background Information

It is now becoming clear that dyslexia is a CVS syndrome that includes difficulties with reading, writing, spelling, and concentration/distractibility (e.g., Attention Deficit Disorder, ADD; Attention Deficit Hyperactivity Disorder, ADHD) and even fears/phobias (anxiety disorders) and mood and behavioral or impulsive disturbances.

To date, most "experts" view dyslexia, ADD or ADHD and phobias as separate and distinct disorders with separate and distinct origins. In fact, research has shown that these are all part of one CV syndrome, and just have differing and most often overlapping mechanisms and symptoms, e.g., just like diabetics with a common insulin deficiency have a wide range of differing but overlapping symptoms. However, the methods and apparatus disclosed herein are useful for the treatment of the disorders and similar impairments and do not necessarily depend on what the surface symptoms are is for the disorders or impairments.

It has been known that dysmetric dyslexic and dyspraxic (DDD) individuals frequently reverse the phonetic sequence of sounds while speaking and often have difficulty blending phonetic sequences in words and letters they see. When attempting to sound out and blend the phonemes in a word, they frequently skip over one or two in a sequence of three or four, and even reverse the whole sequence or phonetic pairs within a word. They even occasionally have difficulty matching, recalling or coordinating the sound of a letter with its visual form. These difficulties were thought to be cortical, since it was not fully appreciated that the cerebellar-vestibular (inner-ear) system of the brain controls sensory input. It was erroneously believed that the cerebellar-vestibular system controlled only motor functions or performance. In reality, the cerebellar-vestibular system acts to dynamically filter the speed and quantity of sensory-motor and related inputs so that they can be recognized and dealt with on a higher level by vital processes within the thinking brain (i.e., the cortical part of the brain). A cerebellar-vestibular disturbance in sequencing (spatial and/or temporal) results in scrambling, reversals, blurring or non-recognition--typical symptoms of dyslexia. Regardless of the underlying cause, the methods and apparatus disclosed herein are effective for treating subjects with relevant disorders.

As described in U.S. Patent No. 3,842,822 (the '822 patent), which is hereby incorporated by reference herein in its entirety, blurring and scrambling of sequential visual stimuli occur at significantly lower input speeds in subjects with cerebellar-vestibular dysfunction (e.g., dysmetric dyslexia and dyspraxia, DDD) than in normal subjects. The '822 patent describes a method of detecting dysmetric dyslexia as a cerebellar-vestibular dysfunction by creating an optokinetic nystagmus superimposed upon a hidden, subclinical nystagmus or eye vibration. This results in the blurring of moving images when engaged in a reading type

activity, i.e. visual fixation, tracking and sequential scanning, which induces the corresponding eye vibration or back and forth reading type eye movement. This movement or eye vibration occurs at a frequency that can be controlled, being more specifically a function of the speed of movement of the material being visualized or read by the subject. Such induced eye vibration is maintained below the normal threshold level producing blurred vision in normal subjects, but which in additive relation to the CVS-determined subclinical eye vibration noted to exist in DDD individuals, results in a total eye vibration at a frequency above the threshold level. Accordingly, those individuals experiencing blurred vision during this reading-like process are automatically identified as possibly being dysmetric dyslexic.

An impaired cerebellar-vestibular system (CVS) cannot properly neutralize, inhibit or "slow down" rapid or fast moving incoming sequential stimuli of a visual nature which thus leads to cortical or perceptual confusion or scrambling. In a screening method using incoming visual stimuli, such as described in the '822 patent, cerebellar-vestibular impairment is manifested by a blurring or scrambling of the visual stimuli under conditions in which "normal" subjects do not similarly experience these effects.

It has been discovered that analogously to visual information, the cerebellar-vestibular system slows down the input rate of auditory and tactile information, maintains the order of incoming sequential stimuli before sending them up to the cortex for interpretation, perception or recognition, and coordinates the various sensory inputs. When the cerebellar-vestibular system is impaired, the order of incoming sequential stimuli cannot be maintained, the rate cannot be properly slowed down prior to their transmission to the cortex, and thus the various sensory stimuli cannot be coordinated in time and space.

Auditory and tactile procedures and apparatus for detecting DDD are described in U.S. Patent No. 3,952,728 (the '728 patent), which is hereby incorporated by reference herein in its entirety. Underlying the auditory and tactile testing procedures described in the '728 patent is the recognition that a DDD subject, because of his cerebellar-vestibular dysfunction, also responds in a characteristically different way to non-visual sensory inputs, and so may also be effectively identified by such response. The methods of the '728 patent are practiced using (a) acoustical or auditory material, and (b) tactile stimulation, as said non-visual sensory inputs, to diagnose cerebellar-vestibular dysfunction and DDD on an individual and mass basis. The auditory test and procedure described therein can detect the failure to identify "dynamic" or sequentially-presented auditory stimuli, even though the individuals that exhibit the failure have normal sufficient auditory acuity, and would perform well taking a conventional hearing test. By analogy to the visual or ocularmotor model, when there is poor performance, it is as if the auditory fixation and sequential scanning functions are impaired. Increasing the rate of incoming and sequential auditory stimuli leads, by analogy, to auditory ataxia or nystagmus and auditory scrambling occurs. Thus, by speeding up the rate of presentation of sounds, e.g. letters, words or sentence sequences to a test subject, a speed is reached where "sound scrambling" or "blurring" occurs. The speed at which this auditory scrambling or blurring occurs is significantly less for individuals with cerebellar-vestibular dysfunction than for those without cerebellar-vestibular dysfunction.

Similar in concept to the aforementioned acoustic method, the '728 patent also describes a dynamic sequential tactile test where tactile sequential stimuli are speeded up to the point where tactile scrambling or blurring occurs. For example, a pattern of two or three

sequential pinpricks or other sensations applied to the skin, when speeded up, may then be perceived as one.

The explanation for the blurring of both the aforesaid forms of non-visual stimuli is that the cerebellar-vestibular circuits have been unable to slow down the rate and maintain the order of incoming sequential stimuli before sending them up to the cortex for interpretation, perception or recognition. In the case of cerebellar-vestibular impairment, the speed levels at which the order of the incoming sequential stimuli cannot be maintained and that cannot be properly slowed down prior to transmission to the cortex are significantly lower than with normal subjects. As a result, the stimuli are transmitted to the cortex at a rate and in a scramble beyond the cortical perception or recognition threshold.

With respect to the visual testing of DDD or CVS dysfunction, it has been discovered that dyslexic subjects have more than one blurring speed. While they have the same blurring speed as do non-dyslexic subjects (i.e., a sequential blurring speed, in which a whole sequence of objects is seen as a panorama and the entire sequence blurs at once), they also have another blurring speed, referred to as the "single-targeting blurring speed." This latter phenomenon is a compensatory one, which takes over when the first, i.e., the reflexive, sequential tracking speed, is impaired. The single targeting blurring speed results from the observation that the subjects have a functionally abnormal narrow lateral or peripheral span of vision. This abnormality is observed when a dyslexic or CV-dysfunctioning subject is forced to read a moving display. It does not occur when reading a stationary display. For example, if the moving display is a continuous line of several discrete objects, the number of which in the field of vision always remains the same, the subject would see fewer than the actual number displayed, usually missing either the initial or the final members of the display. U.S. Patent

No. 4,706,686, which is hereby incorporated by reference herein in its entirety, describes a diagnostic procedure and apparatus appropriate for individual or group examination for testing and identifying CV-dysfunctioning or DDD individuals by employing the inability of the subjects to maintain normal peripheral vision.

Other than the aforementioned visual, auditory and tactile tests, which are specifically effective in the identification of potential CV impairment conditions, such as DDD, traditional testing methods typically require the use of specialized equipment that is not widely available. As a result, there is a substantial delay from the point at which a subject may manifest signs of impairment to the point of confirmation with testing such as that described above. Delay in detection led to even greater delays in treatment. This delay is even greater for individuals located in remote areas, far away from trained professionals who can help diagnose and treat such conditions. Additionally, known testing and treatment techniques are often dependent on language, socioeconomic and educational variables.

Moreover, because such testing and treatment normally requires highly specialized equipment and highly trained technicians and is not readily available, many subjects go untreated. As such, there is a real need to provide such treatment widely and at a low cost. While particularly helpful for young children, so as to prevent the onset of emotional scarring, early treatment is also very helpful for adults, who frequently suffer from poor self-esteem, difficulty maintaining occupations and relationships, etc. and if untreated, drift into depression, anxiety, drugs, crime, etc. Early treatment may even prevent the onset of many of the common, overt symptoms of CV dysfunction and DDD.

It is an object of the present invention to provide an effective method for treating comparatively large groups of subjects, even of pre-school age. Specifically, it is an object to

achieve, by the administration of the disclosed treatments, effective treatment of dysmetric dyslexic and dyspraxic individuals and others with similar disorders.

It is a further object of the present invention to provide a procedure and apparatus which is easily administered and which effectively treats individuals or members of large groups, particularly children, with dysmetric dyslexia and dyspraxia and others with similar disorders.

It is yet a further object to provide a treatment technique that is simple and easy to administer as compared with other known treatments, most of which are time consuming, difficult, and relatively expensive. It is desirable to be able to provide a larger number of people appropriate treatment and to reduce the number of subjects that are required to receive the more difficult and costly treatments.

It is a further objective of this invention to accelerate the compensation processes of dyslexic, dyspraxic and other subjects with dysfunctions, and to thereby correspondingly accelerate the time when such subjects can participate, like normal subjects, in reading exercises and other tasks and activities relating to responses to visual, auditory and tactile stimuli.

Summary Of The Invention

The present invention is directed to methods and apparatus for the remote yet individualized administration of treatments to large numbers of individuals for cerebellar-vestibular (CV) impairment conditions such as dysmetric dyslexia and dyspraxia (DDD) with the use of common computer workstations or personal computers (PCs) coupled to a server or host over a network such as the Internet. A copending application entitled, "Network-Based Method And Apparatus For The Detection Of The Dyslexia Syndrome And Related CVS

Disorders," which is incorporated by reference herein in its entirety, discloses methods and apparatus for detecting such disorders.

In a first aspect, the present invention provides a server or host computer which is accessible via a communications network such as the Internet, a direct dial-up connection or other suitable data communications means, to one or more remotely located client computer workstations, optionally comprising visual, acoustic and/or tactile i/o apparatus. The server stores treatment software which can be downloaded and executed at a client workstation or executed on a network in order to perform a visual, acoustic and/or tactile treatment of a CV impairment condition such as DDD. Prior to treatment, testing can be done to determine which sensory mechanisms are most impaired and which may be amenable to compensatory treatments. The results of the test are reported to the test taker and may be accompanied by further information which may or may not be dependent on the test results. The test results may also be communicated to the server which may, inter alia, obtain additional information from the test taker, administer additional tests, provide further result-dependent information, or utilize the test results for statistical tracking. Similar tasks can be done with the results of the treatment.

Treatment in accordance with the present invention is significantly more advantageous than other known treatment methods as it provides for uniformly administered treatment to a large population of individual subjects, while minimizing the number of persons required to administer the treatment. The treatment instructions will generally be the same, regardless of location, language and the specific idiosyncrasies of individual subjects, although the treatments can be tailored for a given subject and their disorder. Additionally, the influencing of a subject by other subjects, as in the case of a mass-administered treatment for

example, is avoided as are the distractions, anxieties and other factors at play in a group setting. This results in a more accurate, predictable treatment.

In one or more exemplary embodiments, the treatments carried out by the workstations or server are generally based on repetition of the visual, auditory and/or tactile tests described in U.S. Patents 3,952,728 and 4,706,686. In an exemplary embodiment, visual treatment is carried out at a workstation in accordance with software obtained from the server of the present invention. In accordance with an exemplary treatment procedure, a plurality of discrete objects moving in a continuous line between a pair of spaced stationary objects are displayed on the display monitor (e.g., CRT) of the workstation. The displayed objects are first held stationary and the subject reads the display from a distance at which the subject can normally see the entire display within his field of vision. A first, centrally located plurality of the displayed objects are then set in linear motion, while terminal objects arranged on either side of the moving objects remain stationary. The workstation or server will then query the subject to identify the displayed objects the subject was able to see. The workstation or server will then provide the subject with a result based on the subject's response.

Those subjects with a disorder may fail to see the entire display, i.e., subjects with CV dysfunctioning may have a field of vision that does not include both terminal stationary objects. Subjects that repeat the procedure improve their performance, through development or improvement of compensatory mechanisms or otherwise. Repetition of the procedure is an effective treatment and will improve the subject's performance both of the procedure and of similar tasks in their day-to-day lives as well as transfer improved CVS and related functioning to interconnecting circuits, thus triggering more widespread improvements.

This procedure is based upon the discovery that dyslexic subjects have a significantly smaller lateral field of vision than persons not suffering from dysmetric dyslexia, and therefore, when concentrating on a moving display of discrete objects will fail to see one or both of the terminal stationary objects. The use of a visual display consisting of a plurality of discrete objects moving in a continuous line in a single plane insures that the subject will concentrate on the moving objects and be capable of determining the individual terminal stationary objects without being confused by any other blurring vision reaction. Accordingly, the visual display although planar, is moved at a speed significantly less than the threshold level for blurring vision.

Preferably, the moving objects that are displayed are identical to each other and are different from the terminal stationary objects, which terminal objects are preferably themselves different from each other. Preferably, the objects are readily identifiable pictorial representations capable of being recognized even by the youngest of children. It is preferred that the terminal stationary objects be intermittently visible as, for example, by flashing the objects on the display, at a rate substantially equal to the linear movement of the series objects in the movable display. In the foregoing manner, any distractions from the purpose of determining the lateral or peripheral fields of vision are basically eliminated.

In a further exemplary treatment procedure in accordance with the present invention, a moving grid or scene is accelerated across a stationary visual sequence. CVS dysfunctioning (DDD) individuals, especially children, will frequently experience visual illusions (seeing the stationary sequence as blurred) and/or moving illusions (experiencing the stationary sequence and/or themselves in motion) whereas normal individuals will not. Repetition of the procedure improves performance and is an effective treatment.

In yet a further embodiment, a series of rapidly moving sequences are set in motion above the normal blurring speed and then slowed down until sequential recognition occurs. The whole sequence must be recognized to obtain a correct response. Recognizing just one segment of the whole sequence would be inadequate for total identification. With this procedure, it is possible to determine both diagnostic sequential scanning as well as compensatory single targeting, which dyslexics often attempt. Also, compensatory single tracking is often associated with a CV dysfunctioning individual becoming aware that he is tracking (conscious tracking). This occurs in most CVS dysfunctioning individuals below or equal to 1 ft/sec whereas normal individuals do not report this or do so at their normal blurring speed, e.g., 4 ft/sec. Repetition of the procedure improves performance and is an effective treatment of the disorder.

Additional procedures useful for the invention described herein are generally based on, but not disclosed in, tests disclosed in U.S. Patent No. 3,955,564, which is hereby incorporated by reference herein in its entirety. In the procedures of this invention, a server provides software over a network, such as the internet, or otherwise, that presents eye exercises to a subject on their workstation. The eye exercises induce a mild and tolerable nystagmus in a subject with a dysfunction (e.g., dysmetric dyslexia), and in so doing call forth compensatory mechanisms in the subject which are effective in improving their ocular fixation, sequential scanning and reading activity.

These compensatory mechanisms induced by this procedure, and other procedures of this invention, provide a reflex reduction of the subject's dysfunction. In fact, developing and improving compensatory mechanisms in the subject may prevent the dysfunction becoming irreversible in time while spreading improvement over interconnecting CVS circuits.

Thus, for example, improving visual functioning may simultaneously improve auditory processing and the reverse.

In one preferred form, the eye exercise is one which requires the subject to track sequential stimuli moving across their line of vision at a speed just below their blurring threshold. In another form, the subject is required to identify selected static, fixed foreground objects and figures while the background, which has a distracting influence of a controllable degree, is moved at a speed at or below the "distraction" or blurring threshold.

In a further exemplary embodiment, an auditory treatment is carried out at a workstation in accordance with software obtained from the server of the present invention. In such an embodiment, the workstation comprises conventional audio processing means, including, for example a sound card and one or more loudspeakers, and/or a headset. In accordance with an exemplary procedure, the workstation plays spoken words at a selected volume level. Simultaneously with this recitation of words, there is also presented in background relation thereto, auditory material which is initially at a selected volume level below that of the recited words. The subject is required to identify the spoken words by any appropriate method, such as by typing, repeating them, or by pointing to them on a display with a pointing device such as a mouse. The volume level of the background auditory material, however, is progressively increased while the subject continues his efforts to identify the recited words. A subject unable to identify the words because of an inability to suppress the background auditory material is identified as possibly having CV dysfunctioning and thus predisposition to DDD. Repetition of the procedure improves performance and is an effective treatment. As previously noted, enhanced auditory processing may also reflexively trigger visual and/or tactile processing improvements -- and others as well.

In another exemplary procedure according to the present invention, the rate of the recited words is progressively increased to pressure the ability of the listeners, and thus their cerebellar-vestibular system, to achieve proper identification of the recited words. In a related exemplary embodiment, the rate of recited words and sentences starts out very high--above the recognition speed--and then is decreased until recognition of the words and sentences can be repeated. Exceptions aside, the auditory recognition speed should equal the equivalent blurring speed and appears to be a more objective parameter.

In a further embodiment, treatment of a CV dysfunction can be based on the time delay experienced by some DDD between hearing and understanding what they hear. Because the thinking-brain of a dyslexic subject must learn to descramble and/or slow down input signals so as to adaptively respond, it frequently happens that there is a time lag between when a dyslexic hears something and when they register and respond. Thus often, a dyslexic person will ask a speaker to repeat what they said and then know what was said to them before it is repeated. For others, this time lag is greater and it is necessary to repeat the input several times before it registers. This lag in auditory perception is also frequently present when reading (visual lag) and has been mistakenly confused with a reading comprehension defect. In other words, because the signals come in to the thinking-brain too fast and/or too scrambled to be normally interpreted, it takes the thinking-brain longer to compensate for this dysfunction. This delay is a tachistoscopic-like measurement that can be made as an indication of CV dysfunction. Improving compensatory mechanisms with the treatments disclosed herein is beneficial to the subjects.

A similar difficulty occurs for some in terms of delayed motor responses, including saying what they want fast enough. Motor responses are slowed down to compensate

for difficulties with performing various CV-determined motor tasks such as writing, running, balancing, etc.

In a further exemplary embodiment, tactile treatment is carried out at a workstation in accordance with software obtained from the server of the present invention. In such an embodiment, the workstation comprises tactile stimulation means, including for example, a skin-contacting heat application device. In accordance with an exemplary treatment, the heat application device applies a progressively increasing pattern of an intermittently produced elevated temperature. Appropriate measurement or detection methods will find that dyslexic subjects perceive the stimulation as an uninterrupted heat source, i.e., one without a changing pattern, at a significantly lower rate of application than normal subjects. Repetition of the procedure will improve the subject's performance and thus help them with their dysfunction.

The treatment methods and apparatus of the present invention can quickly reach a widely distributed population of subjects from a centralized repository of information and knowledge regarding the aforementioned disorders. With the ongoing administration of such treatments, the knowledge base of this repository grows accordingly, thus helping to provide increasingly accurate and valuable advice as to the best course of treatment for each of a wide variety of related conditions.

Brief Description Of The Drawing

FIG. 1 shows a block diagram of an exemplary embodiment of a workstation in accordance with the present invention.

FIG. 2 shows a block diagram of an exemplary network in accordance with the present invention.

FIG. 3 shows a flow chart of an exemplary treatment session in accordance with the present invention.

FIG. 4A and FIG. 4B show exemplary embodiments of displays in accordance with the present invention.

FIG. 5 shows a schematic representation of exemplary acoustic stimuli presented to a subject being treated in accordance with the present invention.

FIG. 6A and FIG. 6B show exemplary embodiments of apparatus for applying tactile stimuli to a subject being treated in accordance with the present invention.

Detailed Description

Referring to FIG. 1, a computer workstation 100 is shown for carrying out treatments of individuals for cerebellar-vestibular (CV) disorders such as dysmetric dyslexia and dyspraxia (DDD), in accordance with the present invention. The computer workstation 100 can be implemented with a conventional personal computer, or the like, and typically contains a computer 102, having a CPU, memory, and mass storage, connected to a display monitor 104. The monitor 104 provides visual prompting and feedback to the user or subject being treated. Attached to the computer 102 are preferably a keyboard 105, speakers 106, a microphone 107, a mouse 108, and headphones 110. The computer 102 preferably contains a sound processing card, a data communications card and an input/output card for interfacing with peripherals, such as tactile stimulus means, described more fully below. The speakers 106 and the headphones 110 provide auditory prompting and feedback to the subject during execution of the treatment. The microphone 107 enables the computer to receive spoken input from the subject.

The mouse 108 allows the subject to navigate through the computer program, and to select particular responses after visual or auditory prompting by the workstation. The keyboard 105 allows entry of alpha numeric information into the computer 102. A variety of different computer platforms are applicable to the present invention, including the so-called "Wintel" compatible and MacIntosh compatible platforms.

FIG. 2 illustrates an exemplary computer network 200 comprising workstations 202, 204, similar to that described above with reference to FIG. 1, connected to a server or host computer 206. The connection between the computers 202, 204 and the server 206 can be made via a computer network, such as a local area network (LAN), a wide area network (WAN), a global computer network such as the Internet or World Wide Web, via modem connections, directly or through the Internet, or the like. The workstations 202, 204 include the appropriate data communications software, such as internet browser software (e.g., Netscape Navigator or Microsoft Internet Explorer), for enabling the workstations to communicate over the network 200 with other computers on the network, particularly the server 206.

The computer network 200 allows the bidirectional flow of information between each of the workstations 202, 204 and the server 206. Each workstation 202, 204, can access the server 206 and execute the treatments through the server, by, for example, downloading therefrom software (e.g., applets) for carrying out one or more treatment procedures in accordance with the present invention. The downloadable computer software may be kept on one or more servers 206 on the network, accessible by any client computer or terminal capable and authorized for such access. To facilitate treatment, the downloadable computer software and data can be downloaded once and reused repeatedly at the client workstation 202, 204. Alternatively, the downloadable computer software and data can be downloaded for each

individual treatment session via the network as needed. The various network computing techniques and implementations that can be used with the present invention are well known in the art and thus need not be described here in greater detail for brevity's sake. The treatment procedures can then be carried out by the workstation or server 202, 204 and the results reported to the server 206. Performance scores, statistics, and other subject information can flow from a subject's computer 202, 204 to the server 206. The server 206 can then review the information and can then download configuration and control information pertaining to a particular subject, back to the subject's computer 202, 204. The results can be evaluated locally at the workstation 202, 204 or by the server 206. A printer 208 may be coupled to a workstation 202, 204 thereby enabling a user to print out information, performance results, reports, etc. associated with the system of the present invention.

FIG. 3 shows a flow chart illustrating the major steps involved in the operation of an exemplary system of the present invention. As represented by step 301, a person using a workstation 202, 204, such as the workstation 100 described above, will establish a connection to the server 206 via the Internet, for example, using the workstation's browser software and data communications means. The user can browse a site maintained on the server 206, which site will provide the user with general information on cerebellar-vestibular disorders such as dysmetric dyslexia. In addition to browsing the site, the user can take one or more tests to determine whether he may suffer from such a disorder. At step 305, the user may download one or more software files to his workstation for execution of the treatments, or the treatments can be executed by the server. Considering the time-criticality of the treatment procedures (described more fully below) and the current limitations of global public data networks such as the Internet, the software to run the treatments is preferably downloaded from the server and

executed locally by the workstation. (Naturally, with improved network bandwidth and response, as in a LAN, and improved server performance, the treatments may also be executed remotely by the server in real time.)

At some point, such as prior to downloading the treatment software, the user may be asked to go through a questioning process 303 which may entail, for example, providing information about his condition by answering questions posed by the server 206. The questions may be preselected or selected by the server in accordance with the user's answers to prior questions. The information provided by the user may be used by the server 206 to determine which treatment or treatments to administer and thus which software to download to the user's workstation. Once the relevant treatment software has been downloaded, the treatment is executed at step 307. Once the treatment has been carried out at the workstation 202, 204, the results of the treatment may then be evaluated locally (step 309) by the workstation in accordance with the downloaded software. At step 311, the workstation may report the results of the treatment and its evaluation of the results to the user and at step 313 the workstation may communicate the results and its evaluation to the server 206.

Alternatively, the workstation may not perform an evaluation and simply report raw results to the server 206. In this case, the server 206 can evaluate the results and provide the user with its evaluation in real-time or the results can be provided to trained personnel who can evaluate the results off-line and provide their evaluation to the user at a later time, such as through e-mail.

As part of the post-treatment processing, represented by step 315, the server 206 may perform a variety of functions including obtaining additional information from the user, providing the user with additional information such as contact information for suggested health

care professionals specializing in the user's condition as indicated by the treatment results, administering additional treatment procedures including downloading additional software, incorporating the results in a statistical database, etc.

The operation of an exemplary embodiment of a system in accordance with the present invention will now be illustrated with reference to the administration of an exemplary treatment procedure which uses visual means to treat a cerebellar-vestibular condition such as dysmetric dyslexia. The visual procedure of the exemplary embodiment is based on the procedures described in U.S. Patent No. 4,706,686.

The aforementioned procedure can be illustrated and understood with reference to FIG. 4A which shows an exemplary, multipart image 410 as displayed on the monitor 104 of a workstation in accordance with the procedure carried out by the workstation. The image 410, as illustrated, comprises a central field 414 and flanking left and right fields 416 and 418, respectively.

Within the central field 414, a line of discrete, uniformly spaced objects 420 are displayed so as to move at a selected rate of speed from left to right, as indicated by the arrow A. The objects 420 are shown in FIG. 1 as being animals, specifically elephants, for ease of identification. The form of the objects 420 is not critical, except that they should be the same size, shape, color and ornamentation so as to simplify their recognition. Moreover the number of objects 420 in the field 414 should be such so as to be readily countable (e.g., 7), even by dyslexic subjects (at least while the objects are stationary). Further, the rate of speed at which the series of objects 420 are moved through the field 414, must be well below the threshold level of blurring, even for dyslexic subjects.

Simultaneously, a different non-movable object is projected in each of the flanking fields 416 and 418, shown in FIG. 4A as animals, namely, a bear 422 in the left field 416 and a giraffe 424 in the right field 418. The stationary objects 422 and 424 are different from the movable objects 420, so as to be easily distinguished and not confused with the movable objects 420, even by dyslexic subjects. The stationary objects 422 and 424 are periodically flashed on the monitor 104 at a rate substantially equal to that at which the individual movable objects 420 are moved across the central field 414.

Normal subjects at a given distance from the display monitor 104 will be able to see both flanking fields 416 and 418 as well as the central field 414 and will be able as well to determine the exact number of objects 420 within the central field 414. On the other hand, it has been found that dyslexic subjects will be unable to see both flanking fields 416 and 418 simultaneously with a moving central field 414, and will more than likely not to be able to count or determine the exact number of objects 420 within the central field, at the same time they view either one of the flanking fields. However, with repetition, a subject with a disorder will improve their performance by compensatory mechanisms or otherwise. The improved performance in the procedure will translate into improvement in other tasks in the subject's life and thus help to treat the subject's condition.

In carrying out the procedure, the software for executing the treatment is first downloaded from the server 206. The downloaded software is executed which causes the display monitor 104 to display the image of FIG. 4A. The subject and the monitor 104 should be placed at a distance relative to each other, and the size of the image should be selected so that the subject is just barely able to see the entire image. Alternatively, the distance between the subject and monitor are not changed but the size of the image on the screen is appropriately

adjustable. The movable objects 420 in the central field 414 are then caused to traverse across the display, in the direction of arrow A, starting at a very low speed below the threshold level at which blurring occurs so that the subject will maintain clear imaging of the objects. At the same time, the flanking fields 416 and 418 are flashed at the same rate or beat as the rate of travel of the central field 414. The workstation then queries the subject to report (a) if he can see the entire image 410, i.e., both flanking fields 416 and 418 as well as the central field 414, (b) and if not, which of the flanking fields he sees and the number of objects in the central field. For younger children who may not be adept at counting, the report can be simplified by determining which animals or, or how many different animals they, in fact, see. The subject may enter his response by any of a variety of means appropriate, such as by typing it on the keyboard 105 or by using the mouse 108 to point to one of several choices displayed on the display 104.

If a subject has successfully identified all objects with the procedure performed at a low speed (i.e., the speed of traversal of the objects 420 in the central field 414 and the flashing of the flanking objects 422 and 424), the procedure can then progress to higher speeds until the subject fails (e.g., from 0 to 6 ft/sec in increments of 0.2 ft/sec.) The subject's level of CV dysfunction with respect to these mechanisms can be used to determine the proper speed to use for treatment.

The exemplary visual treatment procedure described may also be run with the moving objects 420 traversing the central field 414 from right to left. In a further exemplary embodiment, the moving objects 420 may also traverse the display in a vertical direction (i.e., up or down). In this embodiment (not shown) the image of FIG. 4A is essentially rotated 90

degrees, with the peripheral stationary fields 416, 418 arranged at the top and bottom of the image and the central field oriented vertically between the peripheral stationary fields.

In a further exemplary procedure in accordance with the present invention, a smaller number (e.g., 3) of movable objects 420 are displayed in the center field 414, initially moving at a high speed so as to be appear blurred even to normal subjects. The flanking objects 322 and 324 are also shown, flashing at the same rate as the rate of traversal of the objects 420. The speed of the procedure is then progressively reduced until the subject completely recognizes the entire image displayed. For those subjects who cannot read, sequences of pictorial representations can be displayed instead of words.

As discussed, the above described visual treatment procedure is intended to measure and improve reflex (cerebellar-vestibular) fixation and tracking capacity. Many subjects, both dyslexic and normal, can enhance these reflex speeds by enhanced concentration and deliberate or conscious tracking. Such enhancement stems primarily from the thinking brain or cerebral cortex. Dyslexics can learn to concentrate harder and perform improved voluntarily tracking that will benefit them not only in these procedures but in normal day-to-day living.

An alternative exemplary embodiment of a visual treatment procedure will now be described with reference to FIG. 4B. As illustrated in FIG. 4B, the center field 414 comprises a stationary grid 415 (e.g., a picket fence, or the like) which the movable objects 420 traverse at an accelerating pace. Before setting the objects 420 in motion, the workstation 100 instructs the subject to concentrate primarily on the stationary vertical black stripes of the grid 415 and to indicate the onset of blurring once the objects 420 have been set in motion and accelerated.

In a further exemplary embodiment, the objects 420 are maintained in a stationary state as the grid 415 is accelerated across the central field 414. The subject is then queried to indicate if the objects 420 appear blurred and if the objects 420 or the subjects themselves are perceived as being in motion.

In yet a further exemplary embodiment, a visual treatment procedure in accordance with the present invention is based on the observation that dyslexics frequently focus their total attention on only one task at a time and on a small segment of their visual field. In this embodiment, a stationary object 420 is displayed in the center of the display while rapidly flashing visuals appear simultaneously and at varying peripheral distances equidistant from the central object. The user is prompted to identify the rapidly flashed visuals. By flashing different visuals at different distances from the central object, the subject's ability to identify the various visuals will thus provide an indication of the subject's visual span. As such, this procedure provides a quantitative measure of the subject's visual span at any fixed time of treatment, which improves upon repetition.

In a further exemplary embodiment of a treatment procedure in accordance with the present invention, potential CVS dysfunctioning is treated through the subject's ability to track front/back movement. This procedure employs the recognition that that CV dysfunctioning individuals frequently have greater difficulty tracking movement front/back, also known as flutter, as opposed to horizontal (i.e., right/left, left/right) and vertical (i.e., up/down, down/up) movements. In this exemplary visual treatment procedure, an image is initially shown on the display 104 at a flicker rate above the recognition threshold of even normal subjects and then slowed down until identification can be made. The front/back recognition speed thus determined, can be indicative of CV dysfunction, and can be improved upon repetition.

Atypically, the front/back recognition speed is spontaneously or developmentally compensated for so that recognition of reading material occurs despite low horizontal and/or vertical blurring speeds. Thus, abnormally low or high front/back values become diagnostic of CVS dysfunction and related DDD while indicating that another dimension is capable of conditioning and thus facilitating reading-related impairments.

It is also possible to set a stationary visual sequence with a slower flicker while a moving scene or grid is set into horizontal motion. This technique will enhance the numbers of CV dysfunctioning individuals who report blurring of this "stationary" visual background. Thus, the flicker can be adjusted as appropriate to treat a given subject.

In a preferred embodiment, the visual treatments can be carried out with a variety of colors which may vary from treatment to treatment and during a treatment. The color can be varied to determine, for example, whether a subject's ability to fixate on and track an image is color-dependent. The monitor 104 is thus preferably a color monitor. It is also preferable that the monitor 104 be of a low-glare variety or have glare-reducing means applied thereto.

One preferred treatment is to improve ocular fixation, sequential scanning and reading performance in a subject with a neurological dysfunction by offering an eye exercise procedure over the internet at an internet site through a server. The subject can access the procedure's software from their workstation computer over the internet, either by downloading the software or performing the exercise directly on the internet site. The eye exercise procedure involves providing images on the subject's computer screen that induce eye oscillations. The eye oscillations should be below the subject's or a theoretical or measured threshold level which produces blurred vision. Repetition of the induced eye oscillations results in beneficial compensatory mechanisms.

The induced eye oscillations can result form various images on the computer monitor, such as providing a visual display that moves across the subject's line of vision at a selected rate of speed. In another embodiment, the subject fixes their vision upon a foreground image on the monitor (e.g., words or other symbols) while a background image (e.g., pictorial representations) is moved at a selected speed and the subject is asked to identify changing foreground fixation objects against the moving background. Other embodiments can be derived by those of skill in the art from similar eye exercises such as those disclosed in U.S. Patent No. 3,955,564, which has been incorporated by reference herein.

Some subjects with impaired visual processing have different responses to specific word and object sizes and densities in a given field. An advantageous treatment can be to repeatedly present the subjects with the specific word and object sizes and densities for which they are having difficulty to encourage and improve compensatory mechanisms in them.

Once the subject has been treated by a specific procedure, the subject can then be further treated by any one or more additional treatments. Alternatively, the subject can be given relevant information or be asked to provide information. The subject can also be referred to an appropriate clinic or professional.

In addition or as an alternative to the visual treatment procedures disclosed herein, the system of the present invention can be used to administer an exemplary procedure which uses auditory principles to treat a cerebellar-vestibular dysfunction such as dysmetric dyslexia. Exemplary auditory treatment procedures, which, upon repetition form the basis for a treatment procedure of the present invention are generally based on the procedures described in U.S. Patent No. 3,952,728.

The aforementioned auditory treatment procedure can be carried out by a workstation 100 operating in accordance with software downloaded from the server 206. In this case, the software controls the presentation of auditory information via the sound control card and loudspeakers 106 or headphone 110. In accordance with an exemplary treatment procedure, the workstation 100 generates through one or both speakers 106 a stream of words recited one after the other, preferably in a language understood by the subject. The recited words are referred to herein as foreground auditory material. The foreground auditory material is presented at a selected volume level which is not varied during the execution of the treatment procedure.

During the presentation of the foreground auditory material, the workstation 100 simultaneously generates background auditory material. The background auditory material is also played through the loudspeakers 106 (or headphone 110). The background auditory material may also comprise a stream of words, preferably spoken with a different voice than the foreground material. Initially, the background auditory material is generated at a volume level which is significantly below the volume level of the foreground auditory material but which, in accordance with the present invention, is progressively increased until it approaches the volume level of the foreground auditory material.

As the foreground and background auditory materials are played through the workstation audio sub-system, the subject is required to identify the foreground auditory material despite the distraction caused by the background auditory material. In a preferred embodiment, the subject is instructed to identify the foreground material by speaking it into the microphone 107. Using well-known voice recognition techniques, the computer compares the subject's spoken input with the foreground auditory material to determine whether the subject

has correctly identified the foreground auditory material. In alternative embodiments, the subject can use other input means provided by the workstation, such as the keyboard 105 to type the words he hears or the mouse 108 to select one of several graphical representations of the words he hears. A failure to properly identify the foreground auditory material is a potential indication that the subject suffers from a CVS dysfunction or dysmetric dyslexia. As discussed, dysmetric dyslexia is a condition caused by a dysfunctioning cerebellar-vestibular system, and said dysfunction results in an inability of the individual to suppress the distraction caused by the background auditory material so that proper identification can be made of the foreground auditory material. It therefore follows that a subject unable to make this suppression in all probability has a cerebellar-vestibular dysfunction and consequently also suffers from dysmetric dyslexia. Repetition of the procedure results in improved responses that translate into the subject's improving their performance on many tasks in their day-to-day living.

FIG. 5 provides a graphic representation of the manner in which the auditory material is presented by the workstation to the subject under examination. Specifically, the foreground auditory material 520, consists, as indicated above, of common words recited one after the other, as exemplified by the word "boy" designated 522, the word "dog" 524 and the word "cat" 526. The vertical dimension of these words is intended to illustrate the volume level 528 at which these words are presented to the subject. Following the recitation of word 522, there is a selected time interval 530 (e.g., one or two seconds) which is followed by the recitation of the word 524, another time interval 530, the word 526, and then possibly other common words. Following the recitation of this sequence of words at the volume level 528, the sequence is repeated at the same volume thereby providing word recitation repetitions 532, 534, and so forth.

During the presentation of the foreground auditory material 520, the background auditory material is generated, which as discussed above is intended to interfere, in a controlled manner, with the identification of the foreground auditory material. Such background auditory material, designated generally by the reference numeral 540, may, in a preferred exemplary embodiment, consist of words in a language which is not known to the subject. For example, the background material 540 may consist of the French word "parler" 542 and "vous" 544.

As mentioned, the background material 540 is presented initially at a volume level 546 which is significantly less than the volume level 528 of the foreground auditory material 520. As the procedure progresses, the volume level 546 is progressively increased until it approaches the volume level 528 of the foreground material. The form of background auditory material 540 just described also contemplates presentation of the words 542 and 544 in the time interval 530 between succeeding foreground adjacent words 522 and 524.

Another form of background auditory material which may be effectively used in accordance with the present invention is that designated generally by the reference numeral 550. This auditory material may also consist of words of a foreign language, as exemplified by the words 552, 554 and 556, the same being presented initially at the previously noted diminished volume level 546. The background auditory material 550 differs from the background auditory material 540, however, in that the words 552, 554 and 556 thereof are presented not only during the time interval 530 but in superimposed relation to the foreground recited words 522, 524 and 526, and so on.

As shown in FIG. 5, successive iterations of the background auditory material 550 are made at progressively increasing volume levels, such as volume levels 558 and 560. Individuals who are not CV dysfunctioning or dysmetric dyslexic have no difficulty in

suppressing the distracting background auditory material 540, 550, and consequently making proper identification of the foreground auditory material 520. Ultimately, when the volume level of the background material 550 reaches the level 560 (which will be understood to be almost the level 528 of the foreground auditory material 520), some difficulty may be experienced even by normal subjects. Individuals, however, who are CV dysfunctioning or dysmetric dyslexic are unable to make proper identification of the foreground auditory material 520 even when the background auditory material is at a significantly diminished volume level, as exemplified by level 546. CV Dysfunctioning or dysmetric dyslexic subjects may, for example, identify the foreground word 522 and next identify the foreground word 526 but entirely miss the intermediate foreground word 524. In some instances, the dysmetric dyslexic subject may fail to identify several of the foreground words 520 and, in some instances may totally fail to identify any of the words in a given sequence. Repetition of the procedure results in improved responses which translate into the subject's improving their performance on many tasks in their day-to-day lives.

The auditory treatment procedure of the present invention may be administered in conjunction with the visual treatment described above or as a stand-alone treatment. Administering both treatments provides an additional, integrated approach to treating any impairment or dysfunctioning of the cerebellar-vestibular system of the subject. As may readily be appreciated, if the failure in the identification of the foreground material 520 consists of isolated instances of missing only one word thereof, this would indicate a functional impairment or dysfunctioning of the cerebellar-vestibular system which is not as severe as when the failure in the identification consists of missing many or all of the words of the recited sequence. In this

case, an overall treatment program can be modified to exclude or appropriately limit particular treatments.

In a further exemplary embodiment, instead of using recited words as the background auditory material 540, 550, and thus material of the same quality as the foreground auditory material 520, use can effectively be made of music or a different quality sound as the background auditory material, and still provide an effective method of treating subjects who are dysmetric dyslexic.

In yet another embodiment, the foreground auditory material 520 can be presented as recited words 522, 524, etc. with a time interval 530 therebetween which can be progressively diminished until the succeeding words are recited almost one upon the other. Recitation in this manner also requires a properly functioning cerebellar-vestibular system to enable identification by the listener of the recited words in the sequence in which they are recited. Here again, individuals who are CV dysfunctioning or dysmetric dyslexic have more difficulty than normal individuals in maintaining a recognition of a rapid recitation of words. In a sense, therefore, the time intervals 530 between adjacent words 522, 524 are a form of background and the variation thereof influences the recognition or identification of the recited words. Repetition of the procedure improves the performance of individuals who are dysmetric dyslexic. This embodiment can provide objective data on and improvements in auditory discrimination or processing.

In addition to progressively diminishing the time intervals 530 between words in the foreground auditory material, a background auditory distraction can also be used to treat or improve the subject's cerebellar-vestibular system dysfunction. The background distraction can take many forms, such as music or a foreign language. When using a background sound, the

treatment is thus intensified. Proper identification requires a cerebellar-vestibular system that can keep in proper sequence the words 522, 524, as they are recited at an accelerating rate, while properly suppressing or blocking-out the distraction caused by the background auditory material. The background can be of a fixed volume level, or it may have an initial low volume level which is progressively increased, depending on the extent it is desired to interfere with the subject's efforts to identify the foreground test words. Therefore, the treatment can be appropriately adjusted for a given patient.

In a further exemplary embodiment, instead of accelerating the recitation of words, the treatment can begin with the rapid recitation of words above the recognition speed of even normal subjects. The speed of the treatment is then progressively reduced until the subject can recognize the recited foreground material.

A further exemplary embodiment of a treatment procedure in accordance with the present invention is based on the subject's directional abilities. More specifically, it has been found that some individuals with cerebellar-vestibular dysfunction have difficulty localizing the direction from which signals are presented to the subject. In the case of sounds, the subject may have difficulty determining the direction of the source of a sound signal. In accordance with the present invention, the workstation 100, under the control of appropriate software can randomly generate a sound from one or the other of the two speakers 106 (See FIG. 1) and query the subject to identify which speaker (e.g., the left or the right speaker) generated the sound. This treatment can be repeated several times and the results reported to the subject and/or the server 206. Repetition of the procedure results in improved results which translate into the subject's improving their performance on many tasks in their day-to-day lives.

In addition or as an alternative to the visual and auditory treatment procedures described above, the system of the present invention can be used to administer an exemplary treatment procedure which uses tactile principles to treat a cerebellar-vestibular condition such as dysmetric dyslexia and dyspraxia. The tactile treatment procedure of the exemplary embodiment is generally based on repetition of the testing procedures described in U.S. Patent No. 3,952,728.

The tactile treatment procedure of the present invention can be carried out by a workstation 100 operating in accordance with software downloaded from the server 206. In this case, the software controls a tactile stimulation device for the presentation of tactile stimuli to the subject being treated. The results of the treatment are evaluated to determine if the subject is improving. Dysmetric dyslexic individuals, because of their cerebellar-vestibular dysfunction, respond to stimuli in a characteristically different way than do normal individuals, whether the stimuli be auditory or tactile. This response will now be described in detail in connection with two exemplary methods and apparatus for their practice, which utilize tactile stimulation and which are illustrated in FIGs. 6A and 6B.

FIG. 6A shows an exemplary arrangement in which thermistors 670, 672 and 674 are arranged on various points of the subject's skin. As is generally understood, a thermistor has a large thermal co-efficient of resistance, such that when energized electrically, the current flow through the body of the thermistor causes a flat contact surface 676 of the thermistor to attain an elevated temperature significantly above the ambient temperature. The contact surface 676 of each of the thermistors 670, 672, and 674 is placed in contact with the subject's skin by any appropriate means (e.g., being adhesively taped) at the locations illustrated. These locations may typically include location 678 at the upper portion of

the arm, location 680 at the forearm, and location 682 at the patient's waist. Each of the thermistors are connected by a conductor 684 to an output of an output card 690 installed in the workstation 100. The output card 690, under the control of software executed by the workstation, selectively activates each of the thermistors 670, 672, and 674 at a selected level so as to generate a thermal, tactile stimulus at the point of contact between each thermistor and the subject's body. The output card 690 can be implemented, for example, with a multi-channel digital-to-analog output card such as the PCI-1720-A available from Advantech Co., Ltd. of Cincinnati, Ohio. As can be understood, the thermistors can also be activated by other circuit configurations controlled by the workstation 100 (e.g., a specialized control circuit coupled to the parallel or serial ports of the workstation).

The rate, duration and intensity of activation of each thermistor and the interval between activation of successive thermistors can be controlled by software executed by the workstation 100.

In operation, whenever a thermistor 670, 672, 674 is activated by the control card 690, there is a current flow to the thermistor and an increase in temperature on the contact surface 676 of that thermistor. In an exemplary treatment procedure, the controller 690 sequentially energizes the thermistors 670, 672, 674 in a regular pattern, with only one thermistor on at a time applying a sensation of an elevated temperature to the respective point on the subject's body. The thermistors are preferably energized intermittently, thereby providing an interval between the application of stimuli by successive thermistors. As the treatment progresses, the speed of activation of the thermistors may be increased thereby increasing the rate at which the tactile sensations are applied by the thermistors to the subject's skin.

It has been found that CV dysfunctioning or DDD subjects perceive the tactile stimulation, although intermittent, as a steady, continuously applied stimulation at a significantly lower speed of application than do normal subjects. In other words, even at low rates of tactile stimulus application, a CV dysfunctioning or DDD subject will be unable to perceive the intermittent nature of the tactile pattern. By contrast, normal subjects have no difficulty perceiving the intermittent pattern of the tactile stimulation until the rate of stimulation is quite high. However, by repetition of the procedure, the dysfunctioning subject will improve their performance which will also improve their performance on similar tasks in their day-to-day lives.

In an exemplary embodiment of a procedure in accordance with the present invention, the workstation 100 activates the thermistors in a given pattern based on the positioning of the thermistors. For example, the thermistors may be activated in a clockwise or counterclockwise circular pattern. More complex patterns are possible with larger numbers of thermistors; e.g., four thermistors can be activated in clockwise and counterclockwise circular patterns or in figure-8 patterns. In carrying out a treatment, the computer will activate the thermistors in a given pattern and query the subject to identify the pattern and/or the direction of the pattern. Where blurring occurs, the subject will be unable to identify the pattern. The computer preferably alters the activation pattern regularly so as to increase the difficulty of the procedure. The rate of activation can be increased progressively until blurring occurs.

FIG. 6B illustrates a further exemplary embodiment of an arrangement for executing a tactile stimulation treatment in accordance with the present invention. In the arrangement of FIG. 6B, one thermistor 600 is used on the subject's forearm at location 602. The thermistor 600 is coupled to the control card 690 via a conductor 608. The thermistor 600

is activated intermittently by the controller 690. The rate, duration and intensity of thermistor activation and the interval between successive activations can be varied under software control.

It is generally known that at a substantially lower application rate than for normal subjects, DDD subjects perceive the tactile stimulation as a continuously applied elevated temperature because of the "blurring" or tactile scrambling that is produced by the dysfunction of their cerebellar-vestibular systems. Improved responses result from repetition of the procedure. As such, the procedure of FIG. 6B can be administered as a treatment for cerebellar-vestibular defects such as dysmetric dyslexia.

As in the case of visual and auditory treatment, described above, in a further exemplary embodiment of a tactile treatment procedure, the treatment can begin with the rapid application of tactile stimuli at a rate above the recognition threshold even of normal subjects. The application rate is then reduced until the subject can recognize the stimuli as discrete events. Repetition of the procedure results in improved results which translate into the subject's improving their performance on many tasks in their day-to-day lives.

Preferred embodiments of the invention use a server which provides a visual, auditory or tactile treatment, embodied in a software program, to an individual subject's workstation. The workstation has a monitor for any visual treatments. The workstation also preferably has a speaker or speakers for any auditory treatments. The workstation also preferably is configured to provide tactile stimulation if tactile treatments are to be done.

The individual subject is preferably treated at a workstation. For a visual treatment, a visual display on the workstation's computer monitor is preferably configured to provide linear arrangements of moving objects and stationary objects which are arranged adjacent to the moving objects. Preferably, eye oscillations are induced in the subject through

the visual display and the point at which the individual subject's vision is blurred is recorded. Eye oscillations may be preferably induced by having the visual display move across the individual subject's line of vision at a selected rate of speed. At some speed, the individual subject's vision will blur, and the individual subject will improve with repetition.

In another preferred embodiment, the individual subject is instructed to fix their vision upon a point on a foreground region on the visual display of the computer monitor, a background on the visual display is moved at a selected speed or rate, and the individual subject identifies changing foreground fixation objects against the moving background. The speed of the background at which the individual subject experiences blurring is recorded and it will improve with repetition.

In a preferred embodiment for treating auditory dysfunction, the workstation provides foreground auditory material (e.g., words in the native or a foreign language) and background auditory material (e.g., words or music). Most preferably, the rate or volume (most preferably one or the other) at which the background (or foreground) material is presented may be varied and the point at which the individual subject experiences "blurring" or an inability to distinguish the sounds is recorded, which will improve with repetition.

In a preferred embodiment for treating tactile dysfunction, the workstation provides tactile stimulation (e.g., heat or touch) that varies in intensity and/or rate. As the rate (or intensity) increases, an individual subject will experience an inability to distinguish between different stimuli. The point at which this occurs is recorded, which will improve with repetition.

Preferably, the values at which visual, auditory or tactile "blurring" occurs (e.g., a distraction threshold at which the inability to distinguish or identify different visual, auditory

or tactile stimuli is manifest) are recorded and evaluated to determine whether repetition of the procedures is resulting in improvement, either at the workstation or the server or elsewhere. The improvement gained by the individual subjects through compensatory mechanisms or otherwise will translate into the individual subject's day-to-day life in improvements in visual, auditory and tactile tasks and activities.

Although visual, auditory and tactile treatment procedures have been described as being administered individually, it is possible to administer any combination of these treatments simultaneously. In fact, because many dyslexic subjects have difficulty processing simultaneous stimuli or concentrating on more than one thing at a time, it can be expected that when different types of stimuli are combined, blurring or scrambling for most CV dysfunctioning or dyslexic individuals will occur at a lower speed than when the stimuli applied are of only one type. Accordingly, repetition of combined stimuli treatments acts as a further treatment of a dysfunction.

Furthermore, to aid in their administration to young subjects and to assist with remediation, at least some of the above-described procedures can be administered in a game-like format that the subject will enjoy playing repetitively with hopefully improving results. For example, a procedure may be administered as a scored game, with higher scores rewarded for faster recognition speeds. Thus rewarding individuals scoring better and better in games, hopefully results in progressively higher recognition speeds for visual, auditory and tactile patterns.

What is claimed is:

1. A method of treating a neurological dysfunction, comprising the steps of:

providing a workstation;

establishing communication between the workstation and a server;

downloading software from the server to the workstation;

executing the software at the workstation, wherein the software provides a treatment for a neurological dysfunction; and

evaluating results of the treatment to determine the progress of the treatment of the neurological dysfunction.

2. The method of claim 1, further comprising communicating the results of the treatment to the server.

3. The method of claim 1, wherein the treatment comprises generating a stimulus and capturing a response to the stimulus.

4. The method of claim 3, wherein the stimulus comprises at least one of a visual, auditory and tactile stimulus.

5. The method of claim 4, wherein the visual stimulus comprises a linear arrangement of moving objects and stationary objects arranged adjacent to the moving objects.

6. The method of claim 4, wherein the auditory stimulus comprises a foreground auditory material and a background auditory material.

7. The method of claim 4, wherein the tactile stimulus comprises an application of heat to a portion of a subject's body.

8. The method of claim 3, wherein the stimulus generated is sensed by only one subject and the response captured is generated by the only one subject.

9. A storage medium comprising a computer-executable program for administering a procedure to treat a neurological disorder, the storage medium being accessible to a subject over a network, and the procedure comprising generating a stimulus and capturing a response to the stimulus, wherein the stimulus comprises at least one of a visual, auditory or tactile stimulus.

10. The storage medium of the claim 9, wherein the network comprises the Internet.

11. The storage medium of claim 9, wherein the captured response is evaluated to determine whether the treatment is proceeding favorably.

12. A method for improving ocular fixation, sequential scanning and reading performance in a subject with a neurological dysfunction comprising:

providing an internet site that contains an eye exercise procedure;

communicating the eye exercise procedure to a subject; and

practicing the eye exercise procedure, wherein the eye exercise procedure comprises inducing an eye oscillation of a selected extent, which is below the threshold level producing blurred vision for the subject, using a visual display on a computer monitor, whereby repetition of the induced eye oscillation results in compensation for the neurological dysfunction.

13. The method of claim 12, wherein the visual display on the computer monitor moves across the subject's line of vision at a selected rate of speed.

14. The method of claim 12, wherein the subject is instructed to fix their vision upon a point on a foreground region of the visual display on the computer monitor, moving a moveable background on the visual display at a selected speed, and having the subject identify changing foreground fixation objects against the moving background.

15. The method of claim 14 wherein said foreground comprises words and said background comprises pictorial representations.

16. A method for treating dyslexia comprising:

providing one or more treatments for dyslexia to a subject's workstation through the internet, wherein the one or more treatments for dyslexia comprise a visual treatment comprising a linear arrangement of moving objects and stationary objects arranged adjacent to the moving objects or an auditory treatment comprising foreground auditory material and background auditory material or a tactile treatment comprising application of heat to the subject's body;

having the subject practice the one or more treatments; and

evaluating the results of the one or more treatments to determine whether there has been any effect.

17. A storage medium comprising a computer-executable program for administration of one or more treatments for dyslexia over the internet to a workstation;

wherein the one or more treatments for dyslexia comprise a visual treatment comprising a linear arrangement of moving objects and stationary objects arranged adjacent to the

moving objects or an auditory treatment comprising foreground auditory material and background auditory material or a tactile treatment comprising application of heat to the subject's body; and

wherein the administration comprises providing the one or more treatments over the internet to the workstation and evaluating results of the treatments to determine whether there has been any effect.

18. A treatment system for individually treating large numbers of subjects for a neurological dysfunction comprising:

a server in communication over the internet with a workstation;

a treatment comprising foreground auditory material and background auditory material, wherein the rate or volume at which the foreground or background material is presented is varied and the point at which an individual subject cannot distinguish the foreground material from the background material is measured; and

the server sends the treatment to the workstation over the internet and the individual subject takes the treatment on the workstation.

19. The treatment system of claim 18 wherein the volume of the background material is varied and the volume of the foreground material is kept constant.

20. The treatment system of claim 19 wherein the rate of the presentation of the background material is varied and the presentation of the foreground material is kept constant.

21. The treatment system of claim 18, wherein the foreground material is words and the background material is either words or music.

22. An internet system for individually treating large numbers of subjects for a neurological dysfunction comprising:

a server in communication over the internet with a workstation configured to provide tactile stimulation;

a treatment comprising applying a pattern of tactile stimulation to an individual subject, varying the rate or intensity of the stimulation and measuring the rate or intensity at which the individual subject cannot distinguish between two stimuli; and

the server sends the treatment to the workstation over the internet and the individual subject takes the treatment on the workstation.

23. The internet system of claim 22, wherein the tactile stimulation is heat applied to one or more areas of the individual subject's body.

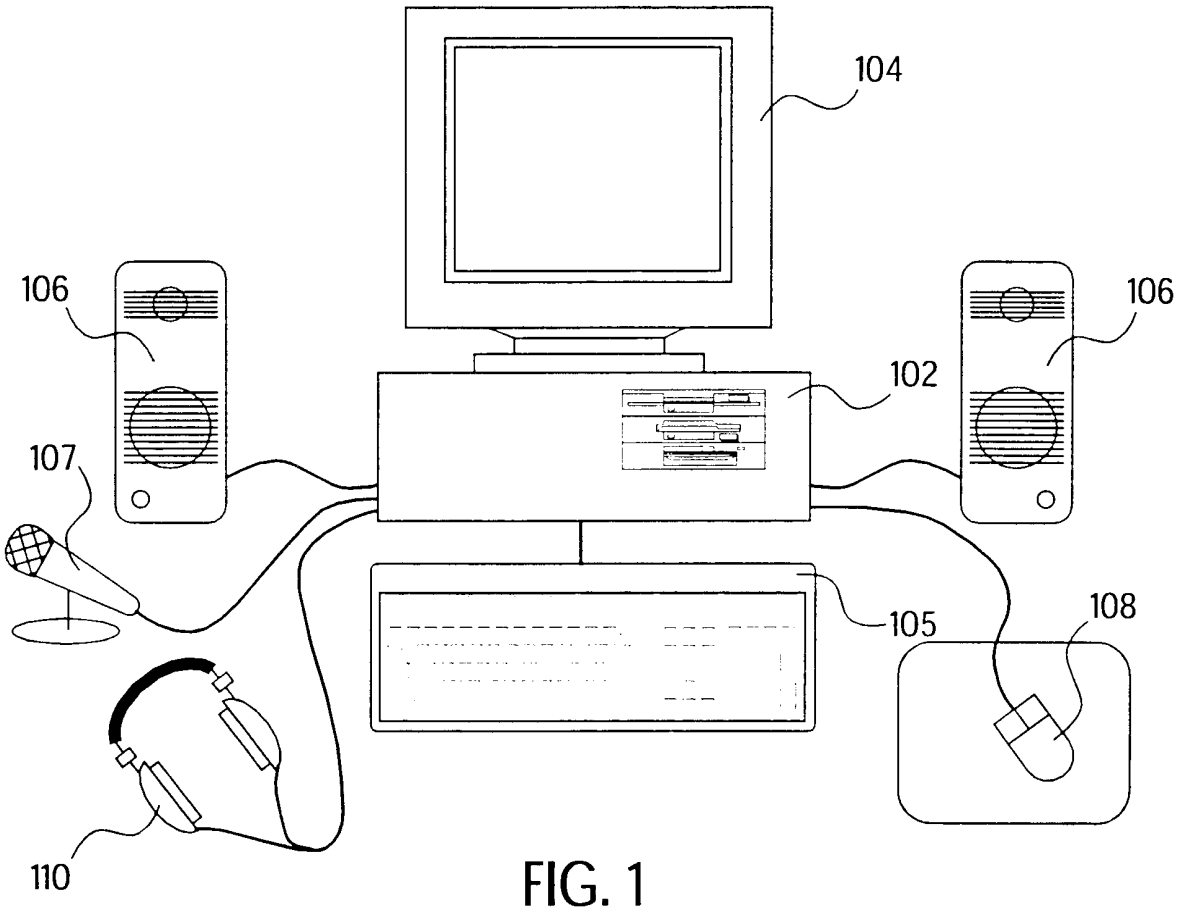


FIG. 1

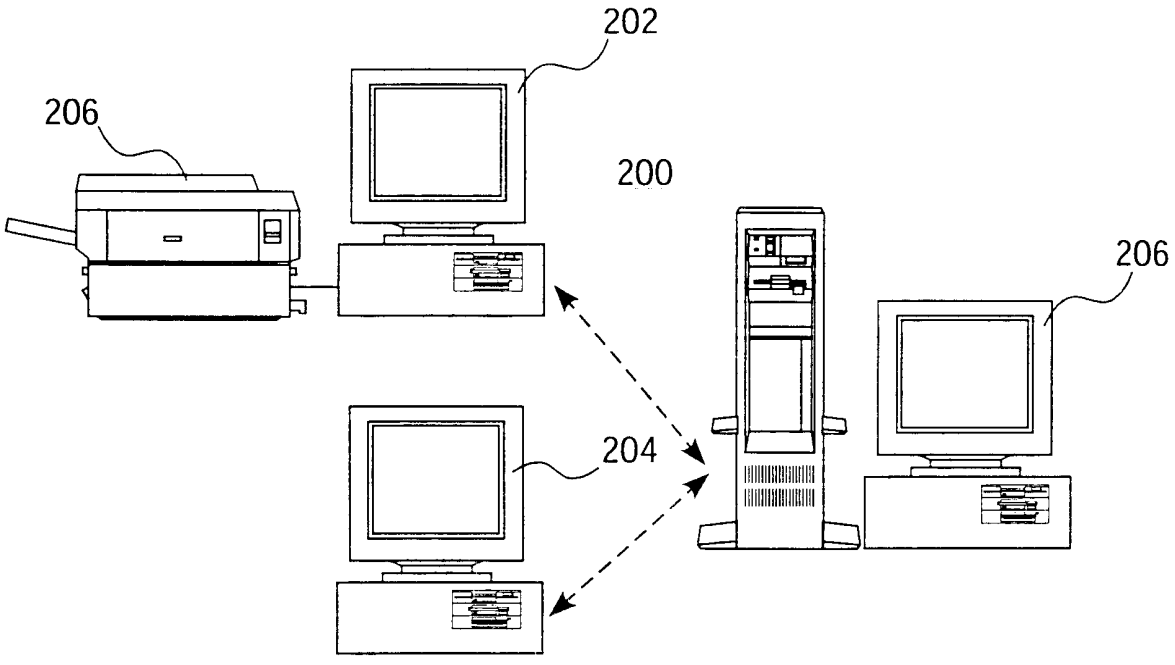


FIG. 2

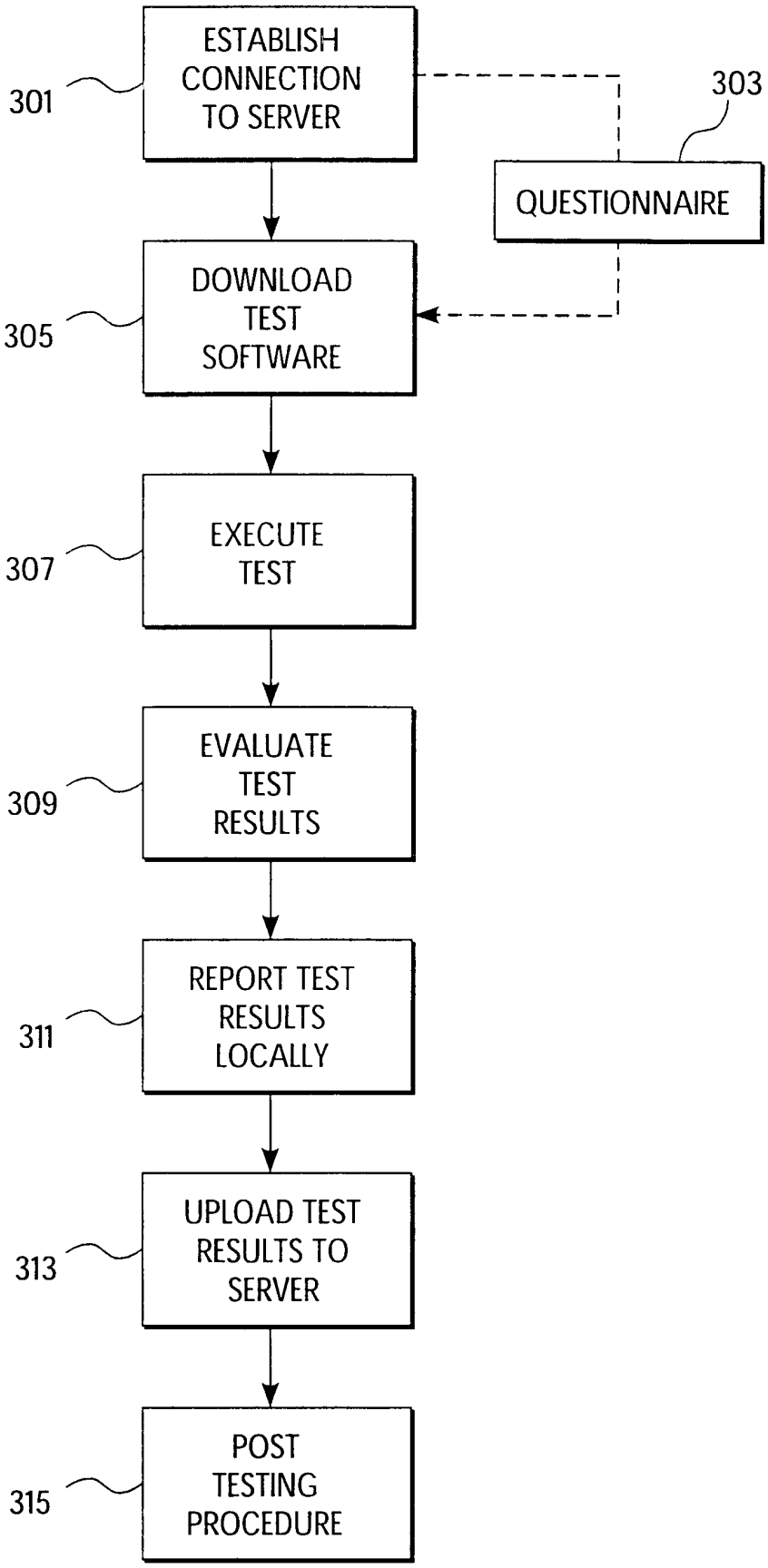

ESTABLISH CONNECTION TO SERVER
301
303
QUESTIONNAIRE
DOWNLOAD TEST SOFTWARE
305
EXECUTE TEST
307
EVALUATE TEST RESULTS
309
REPORT TEST RESULTS LOCALLY
311
UPLOAD TEST RESULTS TO SERVER
313
POST TESTING PROCEDURE
315

FIG. 3

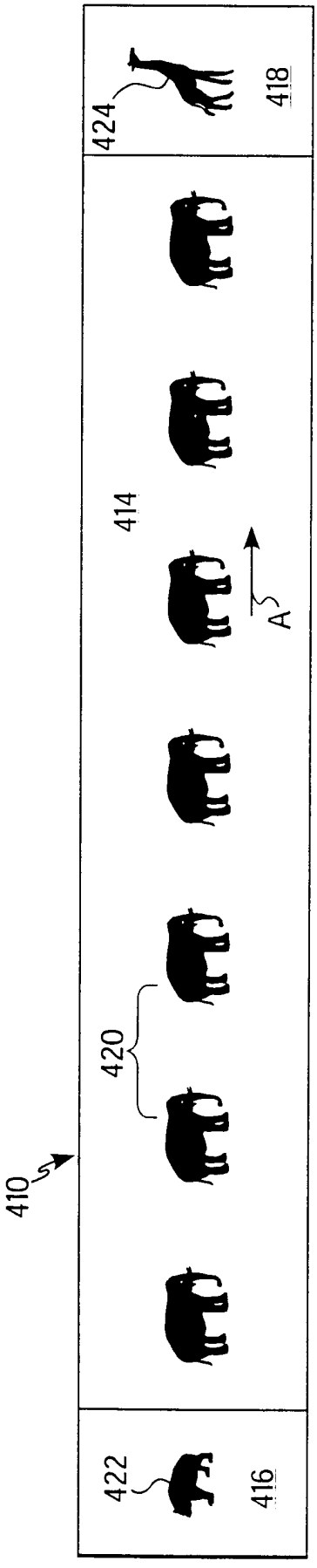


FIG. 4A

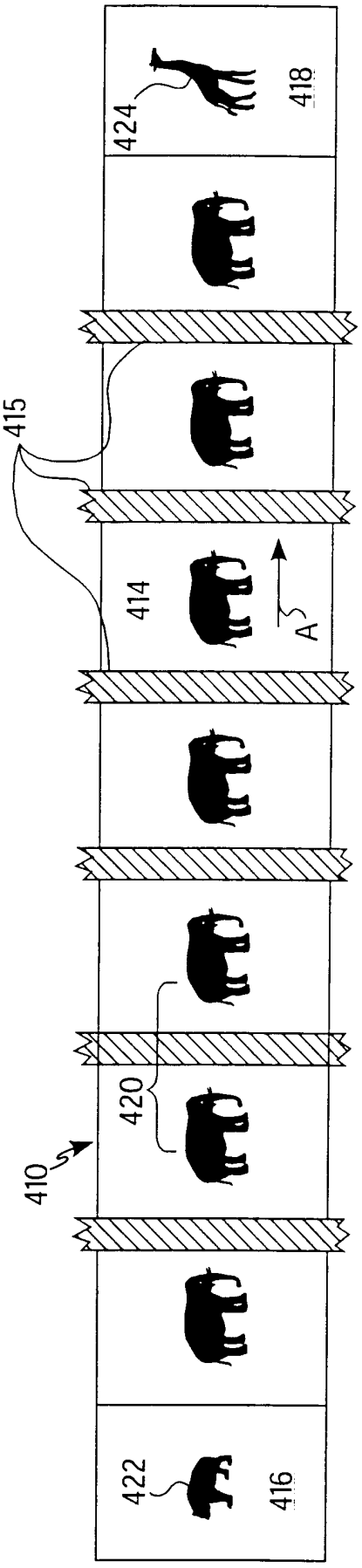
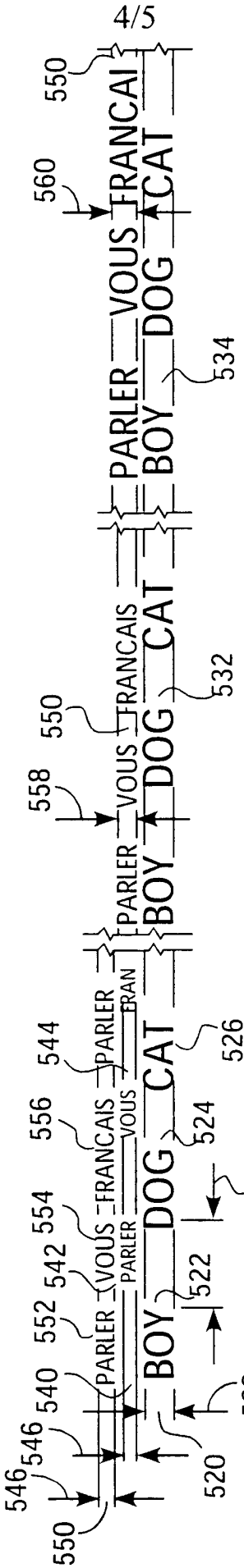


FIG. 4B


550
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CAT
VOUS
DOG
PARLER
BOY
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FRANCAIS
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558
VOUS
DOG
PARLER
BOY
544
PARLER
FRAN
526
556
FRANCAIS
VOUS
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554
VOUS
PARLER
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542
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552
PARLER
VOUS
540
BOY
DOG
CAT
528
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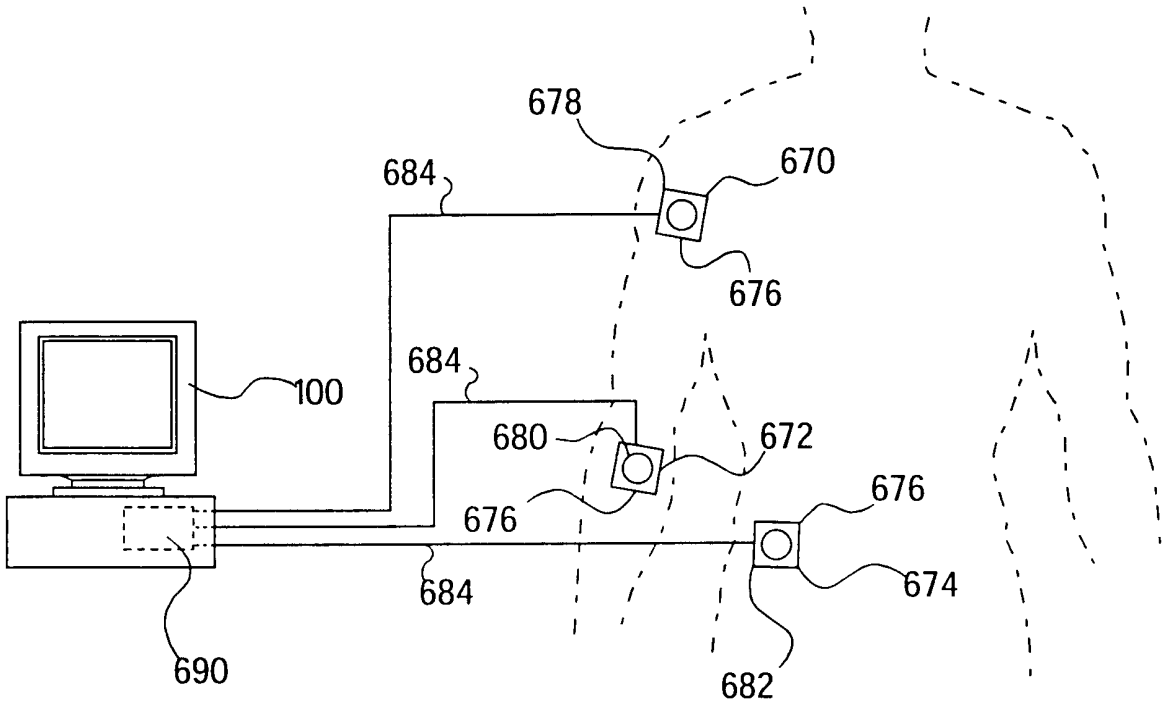
520
550

FIG. 5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100
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680
672
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676
674
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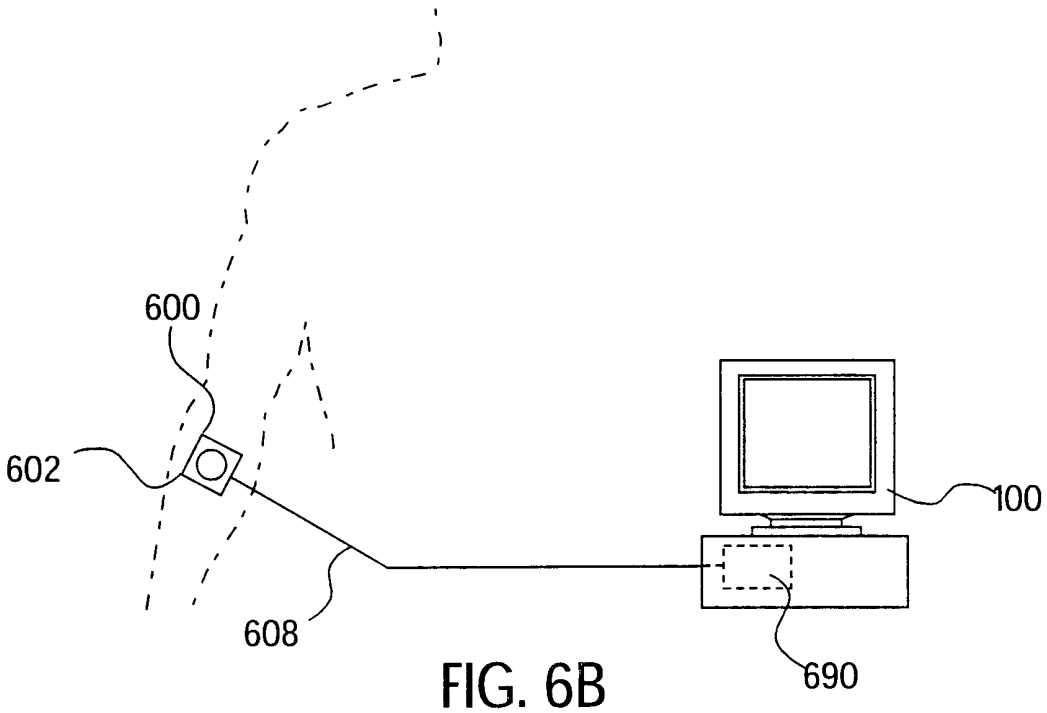
682

FIG. 6A


600
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100
608
690

FIG. 6B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/04630

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :A61B 5/00
US CL : 600/300
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)
U.S. : 600/300, 558, 559, 587

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
XP	US 6,168,563 A (Brown) 02 January 2001, see figs. 1-32	1,2,9-11,17
YP		3-8,15, 16,18-23
Y	US 3,952,728 A (Levonson et al.) 27 April 1976, see figs. 1-4	3-8,16,18-23
Y	US 4,889,422 A (Pavlidis) 26 December 1989, see fig. 1	3-8,16,18-23
A	US 5,997,476 A (Brown) 07 December 1999	1-23
A	US 5,935,060 A (Iliff) 10 August 1999	1-23
A,P	US 6,045,515 A (Lawton) 04 April 2000	1-23

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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
"E"	earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 08 JUNE 2001	Date of mailing of the international search report 28 JUN 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer MAX HINDENBURG Telephone No. (703)- 308-0858

Form PCT/ISA/210 (second sheet) (July 1998)★