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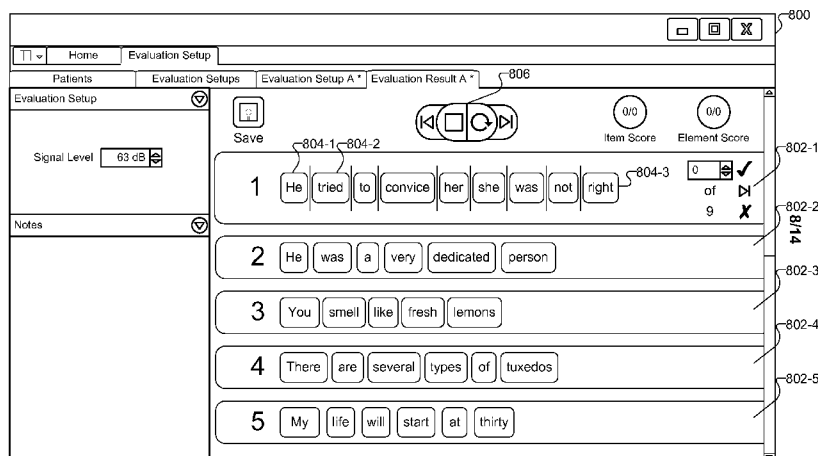


Fig. 8

(57) Abstract: An exemplary programming system presents, in response to user input provided by a user and during an evaluation period during which the programming system is communicatively coupled to a cochlear implant system associated with a patient, an audio clip to the patient. The audio clip includes a plurality of elements. The programming system displays, during the evaluation period, a graphical user interface for experiencing by the user and that includes a plurality of graphical objects each representative of a different element included in the plurality of elements, detects an interaction by the user with a graphical object included in the plurality of graphical objects and representative of a particular element included in the plurality of elements, and determines, based on the interaction by the user with the graphical object, an evaluation score for the patient.

SYSTEMS AND METHODS FOR FACILITATING EVALUATION OF COCHLEAR IMPLANT SYSTEM PERFORMANCE

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BACKGROUND INFORMATION

[0001] It is often desirable to evaluate how well a cochlear implant system is performing for a particular patient. For example, it may be desirable to present the patient with audio clips (e.g., audio clips that include speech and/or other material of interest) at different loudness levels and/or different signal-to-noise ratios and determine how well the patient recognizes the content of the audio clips at the different loudness levels and/or at the different signal-to-noise ratios.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The accompanying drawings illustrate various embodiments and are a part of the specification. The illustrated embodiments are merely examples and do not limit the scope of the disclosure. Throughout the drawings, identical or similar reference numbers designate identical or similar elements.

20 [0003] FIG. 1 illustrates an exemplary cochlear implant system according to principles described herein.

[0004] FIG. 2 illustrates a schematic structure of the human cochlea according to principles described herein.

25 [0005] FIG. 3 shows an exemplary configuration in which a programming system is communicatively coupled to a sound processor according to principles described herein.

[0006] FIG. 4 illustrates an exemplary implementation of the programming system shown in FIG. 3 according to principles described herein.

30 [0007] FIG. 5 illustrates an exemplary programming system according to principles described herein.

[0008] FIG. 6 shows an exemplary flowchart that includes various steps that may be performed in order to calibrate an audio clip for a particular loudness level requested by a user according to principles described herein.

35 [0009] FIGS. 7-12 show various graphical user interfaces that may be displayed according to principles described herein.

[0010] FIG. 13 illustrates an exemplary method of facilitating evaluation of cochlear implant system performance for a patient according to principles described herein.

[0011] FIG. 14 illustrates an exemplary computing device according to principles described herein.

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DETAILED DESCRIPTION

[0012] Systems and methods for facilitating evaluation of cochlear implant system performance for a particular patient are described herein. As will be described in more detail below, a programming system may present, in response to user input provided by a user and during an evaluation period during which the programming system is communicatively coupled to a cochlear implant system associated with a patient, an audio clip to the patient. The audio clip may include a plurality of elements (e.g., a plurality of words that form a sentence) that may be configured to be audible to the patient. During the evaluation period, the programming system may display a graphical user interface for experiencing by the user and that includes a plurality of graphical objects each representative of a different element included in the plurality of elements. The programming system may detect an interaction by the user with a graphical object included in the plurality of graphical objects and representative of a particular element included in the plurality of elements, and determine, based on the interaction by the user with the graphical object, an evaluation score for the patient. The evaluation score may be representative of a total number of elements included in the plurality of elements and that the patient correctly identifies after listening to the presented audio clip.

[0013] To illustrate, a clinician may select a “smart list” that includes a plurality of sentences that may be selectively and audibly presented to a cochlear implant patient while the patient’s sound processor is communicatively coupled to the programming system. In response to the selection of the smart list, each sentence may be displayed within a graphical clinician interface. Each word in each sentence may be represented by an individual graphical object. The clinician may select an option to audibly present a particular sentence included in the smart list to the patient. The clinician may then ask the patient to repeat the sentence back to the clinician. Based on the patient’s response, the clinician may provide various types of interaction with the graphical user interface in order to indicate which words the patient correctly repeated back to the

clinician and which words the patient incorrectly repeated back to the clinician. The various types of interaction that the clinician may perform with respect to the graphical user interface will be described herein.

[0014] The systems and methods may facilitate efficient, effective, and accurate

5 evaluation of cochlear implant performance for a patient. For example, instead of having to mark each word in a sentence as correct (i.e., that the patient correctly identified the word) or incorrect (i.e., that the patient incorrectly identified the word), a clinician may mark all the words in the sentence as correct or incorrect with a single interactive event (e.g., a left or right click of a mouse). Moreover, the systems and
10 methods described herein may provide a “virtual sound booth” and thereby facilitate evaluation of cochlear implant system performance for the patient without requiring the patient to be located in an actual sound booth during the evaluation.

[0015] FIG. 1 illustrates an exemplary cochlear implant system 100. As shown, cochlear implant system 100 may include various components configured to be located
15 external to a user including, but not limited to, a microphone 102, a sound processor 104, and a headpiece 106. Cochlear implant system 100 may further include various components configured to be implanted within the user including, but not limited to, a cochlear implant 108 and a lead 110 (also referred to as an intracochlear electrode array) with a plurality of electrodes 112 disposed thereon. As will be described in more
20 detail below, additional or alternative components may be included within cochlear implant system 100 as may serve a particular implementation. The components shown in FIG. 1 will now be described in more detail.

[0016] Microphone 102 may be configured to detect audio signals presented to the user. Microphone 102 may be implemented in any suitable manner. For example,
25 microphone 102 may include a microphone that is configured to be placed within the concha of the ear near the entrance to the ear canal, such as a T-MIC™ microphone from Advanced Bionics. Such a microphone may be held within the concha of the ear near the entrance of the ear canal by a boom or stalk that is attached to an ear hook configured to be selectively attached to sound processor 104. Additionally or
30 alternatively, microphone 102 may be implemented by one or more microphones disposed within headpiece 106, one or more microphones disposed within sound processor 104, one or more beam-forming microphones, and/or any other suitable microphone as may serve a particular implementation.

[0017] Sound processor 104 (i.e., one or more components included within sound processor 104) may be configured to direct cochlear implant 108 to generate and apply electrical stimulation (also referred to herein as “stimulation current”) representative of one or more audio signals (e.g., one or more audio signals detected by microphone 102, input by way of an auxiliary audio input port, etc.) to one or more stimulation sites associated with an auditory pathway (e.g., the auditory nerve) of the user. Exemplary stimulation sites include, but are not limited to, one or more locations within the cochlea, the cochlear nucleus, the inferior colliculus, and/or any other nuclei in the auditory pathway. To this end, sound processor 104 may process the one or more audio signals in accordance with a selected sound processing strategy or program to generate appropriate stimulation parameters for controlling cochlear implant 108. Sound processor 104 may include or be implemented by a behind-the-ear (“BTE”) unit, a body worn device, and/or any other sound processing unit as may serve a particular implementation. For example, sound processor 104 may be implemented by an electro-acoustic stimulation (“EAS”) sound processor included in an EAS system configured to provide electrical and acoustic stimulation to a user.

[0018] In some examples, sound processor 104 may wirelessly transmit stimulation parameters (e.g., in the form of data words included in a forward telemetry sequence) and/or power signals to cochlear implant 108 by way of a wireless communication link 114 between headpiece 106 and cochlear implant 108. It will be understood that communication link 114 may include a bidirectional communication link and/or one or more dedicated unidirectional communication links. In some examples, sound processor 104 may execute and operate in accordance with a sound processing program that has been loaded into memory contained within sound processor 104.

[0019] Headpiece 106 may be communicatively coupled to sound processor 104 and may include an external antenna (e.g., a coil and/or one or more wireless communication components) configured to facilitate selective wireless coupling of sound processor 104 to cochlear implant 108. Headpiece 106 may additionally or alternatively be used to selectively and wirelessly couple any other external device to cochlear implant 108. To this end, headpiece 106 may be configured to be affixed to the user’s head and positioned such that the external antenna housed within headpiece 106 is communicatively coupled to a corresponding implantable antenna (which may also be implemented by a coil and/or one or more wireless communication components) included within or otherwise associated with cochlear implant 108. In this

manner, stimulation parameters and/or power signals may be wirelessly transmitted between sound processor 104 and cochlear implant 108 via a communication link 114 (which may include a bidirectional communication link and/or one or more dedicated unidirectional communication links as may serve a particular implementation).

5 **[0020]** Cochlear implant 108 may include any type of implantable stimulator that may be used in association with the systems and methods described herein. For example, cochlear implant 108 may be implemented by an implantable cochlear stimulator. In some alternative implementations, cochlear implant 108 may include a brainstem implant and/or any other type of active implant or auditory prosthesis that
10 may be implanted within a user and configured to apply stimulation to one or more stimulation sites located along an auditory pathway of a user.

[0021] In some examples, cochlear implant 108 may be configured to generate electrical stimulation representative of an audio signal processed by sound processor 104 (e.g., an audio signal detected by microphone 102) in accordance with one or more
15 stimulation parameters transmitted thereto by sound processor 104. Cochlear implant 108 may be further configured to apply the electrical stimulation to one or more stimulation sites within the user via one or more electrodes 112 disposed along lead 110 (e.g., by way of one or more stimulation channels formed by electrodes 112). In some examples, cochlear implant 108 may include a plurality of independent current
20 sources each associated with a channel defined by one or more of electrodes 112. In this manner, different stimulation current levels may be applied to multiple stimulation sites simultaneously (also referred to as “concurrently”) by way of multiple electrodes 112.

[0022] FIG. 2 illustrates a schematic structure of the human cochlea 200 into which
25 lead 110 may be inserted. As shown in FIG. 2, the cochlea 200 is in the shape of a spiral beginning at a base 202 and ending at an apex 204. Within the cochlea 200 resides auditory nerve tissue 206, which is denoted by Xs in FIG. 2. The auditory nerve tissue 206 is organized within the cochlea 200 in a tonotopic manner. Relatively low frequencies are encoded at or near the apex 204 of the cochlea 200 (referred to as an
30 “apical region”) while relatively high frequencies are encoded at or near the base 202 (referred to as a “basal region”). Hence, each location along the length of the cochlea 200 corresponds to a different perceived frequency. Cochlear implant system 100 may therefore be configured to apply electrical stimulation to different locations within the

cochlea 200 (e.g., different locations along the auditory nerve tissue 206) to provide a sensation of hearing.

[0023] In some examples, a programming system separate from (i.e., not included within) cochlear implant system 100 may be selectively and communicatively coupled to sound processor 104 in order to perform one or more programming or fitting operations with respect to cochlear implant system 100. For example, the programming system may present audio clips to the patient by way of the cochlear implant system in order to facilitate evaluation of how well the cochlear implant system is performing for the patient.

[0024] To illustrate, FIG. 3 shows an exemplary configuration 300 in which a programming system 302 is communicatively coupled to sound processor 104. Programming system 302 may be implemented by any suitable combination of physical computing and communication devices including, but not limited to, a fitting station or device, a programming device, a personal computer, a laptop computer, a handheld device, a mobile device (e.g., a mobile phone), a clinician's programming interface ("CPI") device, and/or any other suitable component as may serve a particular implementation. In some examples, programming system 302 may provide one or more graphical user interfaces ("GUIs") (e.g., by displaying the one or more GUIs by way of a display screen) with which a clinician or other user may interact.

[0025] FIG. 4 illustrates an exemplary configuration 400 in which programming system 302 is implemented by a computing device 402 and a CPI device 404. As shown, computing device 402 may be selectively and communicatively coupled to CPI device 404 by way of a cable 406. Likewise, CPI device 404 may be selectively and communicatively coupled to sound processor 104 by way of a cable 408. Cables 406 and 408 may each include any suitable type of cable that facilitates transmission of digital data between computing device 402 and sound processor 104. For example, cable 406 may include a universal serial bus ("USB") cable and cable 408 may include any type of cable configured to connect to a programming port included in sound processor 104. In some examples, computing device 402 may present an audio clip to the patient by digitally streaming the audio clip to sound processor 104 by way of cable 406, CPI device 404, and cable 408 without the audio clip ever being converted to an analog signal. In some alternative examples, wireless connections may be used to communicatively couple computing device 402 and CPI device 404, as well as CPI device 404 and sound processor 104.

[0026] Configuration 400 corresponds to a unilateral cochlear implant system (i.e., there is a single sound processor 104 that corresponds to one ear of the patient). It will be recognized that the systems and methods described herein may be applied to a bilateral cochlear implant system in which separate sound processors are associated with each ear of the patient or by a bimodal system in which a sound processor is associated with one of the patient's ears and a hearing aid is associated with the patient's other ear. In these instances, programming system 302 may be implemented by two CPI devices each associated with one of the sound processors, or by a single CPI device configured to connect to both sound processors.

[0027] FIG. 5 illustrates exemplary components of programming system 302. As shown, programming system 302 may include a sound booth emulation facility 502 ("emulation facility 502"), an evaluation facility 504, and a storage facility 506, which may be in communication with one another using any suitable communication technologies. Storage facility 506 may maintain emulation data 508 generated and/or used by emulation facility 502, audio clip data 510 representative of one or more audio clips that may be presented to the patient, and evaluation data 512 generated and/or used by evaluation facility 504. As will be described below, audio clip data 510 may be in the form of digital audio files. Storage facility 506 may maintain additional or alternative data as may serve a particular implementation.

[0028] Emulation facility 502 may perform various operations configured to emulate a sound booth for a patient while the patient's cochlear implant system is communicatively coupled to programming system 302 (e.g., while a sound processor included in the cochlear implant system is communicatively coupled to programming system 302).

[0029] For example, emulation facility 502 may isolate the patient from an acoustic environment of the patient. In some examples, emulation facility 502 may isolate the patient from the acoustic environment by disabling each microphone included in the cochlear implant system. Emulation facility 502 may disable a microphone included in the cochlear implant system by transmitting a command to the sound processor included in the cochlear implant system to turn off the microphone and/or in any other suitable manner.

[0030] Emulation facility 502 may be further configured to calibrate audio clips that are presented to the patient so that the audio clips have a calibrated loudness level when they are presented to the patient. For example, in response to a user request to

present an audio clip to the patient at a particular loudness level, emulation facility 502 may calibrate the audio clip to actually have the particular loudness level when the audio clip is presented to the patient.

[0031] Calibration of the audio clip may ensure that the audio clip actually has the particular loudness level selected by the user, regardless of the initial loudness level of the audio clip (i.e., the loudness level at which the audio clip is recorded or otherwise created), regardless of the particular programming system 302 (i.e., the particular hardware) used to present the audio clip to the patient, and regardless of the particular components included in the cochlear implant system used by the patient. In this manner, a clinician may use different programming systems 302 (e.g., different computing devices) during different visits by the patient to the clinician's office to present audio clips to the patient and know that the selected loudness levels of the audio clips are accurate and consistent between the different programming systems 302.

[0032] Emulation facility 502 may calibrate the audio clip in any suitable manner. For example, FIG. 6 shows an exemplary flowchart 600 that includes various steps that may be performed by emulation facility 502 in order to calibrate an audio clip for a particular loudness level requested by a user. While FIG. 6 illustrates exemplary steps according to one embodiment, other embodiments may omit, add to, reorder, and/or modify any of the steps shown in FIG. 6.

[0033] As shown, in step 602, calibration of the audio clip may include determining, based on a root mean square ("RMS") value of a system calibration signal having a known loudness level, a target RMS value for the audio clip and that will produce the particular loudness level. The system calibration signal may include any suitable signal having a known (e.g., predetermined) loudness level. For example, the system calibration signal may include a one kilohertz sine wave that has a known loudness level of 60 dB SPL.

[0034] The RMS value of the system calibration signal may be determined (e.g., by emulation facility 502) in any suitable manner. For example, the RMS value of a sine wave may be determined in accordance with $a/\sqrt{2}$, where a is the amplitude of the sine wave and representative of the known loudness level of the system calibration signal.

[0035] In some examples, programming system 302 may store data representative of the RMS value of the system calibration signal together with data representative of the known loudness level of the system calibration signal and that corresponds to the

RMS value. Emulation facility 502 may access this data when determining the target RMS value or the calibration signal. Emulation facility 502 may alternatively access the data representative of the RMS value of the system calibration signal from a source other than programming system 302 in any suitable manner.

5 **[0036]** Emulation facility 502 may use the RMS value of the system calibration signal to determine the target RMS value for the audio clip in any suitable manner. For example, if the known loudness level of the system calibration signal is a_1 , the RMS value of the system calibration signal is RMS_1 , the particular loudness level requested by the user is a_2 , and the target RMS value of the audio clip that will result in the audio
10 clip having the particular loudness level is RMS_2 , emulation facility 502 may determine the target RMS value by calculating the following equation: $RMS_2 = RMS_1 * a_2 / a_1$.

[0037] In step 604, emulation facility 502 may determine an initial RMS value of the audio clip. As used herein, the “initial RMS value” of the audio clip refers to the original RMS value of the audio clip before it is calibrated. Emulation facility 502 may
15 determine the initial RMS value of the audio clip in any suitable manner. For example, emulation facility 502 may store information representative of the initial RMS value of the audio clip within metadata associated with the audio clip and determine the initial RMS value of the audio clip by accessing the metadata. To illustrate, when an audio clip is initially loaded onto (e.g., copied or downloaded by) programming system 302,
20 emulation facility 502 may measure the RMS value of the audio clip and designate the measured RMS value as the initial RMS value of the audio clip. The measured RMS value may be stored in metadata associated with the audio clip and then accessed as needed by emulation facility 502 in order to determine the initial RMS value of the audio clip.

25 **[0038]** In some examples, an audio file stored or otherwise accessed by emulation facility 502 may include a plurality of audio clips (e.g., a plurality of audio clips separated by periods of silence). In this scenario, emulation facility 502 may determine the initial RMS value of a particular audio clip included in the audio file by measuring an RMS value of an entire audio file and designating the measured RMS value as the
30 initial RMS value of the audio clip. Hence, in this embodiment, each audio clip included in the audio file may be assigned the same initial RMS value. Alternatively, emulation facility 502 may measure individual RMS values for each audio clip included in an audio file.

[0039] In some alternative examples, a single calibration track may be provided for a set of audio files that each include one or more audio clips. For example, a CD may include a calibration track associated with a remaining number of tracks on the CD. The calibration track may include an audio clip encoded at the same loudness level of the other tracks on the CD. Hence, when the CD is loaded onto the programming system 302, emulation facility 502 may recognize the presence of the calibration track and measure the RMS value of the calibration track. The measured RMS value may be designated by emulation facility 502 as the initial RMS value of each of the audio clips included in the remaining tracks on the CD. In this manner, programming system 302 may avoid having to measure the RMS values of each of the individual tracks provided on the CD.

[0040] In step 606, emulation facility 502 may determine, based on the initial RMS value of the audio clip and the target RMS value, a gain factor that, when applied to the audio clip, will result in the audio clip having the target RMS value and the particular loudness level. This may be performed in any suitable manner. For example, emulation facility 502 may set the gain factor to be substantially equal to a difference between the target RMS value and the initial RMS value.

[0041] To illustrate, if the target RMS value is higher than the initial RMS value (i.e., if the particular loudness level requested by the user is higher than the original loudness level of the audio clip), emulation facility 502 may set the gain factor to a value that amplifies the audio clip when the audio clip is presented to the patient. Alternatively, if the target RMS value is lower than the initial RMS value (i.e., if the particular loudness level requested by the user is lower than the original loudness level of the audio clip), emulation facility 502 may set the gain factor to a value that attenuates the audio clip when the audio clip is presented to the patient.

[0042] In step 608, emulation facility 502 may apply the gain factor to the audio clip. This may be performed in any suitable manner. For example, emulation facility 502 may apply the gain factor to the audio clip in real time as the audio clip is being streamed by emulation facility 502 to the sound processor of the cochlear implant system. Additionally or alternatively, emulation facility 502 may apply the gain factor to the audio clip before the audio clip is streamed to the sound processor (e.g., by buffering data representative of the gain factor-applied audio clip).

[0043] Once the audio clip has been calibrated (or as the audio clip is being calibrated in real time), emulation facility 502 may present the calibrated audio clip to

the patient. This may be performed in any suitable manner. For example, emulation facility 502 may digitally stream the audio clip to the sound processor included in the cochlear implant system. In some examples, the calibrated audio clip may be digitally streamed to the sound processor without the calibrated audio clip ever being converted to an analog signal. This may ensure that the calibrated audio clip is presented at the specified loudness level.

[0044] Calibration of audio clips, as well as various other types of operations configured to emulate conditions within a sound booth for a cochlear implant patient, are described in more detail in co-pending PCT Application No. PCT/US15/52153, Attorney Docket No. 3021-0426-WO, entitled "Systems and Methods for Emulating a Sound Booth for a Cochlear Implant Patient," filed the same day as the present application, and incorporated herein by reference in its entirety.

[0045] Returning to FIG. 5, evaluation facility 504 may perform various operations configured to facilitate evaluation of cochlear implant system performance for a particular patient. For example, evaluation facility 504 may present, in response to user input provided by a user and during an evaluation period during which programming system 302 is communicatively coupled to a cochlear implant system (e.g., a sound processor included in the cochlear implant system) associated with a patient, an audio clip to the patient. The audio clip may include a plurality of elements (e.g., a plurality of words included in a sentence) configured to be audible to the patient. Additionally or alternatively, the audio clip may include acoustic stimulation that is not necessarily audible to the patient. However, for purposes of the examples that follow, it will be assumed that the audio clip is configured to be audible to the patient.

[0046] During the evaluation period, evaluation facility 504 may display a GUI for experiencing by the user. The GUI may include a plurality of graphical objects each representative of a different element included in the plurality of elements. The user may perform various types of interaction with respect to the GUI (e.g., with respect to the graphical objects) in order to indicate whether the patient correctly identifies each of the elements after listening to the presented audio clip. Based on the interaction by the user with the GUI, evaluation facility 504 may determine an evaluation score for the patient, which score may be representative of a total number of elements that the patient correctly identifies. Various examples of each of these operations that may be performed by evaluation facility 504, as well other operations that may be performed by evaluation facility 504, will now be described in more detail.

[0047] FIG. 7 shows an exemplary evaluation setup GUI 700 (“GUI 700”) that may be displayed by evaluation facility 504 (e.g., by way of a display screen included in or connected to programming system 302). GUI 700 may be used by a user to define one or more attributes of a smart list that may be used to evaluate cochlear implant system performance for a patient. The display of GUI 700 may be initiated in any suitable manner. For example, GUI 700 may be displayed in response to a user selection of a particular smart list or audio track stored by programming system 302.

[0048] As used herein, a “smart list” may include a plurality of audio clips that may be presented to the patient. Each audio clip may include a plurality of elements configured to be audible to the patient. Each element may include a word or an individual sound (e.g., a syllable) included in a word. For example, an audio clip may include a sentence that comprises a plurality of words. Alternatively, an audio clip may include a list of words not necessarily organized into a sentence.

[0049] Each audio clip included in a smart list may be represented in GUI 700 by a particular row of graphical objects, wherein each graphical object is representative of a particular element included in the audio clips. For example, GUI 700 shows five rows 702 (e.g., rows 702-1 through 702-5) each corresponding to a different audio clip included in a smart list. In this example, each audio clip is representative of a sentence that includes a plurality of words (i.e., elements). For example, the audio clip associated with row 702-1 is representative of the following sentence: “He tried to convince her she was not right.” Each element is represented by a graphical object. For example, the element “He” in the first sentence shown in FIG. 7 is represented by graphical object 704-1, the element “tried” is represented by graphical object 704-2, etc.

[0050] As mentioned, a user may utilize GUI 700 to define one or more attributes for the smart list used to evaluate cochlear implant performance for the patient. For example, the user may utilize GUI 700 to provide user input representative of different score weightings for different elements included in the audio clips included in the smart list. The score weightings are used to determine how each element is to be weighted when determining the evaluation score for the patient.

[0051] To assign score weightings to the elements included in the audio clip shown in row 702-1, the user may select row 702-1. In response, weighting fields corresponding to the elements included in the audio clip may be displayed within GUI 700. For example, GUI 700 shows that weighting fields (e.g., weighting fields 706-1 and 706-2) corresponding to the elements included in the audio clip shown in row 702-1

are displayed within row 702-1. The user may interact with the weighting fields (e.g., by inputting values directly into the weighting fields and/or selecting up and down arrow buttons) to assign score weightings to each of the elements. FIG. 7 shows that a score weighting of “1” is included by default in each weighting field corresponding to the elements included in the audio clip shown in row 702-1.

[0052] In some examples, a user may assign a score weighting of “0” to non-keyword elements (i.e., elements that the patient does not need to recognize or repeat back to the user). For example, an exemplary non-keyword element may be “a”. Score weightings of “0” may also be assigned to elements included in “practice” items.

Practice items may include sentences or lists of words that the patient may practice listening to prior to beginning an evaluation test.

[0053] GUI 700 may also be used to define one or more other attributes for the smart list used to evaluate cochlear implant performance for the patient. For example, the user may interact with various options shown in pane 706 to specify a name of the particular evaluation that is to be performed, specify a loudness level of the audio clips, and/or specify various attributes (e.g., type, lead in time, trailing time, loudness level, etc.) of noise that is to be presented together with the audio clips.

[0054] Once the attributes of the smart list have been defined in GUI 700, the user may commence with an evaluation of the cochlear implant performance for the patient.

For example, FIG. 8 shows an exemplary GUI 800 that may be displayed by evaluation facility 504 during an evaluation period in which cochlear implant performance for the patient is evaluated using the smart list defined in GUI 700. As shown, each audio clip included in the smart list is represented in GUI 800 by a particular row of graphical objects, wherein each graphical object is representative of a particular element included in the audio clips. For example, GUI 800 shows five rows 802 (e.g., rows 802-1 through 802-5) each corresponding to a different audio clip (i.e., sentence) included in the smart list. Each element included in each sentence is represented by a graphical object. For example, the element “He” in the first sentence shown in FIG. 8 is represented by graphical object 804-1, the element “tried” is represented by graphical object 804-2, the element “right” is represented by graphical object 804-3, etc.

[0055] While GUI 800 is displayed, the user may provide an input command representative of a request to play a particular audio clip included in the smart list. For example, the user may simply select a row that corresponds to the audio clip. To illustrate, the user may select row 802-1. Evaluation facility 504 may detect the

selection of row 802-1 and, in response, initiate a presentation of the sentence shown in row 802-1. The user may additionally or alternatively interact with control options 806 to play a particular audio clip, skip to a different audio clip, and/or stop playing a particular audio clip.

- 5 **[0056]** After the sentence in the audio clip has been presented to the patient, the user may have the patient repeat the sentence back to the user in order to determine which elements included in the sentence that the patient can correctly identify (i.e., correctly repeat back to the user) after listening to the presented audio clip. Based on the patient's response, the user may perform various types of interaction with GUI 800
- 10 (e.g., with one or more graphical objects displayed within GUI 800) in order to record which elements the patient correctly identified and which elements the patient incorrectly identified. Based on the interaction by the user with GUI 800, evaluation facility 504 may determine an evaluation score for the patient, as will be described below.
- 15 **[0057]** In some examples, evaluation facility 504 may facilitate different types of interaction by the user with GUI 800 so that the user may quickly and accurately mark elements that the patient correctly identifies and elements that the patient incorrectly identifies. For example, the user may perform a first type of interaction (e.g., by left-clicking a mouse or other type of pointing device) with respect to a graphical object
- 20 representative of a particular element included in a sentence (or other group of elements) in order to mark the particular element as being incorrectly identified by the patient and the remaining elements included in the sentence as being correctly identified by the patient. Alternatively, the user may perform a second type of interaction (e.g., by right-clicking a mouse or other type of pointing device) with respect
- 25 to a graphical object representative of a particular element included in a sentence (or other group of elements) in order to mark the particular element as being correctly identified by the patient and the remaining elements included in the sentence as being incorrectly identified by the patient. In this manner, the user may mark all the words in the sentence as correct or incorrect with a single interactive event (e.g., a left or right
- 30 click of a mouse).

[0058] The first and second types of interactions may include any type of interactions that differ one from another. For example, the first type of interaction may include a selection of a first button (a left-click button) included on a pointing device (e.g., a mouse) communicatively coupled to programming system 302 and the second

type of interaction may include a selection of a second button (a right-click button) included on the pointing device. Additionally or alternatively, the first type of interaction may include a first type of touch gesture performed with respect to a display screen within which GUI 800 is displayed and the second type of interaction may include a second type of touch gesture performed with respect to the display screen within which GUI 800 is displayed.

[0059] An exemplary evaluation process will now be described in order to describe various types of interactions that may be performed with respect to GUI 800. To begin the evaluation process, the user may select row 802-1 in order to direct evaluation facility 504 to audibly present the first sentence “He tried to convince her she was not right” to the patient. After this sentence has been presented to the patient, the user may have the patient repeat the sentence back to the user. Based on the patient’s feedback, the user may determine that the patient correctly identified all the elements in the first sentence except for the last element “right”. The user may accordingly provide the first type of interaction with respect to the graphical object 804-3 representative of the element “right” in order to mark the element “right” as being incorrectly identified by the patient and a remaining number of elements included in the first sentence (i.e., all of the elements in the sentence other than the element “right”) as being correctly identified by the patient.

[0060] Evaluation facility 504 may detect the first type of interaction with respect to graphical object 804-3 and, in response, determine that the patient incorrectly identified the element “right” and correctly identified the remaining elements included in the first sentence. In response to this determination, evaluation facility 504 may graphically indicate within GUI 800 that the patient incorrectly identified the element “right” and correctly identified the remaining elements included in the first sentence. This may be performed in any suitable manner. For example, evaluation facility 504 may update graphical object 804-3 to have a first display attribute (e.g., a first color, a first type of shading, a first type of hatching, etc.) and the remaining graphical objects representative of the remaining elements included in the first sentence to have a second display attribute different than the first display attribute.

[0061] To illustrate, FIG. 9 shows GUI 800 after the user has provided the first type of interaction with respect to graphical object 804-3. As shown, graphical object 804-3 has been updated to include a first type of hatching and the remaining graphical objects representative of the remaining elements included in the first sentence. The first type of

hatching within graphical object 804-3 may visually indicate that the patient incorrectly identified the element represented by graphical object 804-3 and the second type of hatching within the remaining graphical objects may visually indicate that the patient correctly identified the elements represented by the remaining graphical objects.

5 **[0062]** In response to detecting the first type of interaction with respect to graphical object 804-3, evaluation facility 504 may also update the evaluation score for the patient. The evaluation score may represent how many elements included in the first sentence that the user correctly identified. As shown in FIG. 9, evaluation facility 504 may display the evaluation score within a field 902. In this particular example, each
10 element has a score weighting of one, hence, the evaluation score shown in field 902 is “8”, which indicates that the user correctly identified eight out of nine elements included in the first sentence.

15 **[0063]** In response to detecting the first type of interaction with respect to graphical object 804-3, evaluation facility 504 may also automatically update various other scores associated with the entire smart list. For example, evaluation facility 504 may automatically update an “element score” 904, which indicates how many total elements in all the sentences the patient correctly identifies. Evaluation facility 504 may also automatically update an “item score” 906, which indicates how many total items (which, in this example, are sentences) the patient correctly identifies without a mistake.

20 **[0064]** In some instances (e.g., when the patient incorrectly identifies two elements in a sentence), the user may perform the first type of interaction with respect to a first graphical object, as described above. In response, the display attributes of the graphical objects and the evaluation scores may be updated as described above. The user may then again provide the first type of interaction with respect to a second
25 graphical object. In response, evaluation facility 504 may determine that the patient also incorrectly identified the element represented by the second graphical object and accordingly update both the display attribute of the second graphical object and the evaluation scores.

30 **[0065]** After the user has marked the elements included in the first sentence as being correct or incorrect, the user may select row 802-2 in order to direct evaluation facility 504 to audibly present the second sentence “He was a very dedicated person” to the patient. After this sentence has been presented to the patient, the user may have the patient repeat the sentence back to the user. Based on the patient’s feedback, the user may determine that the patient incorrectly identified all the elements in the second

sentence except for the last element “person”. The user may accordingly provide the second type of interaction with respect to graphical object 908 representative of the element “person” in order to mark the element “person” as being correctly identified by the patient and a remaining number of elements included in the second sentence as being incorrectly identified by the patient.

[0066] Evaluation facility 504 may detect the second type of interaction with respect to graphical object 908 and, in response, determine that the patient correctly identified the element “person” and incorrectly identified the remaining elements included in the second sentence. In response to this determination, evaluation facility 504 may graphically indicate within GUI 800 that the patient correctly identified the element “person” and incorrectly identified the remaining elements included in the second sentence. This may be performed in any suitable manner.

[0067] For example, FIG. 10 shows GUI 800 after the user has provided the second type of interaction with respect to graphical object 908. As shown, evaluation facility 504 has updated graphical object 908 to have the second display attribute and the remaining graphical objects representative of the remaining elements included in the second sentence to have the first display attribute. FIG. 10 also shows that an evaluation score corresponding to the second sentence has been updated in field 1002, and that the element score 904 and item score 906 have also been updated in response to the user providing the second type of interaction with respect to graphical object 908.

[0068] After the user has marked the elements included in the second sentence as being correct or incorrect, the user may select row 802-3 in order to direct evaluation facility 504 to audibly present the third sentence “You smell like fresh lemons” to the patient. After this sentence has been presented to the patient, the user may have the patient repeat the sentence back to the user. Based on the patient’s feedback, the user may determine that the patient correctly identified all the elements in the third sentence. The user may accordingly select a graphical object representative of a “global correct” option in order to mark all the elements in the third sentence as being correctly identified by the patient.

[0069] For example, FIG. 11 shows GUI 800 after the user has selected a graphical object 1102 representative of a “global correct” option in order to mark all the elements in the third sentence as being correctly identified by the patient. As shown, evaluation facility 504 has, in response to the selection of graphical object 1102, updated the

graphical objects representative of the elements included in the third sentence to have the second display attribute in order to graphically indicate that the patient correctly identified all the elements included in the third sentence. FIG. 11 also shows that an evaluation score corresponding to the third sentence has been updated in field 1104, and that the element score 904 and item score 906 have also been updated in response to the user selecting graphical object 1102.

[0070] After the user has marked the elements included in the third sentence as being correct or incorrect, the user may select row 802-4 in order to direct evaluation facility 504 to audibly present the fourth sentence "There are several types of tuxedos" to the patient. After this sentence has been presented to the patient, the user may have the patient repeat the sentence back to the user. Based on the patient's feedback, the user may determine that the patient incorrectly identified all the elements in the fourth sentence. The user may accordingly select a graphical object representative of a "global incorrect" option in order to mark all the elements in the fourth sentence as being incorrectly identified by the patient.

[0071] For example, FIG. 12 shows GUI 800 after the user has selected a graphical object 1202 representative of a "global incorrect" option in order to mark all the elements in the fourth sentence as being incorrectly identified by the patient. As shown, evaluation facility 504 has, in response to the selection of graphical object 1202, updated the graphical objects representative of the elements included in the fourth sentence to have the first display attribute in order to graphically indicate that the patient incorrectly identified all the elements included in the fourth sentence. FIG. 12 also shows that an evaluation score corresponding to the fourth sentence has been updated in field 1204, and that the element score 904 and item score 906 have also been updated in response to the user selecting graphical object 1202.

[0072] The user may subsequently score the fifth sentence shown in row 802-5 in a similar manner. Once all of the sentences have been scored by the user, evaluation facility 504 may provide one or more reports with respect to the evaluation scores, the item score, and the element score as may serve a particular implementation.

[0073] FIG. 13 illustrates an exemplary method 1300 of facilitating evaluation of cochlear implant system performance for a patient. While FIG. 13 illustrates exemplary steps according to one embodiment, other embodiments may omit, add to, reorder, and/or modify any of the steps shown in FIG. 13. One or more of the steps shown in

FIG. 13 may be performed by programming system 302 and/or any implementation thereof.

[0074] In step 1302, a programming system presents, in response to user input provided by a user and during an evaluation period during which the programming system is communicatively coupled to a cochlear implant system associated with a patient, an audio clip to the patient. The audio clip may include a plurality of elements, which, in some examples, are configured to be audible to the patient. Step 1302 may be performed in any of the ways described herein.

[0075] In step 1304, the programming system displays, during the evaluation period, a graphical user interface for experiencing by the user and that includes a plurality of graphical objects each representative of a different element included in the plurality of elements. Step 1304 may be performed in any of the ways described herein.

[0076] In step 1306, the programming system detects an interaction by the user with a graphical object included in the plurality of graphical objects and representative of a particular element included in the plurality of elements. Step 1306 may be performed in any of the ways described herein.

[0077] In step 1308, the programming system determines, based on the interaction by the user with the graphical object, an evaluation score for the patient. Step 1308 may be performed in any of the ways described herein.

[0078] In certain embodiments, one or more of the processes described herein may be implemented at least in part as instructions embodied in a non-transitory computer-readable medium and executable by one or more computing devices. In general, a processor (e.g., a microprocessor) receives instructions, from a non-transitory computer-readable medium, (e.g., a memory, etc.), and executes those instructions, thereby performing one or more processes, including one or more of the processes described herein. Such instructions may be stored and/or transmitted using any of a variety of known computer-readable media.

[0079] A computer-readable medium (also referred to as a processor-readable medium) includes any non-transitory medium that participates in providing data (e.g., instructions) that may be read by a computer (e.g., by a processor of a computer). Such a medium may take many forms, including, but not limited to, non-volatile media, and/or volatile media. Non-volatile media may include, for example, optical or magnetic disks and other persistent memory. Volatile media may include, for example, dynamic random access memory ("DRAM"), which typically constitutes a main memory.

Common forms of computer-readable media include, for example, a disk, hard disk, magnetic tape, any other magnetic medium, a compact disc read-only memory ("CD-ROM"), a digital video disc ("DVD"), any other optical medium, random access memory ("RAM"), programmable read-only memory ("PROM"), erasable programmable read-only memory ("EPROM"), electrically erasable programmable read-only memory ("EEPROM"), a Flash EEPROM device, any other memory chip or cartridge, or any other tangible medium from which a computer can read.

[0080] FIG. 14 illustrates an exemplary computing device 1400 that may be specifically configured to perform one or more of the processes described herein. As shown in FIG. 14, computing device 1400 may include a communication interface 1402, a processor 1404, a storage device 1406, and an input/output ("I/O") module 1408 communicatively connected via a communication infrastructure 1410. While an exemplary computing device 1400 is shown in FIG. 14, the components illustrated in FIG. 14 are not intended to be limiting. Additional or alternative components may be used in other embodiments. Components of computing device 1400 shown in FIG. 14 will now be described in additional detail.

[0081] Communication interface 1402 may be configured to communicate with one or more computing devices. Examples of communication interface 1402 include, without limitation, a wired network interface (such as a network interface card), a wireless network interface (such as a wireless network interface card), a modem, an audio/video connection, and any other suitable interface.

[0082] Processor 1404 generally represents any type or form of processing unit capable of processing data or interpreting, executing, and/or directing execution of one or more of the instructions, processes, and/or operations described herein. Processor 1404 may direct execution of operations in accordance with one or more applications 1412 or other computer-executable instructions such as may be stored in storage device 1406 or another computer-readable medium.

[0083] Storage device 1406 may include one or more data storage media, devices, or configurations and may employ any type, form, and combination of data storage media and/or device. For example, storage device 1406 may include, but is not limited to, a hard drive, network drive, flash drive, magnetic disc, optical disc, RAM, dynamic RAM, other non-volatile and/or volatile data storage units, or a combination or sub-combination thereof. Electronic data, including data described herein, may be temporarily and/or permanently stored in storage device 1406. For example, data

representative of one or more executable applications 1412 configured to direct processor 1404 to perform any of the operations described herein may be stored within storage device 1406. In some examples, data may be arranged in one or more databases residing within storage device 1406.

5 **[0084]** I/O module 1408 may be configured to receive user input and provide user output and may include any hardware, firmware, software, or combination thereof supportive of input and output capabilities. For example, I/O module 1408 may include hardware and/or software for capturing user input, including, but not limited to, a keyboard or keypad, a touch screen component (e.g., touch screen display), a receiver
10 (e.g., an RF or infrared receiver), and/or one or more input buttons.

[0085] I/O module 1408 may include one or more devices for presenting output to a user, including, but not limited to, a graphics engine, a display (e.g., a display screen), one or more output drivers (e.g., display drivers), one or more audio speakers, and one or more audio drivers. In certain embodiments, I/O module 1408 is configured to
15 provide graphical data to a display for presentation to a user. The graphical data may be representative of one or more graphical user interfaces and/or any other graphical content as may serve a particular implementation.

[0086] In some examples, any of the facilities described herein may be implemented by or within one or more components of computing device 1400. For example, one or
20 more applications 1412 residing within storage device 1406 may be configured to direct processor 1404 to perform one or more processes or functions associated with emulation facility 502 and/or evaluation facility 504. Likewise, storage facility 506 may be implemented by or within storage device 1406.

[0087] In the preceding description, various exemplary embodiments have been
25 described with reference to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the scope of the invention as set forth in the claims that follow. For example, certain features of one embodiment described herein may be combined with or substituted for features of another
30 embodiment described herein. The description and drawings are accordingly to be regarded in an illustrative rather than a restrictive sense.

CLAIMS

What is claimed is:

- 5 1. A system comprising:
 at least one physical computing device that:
 presents, in response to user input provided by a user and during an
 evaluation period during which the at least one physical computing device is
 communicatively coupled to a cochlear implant system associated with a patient, an
10 audio clip to the patient, the audio clip comprising a plurality of elements,
 displays, during the evaluation period, a graphical user interface for
 experiencing by the user and that includes a plurality of graphical objects each
 representative of a different element included in the plurality of elements,
 detects an interaction by the user with a graphical object included in the
15 plurality of graphical objects and representative of a particular element included in the
 plurality of elements, and
 determines, based on the interaction by the user with the graphical object,
 an evaluation score for the patient, the evaluation score representative of a total
 number of elements included in the plurality of elements and that the patient correctly
20 identifies after listening to the presented audio clip.
2. The system of claim 1, wherein the at least one physical computing
 device facilitates a first type of interaction by the user with the graphical objects and a
 second type of interaction with the graphical objects.
- 25 3. The system of claim 2, wherein the at least one physical computing
 device:
 detects the interaction with the graphical object by detecting that the user
 provides the first type of interaction with respect to the graphical object; and
30 determines the evaluation score by automatically determining, based on the first
 type of interaction provided with respect to the graphical object, that the patient
 incorrectly identified the particular element represented by the graphical object and that
 the patient correctly identified a remaining number of elements included in the plurality
 of elements.

35

4. The system of claim 3, wherein the at least one physical computing device updates, in response to the determining that the patient incorrectly identified the particular element and that the patient correctly identified the remaining number of elements included in the plurality of elements, the graphical object to have a first display attribute and a remaining number of graphical objects included in the plurality of graphical objects to have a second display attribute different than the first display attribute.

5. The system of claim 3, wherein the at least one physical computing device:

detects that the user provides, subsequent to providing the first type of interaction with respect to the graphical object, the first type of interaction with respect to an additional graphical object included in the plurality of graphical objects and representative of an additional element included in the plurality of elements;

determines, based on the first type of interaction provided with respect to the additional graphical object, that the patient incorrectly identified the additional element represented by the additional graphical object; and

updates, in response to the determination that the patient incorrectly identified the additional element, the evaluation score to reflect that the patient incorrectly identified the additional element.

6. The system of claim 2, wherein the at least one physical computing device:

detects the interaction with the graphical object by detecting that the user provides the second type of interaction with respect to the graphical object; and

determines the evaluation score by automatically determining, based on the second type of interaction provided with respect to the graphical object, that the patient correctly identified the particular element represented by the graphical object and that the patient incorrectly identified a remaining number of elements included in the plurality of elements.

7. The system of claim 6, wherein the at least one physical computing device:

detects that the user provides, subsequent to providing the second type of interaction with respect to the graphical object, the second type of interaction with respect to an additional graphical object included in the plurality of graphical objects and representative of an additional element included in the plurality of elements;

5 determines, based on the second type of interaction provided with respect to the additional graphical object, that the patient correctly identified the additional element represented by the additional graphical object; and

updates, in response to the determination that the patient correctly identified the additional element, the evaluation score to reflect that the patient correctly identified the
10 additional element.

8. The system of claim 2, wherein:

the first type of interaction comprises a selection, by the user, of a first button included on a pointing device communicatively coupled to the at least one physical
15 computing device; and

the second type of interaction comprises a selection, by the user, of a second button included on the pointing device.

9. The system of claim 2, wherein:

20 the first type of interaction comprises a first type of touch gesture performed with respect to a display screen within which the graphical user interface is displayed; and

the second type of interaction comprises a second type of touch gesture performed with respect to the display screen.

25 10. The system of claim 1, wherein the plurality of graphical objects correspond to a single sentence and are displayed within a first row of the graphical user interface, and wherein the at least one physical computing device further displays, concurrently with the plurality of graphical objects and within a plurality of other rows of the graphical user interface, additional sets of graphical objects corresponding to
30 additional sentences.

11. The system of claim 1, wherein the at least one physical computing device isolates the patient from an acoustic environment by disabling a microphone included in the cochlear implant system during the evaluation period.

12. The system of claim 1, wherein the at least one physical computing device:

receives, by way of the graphical user interface, user input representative of a request to present the audio clip at a particular loudness level; and

calibrates, in response to the request and prior to the presentation of the audio clip, the audio clip to have the particular loudness level when the audio clip is presented to the patient.

13. The system of claim 1, wherein the at least one physical computing device presents the audio clip to the patient by digitally streaming the audio clip to a sound processor included in the cochlear implant system without converting the audio clip to an analog signal.

14. The system of claim 1, wherein the at least one physical computing device:

detects user input representative of a score weighting for a particular element included in the plurality of elements; and

wherein the determination of the evaluation score is performed in accordance with the score weighting.

15. The system of claim 1, wherein the at least one physical computing device displays the evaluation score within the graphical user interface.

16. The system of claim 1, wherein the plurality of elements comprise a plurality of words.

17. The system of claim 1, wherein a particular element included in the plurality of elements is an individual sound included in a word.

18. A system comprising:

at least one physical computing device that:

presents, in response to user input provided by a user and during an evaluation period during which the at least one physical computing device is

communicatively coupled to a cochlear implant system associated with a patient, an audio clip to the patient, the audio clip comprising a plurality of elements configured to be audible to the patient,

displays, during the evaluation period, a graphical user interface for
5 experiencing by the user, wherein the graphical user interface includes

a plurality of graphical objects each representative of a different element included in the plurality of elements,

a graphical object representative of a global correct option, and

a graphical object representative of a global incorrect option,

10 detects an interaction by the user with a graphical object included in the plurality of graphical objects and representative of a particular element included in the plurality of elements, and

determines, based on the interaction by the user with the graphical object, an evaluation score for the patient, the evaluation score representative of a total

15 number of elements included in the plurality of elements and that the patient correctly identifies after listening to the presented audio clip;

wherein

if the interaction comprises a first type of interaction with respect to the graphical object, the at least one physical computing device determines that the patient
20 incorrectly identified the particular element represented by the graphical object and that the patient correctly identified a remaining number of elements included in the plurality of elements,

if the interaction comprises a second type of interaction with respect to the graphical object, the at least one physical computing device determines that the patient
25 correctly identified the particular element represented by the graphical object and that the patient incorrectly identified the remaining number of elements included in the plurality of elements,

if the interaction comprises a selection of the graphical object representative of the global correct option, the at least one physical computing device
30 determines that the patient correctly identified each element included in the plurality of elements, and

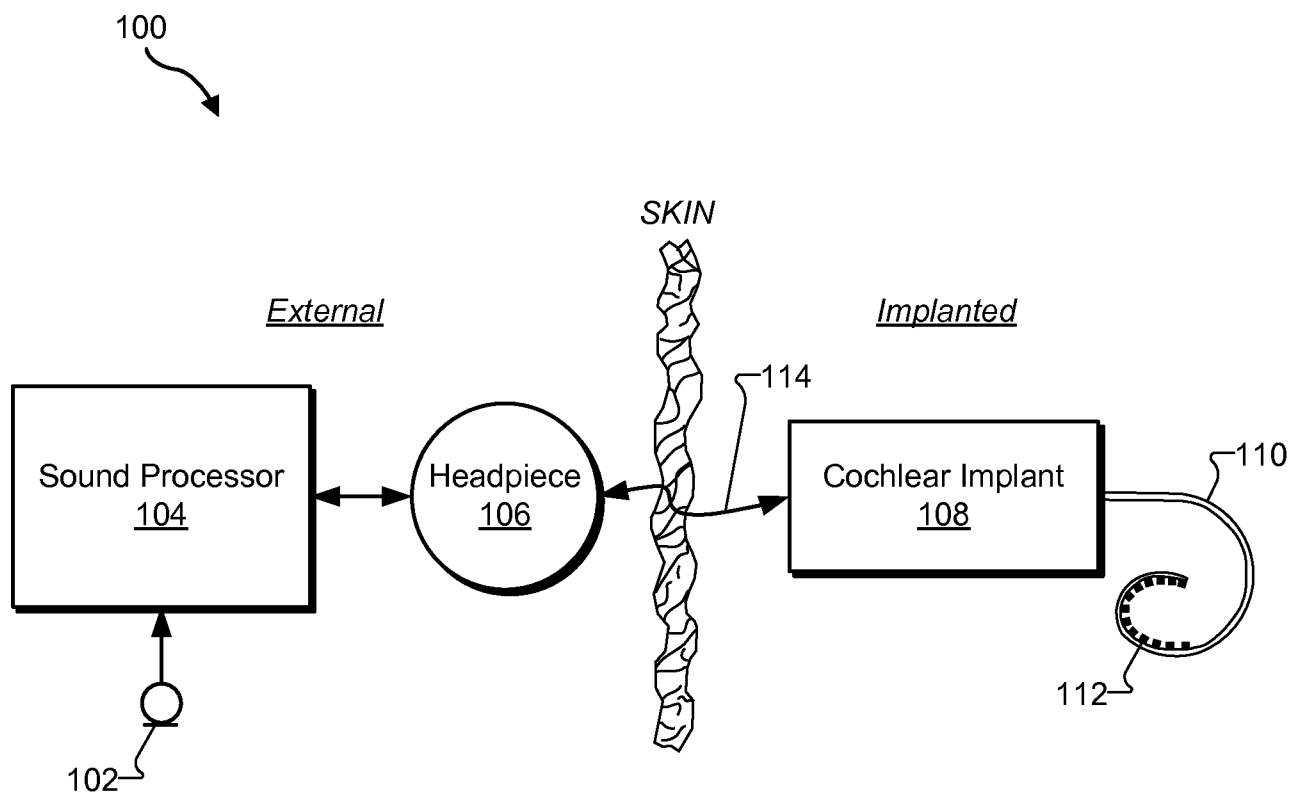
if the interaction comprises a selection of the graphical object representative of the global incorrect option, the at least one physical computing device

determines that the patient incorrectly identified each element included in the plurality of elements.

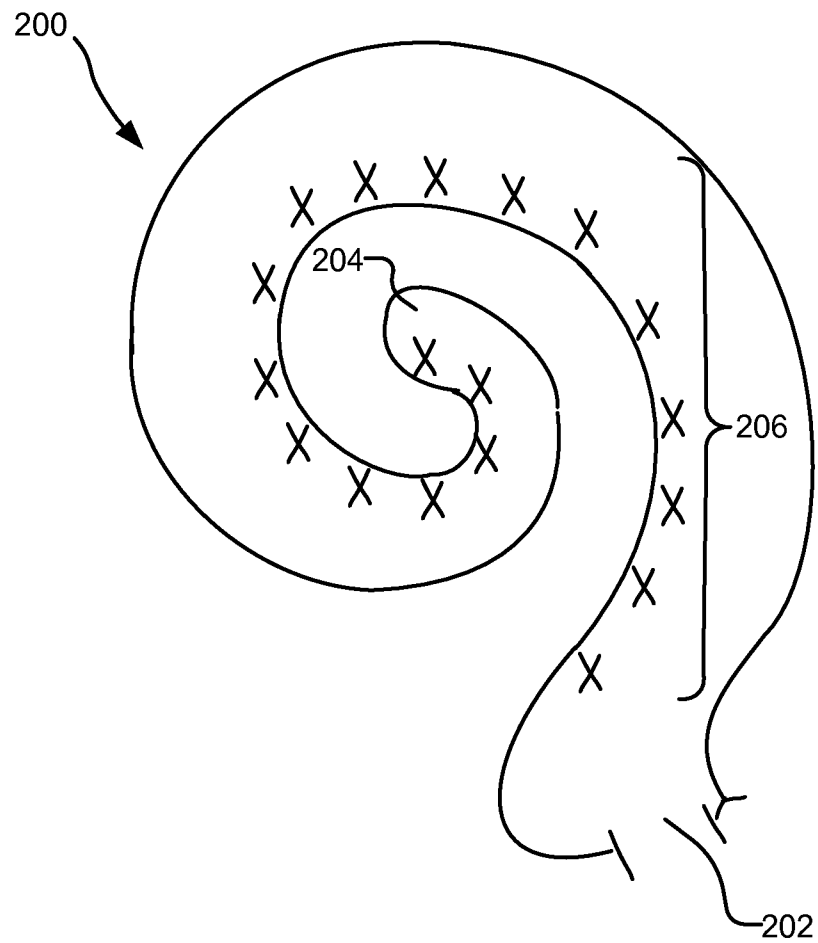
19. A method comprising:

- 5 presenting, by a programming system in response to user input provided by a user and during an evaluation period during which the programming system is communicatively coupled to a cochlear implant system associated with a patient, an audio clip to the patient, the audio clip comprising a plurality of elements;
- 10 displaying, by the programming system during the evaluation period, a graphical user interface for experiencing by the user and that includes a plurality of graphical objects each representative of a different element included in the plurality of elements;
- detecting, by the programming system, an interaction by the user with a graphical object included in the plurality of graphical objects and representative of a particular element included in the plurality of elements; and
- 15 determining, by the programming system based on the interaction by the user with the graphical object, an evaluation score for the patient, the evaluation score representative of a total number of elements included in the plurality of elements and that the patient correctly identifies after listening to the presented audio clip.
- 20 20. The method of claim 19, embodied as computer-executable instructions on at least one non-transitory computer-readable medium.

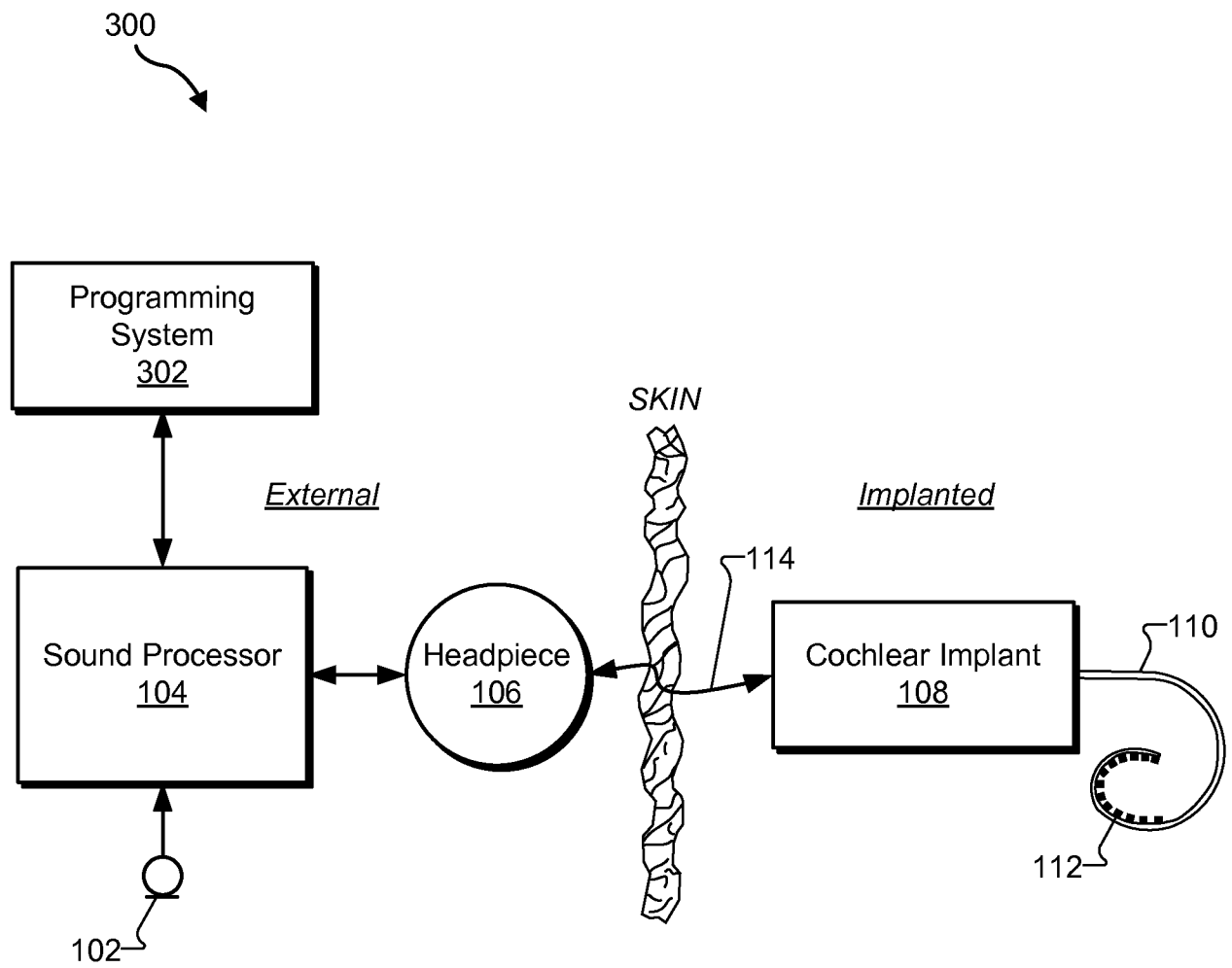
1/14

**Fig. 1**

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**Fig. 2**

3/14

**Fig. 3**

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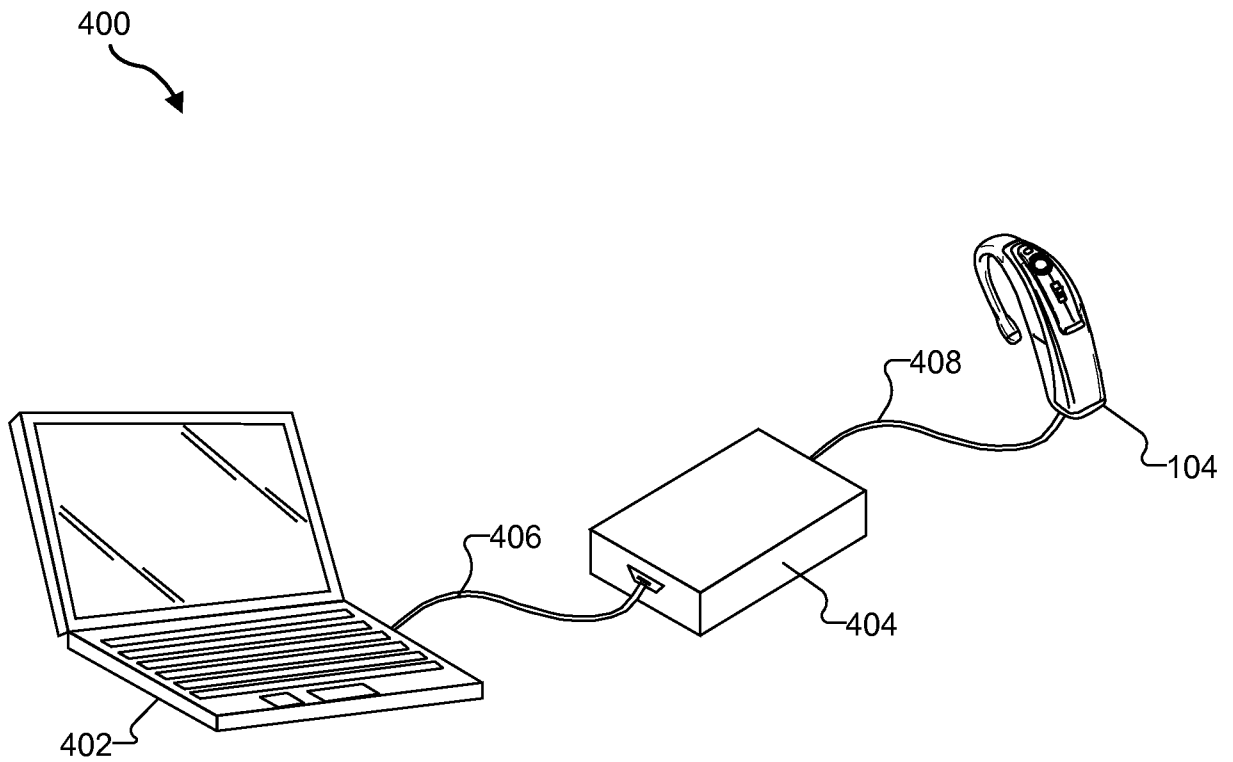


Fig. 4

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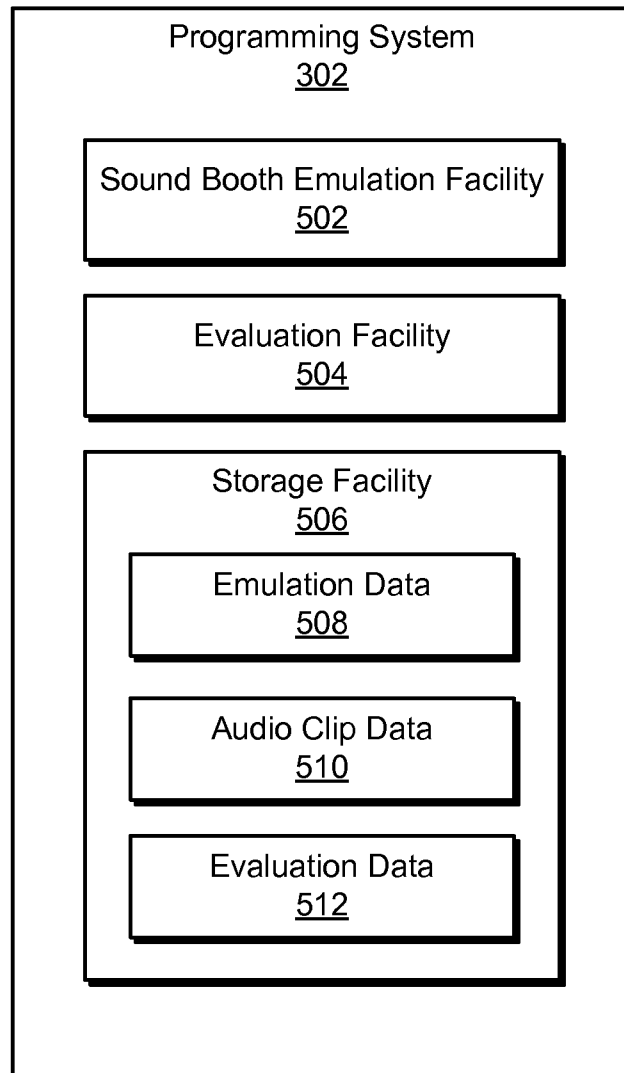
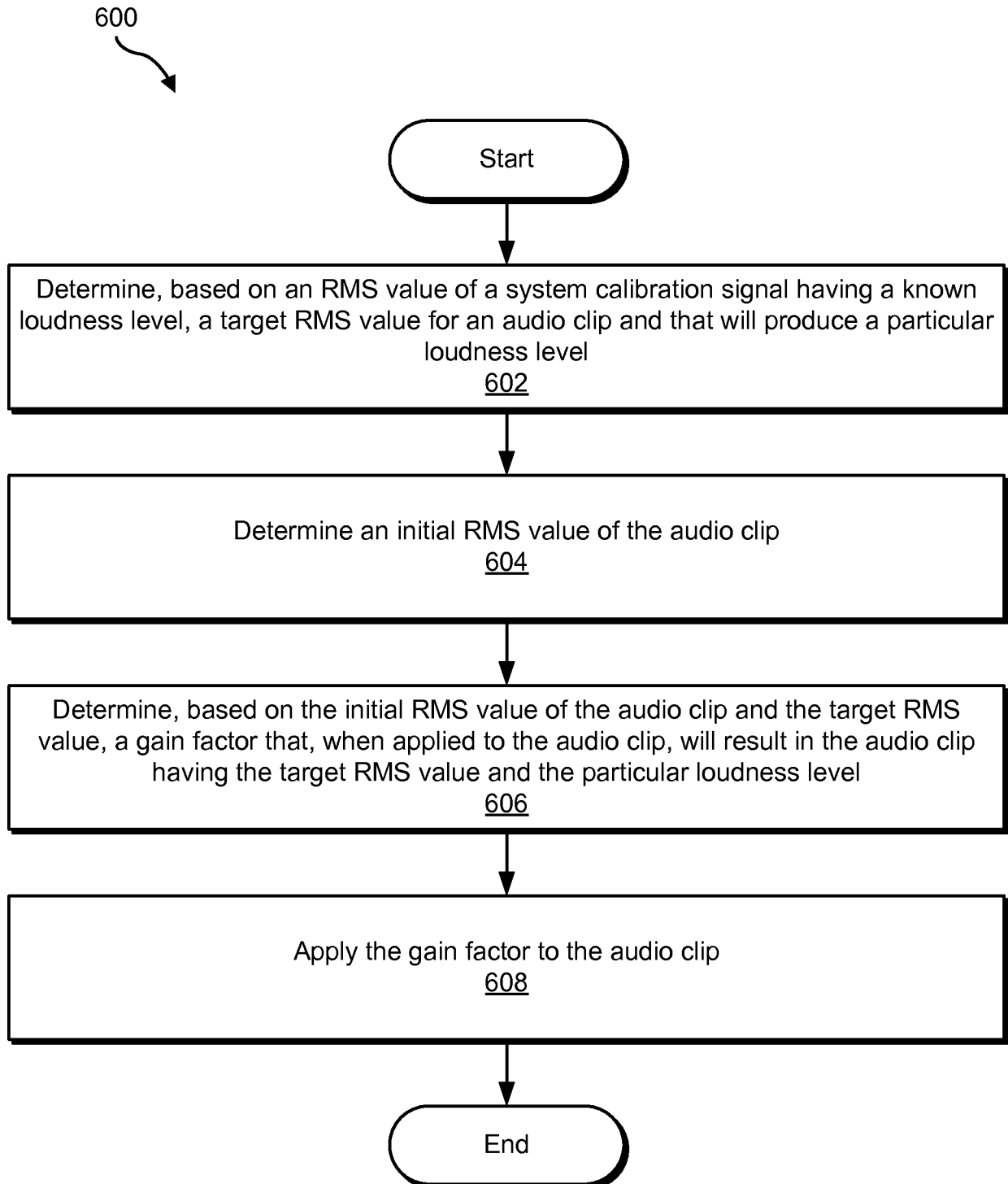


Fig. 5

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**Fig. 6**

700

□ ▾

Home

Evaluation Setup

Patients

Evaluation Setup

Evaluation Setup A *

▽

Evaluation Setup

Name *

▽

Signal

Signal Level

▽

Noise

Play Noise

Noise

Mode

Lead-in Noise

Trailing Noise

Level

702-1

702-2

7/14

702-3

702-4

702-5

704-1

704-2

706-1

706-2

1

He

tried

to

convince

her

she

was

not

right

2

He

was

a

very

dedicated

person

3

You

smell

like

fresh

lemons

4

There

are

several

types

of

tuxedos

5

My

life

will

start

at

thirty

Fig. 7

706

Home

Evaluation Setup

Patients

Evaluation Setup

Evaluation Setup A *

Evaluation Result A *

Signal Level

63 dB

Notes

Save

804-1

804-2

804-3

804-4

804-5

802-1

802-2

802-3

802-4

802-5

8/14

0/0

Item Score

0/0

Element Score

0

of

9

1

He

tried

to

convince

her

she

was

not

right

2

He

was

a

very

dedicated

person

3

You

smell

like

fresh

lemons

4

There

are

several

types

of

tuxedos

5

My

life

will

start

at

thirty

800

Fig. 8

Home

Evaluation Setup

Patients

Evaluation Setup

Evaluation Setup A *

Evaluation Result A *

Signal Level

63 dB

Notes

Save

◀

◻

▶

↺

↻

▶

Item Score

0/1

Element Score

8/9

804-1

He

804-2

tried

to

convince

her

she

was

not

right

804-3

8

of

9

9/14

802-1

802-2

802-3

802-4

802-5

1

2

3

4

5

He

was

a

very

dedicated

person

908

You

smell

like

fresh

lemons

There

are

several

types

of

tuxedos

My

life

will

start

at

thirty

Fig. 9

Home

Evaluation Setup

Patients

Evaluation Setup

Evaluation Setup A *

Evaluation Result A *

Signal Level

63 dB

Notes

Save

◀

◻

▶

↺

↻

▶

Item Score

0/2

9/15

Element Score

8/9

1

He

tried

to

convince

her

she

was

not

right

802-1

2

He

was

a

very

dedicated

person

802-2

3

You

smell

like

fresh

lemons

802-3

4

There

are

several

types

of

tuxedos

802-4

5

My

life

will

start

at

thirty

802-5

10/14

1

of

6

✓

✗

1002

Fig. 10

Home

Evaluation Setup

Patients

Evaluation Setup

Evaluation Result A *

Signal Level

63 dB

Notes

Save

14/20

1/3

800

1

He

tried

to

convince

her

she

was

not

right

802-1

8/9

2

He

was

a

very

dedicated

person

802-2

1/6

3

You

smell

like

fresh

lemons

802-3

5

of

5

1104

11/14

4

There

are

several

types

of

tuxedos

802-4

5

My

life

will

start

at

thirty

802-5

Fig. 11

Home

Evaluation Setup

Patients

Evaluation Setup A *

Evaluation Result A *

Evaluation Setup

Signal Level 63 dB

Notes

800

906

904

802-1

802-2

12/14

802-3

802-4

802-5

1202

1204

0

of

6

✓

✗

Save

14/26

1/4

Item Score

Element Score

1

He

tried

to

convince

her

she

was

not

right

8/9

2

He

was

a

very

dedicated

person

1/6

3

You

smell

like

fresh

lemons

5/5

4

There

are

several

types

of

tuxedos

0

of

6

✓

✗

5

My

life

will

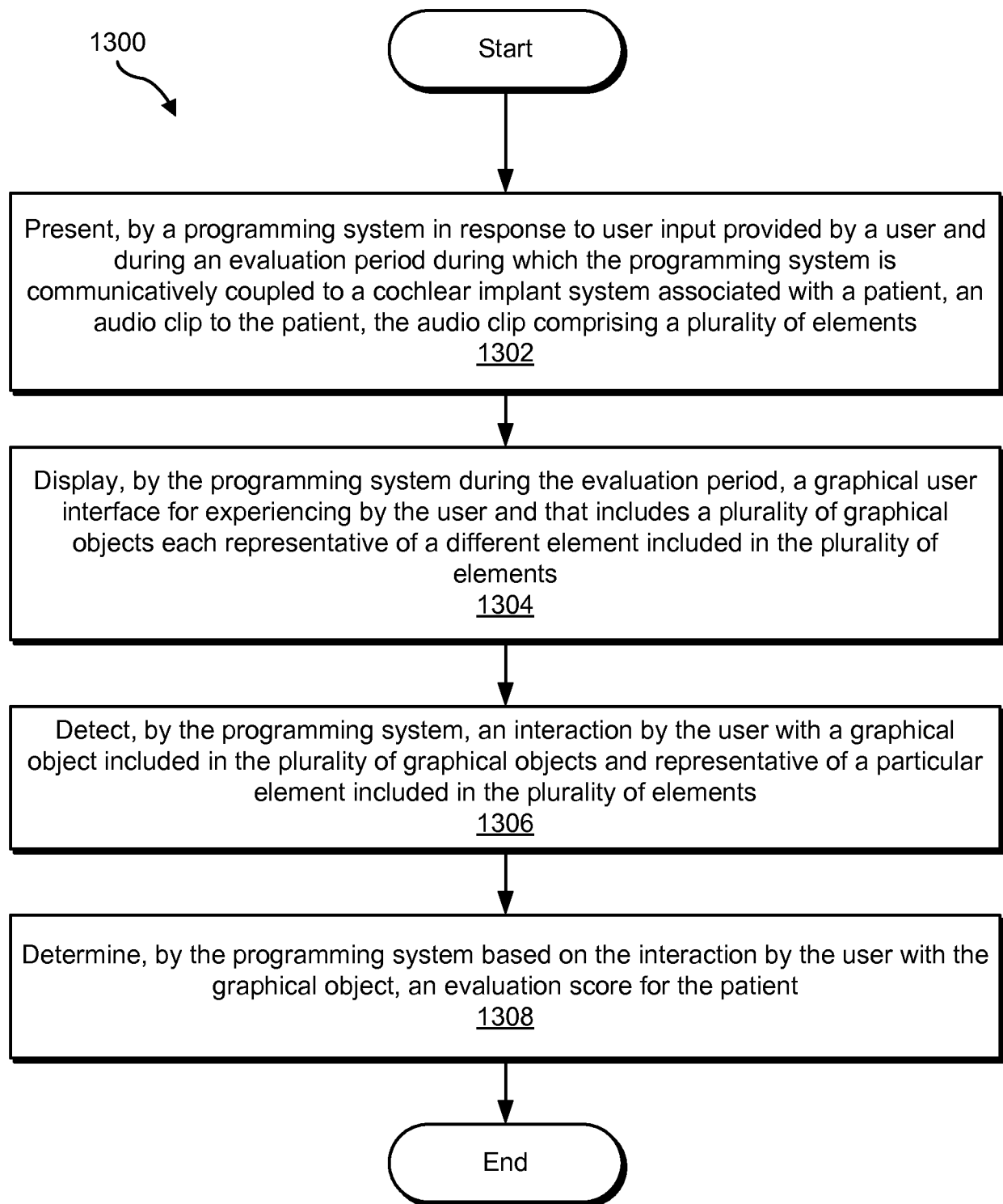
start

at

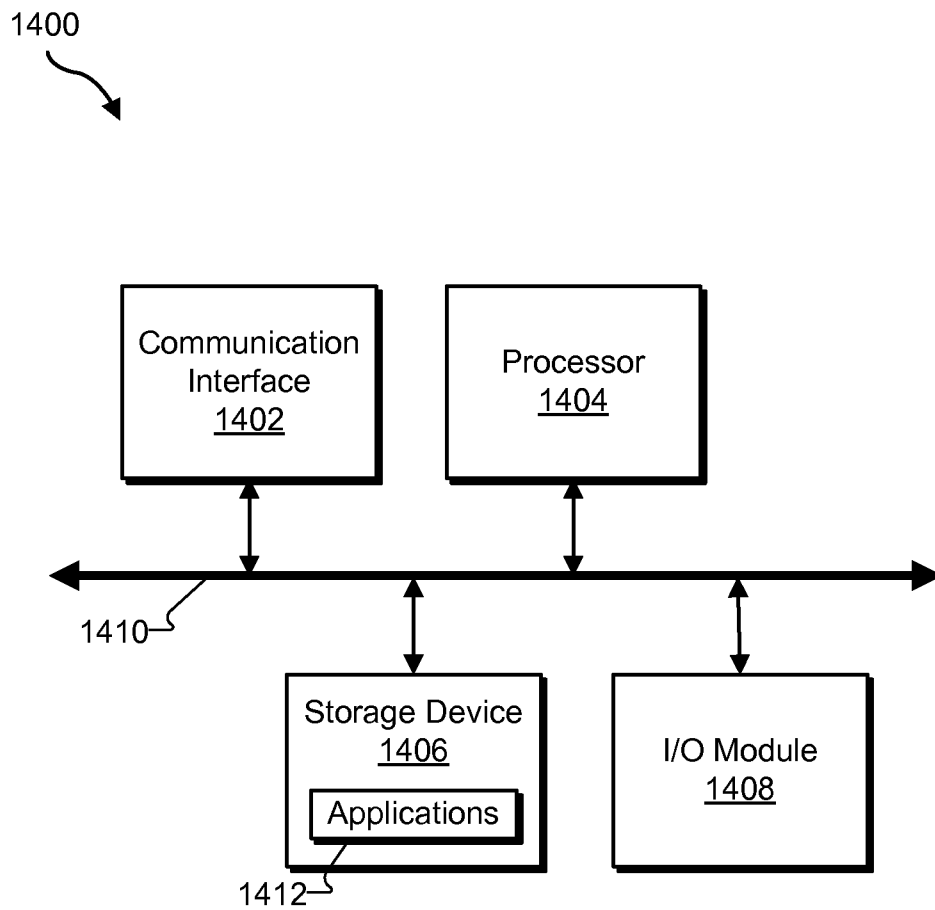
thirty

Fig. 12

13/14

**Fig. 13**

14/14

**Fig. 14**

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/052224

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61N1/36
ADD.

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)
A61N

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/232613 A1 (KRAUSE LEE S [US] ET AL) 16 September 2010 (2010-09-16) paragraphs [0041] - [0060], [0066] - [0069], [0074] - [0081], [0090] - [0099]; figures 1, 2D, 4, 7	1-20
X	US 2010/069998 A1 (SAOJI ANIKET [US] ET AL) 18 March 2010 (2010-03-18) paragraphs [0049] - [0071]; figures 5-7	1-17,19, 20
A		18
X	US 8 401 657 B1 (LITVAK LEONID M [US] ET AL) 19 March 2013 (2013-03-19) column 7, line 32 - column 10, line 12; figure 6A	1-17,19, 20
A		18
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Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

18 May 2016

Date of mailing of the international search report

30/05/2016

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Smit, Jos

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/052224

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2015/018457 A1 (ADVANCED BIONICS AG [CH]) 12 February 2015 (2015-02-12) page 12, line 18 - page 15, line 13; figure 5 -----	1-17, 19, 20 18
A	US 2011/060385 A1 (LINEAWEAVER SEAN K [US]) 10 March 2011 (2011-03-10) the whole document -----	1-20
A	US 2011/276109 A1 (BARTEL LEE R [CA]) 10 November 2011 (2011-11-10) the whole document -----	1-20

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Information on patent family members

International application No

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