prompts swallowing is provided to the subject. The swallowing induction process (S13) will be described later with reference to FIG. 4(b), FIG. 5, FIG. 6(a), and FIG. 6(b).

[0050] The processes of S11 to S13 are repeatedly performed until operation of the swallowing training apparatus 100 ends (S17: YES). During the time, the processes of S14 and S15 are performed by the swallowing detection part 116d. In S14, the swallowing detection part 116d determines whether or not swallowing has been detected. When swallowing has been detected (S14: YES), the swallowing detection part 116d causes, in S15, the display 111 to display information indicating occurrence of swallowing. The swallowing detection process (S14) will be described later with reference to FIG. 3(b).

[0051] Further, in accordance with the detection of the swallowing, a determination output process of S16 is performed by the determination output part 116e. In S16, the determination output part 116e determines appropriateness or inappropriateness of the detected swallowing, and outputs a determination result through the display 111 and the sound output part 113 to outside. The determination output process (S16) will be described later with reference to FIG. 4(a).

[0052] FIG. 3(b) is a flow chart showing the swallowing detection process (S14 in FIG. 3(a)).

[0053] In S21, with reference to the respiration data, the swallowing detection part 116d determines whether or not

swallowing induction part 116c determines whether or not the swallowing induction timing has arrived. When the determination in S41 is YES, the swallowing induction part 116c causes, in S42, the sound output part 113 to output a sound for prompting the subject to perform swallowing. The swallowing induction part 116c repeats the processes of S41 and S42 until an ending operation of the training operation is detected in S43.

[0059] When a swallowing induction timing is to be determined, it is necessary to take into consideration the time period from when the subject has performed swallowing in response to the induction until the subject starts inspiration. That is, even when swallowing has been induced in an expiration period, if the time period from when the subject has performed swallowing in response to the induction until the subject starts inspiration is short, it is highly likely that the swallowing and the inspiration occur consecutively, which increases the possibility of occurrence of aspiration. Therefore, when swallowing is to be induced, it is necessary to set the swallowing induction timing such that the time period from swallowing to the start of inspiration is not short.

[0060] For example, in a case where swallowing is induced in the subject in the middle or in the second half of an expiration period, there is an interval from when the subject has recognized the inducing sound until the subject actually performs swallowing. In the case of a subject who needs

swallowing training, it is considered that this interval tends to be long, and in particular, the older the subject is, the longer this interval becomes.

[0061] Therefore, preferably, the timing of swallowing induction is in the first half of an expiration period. In the present embodiment, an inducing sound is outputted from the sound output part 113 at a predetermined timing in the first half of an expiration period.

[0062] FIG. 5 is a diagram describing a method for setting a swallowing induction timing. In this setting method, the timing when expiration in the first half of an expiration period peaks is set as the swallowing induction timing.

[0063] FIG. 5 shows a graph of a respiration waveform based on respiration data. The vertical axis represents pressure and the horizontal axis represents time. T11, T21, T31, T41, T51, and T61 are timings at each of which expiration is started. T12, T22, T32, T42, T52, and T62 are timings at each of which expiration peaks. Each of ΔT1 to ΔT6 is the difference between the timing when expiration is started and the timing when expiration peaks.

[0064] In the induction timing setting, first, when start of expiration has been detected, an average value ΔT of the difference between this time point when the start of expiration has been detected and the timing when the expiration peaks, is estimated on the basis of differences ΔTn of five expirations preceding that time point. The difference ΔTn is sequentially

of an expiration period P1 has elapsed from the expiration start time point is set as the swallowing induction timing. Also in this case, similar to the case shown in FIG. 5, an average value of time periods ΔTαn obtained from five expirations preceding the expiration at the current time point is obtained as the time period ΔTα for the expiration at the current time point.

[0069] In FIG. 6(b), the timing when a time period ΔTβ corresponding to a predetermined proportion β (for example, 1/8) of a respiration period P2 has elapsed from the expiration start time point is set as the swallowing induction timing. Also in this case, similar to the case shown in FIG. 5, an average value of time periods ΔTβn obtained from five respirations preceding the respiration at the current time point is obtained as the time period ΔTβ for the respiration at the current time point.

[0070] As shown in FIG. 6(a) and FIG. 6(b), in a case where the time period ΔTα and the time period ΔTβ are determined, the proportion α, β is set such that the timing when the time period ΔTα, ΔTβ has elapsed from the expiration start is included in the first half of the expiration period.

[0071] In the setting method shown in FIG. 5, the timing when the expiration peaks is estimated on the basis of past differences ΔTn. However, instead of this, at the timing when the peak of the expiration is detected on the basis of respiration data, the inducing sound may be outputted. Other than this, immediately after expiration is started, an inducing

embodiment is used. In Modification 2, on the basis of the thus-generated respiration data, processes, displaying, and sound output similar to those in the above embodiment are performed. Therefore, also in Modification 2, effects similar to those in the above embodiment can be exhibited.

[0111] <Modification 3>

In the above embodiment, in the displays on the screen D1 shown in FIG. 7(a) to FIG. 9(d), the colors of the bar meters B1, B2 displayed in the regions R21, R22 are set to the same color. However, the colors of the bar meters B1, B2 may be different from each other, as in the case of the regions R11, R12.

[0112] Each of FIG. 14(a) and FIG. 14(b) is a diagram showing a configuration of the screen D1 displayed on the display 111 according to Modification 3. As shown in FIG. 14(a) and FIG. 14(b), in Modification 3, the color of the bar meter B1 is set to green which is the same color as the background color of the region R11, and the color of the bar meter B2 is set to red which is the same color as the background color of the region R12.

[0113] According to Modification 3, not only the background colors of the regions R11, R12 but also the colors of the bar meters B1, B2 are set to green and red, respectively. Thus, the subject can more clearly understand which of expiration and inspiration his/her respiratory motion is in. Therefore, the

subject can more effectively conduct the swallowing training such that the subject performs swallowing at an ideal timing with respect to the respiration.

[0114] In a case where the colors of the bar meters B1, B2 indicate expiration and inspiration in this manner, the displays of the background colors of the regions R11, R12 may be omitted, or alternatively, the background colors of the regions R11 R12 may be the same color. However, as in Modification 3, when the background colors of the regions R11, R12 are set to be different between expiration and inspiration, together with the colors of the bar meter B1, B2, the subject can more clearly understand his/her own respiratory motion.

[0115] <Modification 4>

Each of FIG. 14(c) and FIG. 14(d) is a diagram showing a configuration of the screen D1 displayed on the display 111 according to Modification 4.

[0116] In Modification 4, through adjustment of the display of segment groups forming the bar meters B1, B2, the swallowing timing in the respiratory motion is displayed to the subject. More specifically, the segment farthest from the boundary between the regions R21 and R22, in the segment group displayed in the region R21, R22 at the timing when swallowing has been detected, is continued to be displayed for a certain period (for example, about 1 second) in a color that is different from the color of the other segments.

[0117] In FIG. 14(c), swallowing is detected at the timing when the bar meter of which rightmost segment is a segment B11 is displayed in the region R21. The state of the expiration at the current time point is indicated by the length and the moving direction of the bar meter B1 (excluding segment B11) displayed in the region R21 at the current time point. In FIG. 14(d), swallowing is detected at the timing when the bar meter of which leftmost segment is a segment B21 is displayed in the region R22. The state of the inspiration at the current time point is indicated by the length and the moving direction of the bar meter B2 (excluding segment B21) displayed in the region R22 at the current time point.

[0118] According to Modification 4, the timing of the swallowing just performed by the subject can be confirmed by the display of segment B11, B21. Thus, while the subject sequentially and clearly confirms the timing of swallowing with respect to respiration, the subject can conduct the swallowing training more effectively.

[0119] <Modification 5>

In Modification 5, the color of the bar meter B1 displayed in the region R21 is changed between the first half and the second half of an expiration period. The color of the bar meter B1 is set to green in the first half of the expiration period, and the color of the bar meter B1 is set to yellow in the second half of the expiration period. With respect to an

occurrence of swallowing. At the swallowing induction timing, the swallowing induction part 116c causes the mark M5 to be displayed in the region R31. Here, the mark M5 is continued to be displayed in the entire period from when the expiration has been started until the first half of the expiration period ends. The marks M2 to M4 are displayed through processes similar to those in the cases shown in FIG. 17(a) to FIG. 17(d).

[0135] As shown in FIG. 18(c), the mark M5 is displayed in accordance with the start of expiration. Accordingly, swallowing is induced in the subject. As shown in FIG. 18(d), when the first half of the expiration period ends, the mark M5 is no longer displayed. When the subject performs swallowing in the second half of the expiration period, the mark S1 indicating the swallowing timing is displayed so as to be superposed on the respiration waveform B3, and further, the mark M4 is displayed in the region R31, as shown in FIG. 18(d).

[0136] According to Modification 6, since the respiration waveform B3 is displayed, the subject can understand in a simple manner the state of his/her own respiration, together with the shift of the respiration, and can easily perform swallowing so as to meet the timing of the swallowing induction trigger (display of the mark M5). Therefore, the subject can smoothly conduct the swallowing training.

[0137] <Other modifications>

Methods for detecting respiration have been described