The biofeedback program for speech rehabilitation of oncological patients after full larynx removal surgical treatment.

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Abstract

The biofeedback program for speech rehabilitation of oncological patients after full larynx cut out surgical treatment is described in this paper.

1. Introduction

The medical programs using biological feedback rapidly develop nowadays [3]. The adaptive biocontrol methods are used in speech therapy when there is a necessity in speech and voice correction and in stutter and speech neurosis treatment.

At present we carry out the investigation of using biofeedback in process of the rehabilitations of oncological patients after full larynx removal surgical treatment [2,4].

The main idea of the biofeedback systems consists in making available to observation the parameters, which needs to be controlled and which are inaccessible for observation without using the special technical facilities.

Let’s describe the conceptual approach, founded by Anohin P.K [1].

The Patient motivated on change of existing dysfunction gets feedback on this function. The Strong motivation leads to searching for goal-directed behavior, beginning with choice of the optimum behavior strategy. The replace of internal strategy is realized under the action of self-regulating mechanism. In case the required strategy is positively supported, it becomes dominant and replaces an old one. In case the wrong strategy causes the punishment, it stimulates the further change of strategies and makes patients continue the training toward required strategy. Gradually patient gets authoidentification of the right strategy and specific psychophysiological condition, accompanying achievement of the supported change of physiological function. As a result of biofeedback training the internal disturbance control system is formed. It is directed not on reception of the biofeedback signal, but on achievement of the required condition.

2. The description of program.

The structural scheme of biofeedback is represented on Figure 1.

![Figure 1. The structural scheme of biofeedback.](image1)

The rehabilitation program realizes the biofeedback mechanism on several stages. The initial stage of biofeedback is characterized by appearance of gullet voice, loudness and duration of phonation. The task of these rehabilitation stages is a creation so named gullet voice, which is used for contact by patients with full removed larynx. As a result of operations the source of the excitement of vocal tract — a larynx turns out to be removed we can see the interrupting of the source of the pressure (light) with vocal tract. In given type of the voice not larynx, but physiological narrowing in the gullet is used as a source of the excitement of vocal tract, and the volume of the gullet is a source of the pressure instead of lungs. On the first stages biofeedback locks on loudness of the voice signal and on duration of phonation. Screenshots of first two stages are submitted for figure 2,3.
The last stage of rehabilitations differs on functions from the rest ones. Its task is to make closer the frequency of the pitch of the formed voice to the bottom edge of a healthy person speech sound. Until now, the rehabilitation ended in stage of forming understandable to another persons gullet voice. The frequency of the pitch in this case is very low, since walls of the gullet are more massive in contrast with larynx and do not possess such big set of the muscles and nervous completions, as larynx does. The statistical frequency of the pitch of gullet voice is found within 50-80 Hz after completion of the rehabilitation process and rises up to 80-100 Hz for several years of the contact by means of gullet voice. Right the rehabilitation process is over, the pitch frequency within one phoneme can be very sloppy, up to aperiodic excitement of vocal tract. In this case it’s possible to speak of certain averaged value of the pitch frequency for one phoneme. When period of the contact at gullet voice is rather long, we can see the frequency stabilization of the pitch. This is graphically represented on table 1.

### Table 1: The results of the gullet voice analysis of patients after rehabilitation.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Subjective estimation</th>
<th>Pitch frequency, Hz</th>
<th>Instability of pitch frequency, Hz</th>
<th>Instability of pitch frequency, %</th>
<th>Maximum pitch deviation from mean, Hz</th>
<th>Maximum pitch deviation from mean, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Та. 3 (+)</td>
<td>135,8</td>
<td>6</td>
<td>4,469</td>
<td>12,45</td>
<td>9,1</td>
<td></td>
</tr>
<tr>
<td>Су. 3 (+)</td>
<td>54,3</td>
<td>4,368</td>
<td>8,04</td>
<td>13,81</td>
<td>26,31</td>
<td></td>
</tr>
<tr>
<td>До. 3 (-)</td>
<td>70,84</td>
<td>8,28</td>
<td>11,69</td>
<td>36,06</td>
<td>50,89</td>
<td></td>
</tr>
<tr>
<td>По. (-)</td>
<td>52,49</td>
<td>4,9</td>
<td>9,3</td>
<td>8</td>
<td>15,25</td>
<td></td>
</tr>
<tr>
<td>Ди. 2</td>
<td>21,05</td>
<td>1,1</td>
<td>5</td>
<td>3,3</td>
<td>15,9</td>
<td></td>
</tr>
<tr>
<td>Ка. 1</td>
<td>63,6</td>
<td>14,9</td>
<td>23,43</td>
<td>31,3</td>
<td>49,21</td>
<td></td>
</tr>
</tbody>
</table>

The gullet voice is estimated on three-point system, where 1 point means the difficult contact with weak possession of gullet voice, but 3 points ballets mean free contact. The voice characterized by small differing from normal on rumour is marked by the sign +. The first patient, described in the table, is a woman, whose voice in rehabilitation process approaches to the voice of a healthy person. The decision about entering the additional stage was accepted based on the analysis of statistical data. The task of this stage is improvement of formed gullet voice during finding patient in the hospital, by means of increasing and stabilization of the pitch frequency.

The task of pitch extracting in recently formed gullet voice is more difficult than the task of the pitch extracting from voice of a healthy person. It is explained by presence of strong noise components, and the frequency itself has strong deviation from its average value. Biofeedback will lock on dynamic sonogram, until the problem of the extracting given frequencies in automatic mode is solved. In this case the spectrum of the signal is shown on computer screen in the frequency borders of the pitch frequency and the task on training so is shown. The patient pronounces beforehand determined phrases with long phonation of voiced sound and tries to execute the task. The successful achievement of the given main tone frequency is positively supported (the picture is opened). The conditioned reflex on frequency control of the pitch formed, the patient successfully passes the whole course and makes his main tone frequency up to border in 100 Hz. The screenshot of this stage is represented on Figure 4.

The system of recursive digital filter of fourth order is used in making dynamic sonogram. The motivation of using such system is given in the article named “The investigation of gullet speech spectrum by means of the recursive filters system” given in this book.
3. References


