Collares Ortofónicos: System for the training of the suprasegmental parameters of intensity and time of the articulated sound

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Abstract: This article describes the structure and working of an interactive multimedia environment for the training on two of the speech suprasegmental parameters (loudness and timing), for its application in many types of speech disorders and cognitive-linguistic pathologies. The environment allows the tutor to configure and personalise the exercises to treat specific cases or to let the proper environment propose the exercises following various configured parameters and after that analyse the results obtained by the clients.

1. INTRODUCTION

Collares Ortofónicos is a computer application orientated to the logopedic treatment of children with perception troubles of rhythm, loudness or both parameters in the processing of the acoustic signal related with speech (Torres, 1989), that is, the bases or the articulated sound. Among its
possible users are people affected with profound deafness and other people with a deficit in the space-time processing of the articulated sounds of speech, rhythm, sequence of figures and sounds, simultaneous versus successive processing (Das, 1996, 1988), attention deficits, among other discapacities (McGregor, 1994).

The clinicians and language therapists, in their task with hearing impaired children, must get these children to distinguish the speech suprasegmental parameters, that is, sound, loudness, voicing onset, duration, prosody, rhythm and pause. These parameters have been usually learned by hearing impaired children with imitation and lip-reading imitation, or with discrimination strategies rested in selection techniques of frequency bands and hearing stimulation (Gajic, 1996). “Collares Ortofónicos” pretends that children could have an entertaining autocorrection, overcoat when the computer output is connected with the SUVAG amplifier (Sistema Universal Verbal Auditivo Guberina) and the deaf people can perceive their emissions both by lip-reading and by vibrotactic perception, with the vivag-suvag vibrators, and the headphones adapted for the stimulation of their hearing rests.

The idea of associating a colour to each sound and the characteristics of various geometric figures to various articulated sound properties, that is: the size to indicate intensity and the form to indicate the duration, have allowed us to work, with success, with babies and children younger than three years, some basic linguistic aspects. It is well known that babies and children have an exceptional predisposition to acquire linguistic aspects of great complexity (Pinker, 1995; Neville, 1997; Mehler et al. 1990 y 1996, et al.). This process used to be done with a box or a bag with various forms, sizes and colour figures. The methodology is to prepare a physical element (sphere or cylinder), to articulate the corresponding sound and to present it in a fast way during 1 second more or less, so the child could associate it with the hearing stimulus. In this way, figures are shown in contrast position or phonological opposition so that the child can extract, unconsciously, the phonetic characteristics of the different speech sounds. After the presentation phase, that is, to attract the child’s attention, we have the imitation phase and finally the minimum pair discrimination phase.

“Collares Ortofónicos” follows, essentially, the design with which we have been working with manipulable materials. They are sequences of figures associated with phonetic characteristics, based on phonological oppositions, joined with a little imaginary rope to impose an established order in the execution of the exercise. The sequence will follow the left-right
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and up-down order to create an automatism that will facilitate the learning of the reading process. The result of each screen is a ring, and each figure is a piece of the ring, that represents two or three parameters of speech sounds (MOC, 1992-2000, for material, task and procedure revision).

“Collares ortofónicos” is going to join the list of commercial applications that have been developed to reinforce, rehabilitate, and study the speaking perception and production as psycholinguistic processes. Among these applications we can emphasise its use among the special education teachers and language therapists: (SpeechViewer-III of IBM (IBM, 1997) and the VISHA system (Aguilera, 1995).

2. SYSTEM DESCRIPTION

The application, from an organisational point of view, has two modules or scenarios, one of them is orientated towards the teacher and the other towards the pupil, integrated in the same program. The teacher module function is to facilitate the creation and checking of the exercises that are going to be proposed to the student. On the other hand, the pupil’s module is orientated towards the making of exercises and towards the calculation of success and error statistics.

The application, using only vocal sounds, follows a preestablished sequence for the phonological training: each pupil must do 27 predetermined exercises, where the five Spanish vowel phonologic oppositions are treated: 1) open-close, 2) loud-soft, 3) long-short, 4) front-back and 5) round-enlarged. These exercises are proposed automatically and progressively by the system. When the pupil has finished these exercises, he/she could do other exercises developed by the teacher for specific purposes. The system can generate exercises automatically following various preconfigured parameters selected by the teacher. In this way, the program can adapt itself to the concrete needs of each pupil. To make the decision of what generation parameters are going to be selected, the teacher will base himself on the progress statistics and reports generated by the system.
3. TYPES OF EXERCISES

3.1 Understanding exercises

They are composed of a sequence of figures with a phonetic meaning, that is, that they represent phonetic characteristics of sounds. The pupil must read or articulate the figures to do the exercise. These exercises are named this way because the pupil has to understand and learn accurately the phonetic meaning of the figure.

? Colour – Vocalic phonemes (each vowel is associated to a colour)
  – Blue – /a/
  – Green – /e/
  – Yellow – /i/
  – Red – /o/
  – Black – /u/

? Form – Sound duration
  – Sphere – Short
  – Cylinder – Long

? Size – Sound intensity
  – Big – Strong
  – Short – Weak

A sequence of figures are presented on the screen to the pupil, where the characteristics and meanings are exposed beforehand, and he/she has to pronounce the phoneme that corresponds to each of the figures, into a microphone.

The pupil will have to pronounce the sound corresponding to the actual figure, that is the one that has an arrow inside of it (figure 1).

While the exercise is being done, there will be two indicators, one of them on the left and the other on the bottom of the screen. They are the intensity and duration indicators, respectively, of the sound pronounced by the pupil.

If the sound of the figure is pronounced correctly, a little smiley face will appear in the arrow’s place, and a success sound will sound (positive reinforcement), and the exercise will continue using the next figure. If the pronounced sound is not the correct one, a little sad face and a failure sound
will be heard (negative reinforcement), so the pupil will have to repeat the pronunciation of the figure.

Figure 1. Understanding exercise

When the last figure of the exercise is correctly pronounced, a congratulation sound will be heard and a dancing cookie will appear as a positive reinforcement.

3.2 Composition exercises

They are a series of letters (vowels) followed by the corresponding sound, and the pupil must choose the corresponding figure (as in the understanding exercises).

? The letters are the vowels (a, e, i, o, u).

? Size of the letters – Intensity
   – Capital vowel – Strong.
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? Shadow – Duration
- Vowel with shadow – Long.
- Vowel without shadow – Short.

The pupil will have to propose the corresponding figure to the letter that he has to answer. Before that, the corresponding sound of the actual letter will be heard.

![Figure 2. Composition exercises](image)

This kind of exercise, to manage that the hearing deficient child could hear the sound produced by the computer, the latter will be connected to the S.U.V.A.G. The suvag is a system for the amplification and modification of the speaking signals. It has a vibrotactile and auditory output that allows the hearing deficient person to perceive the stimulations, whatever his age and evolutionary or linguistic development.

While the exercise is being done (figure 2), the figure to answer will be indicated by an arrow that will be on top of the figure. The size, form and colour parameters must be changed to adequate them to the characteristics of the figure that the pupil wants to answer.
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When the figure has the desired characteristics, the pupil can answer clicking the answering button.

### 3.3 Onomatopoeia

They are pre-programmed comprehension exercises that need the articulation of the onomatopoeia of an animal, object or action sound. The onomatopoeias are short speaking segments, normally with a syllable phonological accepted. These phonologic segments have a meaning that the child extracts by associating the images with the corresponding onomatopoeias. The onomatopoeias are the second phase in the logopedic rehabilitation.

The way these exercises are done is the same as the comprehension exercises, except that at the end of the exercise a representative image of the onomatopoeia will appear.

<table>
<thead>
<tr>
<th>Onomatopoeia</th>
<th>Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane</td>
<td>AAA</td>
</tr>
<tr>
<td>Donkey</td>
<td>I AAA, I AAA</td>
</tr>
<tr>
<td>Horse</td>
<td>III</td>
</tr>
<tr>
<td>Pig</td>
<td>o i, o i</td>
</tr>
<tr>
<td>Wolf</td>
<td>A UUU, A UUU</td>
</tr>
<tr>
<td>Monkey</td>
<td>I I I</td>
</tr>
<tr>
<td>Dog</td>
<td>u A u, u A u</td>
</tr>
<tr>
<td>Indian</td>
<td>A, A, A</td>
</tr>
<tr>
<td>Ghost</td>
<td>UUU, UUU, UUU</td>
</tr>
<tr>
<td>Fright</td>
<td>OOO</td>
</tr>
<tr>
<td>Scream</td>
<td>EEE, EEE, EEE</td>
</tr>
<tr>
<td>Mother</td>
<td>cee aaa, cee aaa, cee aaa</td>
</tr>
<tr>
<td>Crying</td>
<td>u AAA, u AAA, u AAA</td>
</tr>
<tr>
<td>Hammering</td>
<td>Ai iii</td>
</tr>
</tbody>
</table>

### 4. Functionalities

One of the main characteristics of the application is to generate exercises automatically. This automatic generation can be configured by the teacher to adequate them to the learning needs of the child. There are options that allow configuring these characteristics, as you can see in figure 3 for the comprehension exercises. You can save personalised configurations too so you can have configuration templates. In this way, you can use them without having to configure them again.
The pupils’ personal data are introduced in the system with a simple form that allows one to navigate through the files. This allows the identification of the pupils in the system.
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The system stores personalised statistics for each pupil, to allow the teacher to analyse them and make decisions about the exercises that the child will have to do. In this way, the teacher must impact in those aspects that haven’t obtained the adequate development of the concrete parameter studied, within the preestablished parameters.

The pupil’s statistics are shown in figure 4, where:

- **Figuras**: Number of elements of the exercise answered correctly.
- **Intentos**: Number of intents needed to answer the elements indicated before.
- **Fallos de intensidad**: Number of failures in the intensity of the sound to pronounce.
- **Fallos de duración**: Number of failures of the sound duration.
- **Fallo de sonido**: Number of wrong sounds pronounced by the pupil.

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| Estadísticas ejercicios de comprensión |
| Figuras: 8 |
| Intentos: 18 |
| Fallos de intensidad: 0 |
| Fallos de longitud: 4 |
| Fallos de sonido: 7 |

| Estadísticas ejercicios de composición |
| Figuras: 9 |
| Intentos: 17 |
| Fallos de intensidad: 8 |
| Fallos de longitud: 0 |
| Fallos de sonido: 7 |

**NOTAS:**
Notes about the pupil’s pursuit or about his/her evolution state at this moment.

Figure 5. Statistic file example

These statistics are stored in files, so the teacher can control the pupil’s evolution. The teacher can add a little comment to the statistics about the pupil’s state, evolution, etc... (figure 5).
The final presentation of the exercises on the pupil’s screen is highly configurable. Most of the procedures can be configured.

5. CONCLUSIONS

Collares Ortofónicos is, firstly, a multimedia environment for the development of the suprasegmental parameters of speaking, concretely for the intensity and duration or time. The user-friendly aspects, presentation and the visual and hearing reinforcements have been taken into account. The application has the friendly and accessibility characteristics needed to apply to children. It is also an environment with a wide set of applications, it depends on the psycholinguistic or altered cognitive processes, that is: onset phonemes per second. Onset voicing (VOT voice onset time), from left to right eyes movement, pattern learning and discrimination, successive and simultaneous processing, etc. The teacher imposes the application’s usage restrictions, since it has wide-open possibilities for imagination and creativity.

Among the possible improvements of the application’s actual state, we could propose to add more phonetic capabilities, and not only vocal phonemes; to add syllable capabilities or even whole words.

As a possible development we could think of substituting the teacher with an intelligent tutor directed by the computer. In this way, the virtual tutor will propose the exercises depending on the pupil’s statistics and evolutions for the correct development of the cognitive and linguistic aspects.

6. BIBLIOGRAPHY AND REFERENCES


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