RehabVisual: Development of an Application to Stimulate Visuomotor Skills

Raquel Machado[1], Ana Ferreira[1,2,3], Carla Quintão[1,4] and Cláudia Quaresma[1,4]
[1]*Departamento de Física, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Caparica, Portugal*
[2]*Serviço Medicina Física e Reabilitação - Hospital de D. Estefânia, Centro Hospitalar de Lisboa Central, Lisboa, Portugal*
[3]*Departamento de Saúde, Escola Superior de Saúde, Instituto Politécnico de Beja, Beja, Portugal*
[4]*LIBPhys - UNL, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal*

Keywords: Rehabilitation, Visuomotor Skills, Pediatrics, Software.

Abstract: The stimulation of visuomotor skills has a relevant role in the rehabilitation of children with neurological dysfunctions / pathologies. However, the methods of evaluation and intervention for children under the age of 18 months are few systematic and not directed to the problem of each one. For this reason it was important to develop a system that will fill this gap. Therefore, the main purpose of this paper is to present the development process of a tool called RehabVisual - evaluation and stimulation of visuomotor competences. RehabVisual has the objective to promote the evaluation and the stimulations of visuomotor skills in children between the ages of 0 and 18 months. The platform has two sessions: database that records all the clinical information of the child and protocol with stimuli according to the development of the child. This plataform it was realized with physicians and occupations therapists from the Service of Physical Medicine and Rehabilitation (PMR) of the Hospital D. Estefânica of the Hospital Center of Lisbon Central and it was approved by the Portuguese Ethics Committees of this Hospital. The RehabVisual can be used by physicians, occupational therapists, and caregivers and is characterized for being a tool user-friendly, versatile and adaptable to the needs of each child.

1 INTRODUCTION

The Physical Medicine Rehabilitation is an area with a growing development in the last years and increasingly necessary, by all age groups, being an area of interest for all aspects of medicine, namely the pediatric.

Pediatric Rehabilitation is focused on the child and his / her family cell, preventing, qualifying and habilitating in the health, education and social action, taking into account its development (Ortibus et al., 2011). For this reason, it is necessary to establish a intervention plan that contemplates the different aspects of the overall development of the child - motor, sensory, cognitive, socio - affective and familiar (Ortibus et al., 2011).

The understanding oh how to characterize the disorder to make best use of vision and effectively teach children with cerebral visual impairment is in its infancy (Lueck and Dutton, 2015)

The methods used to stimulate the visualmotor skills are considered generic and very little directed to the individual needs of each child, there is no systematic treatment method (Best and Miller, 2010). In terms of (re) evaluation of children older than 18 months, there are three scales that are used and that allow a standardized evaluation (Aarnoudse-Moeus et al., 2009). However, in children below to 18 months of age, the lack of a methodology to analyse the initial visual reaction state of the child and / or effectiveness of the implemented therapy was identified (Ortibus et al., 2011; Aarnoudse-Moeus et al., 2009). This gap makes the rehabilitation process difficult, especially at two levels: understanding the needs of the child; in monitoring the child's progress.

Thus, it is necessary to improve the methodology of evaluation and intervention at the level of visuomotor skills in children up to 18 months with developmental disorders.

Please note that the children who are born with the normal visual system do not need additional visual stimulation (Catalano et al., 1986). In children without associated pathology / dysfunction, the

Machado, R., Ferreira, A., Quintão, C. and Quaresma, C.
RehabVisual: Development of an Application to Stimulate Visuomotor Skills.
DOI: 10.5220/0006597001730178
In *Proceedings of the 11th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2018) - Volume 1: BIODEVICES*, pages 173-178
ISBN: 978-989-758-277-6

development of vision is performed spontaneously and extra stimulation may be harmful to the child, leading to an unnecessary effort that causes stress, excitement and disorientation. The children with visual dysfunctions, in the ocular apparatus or in the optical pathways or were deprived of environmental stimuli need adequate additional stimuli to develop visual perception (Giovannett et al., 2013).

Early intervention is very important in children with visual impairment para estimular o processo de mielinização. It can have a preventive character, reducing the appearance of secondary dysfunctions and / or taking an active action in the residual visual stimulation in the child (Heyl and Hintermair, 2015; Sonksen, 1983; Hyvärinen, 2012).

Early visual intervention addresses the following objectives (Cicerone et al., 2010):

- Stimulate visual efficiency;
- Encourage the functional use of vision in all everyday situations, no matter how small the residual view of the subject;
- Encourage the establishment of the mother-child relationship;
- Provide functional activities that integrate sensations captured by the sense organs with the psychomotor functions.

The present paper has as main objective to present development process of a plataform - RehabVisual - evaluation and stimulation of visuomotor competences.

2 THE REAHAB VISUAL PLATAFORM

RehabVisual was developed with physicians and occupational therapists from the Service of Physical Medicine and Rehabilitation (PMR) of the Hospital D. Estefânia of the Hospital Center of Lisbon Central. This study was approved by the Portuguese Ethics Committees of this Hospital

RehabVisual has the objective to promote the stimulation of visiomotor skills in children up to 18 months old and provide the systematic report.

The RehabVisual platform has two sessions: database that records all the clinical information of the child and protocol with stimuli according to the development of the child.

The platform allows access to three types of users: physician, occupational therapist and caregivers.

The caregiver only has access to some stimuli selected by the therapists, not having access to any information that is in the domains of other users.

The physician can record all clinical information such as age, diagnosis, evaluation of ophthalmic parameters performed at children. The occupational therapists can consult this information.

The occupational therapist can record all the information concerning the behavioural assessment, the functional evaluation and can choose the stimulus protocol during the procedure. The physician can consult this information.

RehabVisual was created using several programming languages such as JS, PHP, HTML and CSS. This diversity of languages, namely HTML and CSS, gives the site a more appealing and professional template. PHP makes possible the communication and JS makes the site more dynamic and with more intuitive functionalities, can be can seen from the query figure1. To create the database, the language chosen in SQL was chosen.

2.1 Development of the Database

The requirements defined for the database were:

- be user-friendly
- be versatile registration;
- be in digital format;
- allow the recording of personal information, therapy session details, performance assessment and other relevant clinical information;
- facilitate the analysis of the child's clinical evolution;
- provide a change to the method implemented;
- provide reports, such as a systematic evaluation, for delivery to caregivers or even to file service or the hospital itself.

The database allows the recording of patient data and clinical assessment. Thus, it is divided into: patient chart; assessment of ophthalmological parameters; behavioural evaluation; functional evaluation of the vision; monitoring of intervention sessions.

The patient's record contains socio-demographic data about the patient and caregivers, family composition and diagnosis. These are data considered relevant to identify the social environment that around the child and define the intervention in a personalized way (Hyvärinen, 2012).

In the ophthalmologic evaluation session is carried out the analysis of the evolutionary development of the following parameters: setting and search for objects, reflecting direct fotomotor, visual acuity and stereopsis.

The behavioural assessment session consists of observing how the child reacts to the stimuli

presented (fixation, follow, try touch or not). They are considered activities that help in the perception of the visual functioning of the child, such as the activities of daily living. The behavioural traits observed during the performance of activities are relevant information for a better understanding of visual characteristics. In this evaluation process, the presence of a family member of the child involved is advisable to provide all the details considered important (Ortibus et al., 2011; Aarnoudse-Moeus et al., 2009; Fox and McDaniel, 1982).

To optimize the time of evaluation and behavioural analysis, it was adopted the scale implemented in the visual evaluation (Gordon and Martin, 2010). The scale consists of the following parameters:

1. Never - (0%)
2. Rarely - (25%)
3. Occasionally - (50%)
4. Often - (75%)
5. Always - (100%)

If the child's collaboration is successful, the occupational therapist applies a functional assessment program for vision / motor skills. In this context, the therapist makes an evaluation based on a systematized protocol, elaborated for that purpose based on standardized criteria.

Functional assessment of vision is performed by analyzing the patient's record at the time of application of the stimulus protocol.

Throughout the sessions an evaluation is made to analyze the evolution of the patient.

In all evaluations it is possible to record observations

2.2 Development of the Protocol of Stimuli

It was defined for the protocol of the stimuli should:

- allow the stimulation of visuomotor skills
- have adequate incentives for the needs of each child between the ages of 0 and 18 months
- take into account child's cognitive development
- be of increasing complexity
- provide a change to the implemented method;
- provide reports, as a systematic evaluation, for delivery to care providers or even to file the service or the hospital itself.
- Provide orientated stimulus for caregivers to use at home

This protocol was developed based on the bibliography consulted, on the professional experience and on the stimuli developed for the intervention program (Telles et al., 1974; Atkinson, 2008; Lueck and Dutton, 2015). Two programs were divided in colour and black and white. Both are constituted by the same evaluative sequence, being they differ only in the introduction of colour in the geometric figures. According to the characteristics evaluated in the intervention program, the functional evaluation consists of simple figures, figures with a medium complexity pattern and horizontal, vertical, diagonal and circular movements at medium speed.

For the sake of uniformity of the evaluative scheme, the scale adopted in the behavioural evaluation was implemented.

The attributes of visual stimulation can be adjusted during the instruction, depending on the purpose. These attributes relate to the following characteristics:

1. Dimension;
2. Contrast;
3. Complexity;
4. Lighting;
5. Duration;

All these attributes must be taken into account in order to optimize the visual functions (Lueck, 2004); (Catalano et al., 1986). Based on these characteristics, an intervention program was designed to support the sessions of stimulation of visuomotor skills. This intervention program will be applied during an occupational therapy session.

As support for the evaluative level and for the choice and presentation of the stimuli, a specific menu was elaborated for the situation.

2.3 Characteristics of Stimulus

Visual stimulation at these early ages is dependent on the visual response to stimuli, such as lights, contrasts, colours, glows, objects, and so on (Beery and Beery, 2010; Atkinson, 2008). Thus, the response is an indicator of ocular development and visual learning as well as visual evolution. For children within the age bracket considered in this study, from 0 to 18 months, this response is observed from indicator behaviours such as looking, smiling or balancing and can help the professional to adapt the intervention strategy to be used, such as de fining amore distant distance (Ortibus et al., 2011; (Ortibus et al., 2011; Aarnoudse-Moeus et al., 2009; Catalano et al., 1986).

Considering the response to the functional evaluation protocol of visuomotor skills, the child is directed by the occupational therapist to an

intervention program aimed at developmental needs. The main objective of this program is to be able to define as many variables as possible, making it more complete and universal. This provides the user with a greater number of choices, allowing a more specific and individualized treatment.

Based on previous studies and the high experience of professionals of the PMR service, a differentiated program was developed with a succession of stimuli consisting of the aforementioned attributes of increasing complexity. To do so, these attributes were analysed based on the visual and cognitive development of children aged 0 to 18 months.

The intervention protocol was based on the following parameters: figures; dimension; colour; contrast; movement; presentation distance.

- **Forms:**

Considering the cognitive development of children in this age group, quadrangular, triangular, circular or with a succession of these three intercalated geometries were chosen. In order to increase the complexity, the protocol of stimuli has figures with the following characteristics:

- Simple figures that present only an image with the same shape (Figure 1);
- Patterned figures - several images are displayed with the same shape or with different shapes (Figure 2).

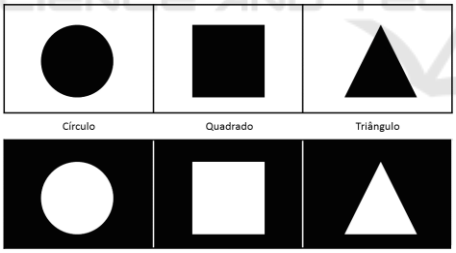

Figure 1: Figures inserted in the intervention program.

The patterns figures are the most used elements in the area of stimulation of visuomotor skills. As such, it was considered appropriate to create a section for its evaluation.

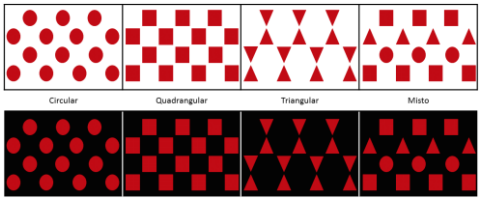

Figure 2: Sequence of average complexity with 4 cm figures in alternate backgrounds.

Using circular, quadrangular and triangular geometric figures it was possible to create patterns with various levels of complexity characterized by an increase in the number of figures presented and a decrease in the space between them. In each degree of complexity it is also possible to find, mixed patterns consisting of a random variance of the three geometric figures presented. These patterns also show the alternation of white and black background for each of the three sizes considered and the animation to fade at the end of the presentation of each figure. This diversity allows a more specific and individualized service to the child's visual development needs.

- **Dimension:**

Considering the reduced information in this context, it was decided to consider the dimensions of Teller cards (Teller et al., 1974). These cards are used for assessing visual acuity in children and adults at ophthalmology visits and are approximately one size 12 x 12 cm (Gordon and Martin, 2010). It was then decided to consider an initial size of 12 cm in the figures, and the following presentations increase their degree of complexity by reducing the size of the figure to 8 cm and then to 4 cm.

- **Colour:**

In this age group are considered colours such us red, yellow, blue, green, black and white. According to the child's development the stimuli are arranged in two groups: black and white; colours.

- **Black and White Stimulus:**

This category has a succession of black and white images in high contrast background, white and black, respectively, as shown in Figure 3.

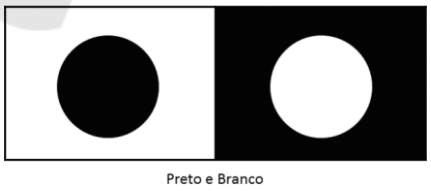

Figure 3: Example of a black and white sequence present in the intervention protocol.

- **Colour Stimulus:**

Colour is an extremely important element in the area of visual stimulation. In order to present a range of colours appropriate to the development of children's colour vision, the following colours were considered: red (RGB: 196/0/0), yellow (RGB: 235/230/0), blue / 57/205) and green (RGB: 0/153/0), with their respective black and white background contrasts (Figure 4).

These are the stimuli that may arouse greater interest on the part of a child with cerebral visual impairment, because they have colour and are more appealing than black and white. Studies show a preference of these children for colours such as blue, green, yellow and red, since most of these anomalies translate into a vision partly dominated by these colours (Gordon and Martin, 2010; Mohn et al. 1988).

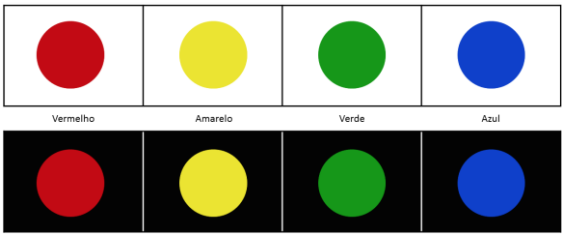

Figure 4: Colours considered for the intervention program.

- **Contrast:**

To obtain greater contrast in the figures, white and black backgrounds were considered, interspersed with the colour of the figure.

- **Presentation Distance:**

The distance from the presentation of the stimulus to the child is approximately 20 cm (Teller et al., 1974).

Based on these attributes, an intervention program was devised, which allowed the optimization of the visual stimulus, favouring a familiarization with the use of simple geometric figures, working on the recognition and discrimination of the same. It was considered an increase in the degree of complexity of the stimuli, present by a decrease in size from 12 cm to 8 cm and then to 4 cm, each presenting the respective white and black background, two initial categories were defined: black and white and colours.

- **Movement**

The ability to detect the direction of movement is one of the most basic and important perceptual capacities and strongly attracts child attention.

Although there are no routine tests to assess the perception of movement in children, visual difficulties are associated with a perception of impaired movement. Usually children have an aversion to rapid television movements or difficulty seeing a moving car (Gordon and Martin, 2010; Mohn et al., 1988).

From the age of eight months, the child needs to gain experience in the horizontal, vertical, diagonal and circular direction. The stimulation of these parameters favours the perception of the relative distance of the objects and their spatial disposition. Progress has also been recorded in the analysis of movement sensitivity, including directional sensitivity, velocity sensitivity, movement perception and stability (Figure 5).

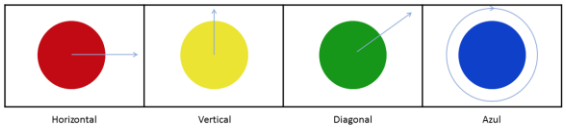

Figure 5: Trajectory guidelines considered for the figures with movement intervention program.

A movement scale categorized them as slow, medium and fast. With this variety it is possible to carry out a more specific intervention by exercising different skills in the field of movement. In all movement orientations, the figures have the same range of trajectory.

3 CONCLUSIONS

RehabVisual platform aims to allow the stimulation of motor skills in children between the ages of 0 and 18 months. It is a tool that revels to be user-friendly and intuitive. It allows the systematic registration of clinical information, assessment and monitoring of the child's progress. It has also one stimulus protocol that allows adapted to each child's needs. This plataform allows a global and integrated evaluation and intervention because it has two sessions: database that records all the clinical information of the patient and protocol with a range of stimuli standardized. This stimuli it was organized according to the development of the child and the pathology / dysfunction of each one.

The validation process it will be the next step and it will performed at the Service of Physical Medicine and Rehabilitation (PMR) of the Hospital D. Estefânia of the Hospital Center of Lisbon Central.

The present work aims to contribute significantly to the prevention and / or reduction of possible consequences at the level of functional vision. For this reason, versatile and diversified protocols have been developed.

The RehabVisual can be used by physicians, occupational therapists, and caregivers. Therefore, it permits to continue the treatment of the clinical environment to the home context and monitories the child progress in real time.

ACKNOWLEDGEMENTS

The authors would like to thank all the healthcare professionals of the Physical Medicine and Rehabilitation Service at D. Estefânia Hospital.

REFERENCES

Aarnoudse-Moeus, C., Smidts, D., Oosterlaan, J. Duivenvoorden , H., e Weisglas – Kupenns N. *Executive Function in Very Preterm Children at Early School* Age.Journal Abnormal Child Psychology. 2009; 37:981–993

Atkinson, J. (2008). *The developing visual brain*. Oxford psychology series. New York.

Best J., Miller, P. *A developmental perspective on executive function*. Child development. 2010; 81(6): 1641-1660

Beery, K., & Beery, N. (2010). *The Beery – Buktenica developmental test of visual – motor integration* (6th ed). Pearson. Texas

Catalano A. R., Simon W. J., Krohel B. G., Rosenberg N. P. *Functional Visual Loss in Children*. Ophthalmology, 1986; 93 (3): 385-390

Cicerone D. K., Dahlberg C, Kalmar K., Donna Langenbahn M. D., Malec F. J., Bergquist F. T., Felicetti P. T., Giacino T. J., Harley J.P., Douglas E. H., Herzog J., Kneipp S., Laatsch L., Morse A. P. *Evidence-based cognitive rehabilitation: Recommendations for clinical practice*. 2010; 81(12):1615

Fox R., McDaniel C. *The perception of biological motion by human infants*. Science, 1982; 218: 486–487

Giovannett M. A., Ragg A., Leonardi M.,

Sonksen PM. *Vision and early development*. In: Wybar K, Taylor D, editors. Paediatric Ophthalmology: Current Aspects. New York: Marcel Dekker; 1983; 85-95.

Gordon N.D., Martin B., *Clinics in Developmental Medicene nº186:Visual impairment in children due to damage to the brain*, chap. 1, 4, 14, 15, 19, 2010

Heyl V., Hintermair M. *Executive function and behavioral problems in students with visual impairments at mainstream and special schools*. Journaal of visul impairment & blindness, 2015

Hyvärinen L. *Assessment of vision for educa- tional purposes and early intervention*. Cited 11.2.2012 Available from http://www.lea-test. fi/index.html

Lueck, A. (2004). *Functional vision: A Practitioner´s Guide to evaluation and intervention*. American Foundation for blind, NY.

Lueck, A., Dutton, G. (2015). V*ision and the brain – understanding cerebral visual impairment in children*. AFB Presss: American Foundation for the blind.

Mohn G, van Hof-Van Duin J, Fetter WP, De Groot L, Hage M. *Acuity assessment in non- verbal infants and children:* Clinical experience with the acuity-card procedure, Dev. Med. Child Neurol. 1988; 30: 232-44.

Mosca F., Gang S., Sabbadin S., Picciolini O. *Usefulness of ICF-CY to define functioning and disability in very low birth weight children: A retrospective study*. Early Human Development. 2013; 89(10): 825-831

Ortibus L. E., Cock De P., Lagae G. L. Visual *Perception in Preterm Children: What Are We Currently Measuring?* Pediatric Neurology. 2011; 45(1): P1-10

Teller D.Y., Morse R., Borton R., Regal D., *Visual acuity for vertical and diagonal gratings in human infants* Vision Res.. 1974; 14: 1433.