DEVELOPMENT OF A GAME FOR THE EVALUATION OF OPERATIVE STRUCTURE IN TEENAGERS WITH DOWN SYNDROME

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Abstract: When an individual presents some type of intellectual disability, there is a tendency to expose him to innumerous evaluations, repeating them several times in a short period so as to verify his development. In some cases, the evaluation is tiring and could lead to the desistance of the person evaluated and to the exhaustion of the appraiser. In this article a computational game was developed in *Flash* for teenagers with the Down Syndrome that demonstrate light or moderate intellectual disability to evaluate cognitive seriation functions and classes inclusion based on the Jean Piaget theory. The game is set up in a kitchen where the individual to be evaluated helps the principal character in achieving tasks. After the termination of the activities a report is made with the analysis of the operative structures demonstrated. To evaluate the efficiency of the game, the subjects went through the evaluation of the operative tests and then played the game. Two pilot tests were made and applied to 13 teenagers with the Down Syndrome. The analysis showed that the method minimizes subjectivity and manipulation of the material needing less time making the report as the game is produced immediately. There was a bigger interest because the game contextualizes the tests even when the individual had verbal difficulty the evaluation access was possible through the game which didn´t occur when applied in the real tests.

Introduction

The Down Syndrome (DS) is related to the chromosome trisomy 21 which [1] can occur in the sperm, in the ovule, or cellular division after fertilization. DS individuals present some classical characteristics such as : hypotonia , cardiac pathology, thyroid dysfunction, intellectual disability, among others.

People with intellectual disabilities are defined as individuals that have global development retarded classified as light, moderate, severe and profound starting from level [2] and [3].

People with disabilities are generally exposed to innumerous repeating evaluations so as to verify the evolution, which is sometimes tiring causing desistance and exhaustion, where in some cases, a type of mobility access to the game would be possible if there was a hardware adaptable to the disability.

To make a good psychodiagnostic, is necessary to observe many facets to the integration of personality, cognition and neurological aspects. Therefore, the individual should go through a battery of different traditional tests to learn the functions of the brain and a complete neuropsychological assessment [4] and [5]. The battery neuropsychological for example, the LNNB is based, on Luria's Neuropsychological Investigation, a measure developed by Christensen in 1975. This battery consists of 269 items in the following 11 clinical scales: reading, writing, arithmetic, visual, memory, expressive language receptive language, motor function, rhythm, tactile and intellectual [6].

> "Almost all batteries of neuropsychological exploitation of children   and adults include classical psychodiagnostic tests. These are generally used in part by the need not to overburden the evaluation itself is long. " (author's translation) [5]

[7] The author comments the goal of the evolutionary neurological examination is to propose a series of tests that is obtained by examining the neurological profile. This result is confronted with chronological age, in order to establish a 'developmental quotient".

The computational game ¨O trapalhão¨ is based on the operative tests seriation and classes inclusion based on the Jean Piaget theory which proposes to evaluate the operative structures that these tests analyze, aiming the facility of the application. For Piaget, it is necessary to know something of the subject performing the action on the object and these actions can be internalized, reversible and are coordinated this is called operative structures. The operative structures are the ratings, seriations, correspondence, matrices, series of numbers, spatial metrics, projective transformations, etc. [8].

It is through action on the objects, organized and directed, the child alters both the medium as their internal structures. The real-world knowledge is taken from the understanding of the similarities and differences between objects [9].

From the seriation and classes inclusion, the child puts in his order cognitive universe, therefore these operational tests were chosen.

From these notions, it is possible the formation of mathematical concepts, and the construction of numerical concepts. The exploration is done in order to build the concept of series, such as the notion of before and after, the notion of higher and lower, union, intersection, subtraction etc., as required in the development of logical-mathematical reasoning.

The computational games are of great value in the psychological, psycho pedagogical, speech, medical diagnosis, among others because they don't need a big space ,and are attractive to the new generations, demanding less time of application and interpretation. Furthermore, according to literature, the application of the tests needs a "very advanced theoretical and experimental formation by the experiences. Parallel to the experimentation and child interrogation, one has to make an interpretive analysis of

conduct"[10], meaning that there is subjectivity by the applier, influencing the final evaluation.

Computer games can contribute to an appreciable extent for the imaginative ability of children presenting gains in thinking skills. According to the same author, the imagination can be seen as fundamental to human cognition and information processing [11].

The Swiss biologist Jean Piaget looked to understand the way the individual knows what he knows, using as a base the biology and structure of what we call biological and epistemology [12]. "If the biological and epistemology problems are really solidary, it is the knowledge that prolongs effectively the proper life".

Through operative tests it is possible to determine the degree of acquisition of some principal notions of cognitive development, and through them detect the levels of cognitive structures the individual evaluated is capable to operate.[10]

The present work shows a new evaluation method of operative structures using a virtual game for DS teenagers presenting light or moderate disability.

Methodology

Volunteers

The research was divided in two phases. In the first one two pilot tests were made to check flaws in the game.

The first application of the pilot that was made with a child (9 years old) who did not have any apparent mental disability, as well as the pilot two which was made with a teenager (14 years old) with DS, were performed in a doctor's office and after application, arose the need to make some changes to the adaptation of the interface.

There have been several changes as the size of the bottles to ensure the credibility of the evaluation, the possibility of returning the movement

with the bottles when they were on the shelf and a few speaks of the main character.

 The second phase evaluations were made in 13 (13-18 years old, 5 female and 8 male) DS teenagers the evaluations, with mild-moderate intellectual disability; were made in the music room of a special school.

The Information on the degree of disability of each volunteer (mild, moderate or severe), were provided by the special school where the teenagers studied.

To minimize stimulus interference, the table used was placed next to the wall so that both applier and participant were with their backs against the door, closed during the application.

Development of the game

The game was developed through the *Flash* which permits the creation of games with more attractive animation than other traditional technologies [13], the files being relatively small, making its usability simpler.

The game presents the final result in a report with the analysis of the operative notions used by the player through the behavior shown during execution. The report was obtained using PHP language and a Mysql data bank available through WAMP application, integrating the web server Apache, Mysql and PHP.

Evaluation

Each operative test was represented by at least three correlating tasks, which when integrated, indicated the level of cognitive notions that the subject operated at the moment of the game.

To facilitate the identification of the game, the ¨O Trapalhão" has a familiar scenario, a kitchen, for those who play. These characteristics aim to facilitate the identification of the individual, approaching to the attitudes in his day to day.

The evaluation application was divided in two stages. The first was realized by a psychologist for the evaluation of the operative tests seriations and the class inclusion as described in the literature after which the application of the virtual game was made for other psychologist previous trained.

Following that, the psychologist emitted a report of each application which was compared with the virtual one and the results analyzed, and all application in the room, there was another educator observing how everything was done.

Results analyzed

Was made a comparative table with the data collected in reports with general information such as age, gender and the others data as: Reaction time of the test virtual x non-virtual (measured from the time the material or the computer was placed in front of the participant, until the moment it start to move to assess the interest in evaluation), Outcomes of class inclusion and seriation of the test non-virtual X virtual, applications Interest in non-virtual objects in the evaluation, easy handling hardware and difficult to play the game, Impossibility evaluation and the comments made by applicators.

Game description

At the opening of the game, the character enters the kitchen Figure 1. The player has to remove a bottle from the shelf and they all drop. The teenager has to put them in order for the seriation evaluation.

Figure 1. Evaluation seriation phase. The character finds the bottles in disorder and has to organize them.

After arranging them they drop again and have to be reorganized but the final order on the shelf is not seen by the player. In the last seriation stage, the player finds a bottle on the floor and has to insert it in order as seen in figure 2.

Figure 2. Last stage of seriation evaluation

Figure 3 shows on the screen if the player can conceptualize the term ¨clothes¨. He has to drag them to the box separating them from other objects. If he can't, the evaluation is stopped due to the impossibility of inclusion of classes through this game.

Figura 3. Inclusion of classes evaluation phase.

After the initial stage, the player has to answer series of questions to verify if he possesses a notion of class's inclusion. Figure 4 shows one of the questions for evaluation.

Figura 4. Classes Inclusion evaluation phase

Results and discussion

After the application with 13 DS teenagers, a comparison was made by the psychologist evaluation report and game report, besides the observation reports made by the researcher and the psychologist. Some data were taken from the interpretation made by observation reports generated by both. The

psychologist, who applied not virtual evaluation, as the psychologist who applied virtual evaluation, both observed the difficulties handling the material and the interest of the tool used.

The graph in figure 5 shows that the participants were not able to be evaluated regarding seriation though they hadn´t the notion, it was possible to do so in the virtual evaluation, where around 15% the participants wouldn't have benefited from the non virtual application; however they could benefit with the game and therefore make it possible the access to this type of evaluation to individuals who couldn't be evaluated by the conventional form. Figure 6 shows the possibility to use the game as an evaluation instrument, as the results between the reports are equivalent.

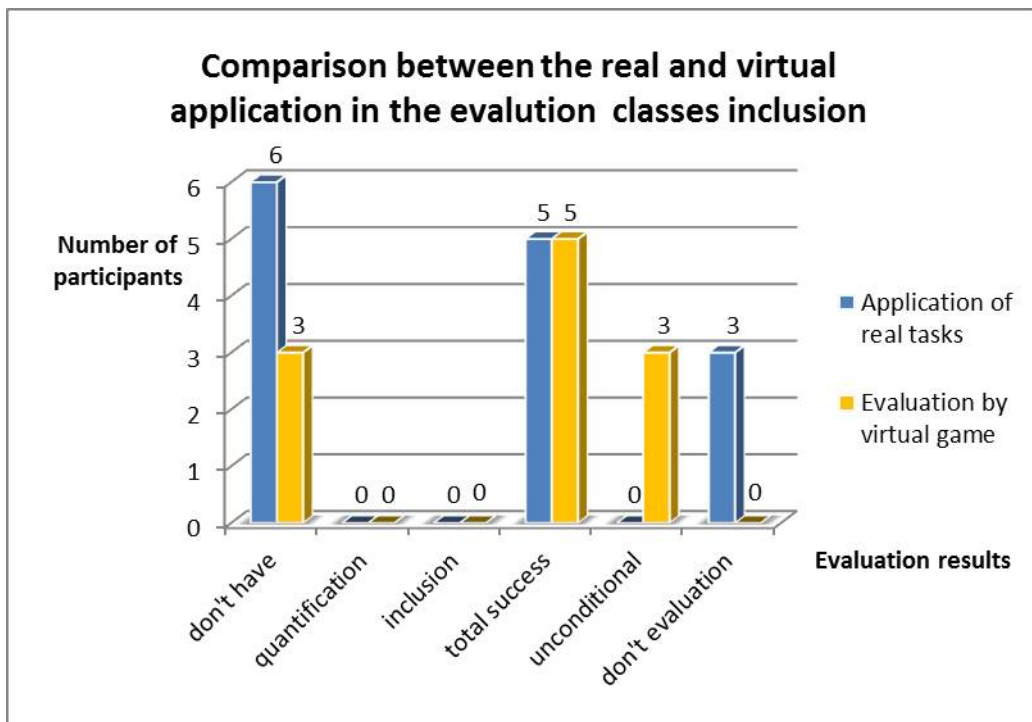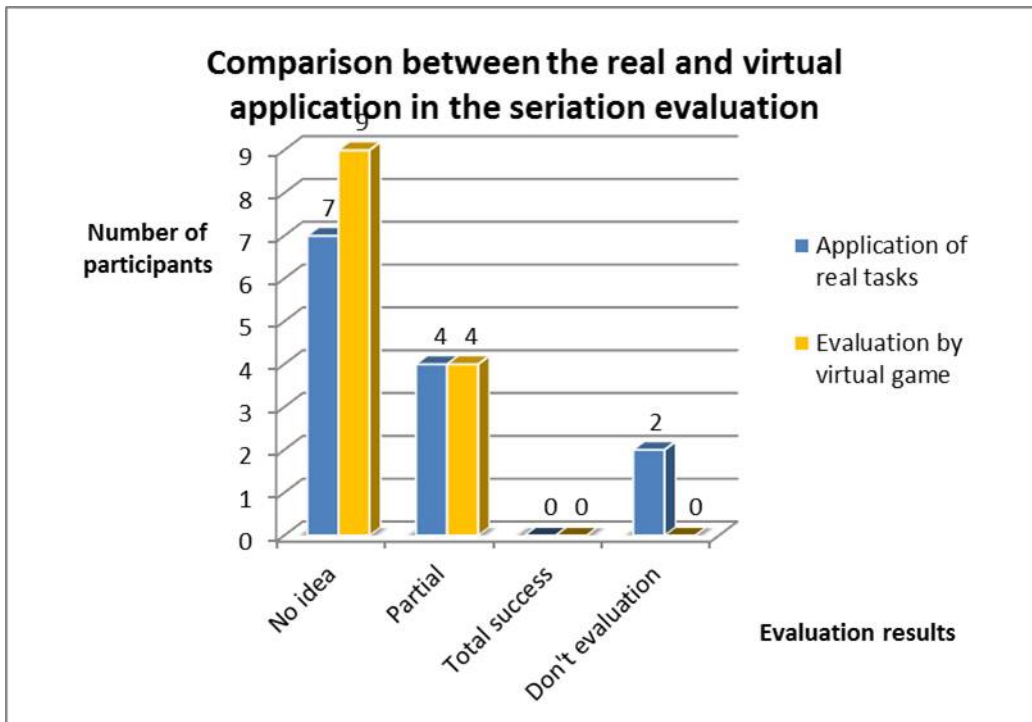*Figure 5. Comparison of application of seriation evaluation*

Figure 6. Comparison of application of evaluation classes inclusion.

From the observation report done by applicators, through the behavior demonstrated by the participants, as seen in Figure 7, it was possible to compare the difference between interest in the virtual application and the not virtual.

Figure 7. Comparison between participants' interests
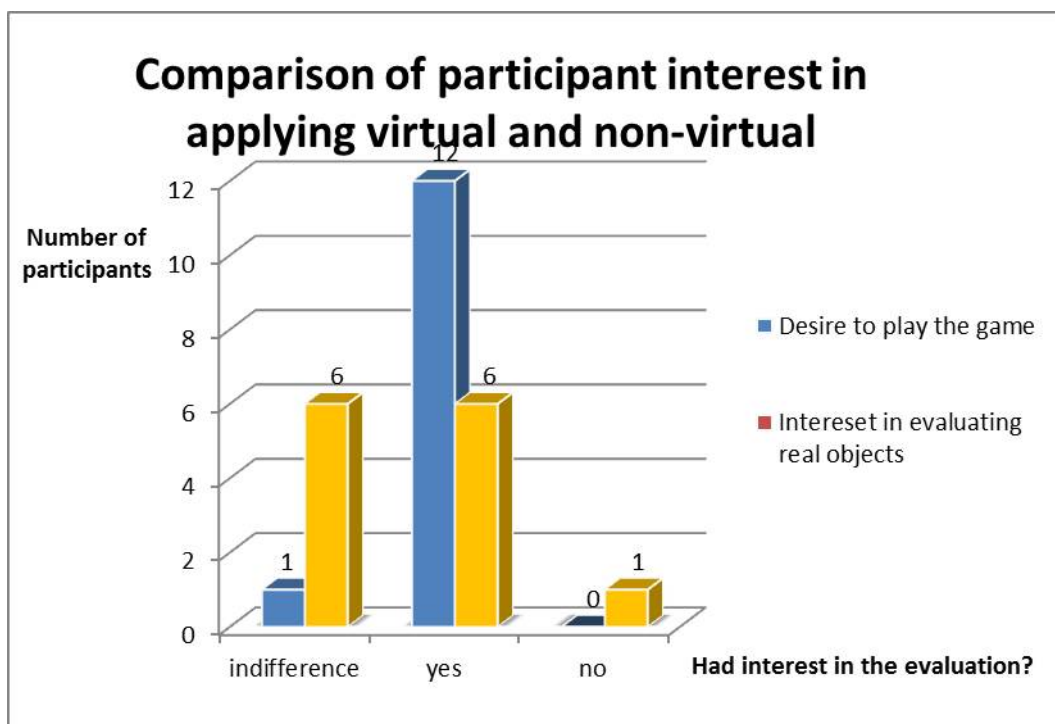
Conclusion and future works

After evaluation application, reports and graphs data, it was possible to point out that during the application, those who were evaluated didn't feel themselves being tested, were very interested by the game, minimized material interference manipulation, facilitated game contextualization identification and the identification with the character, besides using less time for the preparation of the report that is produced immediately after the game, other than the non-virtual assessment should be done after application requiring a great time.

It is important to point out that this game doesn't have the objective to discriminate any individual nor demonstrating mental age; not even a diagnosis instrument but be an instrument to assist a complete diagnosis.

This evaluation interface was well accepted and showed the possibility to be used as an evaluation objective; however there is a need to standardize it for the population wishing to be evaluated.

Besides, this game can be used in adaptable computers for several disability, evaluating operative notions of an individual who for some reason for example has partial or total loss of superior members and would have great difficulty or even the impossibility to be evaluated by conventional Piaget tests.

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