

A comparison between digital and traditional tools to assess autism: effects on engagement and performance

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Abstract. Most autism assessment tools include behavioral observation sessions in a natural environment and are mainly based on subjective measures of behavior. It is often difficult to clearly observe pure cognitive aspects of the disorder. Therefore, in the recent years it is growing the need to make the processes of cognitive assessment more motivating and capable to provide objective measures of the disorder. This study compares the results of performance and engagement of a group of autistic subjects during the execution of a classic cognitive test in its traditional and digital version, highlighting the preference for the digital version, especially for subjects with mental retardation.

Keywords: autism; digital assessment tool; engagement.

1 Introduction

Autism is a neurodevelopmental disorder, characterized by organizational difficulties of thought and of the main functions that regulate human adaptation. It is considered a functional disorder which involves a permanent general disability within three main areas: qualitative impairment of social interaction, qualitative impairment of communication, and the presence of restricted behaviors, interests, and activities, which are repetitive and stereotyped. One of the main problems encountered during treatment and assessment of autism is the motivational aspect. Indeed, is often difficult to involve these subjects in shared activities. The moment of cognitive evaluation could become

very tiring. Moreover, by studying behavior from a merely subjective perspective, referring to purely psychological theories and hypotheses, many fundamental elements that are intrinsically present in natural behaviors do get lost. A “macro-behavior”, as the final result of a cognitive task, can be readily identified through conscious observation, but these behaviors are made of elements that can go undetected, as the time effectively spent concentrating on the task. Elements like these can be useful to evaluate engagement levels [1] but they occur too quickly and elude conscious observation. However, contemporary technology enables us to capture these elements with extreme accuracy. Technology allows us to obtain some transparent and objective measures that can bring studies on autism to a higher and more rigorous standard. The use of digital assessment tools can have a great impact on the clinical evaluation processes. Proposing simplified and more easily controlled models of reality, [2] they can be beneficial to obtain results, which can overcome the limits of mere observational evaluation, focusing more on the construct of interest, and being less dependent on environmental variability. Research incorporating technology has consistently demonstrated good effects for the use of computers [3, 4] video [5, 6] mechanical prompting devices [7, 8], and numerous other technologies with children with autism. The next pressing questions about technology based interventions focus primarily on whether the interventions are more efficacious or enjoyable than more traditional, low-tech interventions. The digitization of a neuropsychological test, in addition to the advantage of providing new objective and more accurate measurements, has another advantage that is to increase the subject's motivation to complete the task. Many tests have the main problem of taking a long time for the administration and the main disadvantage of boring the people evaluated. These characteristics inevitably have an effect on the engagement and motivation of the subjects to complete the task. Cleary and Zimmerman (2001) [9] defined motivation as an intention while engagement is an action, motivation is the “will” to learn and engagement is the “skill” of actually performing the tasks involved in learning. The definition of engagement as the quantity and quality of mental resources directed to an object of thought strongly implies that the time spent interacting with a specific object can give us a measure of motivation and commitment dedicated to it. With the aim to investigate which of the two instruments was the most "motivating" for the subjects, we have chosen to measure the “latency” times between one response and

the other and the “interaction” times with the test materials. The present study aims to test the possible advantages of the use of a digital version of the Leiter-3 [10], cognitive test widely used in the field of autism for non-verbal evaluation of intellectual and cognitive abilities.

2 Methods

Participants were 30 autistic children aged by 5 to 9, with an average age of 7 years and SD of $\pm 1,02$. The group were composed by 5 females and 25 males. All subjects were diagnosed with autism spectrum disorder by qualified doctors and professionals in the sector who have no affiliation with our laboratory or our research. The ASD subjects follow psychomotor and speech therapy treatment at the Neapolitanit S.R.L. center.

The subjects underwent two experimental phases, executed two weeks apart. During the experimental phases the subjects were required to carry out the tasks of the Leiter-3 test in its traditional version and, two weeks later, in a digital version. In order to avoid a possible learning effect, the tests were balanced, so half sample performed the task in its digital version in the first administration, vice versa the second half of the sample. During the administration of the test in its digital version the participants had to carry out the cognitive tasks of the Leiter-3 presented on a tablet screen. A Huawei MediaPad T3 10 tablet has been used for the task. The software was developed in Unity and consists in the presentation of a sequence of scenes taken by the Leiter-3. The user had to select and drag the images to the bottom of the screen and position them on the corresponding image at the top, depending on the task delivery, as shown in Figure 1. Each scene is composed of a maximum of 6 images at the bottom of the screen, which can be moved from one point to another on the screen by dragging, and a maximum of 7 fixed images placed at the top of the screen. We call the images at the top "placeholders" and these are programmed to capture the images moved by the subjects, when they are dropped above them. The placeholders for each task range from a minimum of 1 to a maximum of 7 and include distractor images. All images reproduce geometric figures of different shapes and colors. The task is characterized by a growing difficulty given by the progressive increment in the number of distracting stimuli and the distinctive

details of the images. During the performance, the software recorded the presence of the stimuli and, simultaneously, the movement coordinates resulting from the dragging movement of the images from one point to another of the screen. All data were recorded in real time, each data was associated with its execution time in milliseconds. During the administration of the test in its traditional version, the subjects were required to perform the test according to the standardized procedure of Leiter-3. To measure interaction and latency times, a second experimenter was required to time each user action, using a software that re-proposed the test scenarios. On the tablet screen all the images with which the subject would interact in reality were depicted and a timer was activated by clicking on the selected images. For each item the timer started when all test materials had been correctly placed by the first experimenter and the child was actually ready to begin. The “interaction” time were defined as time starting from the beginning of the manipulation of the test cards until the moment in which the user left the card in the specific box. Latency times, on the other hand, were defined starting from the end of each manipulation up to the beginning of the next one.

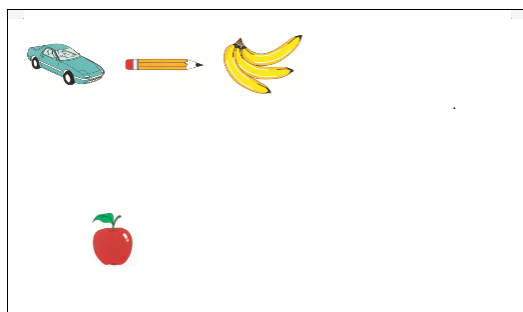


Figure 1. An example of scene reproducing a Leiter-3 classification task.

3 Results

Repeated measures ANOVA was used to compare performance scores, latency times and interaction times. The performance scores for the two tests were slightly higher during the second administration, with an average score of 86,23 for the digital test and 82,03 for the traditional test, and a p value of 0,64. The non-centrality parameter within the subjects was 3,710. Latency time differences were significantly higher during the

traditional test ($p \text{ value} \leq 0,001$), with an average of 2,65 sec and SD 0,56 in the digital test, while the average test was 3,63 sec. SD 1,25. The interaction times were instead slightly higher, but not significantly ($p \text{ value} 0,57$), during the administration of the digital test with an average of 2,9 sec, SD 1,37, against 2,6 sec SD 2,15. A correlation analysis was also conducted between the IQ scores and the differences in scores obtained for the two tests for each subject. The difference between the scores obtained in the digital test minus the scores obtained at the traditional test gave us an index of "best performance" between the tests. Positive values indicated better performance for the digital test, vice versa negative values. This analysis showed the presence of a significant negative correlation between IQ values and the "best performance" index. A second correlation analysis was carried out between the IQ scores and the intra-subject differences between the latency times recorded during the execution of the test in its different proposed versions. Positive values indicated greater latency during the digital test, vice versa negative values. The results indicated the presence of a negative but not significant correlation ($p \text{ value} 0,58$) between the IQ variables and latency times.

4 Discussion

The results obtained have highlighted some interesting aspects. Although there were no major differences in terms of performance, the negative correlation between IQ and "best performance" index in the digital test suggests that there may be a tendency to prefer interaction with digital tools rather than traditional ones, especially for the subjects with more serious mental retardation, supported by a greater level of engagement. Defining the engagement as quantity and quality of time that is dedicated to the interaction with an object, we went to measure the "latency" times and the "interaction" times for the two tests, the results showed longer latency times during the traditional test and a tendency to spend more time interacting with the object during the digital test. In fact, during the traditional test administration, children lost concentration more easily between one answer and another, while during digital administration they preferred to start interacting with the tablet even before to have identified the correct an-

swer. In any case, this behavior has not significantly affected performance, but has affected the total time taken by the subjects to carry out the tasks. Instead, the total administration time is greatly reduced during the digital version, because of the time required for the preparation of all materials in the traditional version. Furthermore, if latency is really an index of engagement and the performance results of subjects with lower IQs are really explained by higher levels of engagement it will also be true that there is a correlation between these two factors, our results of the have shown that there is a correlation that goes in the direction we proposed.

5 Conclusion

The present study had the aim of verifying the advantages of using a tool for assessing cognitive abilities in a digital version on a sample of subjects with autism. The results confirmed the hypothesis that the use of digital tools for the evaluation of autism can have a positive impact on the rapidity of administration and also on motivation and engagement, especially in subjects with more severe mental retardation, which are also the most difficult to evaluate in everyday clinical practice. An interesting future purpose could be to identify new objective measures that can be considered an index of engagement, for instance inserting an eye tracking device, that can reveal eye movement and focus attention which can be all considered constituent elements of the engagement construct [1].

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