Statistical analysis of psychomotor therapy in children with attention-deficit/hyperactivity disorder

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Abstract: One of the most common behavioural disorders in school age children, which has registered a high increase of the prevalence rate in the last decade, is Attention-deficit/hyperactivity disorder – a neurological condition that involves problems with inattention and hyperactivity-impulsivity which are developmentally inconsistent with the children's age. It has much comorbidity affecting a child's life in every domain with a negative influence in the prognosis of her condition. Psychomotor deficits are responsible for many of the learning disabilities of these children. A sample of children with the diagnosis of Attention-deficit/hyperactivity disorder, under psychomotor therapy followed in the Department of Child Psychiatry of Centro Hospitalar Cova da Beira (in Portugal), was submitted to a Psychomotor Battery. Nonparametric approaches (as graphical techniques and hypothesis tests) were applied to the data, collected at baseline and at the end of the intervention. The main result shows that there is a statistical significant improvement of the psychomotor profile after psychomotor therapy (supported by both total scores of Psychomotor Battery and some particular psychomotor factors).

Key-Words: Learning disabilities; paired samples; graphical techniques; limits of agreements.

1 Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a persistent disorder characterized by inappropriate levels of attention and/or hyperactivity-impulsivity, interfering significantly in academic and work performances as well as in some social behaviour [1]. This pathology is a multifactorial condition (involving genetic, biochemical and environmental

factors) and one of the most frequent disorders in school age children. Its worldwide prevalence is estimated at around 5.3% [11] and it affects two to three times more boys than girls [12, 13, 2]. According to the World Health Organization, the symptoms of ADHD that affected children persist into adulthood in approximately 50% [8].

Treatment of ADHD is based on a multimodal approach, consisting of a range of pharmacological interventions that can be associated with psychosocial interventions [12]. The psychomotor therapy emerges as a possible adjunctive or isolated therapy, looking to acquire strategies for behaviour change through awareness of their own body and ability to master body movement [9].

In this study we analysed whether the changes in the level of psychomotor profile are (not) statistically significant, in order to demonstrate the utility of psychomotor therapy, often relegated to the background, on the multimodal treatment of the children with ADHD.

2 Psychomotor Therapy

Psychomotor therapy can be applied to children from four to twelve years old. It consists of several tasks that allow a dynamic observation and evaluation of seven different psychomotor factors grouped into three brain functional units or functional units Luria (FUL), which are involved in structuring all human mental processes: Tone (T), Balance (B), Lateralization (L), Notion of the Body (NB), Spatio-Temporal Structuring (STS), Global Praxis (GP) and Fine Praxis (FP).

Each psychomotor factor is rated on a scale from one to four points and classified as Apraxia, Dyspraxia, Eupraxia or Hiperpraxia (considered Likert-type items), based on the behavioural level and on the performance of the several tasks to which the child is submitted before and after the therapy considering a period of evaluation (Table 1).

Table 1. Scale score to each psychomotor factor.

Scale score (points)	Performance	Each factor profile
1	Incomplete, inadequate and imperfect	Apraxia
2	Difficulties with achieving control	Dyspraxia
3	Complete, adequate and controlled	Eupraxia
4	Perfect, precise, melodic and easily controlled	Hiperpraxia

Source: Adapted from [4].

2.1 Psychomotor Battery

Psychomotor Battery (PMB), which takes approximately 30 to 40 minutes, is a useful tool based on observation once it allows the qualitative evaluation of psychomotor signals or, in other words, the identification of psychomotor disorders, the screen for learning disabilities and consequently the degree of integrity and functionality of the three FUL.

Summing the score of all psychomotor factors, mentioned in Section 2, we get the variable Total Score (TS),

$$TS = T + B + L + NB + STS + GP + FP. \quad (1)$$

The value of TS in (1), before and after therapy (represented by TS_{BT} and TS_{AT}, respectively), is a positive integer that lies between a minimum of 7 (when each of the seven psychomotor factors is rated with one point, 7×1) and a maximum of 28 points (if all psychomotor factors are rated with four points, 7×4), and it gives us the type of psychomotor profile, which is classified as Deficit, Dyspraxia, Normal, Good or Supreme (Table 2).

Table 2. PMB score *versus* Type of psychomotor profile.

TS (points)	Type of psychomotor profile
07 – 08	Deficit (significant, moderate or severe learning difficulties)
09 – 13	Dyspraxia (mild and specific learning difficulties)
14 – 21	Normal
22 – 26	Good
27 – 28	Supreme

Source: Adapted from [4].

3 Statistical Data Analysis

The children of the sample were between 6 and 12 years old (school age children) and were selected in the Child Psychiatry Service of Centro Hospitalar Cova da Beira (CHCB), in Portugal, according to the presence of certain characteristics (diagnosis of ADHD, implementation of psychomotor therapy, PMB and age), but they were not selected previously in the region. This random component led us to consider the available sample as representative of the population of children with ADHD in the region.

The psychomotor therapy lasted from one to

three years, with a sample mean of two years, and the paired sample size is equal to 21, which corresponds to the number of children assessed in both reviews.

3.1 Comparison of Total Score

To answer the question: "Are there statistically significant changes in the level of psychomotor profile after psychomotor therapy?", we have to compare the TS_{BT} and TS_{AT} obtained through (1). In [5] we decided to consider the variable difference of both variables ($TS_{BT} - TS_{AT}$) as an ordinal variable in a Likert scale (instead of considering it approximated to an interval-level), mainly because we have a few even ordered response levels for each factor, despite the controversy in the literature about this subject [7, 10]. Then we applied the nonparametric Wilcoxon test and, based on the p-values obtained, we rejected the null hypothesis of equality of population's medians.

To visualize what happened to each children after psychomotor therapy, we obtained the scatter and difference plots, in Figures 1 and 2, respectively (also considered in [5]). These graphs, very useful in practice, were popularized by [3] to analyse the degree of (dis)agreement between two clinical measurements.

Figure 1 shows the identity line ($TS_{BT} = TS_{AT}$) and the observations of TS_{BT} against TS_{AT}. A clear bias is identified, with the majority of observations lying to one side of the equality line. In Figure 2 we have considered the differences between TS_{BT} and TS_{AT} (i.e, $TS_{BT} - TS_{AT}$) against their means [i.e, $(TS_{BT} + TS_{AT})/2$], where the scatter of differences is around the zero line (zero bias). In difference plot, which is Bland-Altman's nonparametric approach, the average bias estimated as the median of the differences is 2, where the 95% confidence interval is (1.0; 4.0). Since the zero line (line of equality) is not in the interval, it means that there is a significant systematic difference.

In the difference plot presented in Figure 2 we can also include the lines that correspond to the limits of agreement estimated using the 2.5th (= -2) and 97.5th (= 5) percentiles [3, 5, 6].

Based on both graphs it is possible to identify sixteen children who improved (points above the identity line and the zero line in Figures 1 and 2, respectively), one that remains the same (points over the identity line and the zero line) and four who became worse (points under the identity line and the zero line). Thus, we may say that a considerable percentage of children, 76.2% [≈ (16 / 21) × 100], improved, 50% of which are above the median (Figure 2). According to these results we may say that the psychomotor therapy is effective in the case of children with psychomotor deficits with ADHD and learning disabilities as well.

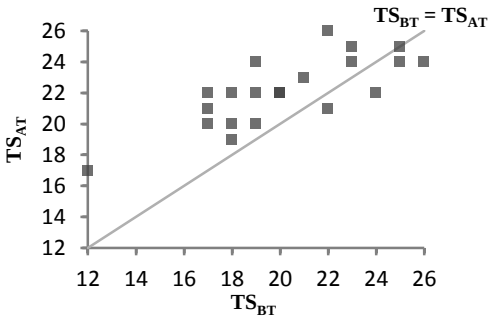

Fig.1: Scatter plot for TS, with identity line.

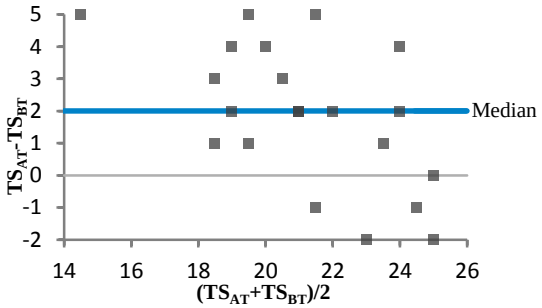

Fig.2: Difference-plot, with TS differences *vs.* TS means.

3.2 Comparison of Psychomotor Factors

It is also important to answer the question: "Is it possible to identify which factors have contributed most to the psychomotor development of those children?".

In order to identify which factors (qualitative variables in ordinal scale) have contributed most to the psychomotor development of children subjected to a second review (after treatment), we obtained the boxplot (Figure 3) which allows a quick visual comparison of the major differences between the two assessments (before and after therapy) for the seven psychomotor factors evaluated in PMB. Based on graphical analysis it seems that the factors T, B and FP report a considerable evolution in the second evaluation.

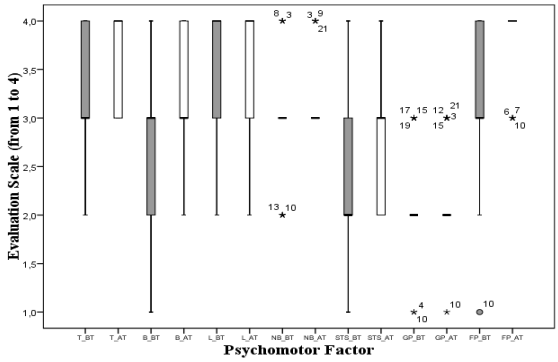

Fig.3: Box-plot for the seven-psychomotor factors, before and after therapy.

The nonparametric sign test for paired samples, with no requirements on the form of the data distribution, was used to compare the results of psychomotor factors in both evaluations. If X_{BT} and X_{AT} represent the results before and after therapy, respectively, the hypothesis to be tested for each of the seven factors are:

$$\begin{aligned} &H_0 : P(X_{BT_k} > X_{AT_k}) = P(X_{BT_k} < X_{AT_k}) \\ &\qquad\qquad versus \\ &H_1 : P(X_{BT_k} > X_{AT_k}) < P(X_{BT_k} < X_{AT_k}); \\ &\qquad\qquad k = T, B, L, NB, STS, GP, FP. \end{aligned} \tag{2}$$

With the individual analysis of the seven factors evaluated by PMB (Table 3), we noted that statistically significant improvements (p-values < 0.05, leading to the rejection of the null hypothesis in (2)) were recorded for the psychomotor factors: T (p-value = 0.008), B (p-value = 0.033) and FP (p-value = 0.000). These conclusions confirm the informal comparison already made based on the box-plot of Figure 3.

The differences of the remaining factors were not statistically significant because the work done in terms of therapy have mainly focused on the factors: T, B and FP. Factors such as NB and L have showed no major differences between the first and second evaluations, since the profiles shown in these areas were already very favourable in the first assessment.

Table 3. Results of the sign test for the seven psychomotor factors, before and after therapy.

Test Statistics *							
AT - BT	T	B	L	NB	STS	GP	FP
Exact *p*-value (1-tailed)	0.008	0.033	0.344	0.188	0.145	0.656	0.000

* Sign test

4 Conclusion

With this study we have tried to trace the global psychomotor profile of children diagnosed with ADHD (followed at the Child Psychiatry Service of CHCB, in Portugal), based on the psychomotor factors evaluated with BPM. It attempts to understand the influence of psychomotor therapy in both the improvement of identified deficits and the psychomotor development of school age children.

The children's psychomotor profile shows significant improvements after a period of psychomotor therapy, since most children in the second evaluation show a normal (eupraxic) or good (hiperpraxic) psychomotor profile.

Despite some limitations commonly verified in the area of Health Sciences (in our case study there is available a small sample size of 21 children with only one female child), this unprecedented study in Portugal tries to trace the global psychomotor profile of children diagnosed with ADHD.

Although the decision about what is a considerably disagreement is still a clinical judgment, the statistical approaches used give an important aid in this process, since they are easy to apply with a friendly software and the results are simpler to interpret.

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