ESTUDOS EM DESENVOLVIMENTO MOTOR DA CRIANÇA XVI

MOTOR DEVELOPMENT STUDIES OF THE CHILD XVI

Eds.

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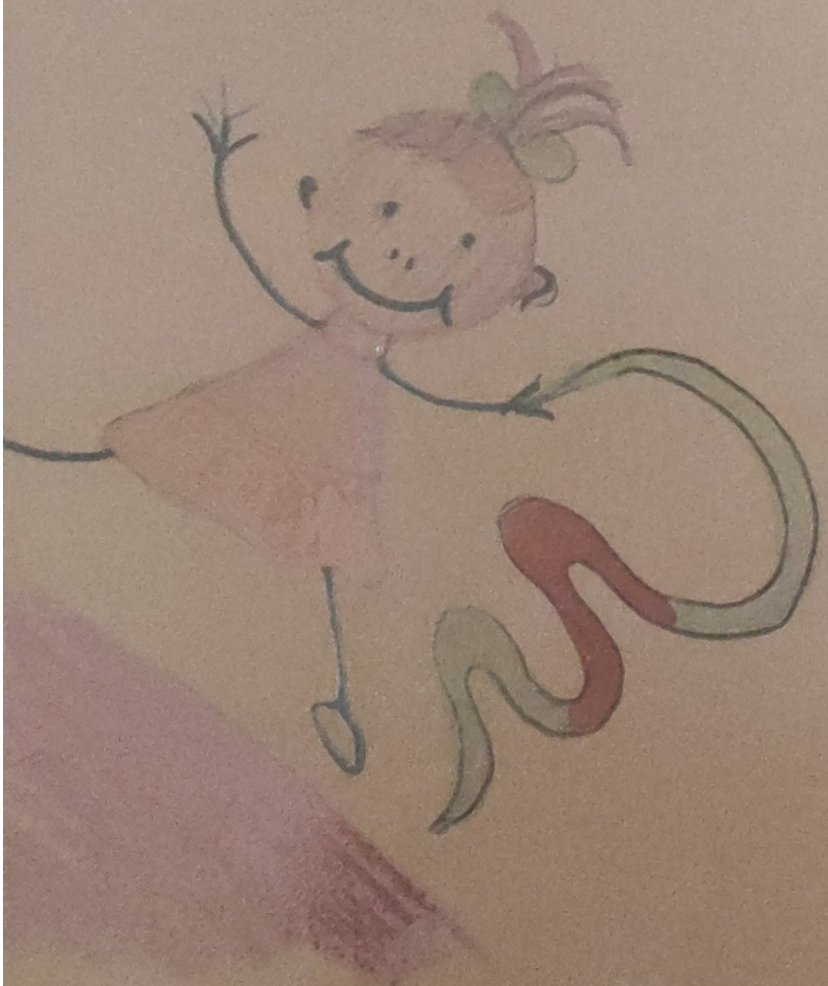
EDIÇÕES ISMAI

O XVIII Seminário do Desenvolvimento Motor em Crianças (XVIII SDMC) procura, assim, abordar questões práticas e refletir sobre aspetos conceptuais para que os especialistas deste ramo do saber estejam bem preparados para enfrentar os problemas da aprendizagem, do desenvolvimento e do controle motor.

Carlos Carvalho



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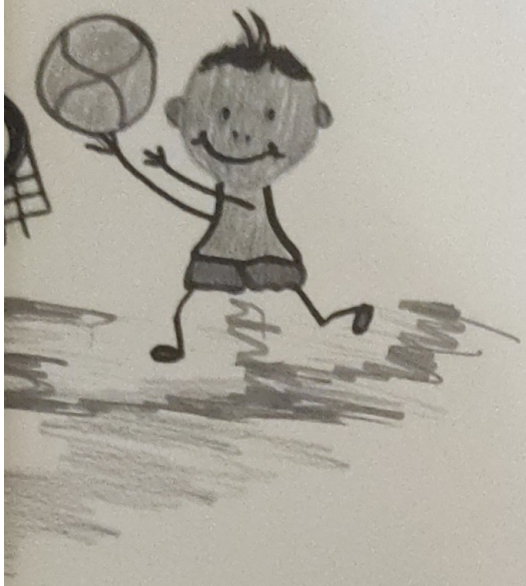

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FINE MOTRICITY IN FINGER TAPPING TEST WITH CHILDREN: INCREMENTAL ENTROPY ANALYSIS

MOTRICIDADE FINA NO TESTE DE BATIDAS DO DEDO COM CRIANÇAS: ANÁLISE DA ENTROPIA INCREMENTAL

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Summary

During the development process, the nervous system is constantly changing (1). The application of non-linear measures such as entropy has allowed a deeper analysis of motor control (3). The Finger Tapping Test (FTT) is usually used to assess fine motor skills, and in this study we intend to use this test to analyze entropy levels and assess the development of fine motor control in children. Sixty children (M=8.141±1.064) participated in this study. Participants performed the FTT, 6 trials tapping with the index finger on a surface as fast as possible for ten seconds per trial. The test started with the preferred hand, followed by the non-preferred one. An inertial sensor was used to collect three--dimensional angular velocity. The entropy results indicated a change that occurs between the ages of 7 and 8 years old. It was observed that 6-years-old children, compared to other age groups, had lower entropy values, suggesting that they were more predictable when performing the FTT. The 8-years-old children seemed to have the highest entropy values, which might indicate that these children were less predictable (4). These findings suggest a transition to the third childhood, where significant changes occur in the nervous system during development. Entropy appears to be highly sensitive to these changes.

Keywords: Fine Motricity; Children; Finger Tapping Test; Nonlinear; Entropy.

Resumo

Durante o processo de desenvolvimento, o sistema nervoso está em constante mudança (1). A aplicação de ferramentas não-lineares como, a entropia, tem permitido uma análise mais profunda do controlo motor (3). O Finger Tapping Test (FTT) ou teste de batidas do

dedo é normalmente utilizado para avaliar a motricidade fina, e neste estudo pretende-se utilizar este teste para analisar os níveis de entropia e avaliar o desenvolvimento do controlo motor fino em crianças. Sessenta crianças (M=8,141±1,064) participaram deste estudo. Os participantes realizaram o FTT, 6 tentativas batendo com o dedo indicador em uma superfície o mais rápido possível por dez segundos por tentativa. O teste iniciava com a mão preferida, seguida da não preferida. Um sensor inercial foi utilizado para recolher os dados tridimensionais de velocidade angular. Os resultados da entropia indicaram uma alteração que ocorre entre os 7 e os 8 anos. Observou-se que as crianças de 6 anos, em comparação com outras faixas etárias, apresentaram valores de entropia mais baixos, sugerindo que eram mais previsíveis ao realizar o FTT. As crianças de 8 anos apresentaram maiores valores de entropia, o que pode significar que eram menos previsíveis (4). Estes resultados sugerem uma possível transição para a terceira infância, onde parecem ocorrer mudanças significativas no sistema nervoso durante o desenvolvimento. A entropia parece ser altamente sensível a essas mudanças.

Palavras-Chave: Motricidade Fina; Crianças; Teste de Batidas do Dedo; Não-Linear; Entropia.

INTRODUCTION

Throughout the process of development, the nervous system undergoes constant modification and maturation (1). The dynamical system theory offers a suitable framework for studying the process of development. It encompasses the study of changes and aims to comprehend and depict the transitions that take place within complex systems (2). In recent times, the application of non-linear measures has enabled a more in-depth analysis of motor control, with a specific focus on the process and quality of movement. One such non-linear analysis measure is entropy (3). Entropy on a single-scale is able to quantify the predictability of the system (4). Fine motor control refers to the skill set involving the manipulation of small objects, manual dexterity, and handwriting skills (5, 6). Alongside these aptitudes, fine motor control also entails the capacity to execute repetitive actions drive by speed, like rapidly tapping a finger on a surface (5, 6). The Finger Tapping Test (FTT) is an example of fine motor skills assessment and it is a commonly employed tool to assess fine motor impairment (7). In this study, we intend to use the FTT to analyze the entropy levels and evaluate the development of fine motor control among children between the ages of 6 and 9 years old.

METHODOLOGY

Sample

Sixty children with ages between 6 and 9 years old, divided into 4 groups of ages (6 years=12; 7 years=19; 8 years=14; 9 years=15). Informed consent and assent were obtained.

Procedures and Instruments

In order to evaluate fine motor control, participants were instructed to complete the FTT, which involved performing 6 trials of tapping their index fingers as quickly as possible for a duration of ten seconds per trial. The test started with the preferred hand, followed by repeating the entire process with the non-preferred hand. Preferred hand was considered hand used for writing. To collect data during the FTT, a custom inertial sensor, MEMS, model MPU9250, was used. This sensor recorded three-dimensional (3D) linear acceleration and angular velocity and was operated using a specific program designed specifically for it. A rubber finger was employed to secure the inertial sensor onto the distal phalanx of the index finger, for the gathering of linear acceleration and angular velocity, transmitted wirelessly to a computer, using Bluetooth technology and received through a serial terminal, YAT (8), which served as the connection endpoint. The data was subsequently recorded in a text file format (.txt) (9).

Data Treatment and Statistical Analysis

The angular velocity txt files were then transferred to MATLAB (10) to calculate the incremental entropy (IncE). In the analysis of brief signals, IncE has proven to be a highly effective tool. IncE possesses greater sensitivity and the ability to detect subtle changes in amplitude and structure without making any assumptions. This characteristics makes it applicable to various types of signals (11). Afterwards the data was transferred to SPSS (12) for statistical analysis. Normal distribution was tested and it was not assumed. Non-parametric tests were performed for comparison between hands (Wilcoxon) and groups (U Mann-Whitney). Cohen's d was used to estimate the effect sizes (13).

RESULTS

In table 1 are presented the values for the statistical analysis and significance levels for the variables of mediolateral (ML), anteroposterior (AP) and vertical (V) IncE, between hands (Preferred, Non-Preferred) and per group.

Table 1. Statistical values of IncE for ML, AP and V axis, between hands and per age group. In bold are the variables with significant differences.

Group/Hand Mean±SD		Preferred	Non-Preferred	Test Statistics		
		Mean±SD	Z	Sig.	Effect Size	
Age 6	Ent ML	**2.977±0.216**	**2.923±0.172**	**-2.071**	**0.038**	**0.598**
	Ent AP	3.374±0.259	3.410±0.226	-1.156	0.248	
	Ent V	3.353±0.282	3.323±0.184	-1.145	0.252	
Age 7	Ent ML	2.926±0.197	2.921±0.211	-0.660	0.509	
	Ent AP	3.404±0.178	3.389±0.251	-0.592	0.554	
	Ent V	**3.281±0.184**	**3.357±0.163**	**-2.660**	**0.008**	**0.610**
Age 8	Ent ML	3.149±0.201	3.079±0.229	-1.398	0.162	
	Ent AP	**3.557±0.254**	**3.630±0.162**	**-2.420**	**0.016**	**0.647**
	Ent V	**3.378±0.248**	**3.499±0.186**	**-3.655**	**0.000**	**0.977**
Age 9	Ent ML	3.159±0.236	3.119±0.192	-1.760	0.078	
	Ent AP	**3.502±0.269**	**3.630±0.289**	**-3.865**	**0.000**	**0.998**
	Ent V	3.416±0.252	3.458±0.242	-0.662	0.508	

SD – Standard Deviation; Z – Statistical Test (Wilcoxon); Sig. – Significant Differences; Ent ML – Incremental Entropy (Mediolateral Axis); Ent AP - Incremental Entropy (Anteroposterior Axis); Ent V - Incremental Entropy (Vertical Axis).

In the 6-years-old group, the ML entropy was significantly higher in the preferred hand when compared with the non-preferred one. In the 7-years-old group, the V entropy was significantly lower in the preferred hand than in the non--preferred one. In the 8-years-old group, the AP and V entropy were significantly lower in the preferred hand when compared to the non-preferred one. In the 9-years-old group, the AP entropy was significantly lower in the preferred hand than in the non-preferred hand. Regarding comparisons between groups, there were no significant differences between the groups of 6 and 7 years old. There were significant differences between the groups of 6 and 8 years old, for the ML (U=1732.0; p=0.001; d=0.901) and AP IncE (U=1954.0; p=0.001; d=0.746) in the preferred hand and, for the ML (U=1881.0; p=0.001; d=0.779), AP (U=1414.0; p=0.001; d=1.107) and V IncE (U=1554.0; p=0.001; d=1.009) in the non-preferred hand. There were significant differences between the age 6 and age 9 groups, for the ML (U=1948.0; p=0.001; d=0.838) and AP IncE (U=2358.0; p=0.003; d=0.572) in the preferred hand and, for the ML (U=1622.0; p=0.001; d=1.050), AP (U=1834.0; p=0.001; d=0.912) and V IncE (U=2177.0; p=0.001; d=0.690) in the non-preferred hand. There were significant differences between the age 7 and the age 8 groups, for the ML (U=2218.0; p=0.001; d=1.123), AP (U=3209.0; p=0.001, d=0.690) and V IncE (U=3589.0; p=0.003; d=0.524) in the preferred hand and, for the ML (U=2999.0; p=0.001; d=0.750), AP (U=2155.0;

p=0.001; d=1.124) and V IncE (U=2794.0; p=0.001; d=0.841) in the non-preferred hand. There were significant differences between the groups of 7 and 9 years old, for the ML (U=2527.0; p=0.001; d=1.066), AP (U=3872.0; p=0.003; d=0.515) and V IncE (U=3625.0; p=0.001; d=0.617) in the preferred hand and, for the ML (U=2602.0; p=0.001; d=1.024), AP (U=2856.0; p=0.001; d=0.919) and V IncE (U=3792.0; p=0.002; d=0.533) in the non-preferred hand. There were no significant differences between the age 8 and age 9 groups per hand. The effect sizes showed a large effect (13).

DISCUSSION

In children, fine motor control like drawing and tracing, are still in development. Unlike adults, these types of movements are not yet automated in children and are constantly changing, being most noticeable between the ages of 7 and 10. Children exhibit different maturation levels of neural structures involved in motor control. For example, an important structure that go through quick modifications from infancy to adolescence and is crucial for fine motor skills is the corticospinal tract (1). The findings presented in this study clearly indicates a notable change that occurs between the ages of 7 and 8 years old. In the single-scale results, it was observed that 6-years-old children exhibited lower entropy values, indicating that they are more predictable when performing the FTT compared to other age groups. On the other hand, 8-years-old children tended to have the highest entropy values. These values increased at age 7 and then started to decrease at age 9. Higher entropy values are usually seen in younger and healthy adults, suggesting that at this age, these children are less probable with highly new information received from the next stages of the system (4). These results may suggest a noticeable transition into the third childhood (14), indicating significant maturation changes in the nervous system during development. Entropy seems to be highly sensitive to these changes, and with the utilization of this tool, we might have the potential to analyze the developmental process of fine motor control in children, particularly within the 7-8 years age range.

CONCLUSION

Examining fine motor control throughout development serves a crucial purpose in recognizing typical patterns and inconsistencies (1). This study demonstrated the potential to analyze fine motor control across different age groups through the use of the FTT and nonlinear analysis methods. Entropy appears to exhibit high sensitivity to these maturation changes.

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