World Journal of Sport Sciences 3 (S): 60-67, 2010
ISSN 2078-4724

Time-series Analysis Through Motor Programming forSequence Punches

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Abstract: The research problem is represented in the attempt to focus on the motor series of sequence punches due to their utmost importance to the Boxer's ability to score more points during the boxing matches; through using the motor programming method of sequence punches (Straight Sequence Punches). The research aims to identify the phases of construction a motor program for Straight Sequence Punches through the time-series analysis of the motor sequence in this search. The search sample consisted of a single international player who performed a sequence of 360 repetitions punches distributed to six exercise sessions, The search implementation took 6 consecutive practice days, and daily practice lasted 65 minutes, and included 60 repetitions of the sequence punches over the practice days, the boxer was filmed 6 consecutive times) after every 60 repetition of the sequence punches.. The researcher used the descriptive method through using high-speed camera, frequency (250 frame / second) and the Kinematographic analysis. The most important research results indicated that the motor sequence which can be performed sequentially and in a time less than the reaction time is a programmed sequence because their performance does not depend on feedback, in accordance with the concept of the Motor Program. The time-series analysis of straight sequence punches proved that the length of time is the basis to judge the speed of programmable variable compared to another. Interference time has played the first role in construction the motor program, followed by reverse time, then punching time, and then total time for each punch.

Key words: Motor programming · Boxing · Straight punches · Motion analysis

INTRODUCTION

The motor programming of a motor sequence is extremely important in the field of motor learning and control - according to the Motor Program Theory [1]. Motor skills are broad and variable in their shapes, aims, and methods of performance. The sequence of performance has the leading role in motor skills; accordingly, the Motor Program Theory focuses on the representation of the motor sequence in the kinetic memory.

Stimulus–response theory seemed to be inappropriate to clarify the huge complexities in the skillful motor performance. Some skills can be performed in absence of kinesthetic feedback; therefore, represented centrally in the brain.

However, several motor skills especially those performed in a time less than the reaction time have to be represented in the center of the memory as a motor program rather than a stimulus - response series. This conception of the motor skill is essential in the skill training especially when connected to the concept of Feedback [2].

The central representation of the motor program does not include terminal feedback as a stimulus. Although the indicated representation constitutes the basis of the motor sequences stored in the memory as a sequence of movements and although the timing of the movements is independent from their sequence, it seems as an integrated part of the motor program especially in terms of the timing rhythm which plays the role in performing the motor sequences [3].

In the boxing matches, the basis is mainly on the motor sequences (sequence punches) to score the most points to win the game; therefore the importance of straight punches and the boxers' dependence on them has increased remarkably [4].

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The research problem is to study the motor sequence of straight punches directed to the head - as they are easier to be performed as quickly as possible during the matches. This can be done through conducting time-series analysis. Furthermore, it is an attempt to focus on the motor series of sequence punches due to their utmost importance to the Boxer's ability to score more points during the boxing matches; through using the motor programming method of sequence punches in the boxer's kinetic memory based on the Motor Program Theory which states that each movement or sequence of movements is a special motor program controlling the movement performance without dependence on any kind of feedback. Due to the high speed of straight punches and sequences, the researcher used the Movement Analysis method which is the most accurate measurement method and basic approaches in evaluating and studying motor performance [5], It is also the best approach to help understanding the changes occurring between the stimulus and response [6].

Research Objective: The research aims to use the time-series analysis of a movement sequence consisted of 6 straight punches in order to identify the method of construction a motor program in the boxer's kinetic memory through defining and measuring the following time variables: punching time, reverse time, interference time, total time for each punch, and the total time of the sequence.

Research Hypothesis: There are no statistical significance among the sequential measurements in the selected time variables (punching time, reverse time, interference time, total time for each punch, and the total time of the sequence).

MATERIALS AND METHODS

The researcher used the descriptive approach represented in the case study.

Research Sample: Was a Purposive sample represented in one highly qualified international boxer in the middleweight class (he weighed 73 kilograms and was 177 cm tall). The boxer's training age is 15 years, and he was about 28 years old. The boxer performed 360 repetition sequence punches and was photographed 6 consecutive times according to the categorization of number of iterations contributing to construction the correct motor program, i.e. after each 60 repetitions of sequence punches. Thus, the study sample becomes 6 measurements for the boxer.

Research Tools:

- The researcher used the boxing tools (boxing gloves - punching bag - wall pad).
- Rustamer device to measure height and weight.
- Light signals-phosphorus signs of the boxer's anatomical points-a Stopwatch.
- To conduct the filming and the Movement analysis, the researcher used: 2 video camera high-speed, frequency (250 frame / second) Sports Cam.
- Kinematographic Analysis by Unit of Movement analysis (Simi Motion) which using Motion Analysis Program (Simi Motion).
- The sequence punches included six straight punches directed to the head performed from the fundamental position. Only straight punches were used as they are easier to be programmed in the boxer's long-term memory; thus he is given enough time to focus on the performance speed and construction the motor program. The movement sequence was as follows: (1) Straight Left, (2) Straight Left, (3) Straight Right, (4) Straight Left, (5) Straight Right, (6) Straight Left.

Steps Implement

- The research procedures were conducted in the boxing ringside at the Faculty of Physical Education - Mansoura University.
- The research implementation took (6 consecutive practice days). The researcher started the basic experiment and filmed the boxer in question during performing the selected sequence punches as an initial measurement on Sunday 2nd of May 2010, then the boxer was filmed for 6 repeated measurements.. The final measurement was on Friday 7th of May 2010.
- The boxer acknowledged the sequence punches at the first day, then he immediately started warming up, then executing the practice which was repeated for 6 days.
- The daily practice lasted for 55 to 65 minutes, and included 60 repetitions of the sequence punches with a total of 360 repetitions over the practice days. This was the number of repetitions which formed the basis of the motor program for the sequence punches and their programming in the boxer's kinetic memory.
- Repetitions were distributed to 12 equal units with 5 repetitions at each unit. In order to reduce the fatigue factor, the boxer was granted 30 seconds break to rest among repetitions. He was also granted 2.30 minutes break to rest among units.

- The boxer was filmed 6 consecutive times according to the repetitions distribution on which the correct motor program was built, and 6 measurements were used; i.e. filming took place after every 60 repetition of the sequence punches. This started at the beginning of the practice after completing the performance of the first unit (5 repetitions), then he was granted a 5 minutes break to rest. Filming and measuring were resumed for the 6th time after performing the warm-up and completing the first unit only 5 repetitions of the selected sequence punches.
- Two lamps were placed; one within the boxer's vision, and the other within the one of the cameras'. The boxer can start performing the sequence punches when the light is on - in order to eliminate the boxer's reaction time from the moment the light is on until the beginning of the first punch of the sequence punches.
- The boxer was provided with an external feedback: (knowledge of results) represented in the time he took in performing the sequence punches; and (knowledge of performance) represented in watching his performance in the former measurement [7]. This takes place every time directly before starting the next shooting.

Statistical Analysis: The researcher used (Mean - Standard Deviation - Analysis of Varianceþ for unequal measurements - Multiple Comparisons using the least level significance (0.05) LSD Test.

RESULTS AND DISCUSSION

Research Results: The statistical analysis conducted by the researcher for the motor analysis related data revealed the research results which included the time-series analysis of the selected sequence punches over 6 simultaneous measurements. Time analysis variables are: the punching time, the Reverse time, the interference time, the total time for each punch.

Table 1 and Fig. 1 show the Mean (M^{-}) and the standard deviation (Std. D±) for the time variables of the sequence punches over the 6 measurements closer to 1\1000 ml.\sec. Table 2 and Fig.2 show analysis of varianceþ for unequal measurements (unequal frames).

Table 1: Mean and standard deviation for the time variables of the sequence punches in the six measurements (ml\sec)

Time	Punching time		Return time		Interference time		Total time punching		Time sequence
Measurement	Mean	Std. D ±	Mean	Std. D ±	Mean	Std. D ±	Mean	Std. D ±	sec.
1	209.121	56.92	170.247	55.68	62.634	40.35	379.368	98.65	2.274
2	191.241	61.42	159.220	65.11	53.142	40.13	350.461	87.24	2.102
3	171.361	66.35	150.621	63.65	48.361	39.27	321.982	82.38	1.931
4	164.118	57.28	143.741	70.19	41.173	36.58	307.859	81.05	1.847
5	150.921	62.22	139.501	64.30	38.810	34.20	290.422	80.69	1.742
6	149.281	60.71	138.428	59.34	37.015	33.98	287.709	80.32	1.729

Tables 1 shows Mean and Std. D ± for the time variables, High values of Std. D ± due to the difference in time for the left-right punches, as well as the use of (ml\sec.) and not the second.

Table 2: Analysis of varianceþ between groups of the six measurements for time variables (punching time, return time, interference time, total time punching) The value of "P" indexed at the level of significance (0.05) and the degree of freedom (5, 30) = 2.210

Point	Source of variation	Sum of squares	Degrees of freedom	Average value	Value "P"	Level of significance
Punching time	Between Group	6929.135	5	1385.827	2.442	0.051*
	Within Group	17022.930	30	567.431		
	Grand Total	23952.065	35			
Return time	Between Group	7486.620	5	1497.324	2.870	0.053*
	Within Group	15649.650	30	521.655		
	Grand Total	23136.270	35			
Interference time	Between Group	1928.365	5	385.673	1.296	0.821
	Within Group	8925.540	30	297.518		
	Grand Total	10853.905	35			
Total time punching	Between Group	26211.595	5	5242.319	3.102	0.052*
	Within Group	50684.760	30	1689.492		
	Grand Total	76896.355	35			

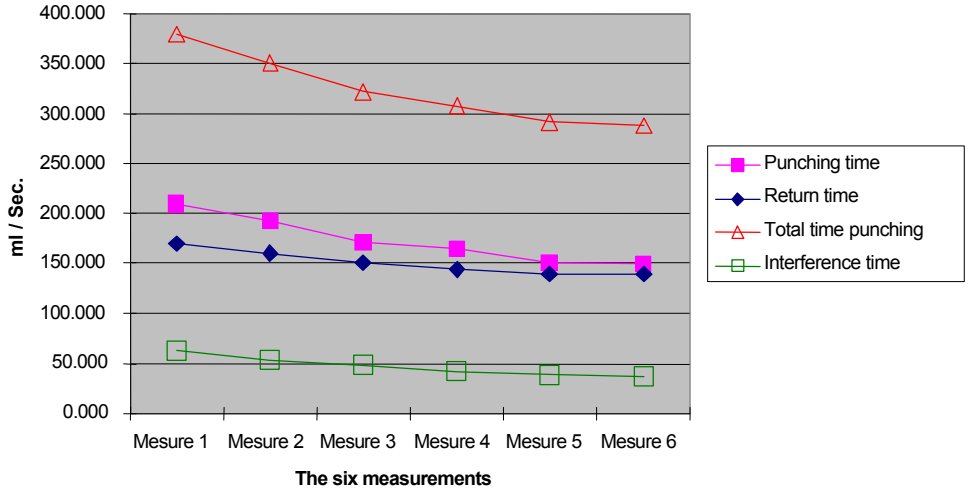

Fig. 1: Time variables average of the sequence punches in the six measurements.

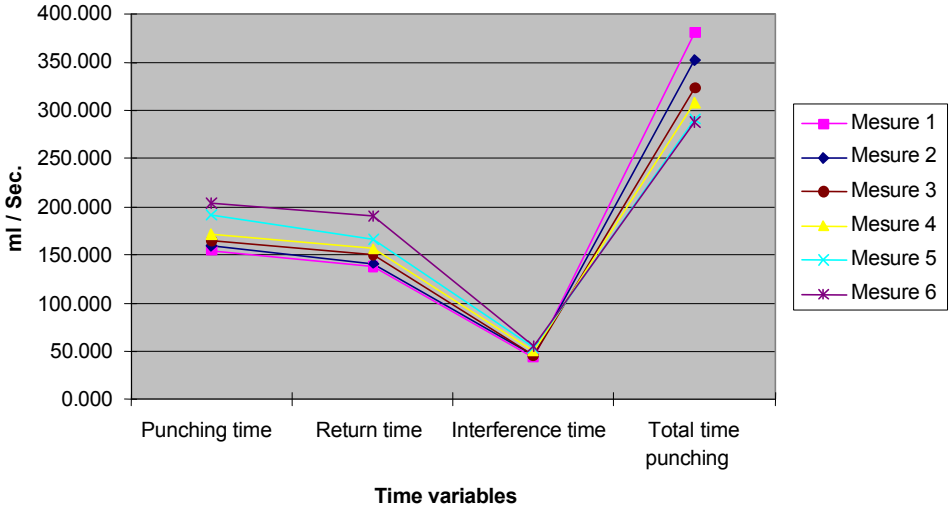

Fig. 2: Matching of Time variables of the sequence punches in six measurements

Table 3: Multiple comparisons of punching time average among six measurements

Measurement	(1) 209.121	(2) 191.241	(3) 171.361	(4) 164.118	(5) 150.921	(6) 149.281
(6) 149.281	59.840	41.960	22.080	14.837	1.640	
Significance Level	0.028*	0.021*	0.038*	0.651	0.891	
(5) 150.921	58.200	40.320	20.440	13.197		
Significance Level	0.039*	0.027*	0.041*	0.855		
(4) 164.118	45.003	27.123	7.243			
Significance Level	0.051*	0.038*	0.619			
(3) 171.361	37.760	19.880				
Significance Level	0.451	0.054*				
(2) 191.241	17.880					
Significance Level	0.586					
(1) 209.121						
Significance Level						

The minimum significance level (0.05). Table 3 shows the significance of matching between each measurement and the remaining measurements by using Multiple Comparisons (LSD Test).

Table 4: Multiple comparisons of Return time average among six measurements

Measurement	(1) 170.247	(2) 159.220	(3) 150.621	(4) 143.741	(5) 139.501	(6) 138.428
(6) 138.428	31.819	20.792	12.193	5.313	1.073	
Significance Level	0.028*	0.041*	0.051*	0.097	0.908	
(5) 139.501	30.746	19.719	11.120	4.240		
Significance Level	0.035*	0.049*	0.054*	0.895		
(4) 143.741	26.686	15.479	6.880			
Significance Level	0.042*	0.050*	0.821			
(3) 150.621	19.626	8.599				
Significance Level	0.538	0.618				
(2) 159.220	11.027					
Significance Level	0.504					
(1) 170.247						
Significance Level						

The minimum significance level (0.05), Table 4 shows the significance of matching between each measurement and the remaining measurements by using Multiple Comparisons (LSD Test).

Table 5: Multiple comparisons of Interference time average among measurements

Measurement	(1) 62.634	(2) 53.142	(3) 48.361	(4) 41.173	(5) 38.810	(6) 37.015
(6) 37.015	25.628	16.127	11.346	4.158	1.795	
Significance Level	0.624	0.661	0.712	0.836	0.984	
(5) 38.810	23.824	14.332	9.551	2.363		
Significance Level	0.681	0.724	0.851	0.961		
(4) 41.173	21.461	11.969	7.188			
Significance Level	0.786	0.811	0.913			
(3) 48.361	14.273	4.781				
Significance Level	0.842	0.898				
(2) 53.142	9.492					
Significance Level	0.876					
(1) 62.634						
Significance Level						

The minimum significance level (0.05).Table 5 shows the significance of matching between each measurement and the remaining measurements by using Multiple Comparisons (LSD Test). It is clear from the results no significant differences for any of the six measurements.

Table 6: Multiple comparisons of total time punching average among measurements

Measurement	(1) 379.368	(2) 350.461	(3) 321.982	(4) 307.859	(5) 290.422	(6) 287.709
(6) 287.709	91.659	62.752	34.273	20.150	2.713	
Significance Level	0.011*	0.009*	0.018*	0.015*	0.881	
(5) 290.422	88.946	60.039	31.560	17.437		
Significance Level	0.028*	0.031*	0.037*	0.828		
(4) 307.859	71.509	42.602	14.123			
Significance Level	0.33*	0.050*	0.054*			
(3) 321.982	57.386	28.479				
Significance Level	0.51*	0.451				
(2) 350.461	28.907					
Significance Level	0.508					
(1) 379.368						
Significance Level						

The minimum significance level (0.05), Tables 6 shows the significance of matching between each measurement and the remaining measurements by using Multiple Comparisons (LSD Test).

Tables 3-6 (Multiple Comparisons by using LSD Test) shows the significance of matching between each measurement and the remaining measurements according to the following order: punching time, return time, interference time, total time punching.

DISCUSSION

The research aim is to examine the significance of the Motor Program Theory in relation to a motor sequence; as well as its validity to program a sequence

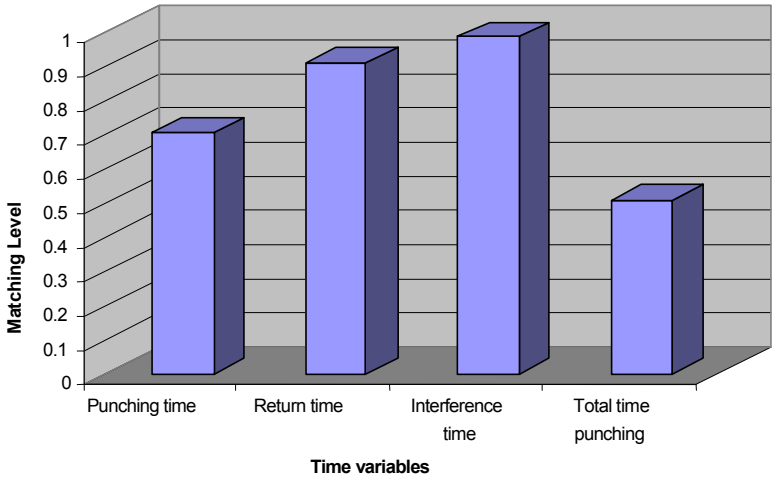

Fig. 3: Matching level of Time variables of the sequence punches in six measurements

punches consisting of 6 straight punches in the head that have been practiced for a long time through using the kinetic motor analysis, in addition to following the changes which might have happened during construction the Motor Program.

The validity of the Motor Program Theory depends on the levels of significance and matching among measurements. Accordingly, the researcher used the minimum significance level (0.05). Matching levels are as follows: (0.600 - 0.699) medium match, (0.700 - 0.799) good match, (0.800 - 0.899) very good match, (0.900 - 0.999) excellent match and perfect match is 1.000 [8].

The sequence punches used in this research are: (1) Straight Left, (2) Straight Left, (3) Straight Right, (4) Straight Left, (5) Straight Right, (6) Straight Left. If we consider that number (1) represents the Straight Left, and number (2) represents the Straight Right, then the kinetic rhythm of the selected sequence punches is (1-1-2-1-2-1), which is easily memorable in the boxer's kinetic memory. Therefore, the motor programming is fast; especially when performed by a highly qualified international boxer [9].

The results concluded through analyzing time variables for the whole sequence which included (the punching time, the Reverse time, the interference time, the total time for each punch, and the total time for the sequence punches) have revealed a significant gradual reduction in the mean values (Table 1, Fig. 1). This result is extremely logical because starting to practice a motor sequence requires memorization of its sequence first. The more practice, the less Return time among movements gradually, and the performance time is also reduced [10].

The results of time variable averages in Table 1 are represented in Fig. 1, which revealed that the results of the six measurements have been gathered to constitute their values from a temporal point of view for each variable, and from an initial point of view about the matching which took place among the six measurements. Interference time variable was the least, followed by the Reverse time, ten the punching time (Fig. 2).

In order to answer the important question: how to build a motor program and to program the selected sequence punches in the boxer's kinetic memory using time variables? An analysis of variables and multiple comparisons among the six measurements was conducted to evaluate the stability order of each time variable in the boxer's kinetic memory among the six measurements [11].

Figures 2 and 3 show that Interference time was the best matching time over the six measurements, followed by the Reverse time, then the punching time, the total time of each punch. The indicated results were confirmed by the results of the analysis of variance (Table 2). They revealed that there are no statistical differences among the measurements for the interference time, while there were statistical differences among the measurements for the remaining time variables. The results of the multiple comparisons among measurements for each time variable are shown in the tables (3-6) and represented in (Fig.3). Their order according to their matching is as follows:

Interference time was the best matching time among former and subsequent measurements starting from the first to the sixth measurement (Table5). The matches were between very good and excellent; as they reached 0.876 between the first and second measurement; 0.898 between the second and third measurement; 0.913 between the third and fourth measurement; 0.961 between the fourth and fifth measurement; 0.984 between the fifth and sixth measurement. The indicated results show that Interference time when monitored in the movement

sequence performed extremely fast as in the selected sequence punches, constitutes the time intervals among punches (-) which controls the start of each punch following the first punch. It also constitutes the kinetic rhythm of the sequence performance (1-1-2-1-2-1). Therefore, Interference time plays the leading role in controlling the timing factor of performing the punches and their speed. The stability of Interference time over the six measurements indicates that it is the basic component of the sequence punches time components which formed the basis of the sequence programming, and accordingly the motor program in the boxer's memory as well [12].

Return time was following the interference time. The results of the multiple comparisons (Table 4) indicated that the stability and high matching level among measurements began from the third to the sixth measurement; as they reached 0.821 between the third and fourth measurement; 0.895 between the fourth and fifth measurement; 0.908 between the fifth and sixth measurement. Return time comes at second place probably because of its close connection to Interference time during consecutive punches.

The punching time comes at third place. The results of the multiple comparisons (Table 3) indicated that the stability and high matching level among measurements began from the fourth to the sixth measurement; as they reached 0.855 between the fourth and fifth measurement; 0.891 between the fifth and sixth measurement.

Total time punching (total time for each punch) comes at fourth and last place. The results of the multiple comparisons (Table 6) indicated that the stability and high matching level among measurements began from the fourth to the sixth measurement; as they reached 0.828 between the fourth and fifth measurement; 0.881 between the fifth and sixth measurement. The researcher believed that combining the Punching and Return time in an integral conception can produce a better result than dealing with each of them separately. However, the total time for each punch retains the least matching results among the time variables.

The above-mentioned reveals that the punching time with motor timing can be adequately programmed among the fifth and sixth measurement. However, the process of introducing it to the memory and to be represented centrally inside the brain according to the Motor Program Theory, started first with the interference time, combined by the Reverse time, then the punching time. Since Interference time is the least of the three and the most important, it was programmed first, followed by the Reverse time, then the punching time. Whenever less the time - to the extent that the individual can control it - and increasing importance this time increases the possibility of its programming first [13].

This has been indicated by the motor program theory which states that motor programming for people cannot be done literally or automatically for the entire motor variables. Scientific research in the field of motor learning and control should seek the variables that can be programmed to build a motor program, and to order them according to their stability in the long-term kinetic memory [11]. Keele [1] indicates that when a motor program is recognized in the kinetic memory as a result of long term repetition and prolonged practice, the motor sequence which is the basis of the program is represented centrally in the brain - in some cases it can be represented in the spine. Therefore, it is not subject to the input data from the visual feedback or Kinesthetic.

Generally speaking, the results confirmed the validity of the theory, and the impact of long term prolonged practice on a movement sequence represented in sequence punches through the time-series analysis [14]. The results revealed the possibility of programming the selected sequence punches and their representation centrally in the boxer's kinetic memory (in the brain).

CONCLUSION

- The movement sequence which components can be performed sequentially in a time less than the reaction time can be considered programmed sequences due to their performance dependence on feedback in terms of the Motor Program Theory.
- The time-series analysis of straight sequence punches proved that the time length is basis to judge the speed of programming a variable compared to another.
- Interference time plays an important role in controlling the motor rhythm of the movement sequence (sequence punches).
- Interference time plays a leading role in construction the motor program, followed by the Reverse time, the punching time, and then the total time of each punch.
- Each movement in the movement sequence (sequence punches) has its own speed, even if it was similar to another movement of the same kind.
- The motor program is built on the correlation between the movement sequences. There was a binary correlation between every consecutive punch. The cognitive order in the kinetic memory was conducted based on the priority of the punches 1 and 2, then of the punches 5 and 6, then of the punches 3 and 4.

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