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Original Article

Analysis of a Boxing match - A pilot study

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Abstract:
The focus of this article is in creating a timeline of a boxing match. We observed 3 semi-final matches of later winners in weight categories of 64kg, 69kg and 75kg. We divided the observed parameters into inactive phases, active phases (punch activities) and clinches. Consequently we further divided the active phases to three more parameters which are: the actual attack, the actual attack with contra attack of the opponent and the clash. We observed the frequency and time duration of individual phases. In the second part of the experiment we tried to divide the match into 5 seconds intervals where we observed the number of initiated active phases and we determined average time, frequency and time duration of inactive phases longer than 4 seconds. The average active phase is 1.2 +/- 0.8 seconds and inactive phase's duration was 2.3 +/- 1.8 seconds. The actual attack lasts 0.7 +/- 0.2 seconds where around 1/4 of the attacks consist of multiple punches. The actual attack with the opponent's contra attack lasts 0.9 +/- 0.2 seconds and the clash between 1.9 +/- 0.9 seconds. The ratio of the actual attacks and clashes is approximately the same. The average number of active phases for an individual round is 47.3 +/- 3.8 seconds and the number of initiated active phases for each 5 seconds is 1.3 +/- 0.8. The average duration of an inactive phase longer than 4 seconds is 5.6 +/- 1.7 seconds; the average frequency of inactive phases longer than 4 seconds of an individual round is 7.6 +/- 1.9 repeats. The time between the two consecutive inactive phases longer than 4 seconds is 22.6 +/- 11.2 seconds. The results of this experiment can be directly applied into the training process with an immediate effect. This is especially applicable to the conditional training. This was one of the main impulses for conducting this research. All the results are also applicable for diagnostic reasons.
Key Words: box, analysis, time, phase, match

Introduction

Box is a contact sport demanding high level of physical fitness as well as mental strength. The main objective is to direct as many scored punches at the opponent where as at the same time to receive as few as possible of these. In a boxing match we can observe these punches in an isolation as well as in a punch combination. In order to succeed it is imperative to know the structure of a match which then determines the best form of preparation. Detailed analysis of a boxing match was a study focus of numerous authors who predominantly observed the frequency of individual punches as well as their combinations which either hit or missed the opponent as well as other technical parameters of a match. Kapo (2008) observed matches at the National Championship of Bosnia and Herzegovina where he found that the frequency of direct and hook punches is approximately the same where the most frequent group of punches were direct punches with the front hand (28.9%) and hook punches with the front hand (23.2%). During the defence the back hand is used more frequently than the front one. The actual number of performed punches was recorded by Ashker (2011), Martsiv (2014) and Davis (2015). They observed between 51 to 70 punches per individual round or between 155 to 190 punches per the whole match. They are in agreement with Kapo (2008) that the most frequent punches are the direct front punches followed by front hook punches. Out of the final number of punches the opponent is hit by an average of 45 punches during the match which represents the efficiency of 25%. Davis (2015) also observed the energy intensity of punches where he measured the values of lactate of 11.8 +/- 1.6 mmol/L. From the point of view of conditional preparation it is very important to know the time breakdown of the match and the duration of individual phases. This was the focus of a study of Oeurgi (2014). He divided a kick box match into high intensity and low intensity activities and pauses. The high intensity phase lasts 2.2 +/-1.2 seconds and low intensity phase lasts 2.3 +/- 0.8 seconds. The duration of the pauses are 5.4 +/- 4.3 seconds and time duration between two consecutive high intensity phases is 3.4 +/- 1.2 seconds. In general we can divide the kinetic activity during the match into the activity performed by hands, body and feet. As the only scored punches are the ones performed by hands these then of course deserve specific attention. Our study for that reason focuses on time division of kinetic phases performed by hands.

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Material & Methods

The main aim of this article is to establish the time analysis of a boxing match. We observed 3 semi-finals matches of later winners at the World Boxing Championships in Doha 2015 in the following weight categories: 64 kgs - Yasniel Toledo Lopez (CUB) vs. Vitaly Dunaytsev (RUS), 69 kgs - Wei Liu (CHI) vs. Mohammed Rabii (MAR), 75 kgs - Hosam Abdin (EGY) vs. Arlen Lopez (CUB)

We divided the observed parameters into three categories:

Active Phase - Visible activity of upper limbs (punches) irrespectively of which fighter performed them. We considered the total activity in a given time period.

Inactive Phase - Any other activity, footwork, movement across the ring, preparation for the action. We did not considered stoppage times imposed by the referee where the clock stops.

Clinch - Specific parameter not allocated into active nor inactive phase describing the activity where one opponent prevents the other form any action

We furthermore divided the active phase into three more categories:

Individual attack - Isolated individual punch performed form the basic position, alternatively two or three combination from the distance not shorter than is the reach of a stretched front arm which does not lead into further action. Individual Contra Attack - Isolated individual punch performed form the basic position, alternatively two or three combination from the distance not shorter than is the reach of a stretched front hand with and immediate single or combined contra punch of an opponent which does not lead into further action Clash - Any activity performed at the distance of a stretched front arm or combined activity performed at the distance of a stretched front arm. In the second part we calculated frequency and standard deviation initiated active phases every 5 seconds based on complete graphs - 180 pgs. This we consequently verified by a calculation of a common ratio of active phases per round and the constant 36 which is a number of 5 seconds interval per round. We divided inactive phases according to their lengths into: up to 4 seconds and more than 4 seconds, determined the average time, average frequency a and standard deviation inactive phases longer than 4 seconds per individual round. We also calculated the time duration and standard deviation between two consecutive inactive phases longer than 4 seconds.

Results

Tab. 1. Basic characteristics of the Dunaytsev vs. Lopez match

	AAP	AIA	AICA	AC	TTAP	TTIP	ATAP	ATIP
TOTAL	154	71 (46,1%)	34 (22,1%)	49 (31,8%)	164,9	331,9	1,1 ± 0,6	2,2 ± 1,4
I. ROUND	50	26 (52%)	9 (18%)	15 (30%)	53,3	118,8	1,1 ± 0,6	2,5 ± 1,5
II. ROUND	52	26 (50%)	11 (21,2%)	15 (28,8%)	55	101	1,1 ± 0,7	2,0 ± 1,1
III.ROUND	52	19 (36,5%)	14 (27%)	19 (36,5%)	56,6	112,1	1,1 ± 0,6	2,2 ± 1,5
	ATIA	ATICA	ATC	TTIA	TTICA	TTC	AC	ATC
TOTAL	0,7 ± 0,2	0,9 ± 0,2	1,8 ± 0,7	47,4	30,8	86,7	6	4,8
I. ROUND	0,7 ± 0,2	0,9 ± 0,3	1,9 ± 0,5	17,3	8,1	27,9	1	3,7
II.ROUND	0,6 ± 0,2	0,9 ± 0,3	1,9 ± 0,9	16,5	10,3	28,2	4	4,6
III.ROUND	0,7 ± 0,2	0,9 ± 0,1	1,6 ± 0,7	13,6	12,4	30,6	1	6,9

AAP - amount of active phases, AIA - amount of individual attacks, AICA - amount of individual contra attacks, AC - amount of clashes, TTAP - the total time duration of active phases, TTIP - the total time duration of inactive phases, ATAP - average time duration of an active phase, ATIP - average time duration of an inactive phase, ATIA - average time of an individual attack, ATICA - average time of an individual contra attack, ATC - average time of a clash, TTIA - total time duration of and individual attack, TTICA - total time of an individual contra attack, TTC - total time duration of a clash, AC - amount of clinches, ATC - average time duration of a clinch.

Out of a total amount of 26 attacks in the first round 6 of there were multiple punch attacks, Second round 26 attacks - 5 of them multiple punch attacks, Third round - 19 attacks of which 7 were multiple punch attacks. Out of total number of 71 attacks in the match 18 were multiple punch attacks.

Tab. 2. Basic characteristics of Rabii vs. Liu match

	AAP	AIA	AICA	AC	TTAP	TTIP	ATAP	ATIP
TOTAL	134	34 (25,4%)	16 (11,9%)	84 (62,7%)	189,2	304,4	1,4 ± 0,8	2,4 ± 2
I. ROUND	43	13 (30,2%)	7 (16,3%)	23 (53,5%)	53,6	113,3	1,2 ± 0,6	2,8 ± 1,8
II.ROUND	48	13 (27,1%)	7 (14,6%)	28 (58,3%)	69,3	97	1,4 ± 0,9	2,1 ± 1,8
III.ROUND	43	8 (18,6%)	2 (4,7%)	33 (76,7%)	66,3	94,1	1,5 ± 0,8	2,2 ± 2,3
	ATIA	ATICA	ATC	TTIA	TTICA	TTC	AC	ATC
TOTAL	0,7 ± 0,2	0,9 ± 0,2	1,8 ± 0,8	22,8	14,1	152,3	11	2,9
I. ROUND	0,7 ± 0,2	0,8 ± 0,1	1,7 ± 0,6	9,3	5,6	38,7	3	1,6
II. ROUND	0,6 ± 0,1	0,9 ± 0,3	2,0 ± 0,9	7,9	6,6	54,8	4	2,6
III.ROUND	0,7 ± 0,3	1,0 ± 0,1	1,8 ± 0,8	5,6	1,9	58,8	4	3,6

Out of a total amount of 13 attacks in the first round 4 of there were multiple punch attacks, Second round 13 attacks - 3 of them multiple punch attacks, Third round - 8 attacks of which 1 were multiple punch attacks. Out of total number of 34 attacks in the match 8 were multiple punch attacks

Tab. 3. Basic characteristics of Lopez vs. Abdin match

	AAP	AIA	AICA	AC	TTAP	TTIP	ATAP	ATIP
TOTAL	138	54 (39,1%)	35 (25,4%)	49 (35,5%)	177,4	305,2	1,3 ± 0,9	2,3 ± 2,2
I. ROUND	47	22 (46,8%)	14 (29,8%)	11 (23,4%)	51,7	113,7	1,1 ± 0,7	2,5 ± 1,9
II.ROUND	49	19 (38,8%)	11 (22,4%)	19 (38,8%)	60,3	98,6	1,2 ± 0,8	2,1 ± 2,4
III.ROUND	42	13 (31%)	10 (23,8%)	19 (45,2%)	65,4	92,9	1,6 ± 1,2	2,3 ± 2,1
	ATIA	ATICA	ATC	TTIA	TTICA	TTC	AC	ATC
TOTAL	0,7 ± 0,3	0,9 ± 0,2	2,1 ± 1,1	39,2	33,2	105	14	2,7
I. ROUND	0,7 ± 0,2	1,0 ± 0,2	2,1 ± 0,7	15,3	13,4	23	3	2,4
II. ROUND	0,7 ± 0,3	0,9 ± 0,2	1,9 ± 1,0	14	9,9	36,4	6	2,4
III.ROUND	0,8 ± 0,3	1,0 ± 0,2	2,4 ± 1,3	9,9	9,9	45,6	5	3,1

Out of a total amount of 22 attacks in the first round 6 of there were multiple punch attacks, Second round 19 attacks - 4 of them multiple punch attacks, Third round - 13 attacks of which 4 were multiple punch attacks. Out of total number of 54 attacks in the match 14 were multiple punch attacks

Tab. 4. Basic characteristics for all matches combined

	AAP	AIA	AICA	AC	TTAP	TTIP	ATAP	ATIP
TOTAL	426	159 (37,3%)	85 (20%)	182 (42,7%)	531,5	941,5	1,2 ± 0,8	2,3 ± 1,8
I. ROUND	140	61 (43,6%)	30 (21,4%)	49 (35%)	158,6	345,8	1,1 ± 0,6	2,6 ± 1,7
II. ROUND	149	58 (38,9%)	29 (19,5%)	62 (41,6%)	184,6	296,6	1,2 ± 0,9	2,0 ± 1,8
III. ROUND	137	40 (29,2%)	26 (19%)	71 (51,8%)	188,3	299,1	1,4 ± 0,9	2,2 ± 1,9
	ATIA	ATICA	ATC	TTIA	TTICA	TTC	AC	ATC
TOTAL	0,7 ± 0,2	0,9 ± 0,2	1,9 ± 0,9	109,4	78,1	344	31	3,2
I. ROUND	0,7 ± 0,2	0,9 ± 0,2	1,8 ± 0,6	41,9	27,1	89,6	7	2,7
II. ROUND	0,7 ± 0,2	0,9 ± 0,3	1,9 ± 0,9	38,4	26,8	119,4	14	3,1
III. ROUND	0,7 ± 0,3	0,9 ± 0,2	1,9 ± 0,9	29,1	24,2	135	10	3,7

Out of a total amount of 61 attacks in the first round 16 of there were multiple punch attacks, Second round 58 attacks - 12 of them multiple punch attacks, Third round - 40 attacks of which12 were multiple punch attacks. Out of total number of 159 attacks in the match 40 were multiple punch attacks

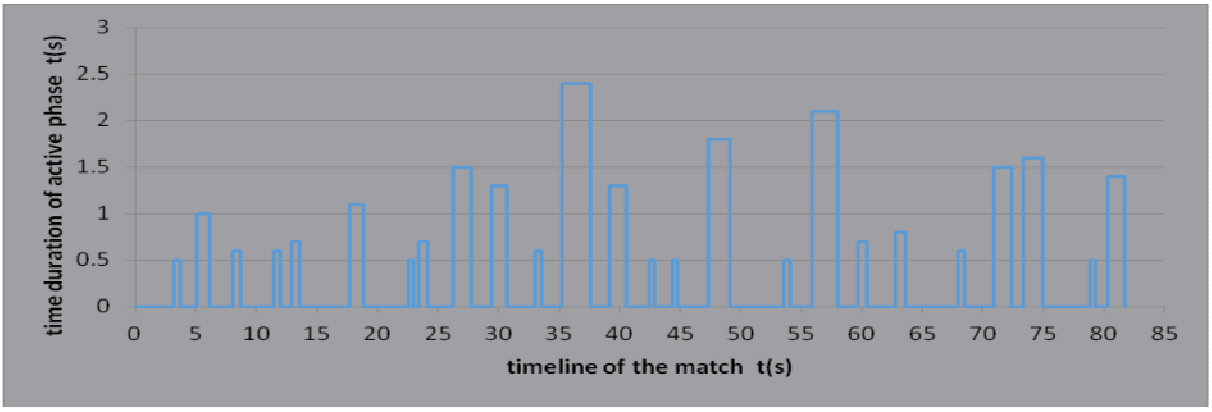

Fig. 1. Progress and time duration of active and inactive phases first 85 seconds of Dunaytsev vs. Lopez match

Average number of active phases per round	**47.3 +/- 3.8**
Number of initiated active phases every 5 seconds	**1.3 +- 0.8**
Average time duration of inactive phase longer than 4 seconds	**5.6 +/- 1.7**
Average frequency of inactive phases longer than 4 seconds per round	**7.6 +/- 1.9**
Time duration between two consecutive inactive phases longer than 4 seconds	**22.6 +/- 11.2**

Discussion

Our research is the first of this kind analyzing a boxing match not only from the quantitative but also from the time aspect. This king of analysis is needed especially for the tailoring the conditional training either general or specific as well as adequate diagnostic of boxing skills. The results showed that box can be classified as an interval type of activity where both active as well as inactive phases are of short duration and a ratio of activity and a relative rest is approximately 1:2. Our results regarding the time duration of an active phase which is 1.9 +/- 0.9 correspond with the study of Oeurgi (2015) where he observed the time duration of high intensive activity at 2.2 +/- 1.2 seconds. We have to realize that this research is mainly focused on a kickboxing match

where individual punch is not so commonly used as it is in classic box and for that reason we cannot compare the total average activity which is shorten by the time duration if an individual attack. Kickbox more uses continual activity at which the comparison is more evident. Equally the average number of active phases per round is comparable with that one in box although the time duration of this is 2 minutes during which we measured 27 active phases whereas in box this is 3 minutes where the number of active phases was 47 of which some were shorter than 1 second. When research focuses solely on box, especially on the analysis of individual boxing skills we can compare the frequency, average as well as total time of clinches which we observed at comparable level as Davis (2015): frequency: 2.5 +/- 2.0, 3.2 +/- 2.1, 4.8 +/- 2.6 seconds. I. II. III. rounds respectively 12.6 +/- 11.0, 17.2 +/- 12.1, 28.7 +/- 17.7 in total time. Comparable is also the amount of all punches per round - approximately 60 (Ashker 2011), (Martsiv 2014), (Davis 2015).

In our research we observed frequency of 47 active phases per one round and if we take into consideration that both fighters are not performing punches in all active phases and where the active phase is of a longer duration fighters perform more than one punch we can measure comparable values in terms of total number of performed punches. Look at time values of individual phases we can determine adequate means to be used in training process. Exercises of between 1 to 3 seconds can be performed either with one's own weight as well as the ones involving heavy lifting which are recommended for conditional training. English squat (burpess), press up or dead lift, movement with the weights with the sudden front movement can be combined with static phase standing straight or holding weights. This phase can be shorter followed by a rapid change to the dynamic regime. Number of initiated active phases within 5 seconds can be counted as shorter working interval of combination of an exercise and static phase. Average time, frequency and time interval between two inactive phases longer than 4 seconds can determine how many consecutive shorter intervals we can use before 5 second break. We can state that our study is just a pilot one and there are still issues to work on especially in terms of assessing of individual parameters. Some attacks with the opponent's contra attacks can be classified as clash. Situation in the phase of a clash can also be viewed from different aspects. In future research we would definitely like to focus on observing periodically repeating situations for example defence, body work, movement in double cover or receding individual attack and based on these observations to prepare complete basic structure for training process. Our results and observations , however, are fully sufficient for our immediate needs.

Conclusion

We can conclude that we successfully achieved our goals set at the beginning of this research and these can be applied in practical training. For the conditioning training we can suggest specific training unit lasting one match 3x3 minutes with 1 minute break. Burpees exercise should last between 1.7 to 2.2 seconds depending on the speed of performing this exercise. If we divide 180 seconds - which is the time duration of one round - into 5 seconds intervals we get 36 of such intervals. In each of these intervals we can perform one exercise which is total 108 exercises in 3 rounds. Intervals of course can be shortened into 4 seconds or prolong according to the needs and abilities of athletes. For diagnostic purposes we recommend measuring the force and time duration of repeated direct front punch or a combination of a direct front and direct back punch starting with visual signal as well as repeated series of punches for a time interval to 2 seconds. In ideal case the punch with a "ducking" movement.

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