

ARS ENSIS - HEMAC

Training theory of longsword fencing

DEFINITIONS, BASIC MOTION ANALYSIS AND THEORETICAL BACKGROUND

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Some basic research and definition and help for better understanding HEMA Longsword – fencing as sport. The study will give some minor guideline for fencer and trainer of HEMAC

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Prologue

My present study try to summarize the theoretical background of longsword fencing.

We need to know the following fact: despite the ancient tradition of our martial arts, the longsword fencing is very young as modern sport. We do not have yet the axioms, research, experience and knowledge, which evidences in other sports. I hope, that in the future our community will go further in the way of HEMA as modern sport and martial arts.

The longsword fencing is a very complex sport. The necessary things for success are the technical knowledge, experience, physical power and the most elusive thing, the „fighting spirit“, or „warrior spirit“.

The longsword fencing is a Martial Arts. Arts, because contain the beauty of the perfect, lethal efficiency, and Martial, because the techniques was forged on the anvil of war, and deadly duels during the ages.

Nowadays the longsword fencing has different meaning for everybody who practice. Sport, Arts, Hobby, Tradition. My study wouldn't like take any stand in this discussion. I just want to study the scientific aspect of longsword fencing as sport.

Motion analysis of the longsword – fencing

General characteristic of longsword fencing

If we would like prepare to longsword fencing we must know the characteristic of the movement. We must know the intensity, duration and the period of the physical activity. The periodic changes of the intensive and less intensive cycles will define the required motoric skills.

I was looking for a specific event for the analysis, which can represent the current status of the competitive longsword fencing. I used the Swordfish, because:

- All material available in Youtube¹
- Big international event, which can represent the current level of longsword – fencing
- Enough fight for making relevant conclusion
- The tournament's rules was general – does not distort the results. (eg: limited area of hit etc.)

Explanation

Gross length = Length of the fight between the judge's first „fight” to the end of the last active period.
Unit=Sec.

Net length of fight = time between the judge's „fight” order to the end of the current active period.
Unit=Sec.

Net length % = (Net length of fight/ Gross length)*100

Net length of active period = net length of each active period during the fight. Unit=Sec.

Average length of period = (net length of fight/number of active period). Unit=Sec.

#	link	Gross length	Net length of fight.	Net length %	Net length of active period	Average length of active period
1	http://youtu.be/ELdWR-X1mI0	181	109	60	8, 14, 8, 15, 11, 6, 9, 9, 8, 11, 10, 8	9,08
2	http://youtu.be/TPYcRdqxscs	219	118	54	17, 33, 12, 10, 8, 8, 8, 5, 8, 9	11,8
3	http://youtu.be/WQTtUK0tuik	284	140	49	12, 13, 15, 7, 17, 13, 23, 6, 17, 6, 11	12,72
4	http://youtu.be/3HAKzDIEin8	426	227	53	16, 13, 9, 18, 9, 21, 18, 9, 14, 16, 6, 17, 5, 8, 11, 9, 8, 6, 9, 5	11,35
5	http://youtu.be/5dcu7wTYqOI	143	80	55	28, 8, 12, 12, 10, 4, 6	11,42
6	http://youtu.be/iZhyLOiWuwv	117	61	52	4, 5, 7, 8, 6, 12, 5, 8, 6	6,77
7	http://youtu.be/8G1rSLW_IF4	122	96	78	27, 21, 15, 20, 13	19,2
8	http://youtu.be/w36PlyMcraY	120	79	66	15, 11, 12, 8, 11, 9, 13	11,28
9	http://youtu.be/OLzdWVBovtg	519	264	51	15, 10, 19, 8, 5, 7,	12

¹ http://youtu.be/tD_iG65Dral

					23, 16, 9, 5, 27, 16, 6, 9, 16, 9, 8, 23, 9, 5, 13, 6	
10	http://youtu.be/mOuOaM_OaEQ	166	109	66	11, 18, 8, 8, 7, 14, 7, 11, 8, 12, 5	9,9
11	http://youtu.be/0guFehv3T44	120	76	63	25, 13, 7, 20, 7, 4	12,6
12	http://youtu.be/bVt8uZFaaG4	120	75	62	5, 17, 13, 7, 7, 9, 7, 10	9,37
13	http://youtu.be/-KgCf0tP7SY	172	130	76	20, 10, 16, 6, 19, 9, 16, 14, 20	14,44
14	http://youtu.be/JVtfkoMEuck	124	89	72	12, 37, 5, 20, 15	17,8
15	http://youtu.be/FOm0jac2FuQ	131	79	60	4, 12, 8, 6, 19, 9, 10, 11	9,87
Summa	averages	197,6	115,46	58,43	n.a	11,97

Based on the analysis, the average length of intensive period during the fight was 11,97 secundum, and the length of fight scattered between 117 sec and 519 sec. Average: 197,6 sec.

During the training period we can calculate this length of maximum intensity period. If the fencer can improve his ability to work in this duration above the average, he has advantage.

Analyze the type of the motion, we can say that the longsword fencing is acyclic motion, namely:

„a manifestation of an activity, when we connected together different type of movements, or the activity represents a form of self-contained movement such as: throw, jump, blast etc.”²

General characteristic of longsword – fencer

The longsword fencers are typically 17 – 30 year old male, without any professional sport experience³. We can define the longsword fencing as leisure activity⁴.

Because of this we must calculate with some facts, if we would like use the conclusion for the „average” fencer:

- The majority has no enough basic motoric skill (stamina, maximum power, rapid force etc.) for the targeted training
- The majority has no enough motivation for professional training
- The diversification are high according the health, fitness level and age.

Because of this we must separate the level of training for „hobby fighter” and „dedicated fighter”. We call „dedicated” the fighter if he can make the necessary training work for effective, targeted work, **minimum** 3 times per week.⁵

² Source: Edzés, versenyzés címszavakban

³ Source: „Survey of physical condition” Ars Ensis internal project. Project # 2012/09

⁴ NOT a philosophical definition!

⁵ Definition of the author

General seasonal characteristic of longsword – fencing

Because this study depends on my research within Ars Ensis I can calculate the available tournament for the members of this group. In other countries the seasonal characteristics can differ from this. For example the Fight Camps are very far from us, but we have our own tournaments in the autumn. Please calculate with these facts. The available tournaments for an average Ars Ensis member are the following:

1. Dryevent (January)
2. HEMAC tournament; Dijon (middle of May)
3. Swordfish; Sweden (November)
4. Wien tournament, Wien (September)
5. League of Ars Ensis (September - December, only AE member)
6. Championship of Ars Ensis (October, only AE member)

Based on this calendar, the most important periods of competition are autumn, September – December. My calculations depend on this calendar during the study.

The training

Definition⁶

The science – driven enhancing process of the performance during which we strategically develop the fencers' performance and performing skills, therefore can achieve better results.

By type:

- Ability developer training
- Technical/Tactical training
- Complex training
- Contest-simulator training
- Additional training

Ability developer: during the training we work on the improvement of one, pre-defined motoric skill. That kind of training requires strict planning and long time. Without consistency this kind of training is useless.

⁶ Source: Edzéselmélet és módszertan

Technical/tactical: during the training the fencers learn and practice the specific movement of the sport. Because of the characteristic of longword fencing, the technical parts dominating above the tactical elements.

Complex: the training can improve different important elements (f.e: technical and some motoric skills) This is the most popular training method. During the planning care must be taken of the sequence of exercise. Based of the nature of the human body the recommended sequence are the following:

1. Warm-up
2. Technical part. The human body can learn and practice new motion in rested state⁷.
3. Speed and reflex development.
4. Strenght development
5. Stamina development
6. Mental stamina development
7. Relaxation

Contest – simulator: during the training we will simulating the circumstances of the competition. The fencer must be familiar with the stressor of the competition, like spectators, judges, rules, etc.

Additional training can improve the most important motoric skills, but not focusing on one dedicated skill, but can improve the average skill level. (like fitness)

⁷ When we calculating the intensity of training, do not forget the energy demand of the daily routine!

Warm-up

The warm – up is the most important part of any kind of sport activity. During the warm up the body can be prepared for the intensive load, and can perform the practice without injury. The minimum and maximum level of warm up depend on the age and physical condition of the fencer.

Based on the most popular theory the warm up has 6 different phases.

First phase – moderate stretching (2-3 min)

In this phase we warm-up the joints. The load must be low, and must be activated all of the joints (legs, arms, neck, back etc). Typically must work with round motion and the joints must be unencumbered. The target of the phase is the minor increase of the muscle tone.

Second phase – moderate exercises for increasing the blood circulation (3-5 min)

The target of the phase is to improve the working level of blood circulation system. Must open the capillaries, and increase the pulse. Parallel with this, in the “capsula articularis” the “membrana synovialis” start to producing the synovial liquid, which is necessary for the proper work of the joints.

Third phase – powerful stretching (5-8 min)

In this phase we must prepare the joints, tendons and the muscles for the work in the border movement. We can actualize the previously reached flexibility in this phase. Based on the newest research⁸ the passive stretching has a big advantage against the active stretching (f.e: Dynamic hurls) which can make micro-injuries in the muscles (because of the myotonic reflex)⁹

Fourth phase – intensive exercises for increasing the blood circulation (2-3 min)

In this phase we must reach the fully active status of blood circulation system. Aerobic exercises with fast pace, optimal intensity and high repeat can work well. In this phase must be reached the top of the targeted pulse frequency. The intensity can assimilate to the nature of the sport activity.

Fifth phase - Static power increasing exercises (1-2 min)

This phase prepares the muscle system for the sport motion. We must use the strength-endurance motoric power. Slow push-ups, squats, other static exercises can work.

Sixth phase – Sport-specific exercise (2-5 min)

We must warm – up not only the body but the nervous system too for the specific motions. The target of the phase that our body can be familiar with the swords, the movements, etc. One of the best practices is the Meyer – square.

⁸ Source: Gimnasztika jegyzet az OKJ-s sportszakember képzés számára

⁹ Source: Sportegészségügyi ismeretek

The intensity of warm-up

The most professional way, if we calculating the warm – up based on the persons body and physical statement. If we would like to do this, we need the following data:

Maximum load pulse (MLP) = $220 - \text{age (in year)}$

Rested pulse (RP) = You must count your pulse after your morning wake – up in 3 consecutive morning. The average of the three data is your RP.

Working pulse (WP) = $MLP - RP$

Target pulse of the warm – up:

$WP * 0,4 + RP$ = the lower limit of the targeted pulse

$WP * 0,5 + RP$ = the upper limit of the targeted pulse

Calm down/Relaxation

Most of the time the trainer omit the calm down phase. But this is very important – especially after of serious, hard training. The calm down is a reverse warm up. This phase can prevent the muscle strain and micro-injuries. Typical sequence is:

- Running
- Jumping
- Wheeling exercises of joints
- Stretching of joints and muscles
- Respiratory exercises

The basic principles of skill development

During the development of any kind of motoric skills there is some basic fact, wich should be considered.

1. Gradual – gradually feed the load, depending on the individual's performance.
2. Planning – the developing must be planned and monitored. The minimum duration of skill development: 6 weeks
3. Consistency – must follow the plan. Any unplanned break can eliminate the benfeit of previous work.
4. Patience – Do not wait the miracle! Rome wasn't build in a day, you need time to see the result of the training.
5. Sense of reality – choose targets wich are proportion with the ability and the possibilities of the fencer.

Intensity of the training¹⁰

The developed motoric skill was determined by the intensity and way of the exercise. The 'intensity' is a very important concept, so we must define the meaning.

The intensity indicating the strength of the internal and external stimuli's

The intensity was defined by:

- Frequency of the movement under one unit of time (f.e: push-ups/minutes)
- Execution speed of complex motion (cyclic or acyclic motion)
- Magnitude of lifted or moved weight
- The size of the resistance (of opponent or sporting goods)
- Time unit/work
- Pulse under load

Because of this we can see, that the intensity depend on the person. Same exercise was submaximal intensity for one fencer but maximal intensity for other. We must know this fact during the training.

The intensity define the load of work. Based on this we can talk about:

1. Border intensity (100% of the person's capacity)
2. Maximum intensity (80-100% of the person's capacity)
3. Submaximal intensity (60-80% of the person's capacity)
4. Medium intensity (50-60% of the person's capacity)
5. Low intensity (30-50% of the person's capacity)
6. Slight intensity (bellow 30% of the person's capacity)

The basic effect of intensity:

1. Border & Maximum intensity = Speed, Maximum force, techniques in competitive condition. Short time.
2. Submaximal intensity = Speed endurance, rapid force, strength – endurance, stamina, final stage of motion learning. Medium time.
3. Medium & low intensity = basic stamina, initial phase of motion learning. Long time.

¹⁰Source: Edzéselmélet és módszertan

Planning of the training

In case of „hobbi fighter” the most popular and useful type of training is the complex training. This fencer have 1 or 2 training per week. In case of hobbi fencer we must concentrate for the technical elements. This time and level of motivation sympli not enough for higher level of work.

„dedicated fighter” can and will do **3 or more** training per week. Based on this we can planning the training load, based on the personal abilities, competition calendar and other facts. In the next pages I will show you one **example**. This yearly plan based on the competition calendar of the member of Ars Ensis. We counting 3 training/week.

Different training periods

- Initial period: 1 complex and 2 Ability developer training
- Technical preparation period: 1 ability developer 1 complex and 1 technical training
- Preparation for competition period: mixture of technical/tactical and contest simulator training. Sometimes must make some ability developer for maintain the fitness. Do not study any new movement close to the beginning of competition.
- Competition period: based on the length and intesity of the competition period. Do not study any new technique during the competiton, but must maintain the fitness level if the intensity of the competition are not enough
- Rest period: Rest period is very important after the competition. The fencer need some time for physical and mental recreation.

At the moment, based on the current status of longsword fencing’s general sesonal characteristic this is one of the possible yearly training plan. This plan based on Ars Ensis fencer, and of course it is just a general example, not a strictly planned system.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1. Initial phase		1. Technical preparation	1. Preparation for competition (HEMAC – DIJON)	2. Initial phase		c a m p	2. Technical preparation	2. Preparati on for competition	Competition period		Res t peri od
First mesocycle 11	Second mesocycle										

If the fencer follow this plan, he can have good performance in Dijon. (middle of May) After this he worked on his motoric skill (stamina, power, quickness etc) In the summer camp he has a high load of work both in technical and physical level (middle of July) When the summercamp ended he can deepen their technical knowledge, and has time to prepare the most important competition period of the year. This will begins at 1 of September (AE Leauge). Lot of important competition (Wien, Swordfish, etc) will be organised in this period, and the fencer has his top performance in this time.

¹¹ Mesocycle: In case of the motorical skill’s development we must count 4-7 weeks long period per skill. This period call „mesocycle” In one mesocycle you must concentrate for one motoric skill. For example you will improve your maximum strenght. Becasuse of this durig 5 week you made training in your gym wich can improve your maximum strenght. After this period you can lift up 10% more kg than previously.

Developing of the most important motoric skills in longsword – fencing

For the proper work and planning we must know which motoric skills are the most important for the longsword fencing. In Ars Ensis we made a study¹² to find the answer to this question. The result was in line with our expectation.

- Experience – the most important ability. The number of „motion pattern” are vital for success.
- Speed – we can split this basic motoric skill to two separate components:
 - Reaction time – the elapsed time between the stimulus and the reaction
 - Movement speed – An internal start-up command, which shows the elapsed time between the stimulus and the implementation of the selected of among several options.
- Rapid force – Ability of the nervous and muscle system. The organ uses this ability against relatively high resistance (60-85% of maximum) in high speed motion.
- Strength endurance – the body's resistance against fatigue in case of relatively large long-term effort.

Experience, reaction time and movement speed

These two important skills have a close relationship. The optimal answer for complex stimuli needs a very complex and coordinated nervous, muscular and decision-making cooperation. The three different fields have minor differences in case of developing, but the background is similar. Because of the complexity of longsword – fencing, the highest time-factor is the decision making process.

Information flow

1. Receptors (primarily the photo and mechanoreceptors) detect the stimulus. The stimuli reach the central nervous system¹³ (typically the cortical system)
2. After the processing the fencer's brain makes the response. If the response contains non-skill level motion, the response goes to the muscular system in the pyramid track. If we can talk about skill-level motion, the response uses the non-pyramid track.

Because of this, the motion in skill level (in fact: conditioned reflex) is much faster. If the fencer will make optimal decisions with high speed, need high amount for sample responses. This is the „experience”

For example: Your opponent uses right oberhau against you. You catch his strike with ochs and immediately thrust his face. If you made enough training, the oberhau starts your „conditioned reflex” answer (ochs-trust- exit movement) This means only 1 decision making. If you haven't this automatized response you make first the ochs, and after you thrust, and (maybe) the exit movement. This is minimum 3 decision – making.

The knowledge sample responses is not enough. The muscular and nervous system must be ready to perform the motion with high speed and precision. That's the reason why the accuracy in the learning are very important.

¹² Source: „Survey of physical condition” Ars Ensis internal project. Project # 2012/09

¹³ Source: „Sportegészségügyi ismeretek”

Theory of motion learning

Now we see how important the motion learning in the longsword – fencing. Three of the most important factors of the success depend on it. Because of this we must know the basic process of motion learning.

Stages of learning

The process has fixed, unchangeable stages. The time spent in each stage depends on the person's ability and the complexity of the motion. Because of stress the level can decrease but never can increase.

First stage – knowledge

In the stage, the coordination has a low level. The elements of the motion have no connection, the motion is inaccurate, too wide or too small. The implementation has too much or too little power. The fencer can recognize the technique.

Second stage – skill

In this stage we start to develop the fine coordination. Some elements are automatic but few need concentration. The fencer has experience with the total motion.

Third stage – readiness

In the final stage the motion can work automatically. The beginning of the motion needs mental command, but after this the full motion-structure can work without concentration. The fencer must practice the motion under stress, because the high arousal – level¹⁴ decreases the competences. This phase can be achieved only with practice.

Some phenomenon during the motion – learning

Transfer – The known motion can help the learning. (f.e. right pflug can help the learning of left pflug)

Negative transfer – The known motion prevents the learning (f.e. pflug in Lichtenauer prevents the learning of pflug in Meier)

Error - inadequate implementation. The reason can be:

- Misunderstanding of the motion
- The fencer has insufficient physical (or mental) condition
- The fencer has low motivation
- Negative transfer

The error must be corrected as soon as possible. The next rules must be followed during the correction:

¹⁴ Arousal is a physiological and psychological state of being awake or reactive to stimuli. Source: wiki

1. Correcting the most critical error
2. Only correct one error per time
3. Do not break the learning process with constants correction, especially in the first stage.

We can correct the errors with the following methods:

- Good vs bad performance
- With objective information
- Separate practice of the motion's elements
- Using compelling cases
- Guidance

*10.000 hours rule*¹⁵ – Popular (but contested!) theory. The theory said, that 10 000 hours of practice is necessary for reaching of the master level if the basic abilities are given. (45-50 000 samples of decision)

¹⁵ Source: „Outliers“

Rapid force

For the development of rapid force the two most effective method was training with barbell and plyometric training. Both training methods has a lot of information, so I wouldn't like to describe again. For the longsword fencing the explosive force is very important. Be carefull with this training (especially the training with barbell) because the 99% of exercises was developed for body – builder! The training with barbell can improve your maximum strenght wich is one of the most important factor of your rapid force. Must be carefull, because the too much barbell-training makes you slow!

During the training you must watch for the following:

- 85-95% Repetition maximum. 1RM= the maximum weight wich can allow correct implementation 1 times. You can mesure during experience or you can count (cc) with the following methods: $1RM = [36/(37-\text{number of repetition})] * \text{lifted weight}$ For example: You can lift 60 kg 3 time. $[36/(37-3)] * 60 = 63 \text{ kg}$
- Low number of series, 3-5 times/training/muscle group
- 3-5 min break whitin series
- Do not forget train the antagonist muscle group too! (f.e: biceps – triceps)
- After the training do some speed-up exercise (f.e: boxing into the air etc.)

The plyometric training is very useful for longsword – fencer. During the training follow this rules:

- Warm – up!
- Making the training in resting state. The best is, if the plyometric training was a separate training.
- Never make plyometric training with join injuries, overweight, and hearth problems etc.

For longsword fighters the Meier – square is also very useful. In case of the rapid force development do the exercise with full speed during 20 seconds. (only with well-prepared partner!) After this make a rest during 3-5 minutes and repeat the exercise.

Strenght - endurance

This motoric skill allows for the fighter to use his abilities with full speed and maximum intensity during the whole fight. Direct development is appropriate if the fencer has enough basic endurance. The strenght endurance was between the two basic motoric skills, the endurance and the strenght. Because of this we can distinguish three basic metod of development.

Intensive: Concentrate on the strenght.

Load: 50-60%

of repetition: 10-15

of series: 3-6

Resting time between series: 1-3 min

Medium: good balance between the two components.

Load: 40-60%

of repetition: 15-20

of series: 4-6

Resting time between series: 0,5 – 1,5 min

Extensive: concentrate for the stamina.

Load: 25-40%

of repetition 20-30

of series: 3-5

Resting time between series: 0,5 – 1 min

Possible exercises:

- Barbell
- Push – ups
- Squat
- Abdominal

In case of the fencer, who has the basic strenght and stamina the best training method was the HIIT¹⁶
The advantages of HIIT:

- Higher time/calorie consumption compare with other exercises, because of EPOC¹⁷– effect
- Less time requirement. Average lenght (without warm – up) 15-20 min
- Can improve the endurance with high efficiency
- Similar load index, than the general characteristic of longsword - fencing

One of the best type of HIIT was the Tabata. This type of training have very similar load index than the longsword – fencing, wich can improve the effectiveness of the fencer dramaticaly. Some basic fact about Tabata:

¹⁶ HIIT= High intense interval training

¹⁷ Excess post-exercise oxygen consumption effect

The basic workload of Tabata was:

- 10 sec work – 10 sec resting time (basic level)
- 15 sec work – 15 sec resting time (advanced level – this is the ideal for longsword fencing¹⁸)
- 20 sec work – 10 sec resting time (professional level)

4 of this period without extra resting time will be 1 series. Making 1-4 series with 30 - 40 sec resting time between each. After the fourth (last) period we will have 3-5 minutes break. During the series we can choose different type of exercise. (f.e: Push – ups, abdominal, jumping etc) The key is the 100% intensity. All exercise must be made as high speed and force as possible.

During the HIIT training must follow some basic rules:

- Warm – up is necessary!
- The fencer must be healthy and fitt
- The HIIT are very stressful for the used muscle - group. Must calculate with this during the planning of workload.
- The well – implemented HIIT are very unpleasant. Can occur nausea, burning sensation in the legs (muscles) shortness of breath, bowels, dizziness
- High risk of injuries because of the high intensity

Summary

This studies is not complete. Our beloved HEMA paradoxically has a very short history as sport. I simply do not have enough experience to find the final answer. The style of the fencing and the competition changes from year to year, and maybe the present findings becomes invalid in the future. Because of this please use this study with benign criticism, and think further the correlations I found. Each of this chapter can easily fulfill a separate publication, and I hope, that in the future we can make this research with the great community of the HEMAC.

Thank you!

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¹⁸ See: page 3.

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