A quantitative analyses of Team Time Outs in Team Handball

Does the current application of Team Time Outs match the psychological theory of directly controlling activation of athletes?

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1. Abstract

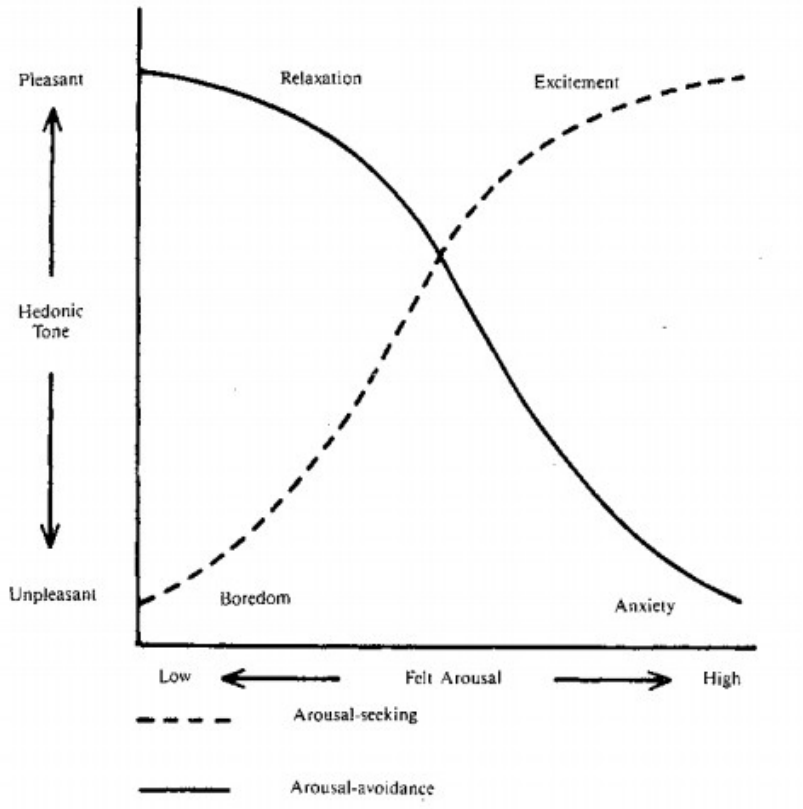
This study investigates the statistical effects of Team Time Outs. While Team Time Outs are an integral part of today's game of Team Handball, there is little research done in this particular field. The purpose of this study was to determine whether there are any differences in behaviour, timing and possible reasoning between Team Time Outs taken by the eventual winning teams' coaches and the eventual losing teams' coaches. A total of **750 games in four different competitions** (national men's highest league, national men's second highest league, 2016 Women's Euopean Championship and 2018 Men's European Championship) was analyzed and five intermediate scores were recorded per taken Team Time Out in order to analyze differences between intermediate score development and score differential development between winning and losing teams' Team Time Outs. Results indicate that losing teams' coaches await a score differential development of -1,45 (HLA), -1,5 (BLM), -1,35 (WECh) and -1,37 (MECh) goals over the course of a five minute time span, while winning teams' coaches await as little as -0,48 (HLA), -0,57 (BLM), -0,56 (WECh) and -0,43 (MECh) goals over the course of a five minute time span before collectively intervening via using a Team Time Out. The eventual losing teams can, after the Team Time Out has been used not lessen the previously emerged deficit, while the eventual winners manage to build their lead afterwards. Based on Apter's Reversal Theory the results of this study therefore suggests that Team Time Outs should be taken earlier and **performance-based**, since late and **result-based** interventions statistically speaking turn into irreversible deficits.

2. Introduction

According to the German Wikipedia-entry the Team Time Out in Handball *(from now on referred to as „TTO" in this article)* is defined as follows: **„Während der Auszeit werden gewöhnlich Spieltaktiken besprochen. Häufig wird das TTO aber auch nur aus rein taktischen Gründen genommen, um den Spielfluss der gegnerischen Mannschaft zu unterbrechen."** This roughly translates to: **„Usually during a Time Out tactics are being discussed. In many cases the Time Out is taken solely for tactical reasons, in order to disrupt the current run** *(as in multiple unanswered goals by the opposing team)* **of the opponent."**. According to this definition, common opinion and general practice the TTO is mostly and paramountly regarded and used as a means to stop an ongoing upswing of the opposing team and can therefore be described as a destructive intervention, rather than a strictly tactical one.

Opposing to common practice there is the option to take a TTO in order to tactically change the defence-formation, give intructions regarding the offensive gameplan, substitute multiple players at once or stabilize your own run, if the upswing in one team's performance is equated with the decline in the other team's performance and vice versa respectively. Nonetheless in both approaches the TTO remains the only way a coach can collectively intervene during the course of the game and/or re-adjust group-tactics and should accordingly be treated as a helpful tool, rather than being dismissed and remain unused.

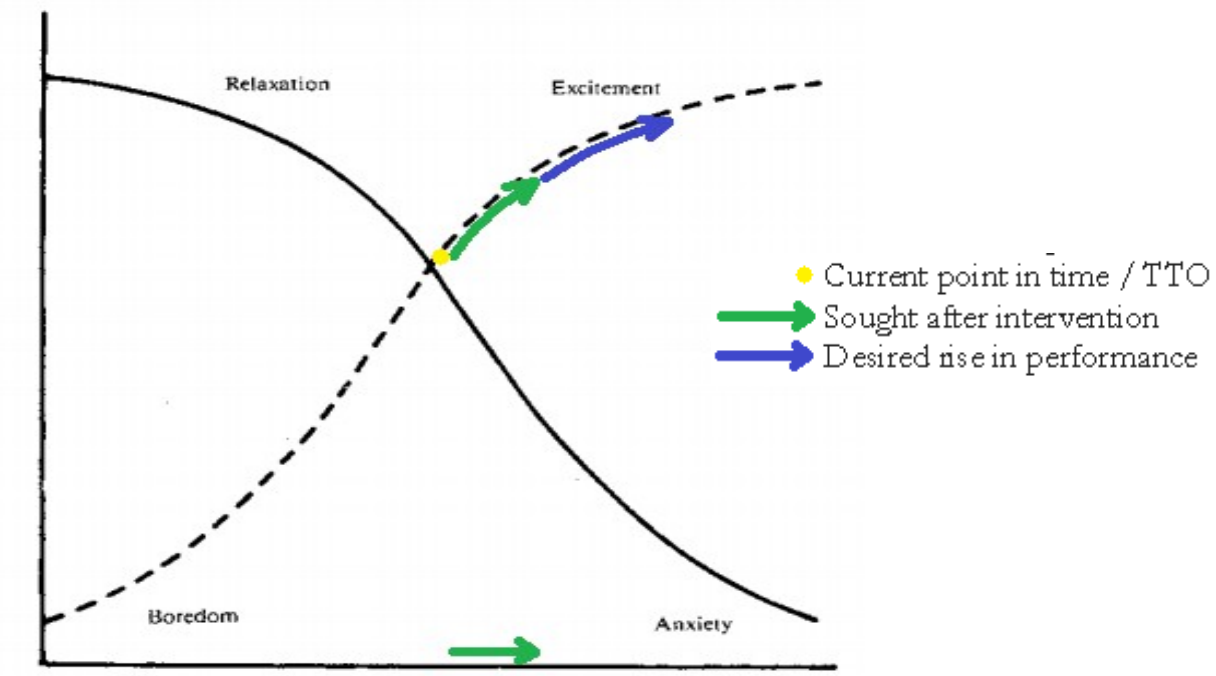
Psychologic background for the equation named above is provided by Apter's Reversal Theory (1989):



Graphic 1: Apter's reversal theory (1989)

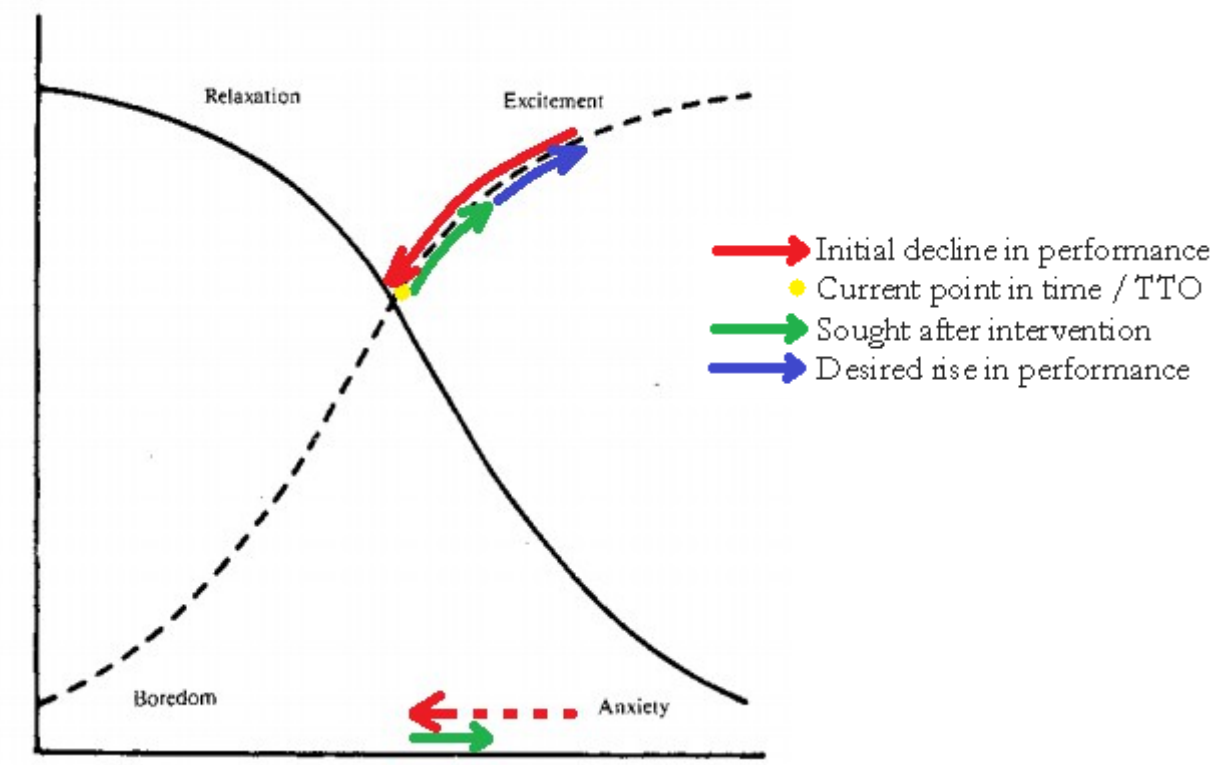
Apter's reversal theory in its core is a personality/character-theory, which describes the correclation between hedonic tone and level of activation, applying those attributes to two axis. The result of this theory is the phenomena originally called arousal-seekers and arousal-avoiders and later on changed to thrill-seekers and tension-avoiders, whereas one of the two is usually more dominant and developed than the other despite both existing within an individual. The thrill-seeker is depicted by the ascending curve in Graphic 1. Accordingly his or her hedonic tone increases as the level of activation rises. The tension-avoider is depicted by the descending curve. Accordingly his or her hedonic tone decreases as the level of activation increases. Considering athletes carry both traits within them it should be and is in theory and practice feasible to counteract possible declines in performance via specifically targeted coaching.
This specifically targeted coaching would result in either actively and deliberately raising or lowering the level of activation in order to (re-)increase performance, as the TTO serves as an intervention and a possible enabler to switch from one curve to the other later on. In this context it is logical that short *(in terms of both time and movement along the curves)* declines in performance can be counteracted easier than longer ones, since the adjustment following the decline in performance is smaller and the soon to be counteracted decline in performance itsself might not have made an irreversible negative impact in regard to the intermediate score yet.

Graphic 2 shows a simple thrill-seeking horizontal intervention after a team's performance has stagnated: The coach raises the level of activation during the TTO, resulting in the team moving alongside the curve they currently are on and thus increases their performance. A practical example would be the scenario of intermediate scores of 10:10 after fifteen minutes of play and 12:12 after twenty minutes of play, at which point the TTO is taken.



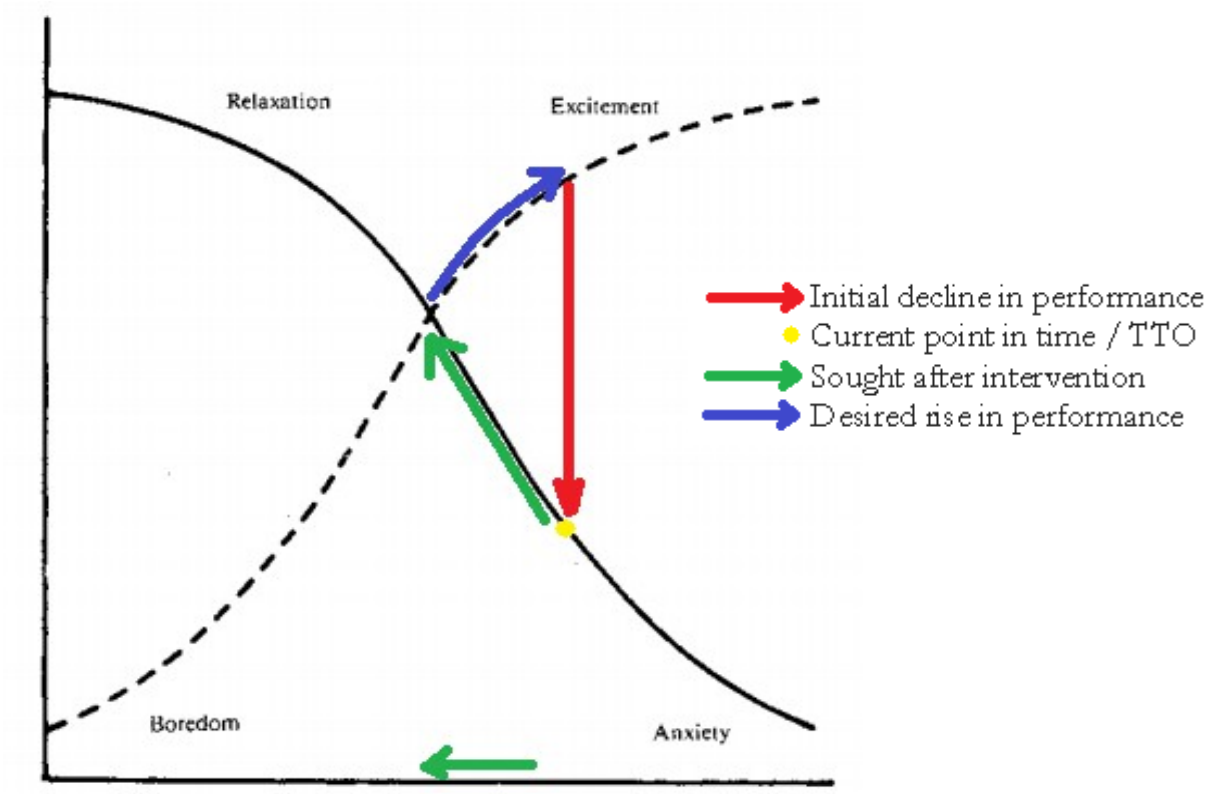
Graphic 2: Horizontal intervention in case of stagnation – raising arousal/activation

Graphic 3 depicts another thrill-seeking horizontal intervention after a decline in performance, either caused by the athletes lowering their efforts themselves or by an upswing of the opposing team: The coach re-adjusts the level of activation accordingly and tries to increase his or her team's performance via a timely TTO. In this case practical example would be the scenario of intermediate scores of 12:6 after fifteen minutes of play and 14:12 after twenty minutes of play, at wich point the TTO is taken.



Graphic 3: Horizontal intervention in case of decline in performance due to declining arousal/activation

Additionally a contingent event during a game can easily tilt the dimensons and make a tension-avoiding horizontal intervention with the focus of reducing the level of activation necessary, as can be seen in Graphic 4: A nowadays popular practical example would be the scenario of not scoring in a 7on6-situation and allowing an empty net-goal directly afterwards, after which the TTO is taken.



Graphic 4: Horizontal intervention in case of dimension tilting

A critical analysis of the graphics above therefore suggests, that a collective intervention via taking a TTO is supposedly easier and more successful if the TTO is taken sooner than later, since early and therefore shorter horizontal interventions take effect and lead to rise in performance earlier. Correspondingly the target situation would be to minimize a decline in performance with the means of a timely intervention, whereas in this context "timely" is synonymous with an as small as possible decline in performance and as short as possible horizontal red arrow in the graphics. As additional premises it has to be said that firstly the following obseravtions did not focus on single scores at the point in time of the TTO in a vaccum, but rather multiple scores of a set period of time. Secondly the study's purpose was not to determine that the eventual winners on average took their TTOs while leading, whereas the eventual losers took their TTOs while trailing respectively. The study was however conducted to determine whether there is a difference in behaviour, timing and possible reasoning between TTOs taken by the eventual winners and the eventual losers, based on either the intermediate score at the time the TTO was taken (**result-based TTO**) or the progression, stagnation or decline of the development of multiple intermediate scores (**performance-based TTO**). Furthermore the study also examines possible discrepancies in the TTO-usage rate.

3. Methodology

Subsequent to the aforementioned reversal theory a quantitive observation was conducted, trying to determine the actual state of the current TTO-use so as to a variance analysis and a target/actual-comparison can be performed. In total data was gathered from 750 games over the course of more than three years from the HLA *(Handball Liga Austria – Austria's highest men's league)* season 2015/2016 (90 games), season 2016/2017 (146 games) and season 2017/2018 (151 games), the BLM *(Bundesliga Männer – Austria's second highest men's league)* season 2016/2017 (139 games) and season 2017/2018 (130 games), the women's EHF Euro 2016 (47 games) and the men's EHF Euro 2018 (47 games). Out of these 750 games only 46 ended in draw, eliminating them from the final analysis. In the remaining 704 games five intermediate scores were recorded per taken TTO: The score ten minutes before the TTO (A) and five minutes before the TTO (B), the score when the TTO was actually taken (X) and the scores five (C) and ten minutes (D) after the taken TTO. The sum of all these scores per point in time divided by the number of TTOs taken yield an arithmetic mean. In the chronological timeline the arithmetic means were then graded from best (1), second best (2), average (3), second worst (4) to worst (5) and score differentals between these arithmetic means and their development over the course of the recorded twenty minute-time span were examined. The calculated score differentials were then used to determine whether there is difference in how long (in terms of intermediately falling behind) the eventual winning's team and losing's team coaches wait until they decide to use a TTO. If a TTO was taken within five minutes of the start of a game 0:0 was pulled as the intermediate score for ten and five minutes before the TTO. If a TTO was taken within the last five minutes of a game the end-result was taken as the intermediate score for five and ten minutes after the TTO. Additionally the TTO-usage rate was calculated by dividing the number of used TTOs by possible TTOs. In order to ensure and maintain level of comparability and reproducibility of the results the analysis were divided by leagues and championships, meaning the HLA (387 games in total), the BLM (269 games in total), the women's EHF Euro 2016 and the men's EHF Euro 2018 were analyzed separately.

4. Results

4.1. HLA

In the three observed season of 2015/2016 *(regular season)*, 2016/2017 and 2017/2018 of the HLA 387 games were observed in total, wheras 27 ended in a draw, resulting in 360 analyzed games. Subsequently 1080 TTOs could have been taken by each team. The eventual winners of the analyzed games took 769 TTOs, amounting to a TTO-usage rate of 71,2 %. The eventual losers of the analyzed games took 877 TTOs amounting to a TTO-usage rate of 81,2 %. Accordingly 3845 intermediate scores were recorded when looking at TTOs taken by winning teams and 4385 intermediate scores were recorded when looking at TTOs taken by losing teams.

4.1.1. Analyses of HLA's winning teams' TTOs

Season	**# of TTO**	**A**	**B**	**X**	**C**	**D**
2015/2016	168	549	618	492	580	624
2016/2017	291	676	779	650	796	890
2017/2018	310	732	896	777	951	1021
Total	*769*	*1957*	*2293*	*1919*	*2327*	*2535*
Ø	**-**	**2,54**	**2,98**	**2,5**	**3,03**	**3,3**

Table 1

Grading the five intermediate scores from worst to best chronologically, the HLA's winning teams' TTOs form the pattern of **4 – 3 – 5 – 2 – 1**. The score differentials are as follows: A-X: -0,04 / B-X: -0,48 / X-C: +0,53 / X-D: +0,8. The TTO-usage rate was 71,2 %.

4.1.2. Analyses of HLA's losing teams' TTOs

Season	**TTO**	**A**	**B**	**X**	**C**	**D**
2015/2016	212	-406	-503	-839	-868	-925
2016/2017	325	-498	-559	-1049	-1110	-1183
2017/2018	340	-551	-647	-1092	-1137	-1255
Total	*877*	*-1455*	*-1709*	*-2980*	*-3115*	*-3363*
Ø	**-**	**-1,66**	**-1,95**	**-3,4**	**-3,55**	**-3,83**

Table 2

Grading the five intermediate scores from worst to best chronologically, the HLA's losing teams' TTOs form the pattern of **1 – 2 – 3 – 4 – 5**. The score differentials are as follows: A-X: -1,74 / B-X: -1,45 / X-C: -0,15 / X-D: -0,43. The TTO-usage rate was 81,2 %.

4.2. BLM

In the two observed season of 2016/2017 and 2017/2018 of the BLM 269 games were played in total, wheras 13 ended in a draw, resulting in 256 analyzed games. Subsequently 768 TTOs could have been taken by each team. The eventual winners of the analyzed games took 501 TTOs, amounting to a TTO-usage rate of 65,2 %. The eventual losers of the analyzed games took 543 TTOs amounting to a TTO-usage rate of 70,7 %. Accordingly 2505 intermediate scores were recorded when looking at TTOs taken by winning teams and 2715 intermediate scores were recorded when looking at TTOs taken by losing teams.

4.2.1. Analyses of BLM's winning teams' TTOs

Season	**TTO**	**A**	**B**	**X**	**C**	**D**
2016/2017	234	602	685	543	681	749
2017/2018	267	686	781	638	751	810
Total	*501*	*1288*	*1466*	*1181*	*1432*	*1559*
Ø	**-**	**2,57**	**2,93**	**2,36**	**2,86**	**3,11**

Table 3

Grading the five intermediate scores from worst to best chronologically, the BLM's winning teams' TTOs form the pattern of **4 – 2 – 5 – 3 – 1**. The score differentials are as follows: A-X: -0,21 / B-X: -0,57 / X-C: +0,5 / X-D: +0,75. The TTO-usage rate was 65,2 %.

4.2.2. Analyses of BLM's losing teams' TTOs

Season	**TTO**	**A**	**B**	**X**	**C**	**D**
2016/2017	281	-355	-478	-910	-968	-1018
2017/2018	262	-334	-432	-819	-852	-868
Total	*543*	*-689*	*-910*	*-1729*	*-1820*	*-1886*
Ø	**-**	**-1,27**	**-1,68**	**-3,18**	**-3,35**	**-3,47**

Table 4

Grading the five intermediate scores from worst to best chronologically, the BLM's winning teams' TTOs form the pattern of **1 – 2 – 3 – 4 – 5**. The score differentials are as follows: A-X: -1,91 / B-X: -1,5 / X-C: -0,17 / X-D: -0,29. The TTO-usage rate was 70,7 %.

4.3. EHF Women's European Championship (WECh) 2016

In the observed tournament 47 games were played in total, wheras 4 ended in a draw, resulting in 43 analyzed games. Subsequently 129 TTOs could have been taken by each team. The eventual winners of the analyzed games took 96 TTOs, amounting to a TTO-usage rate of 74,4 %. The eventual losers of the analyzed games took 111 TTOs amounting to a TTO-usage rate of 86 %. Accordingly 480 intermediate scores were recorded when looking at TTOs taken by winning teams and 555 intermediate scores were recorded when looking at TTOs taken by losing teams.

4.3.1. Analyses of WECh's winning teams' TTOs

Euro 2016	**TTO**	**A**	**B**	**X**	**C**	**D**
Total	*96*	*182*	*219*	*165*	*190*	*205*
Ø	**-**	**1,9**	**2,28**	**1,72**	**1,98**	**2,14**

Table 5

Grading the five intermediate scores from worst to best chronologically, the WECh's winning teams' TTOs form the pattern of **4 – 1 – 5 – 3 – 2**. The score differentials are as follows: A-X: -0,18 / B-X: -0,56 / X-C: +0,26 / X-D: +0,42. The TTO-usage rate was 74,4 %.

4.3.2. Analyses of WECh's losing teams' TTOs

Euro 2016	**TTO**	**A**	**B**	**X**	**C**	**D**
Total	*111*	*-134*	*-142*	*-292*	*-292*	*-313*
Ø	**-**	**-1,21**	**-1,28**	**-2,63**	**-2,63**	**-2,82**

Table 6

Grading the five intermediate scores from worst to best chronologically, the WECh's winning teams' TTOs form the pattern of **1 – 2 – 3 – 3 – 5**. The score differentials are as follows: A-X: -1,42 / B-X: -1,35 / X-C: 0 / X-D: -0,19. The TTO-usage rate was 86 %.

4.4. EHF Men's European Championship (MECh) 2018

In the observed tournament 47 games were played in total, whereas 2 ended in a draw, resulting in 45 analyzed games. Subsequently 135 TTOs could have been taken by each team. The eventual winners of the analyzed games took 96 TTOs, amounting to a TTO-usage rate of 71,1 %. The eventual losers of the analyzed games took 111 TTOs amounting to a TTO-usage rate of 82,2 %. Accordingly 480 intermediate scores were recorded when looking at TTOs taken by winning teams and 555 intermediate scores were recorded when looking at TTOs taken by losing teams.

4.4.1. Analyses of MECh's winning teams' TTOs

Euro 2016	**TTO**	**A**	**B**	**X**	**C**	**D**
Total	*96*	*209*	*253*	*212*	*256*	*275*
Ø	**-**	**2,18**	**2,64**	**2,21**	**2,67**	**2,86**

Table 7

Grading the five intermediate scores from worst to best chronologically, the MECh's winning teams' TTOs form the pattern of **5 – 3 – 4 – 2 – 1**. The score differentials are as follows: A-X: +0,03 / B-X: -0,43 / X-C: +0,46 / X-D: +0,65. The TTO-usage rate was 71,1 %.

4.4.2. Analyses of MECh's losing teams' TTOs

Euro 2016	**TTO**	**A**	**B**	**X**	**C**	**D**
Total	*111*	*-121*	*-157*	*-309*	*-312*	*-343*
Ø	**-**	**-1,09**	**-1,41**	**-2,78**	**-2,81**	**-3,09**

Table 8

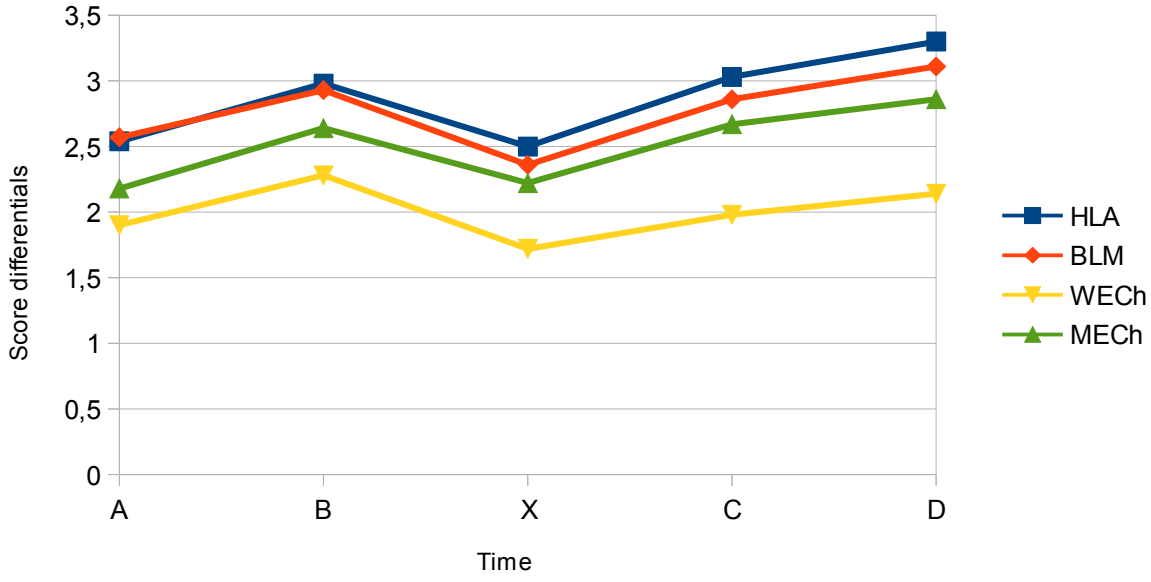
Grading the five intermediate scores from worst to best chronologically, the MECh's winning teams' TTOs form the pattern of **1 – 2 – 3 – 4 – 5**. The score differentials are as follows: A-X: -1,69 / B-X: -1,37 / X-C: -0,03 / X-D: -0,31. The TTO-usage rate was 82,2 %.

4.5. Pattern analysis

4.5.1. Winning teams' pattern analyses and tendencies

Competition	A	B	X	C	D
HLA	*2,54*	*2,98*	*2,5*	*3,03*	*3,3*
	4	3	5	2	1
BLM	*2,57*	*2,93*	*2,36*	*2,86*	*3,11*
	4	2	5	3	1
WECh	*1,9*	*2,28*	*1,72*	*1,98*	*2,14*
	4	1	5	3	2
MECh	*2,18*	*2,64*	*2,21*	*2,67*	*2,86*
	5	3	4	2	1

Table 9



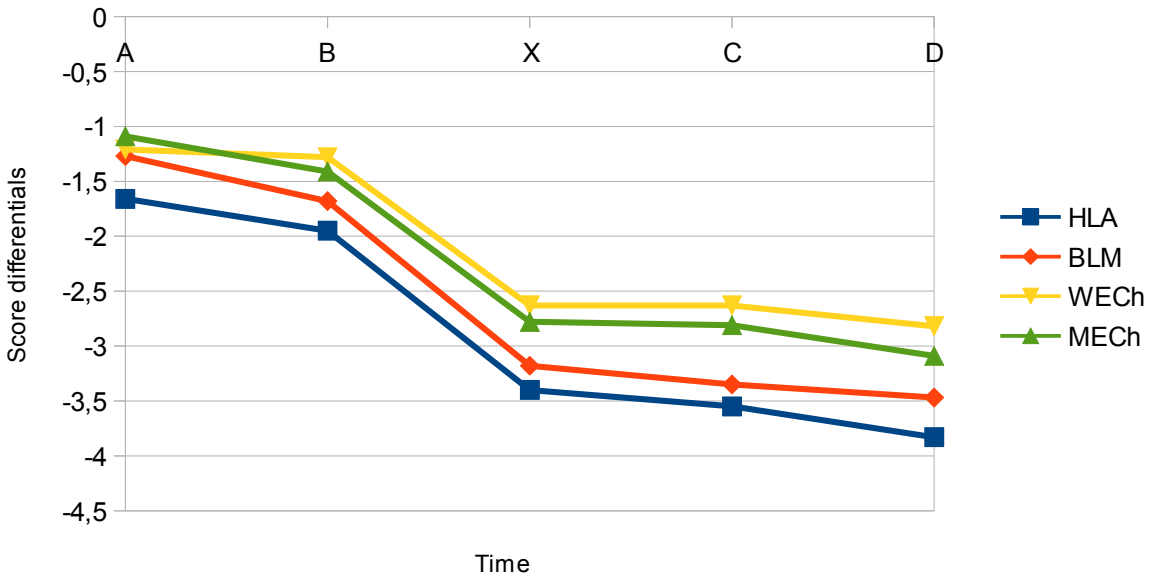
Graphic 5: Score development of winning teams

Throughout all analyzed competitions winning teams took their TTOs at either the worst or second worst intermediate score, but afterwards manage to continously improve the score over the course of the ten minutes after the TTO.

4.5.2. Losing teams' pattern analyses and tendencies

Competition	A	B	X	C	D
HLA	*-1,66*	*-1,95*	*-3,4*	*-3,55*	*-3,83*
	1	2	3	4	5
BLM	*-1,27*	*-1,68*	*-3,18*	*-3,35*	*-3,47*
	1	2	3	4	5
WECh	*-1,21*	*-1,28*	*-2,63*	*-2,63*	*-2,82*
	1	2	3	3	5
MECh	*-1,09*	*-1,41*	*-2,78*	*-2,81*	*-3,09*
	1	2	3	4	5

Table 10

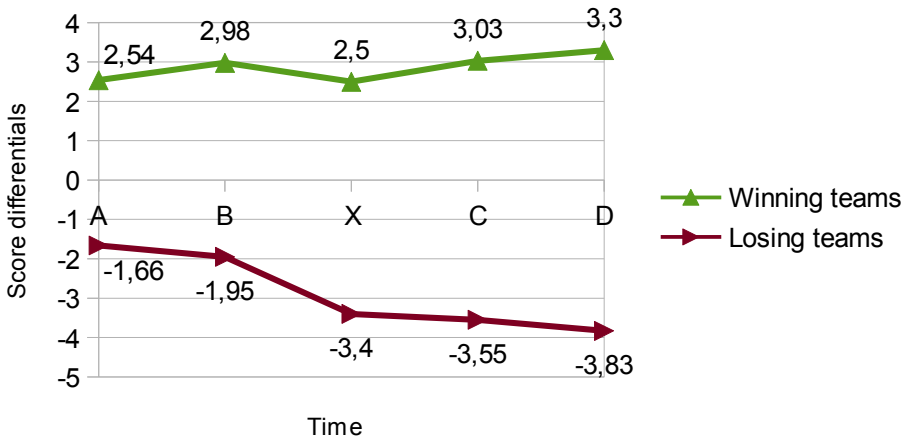


Graphic 6: Score development of losing teams

Throughout all analyzed competitions losing teams took their TTOs at the average intermediate score and afterwards continue continously falling behind over the course of the ten minutes after the TTO until the overall worst intermediate score is reached. The patterns are parallelling and almost identical throughout all competitions.

4.6. Score differential development analysis

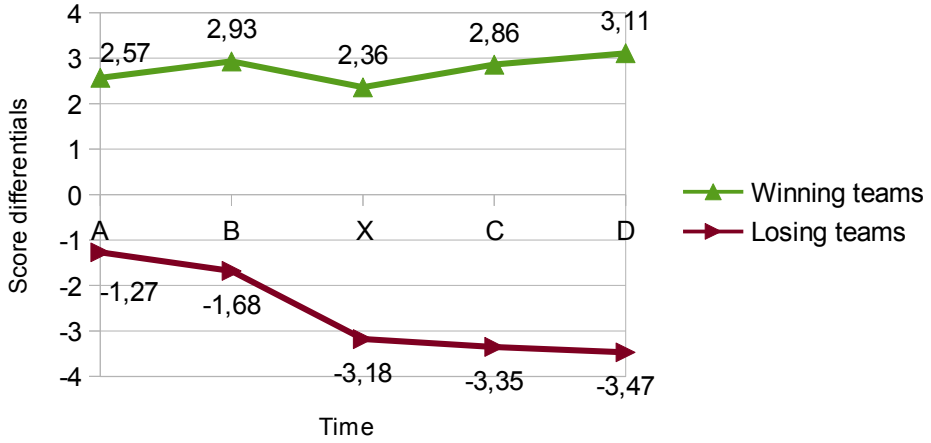
4.6.1. HLA score differential development analyses



Graphic 7: HLA score development contrast

The curves start drifting apart after the TTO (X-D). Winning teams' coaches reacted with a TTO following an intermediate score differential development of -0,48 (B-X). Losing teams's coaches reacted with a TTO following an intermediate score differential development of -1,45 (B-X). Following the TTO the winning teams recorded a score differential development of +0,53 (X-C), while the losing teams continued to fall behind by -0,15 (X-C).

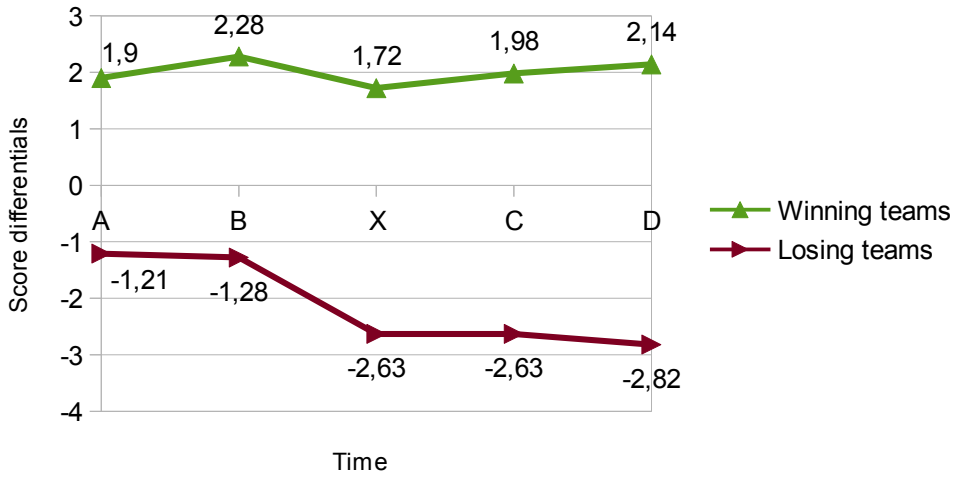
4.6.2. BLM score differential development analyses



Graphc 8: BLM score development contrast

The curves start drifting apart after the TTO (X-D). Winning teams' coaches reacted with a TTO following an intermediate score differential development of -0,57 (B-X). Losing teams's coaches reacted with a TTO following an intermediate score differential development of -1,5 (B-X). Following the TTO the winning teams recorded a score differential development of +0,5 (X-C), while the losing teams continued to fall behind by -0,17 (X-C).

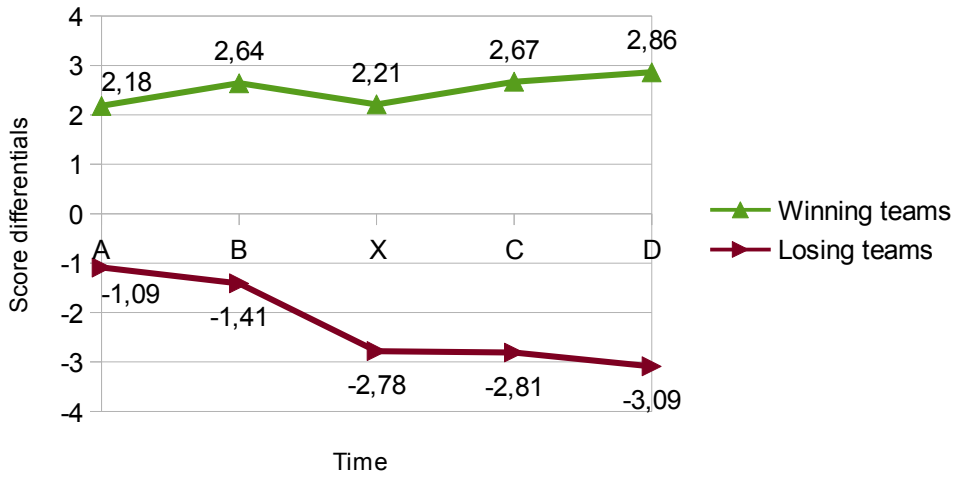
4.6.3. WECh score differential development analyses



Graphic 9: WECh score development contrast

The curves start drifting apart after the TTO (X-D). Winning teams' coaches reacted with a TTO following an intermediate score differential development of -0,56 (B-X). Losing teams's coaches reacted with a TTO following an intermediate score differential development of -1,35 (B-X). Following the TTO the winning teams recorded a score differential development of +0,26 (X-C), while the losing teams kept the previously emerged deficit (X-C).

4.6.4. MECh score differential development analyses



Graphic 10: MECh score development contrast

The curves start drifting apart after the TTO (X-D). Winning teams' coaches reacted with a TTO following an intermediate score differential development of -0,43 (B-X). Losing teams's coaches reacted with a TTO following an intermediate score differential development of -1,37 (B-X). Following the TTO the winning teams recorded a score differential development of +0,46 (X-C), while the losing teams continued to fall behind by -0,03 (X-C).

5. Conclusion

As previously mentioned in the introduction this study was conducted to determine possible differences in behaviour, timing and possible reasoning between TTOs taken by the eventual winners and the eventual losers. The results outline that throughout multiple competitions both the winners and losers followed similar patterns in terms of when they took a TTO as can be seen in Graphic 5 for winners and Graphic 6 for losers.

In detail the winning teams' coaches on average took a TTO, when the previously established lead had not been increasing anymore, but slightly shrinking within five minutes before the TTO is ultimately taken. These slight decreases do not exceed a disadvantage of 0,57 goals (*see 4.6. Score differential development analysis / Graphics 7 - 10)* in any analyzed competition over the course of five minutes.. In the HLA winning team's coaches on average awaited a deficit of -0,48 goals within the span of minutes. In the BLM the bar was statistically set at a deficit of -0,57 goals, in the WECh at -0,56 goal and in the MECh at -0,43 goal before the respective coaches intervened. Correspondingly these were **performance-based** TTOs, since firstly the score as such had not changed extensively and the team still held the lead at the point in time when the TTO was taken. The statistical consequence of these **performance-based** TTOs was that those teams managed to regain composure in the form of re-extending their lead afterwards up to either the second best recorded intermediate score *(WECh)* or even the best recorded intermediate score *(HLA, BLM, MECh)* as is depicted in Table 9 and Graphic 5. In accordance with Apter's Reversal Theory the specific choice of when the TTOs were taken suggest that the observed TTOs led to therefore easy and succesful horizontal interventions, following a shorter red arrow than depicted in Graphic 3.

In contrast the losing teams' coaches took their TTOs considerably later: On average the coaches of the eventual loser awaited a deficit of -1,45 (HLA), -1,5 (BLM), -1,35 (WECh) and -1,37 (MECh) goals over the span of five minutes respectively (*see 4.6. Score differential development analysis / Graphics 7 – 10)*. Consequently these interventions can be considered **result-based** TTOs, since the score as such had changed extensively to the point where the intermediate score is apparently not considereded "acceptable" anymore, which can not happen in an instant and is the result of a decline in collective performance, which had happened previous to when the TTO was taken. The statistical consequence of these **result-based** TTOs was that those teams were in fact able to slow the opponent down as the they were not able to extend their lead at the same pace they had previously done, as can be seen in the score differential development analysis (Graphic 6 – 10). However even though the downward curves flatten after the TTO (X-D), which speaks for a potential improvement, the overall deficit still grew afterwards to the worst recorded intermediate score in all analyzed competitions (Table 10). Coinciding with Apter's Reversal Theory the untimeliness of when the TTOs were taken suggest that the interventions came too late both in time and decline in performance to allow for a short and easy horizontal intervention. Therefore the sought after intervention following the bided decline in performance either has to be done thrill-seeking horizontally along the ascending curve (Graphic 3) following a longer red arrow than depicted, or tension-avoiding along the descending curve after a tilt in dimensions, which takes longer to make an impact (Graphic 4).

In conclusion the coaches of the eventual losing teams bide their time and wait too long before they decide to collectively intervene via a **result-based** TTO, which leads to the intervention being more difficult and complicated, while also having less impact than a **performance-based** TTO, since performance is actually controllable by a coach, whereas the result is not. Given these essential findings and the fact that the curves of the analyses done in "4.5.2. Losing team's pattern analyses and tendencies" are paralleling (Graphic 6) the integration of psychologically correct TTO-usage into coaching-instruction, -education and -training courses should be considered.

6. References

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Mentalcoaching
Eigenverlag, Bad Vöslau

Wikipedia-entry: https://de.wikipedia.org/wiki/Handball#Auszeit_.28TTO.29

National results: https://www.oehb.at/de

International results: http://www.eurohandball.com

