RESPONSE CHARACTERISTICS OF A SQUAT AND COUNTERMOVEMENT JUMP

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INTRODUCTION

The purpose of this study was to investigate the differences of the kinetic and time parameters between a Squat Jump (SJ) as a simple reaction movement (e.g. all the starts) and a Countermovement Jump (CMJ) as an anticipated reaction movement (e.g. football, table tennis etc).

The study focused upon the contribution of the reaction time (RT) to the total action time (TAT) of the movement in both types of jumps.

METHODOLOGY

Ten (10) high performance volleyball players (Age: 23.3±2.6, body weight: 86.2±6.4 kg, Body height: 195±0.05 m) performed ten (10) different SJ and CMJ after both an acoustic and optic, predicted or unpredicted stimulus. Every jump was performed twice - as fast and high as possible - and the mean of the two values was estimated. The arms were bent behind the head.

Additionally, both types of jump were performed without any stimulus.

The kinetic and time data were collected using a force platform (KISTLER 0.4 x 0.5m) which was at ground level. The optic stimulus was given by turning on a light, while the acoustic by a characteristic sound.

During the test both types of stimulus were recorded as an electrical signal on an UV oscillograph simultaneously with the force curve (Fig.1).

RESULTS

There were no significant differences between the reaction time after a predicted and unpredicted stimulus (Tab.1).

Significant differences were found between the reaction time after an optic and/or acoustic stimulus in SJ (p<0.001) and in CMJ (p<0.001) (Tab.2).

The total action time (TAT) for the CMJ was over 49% longer than the TAT for the SJ.

The contribution of the RT to TAT was <25% for the SJ and <19% for the CMJ.

The acceleration time (AT) of the CMJ was significantly shorter than the one of the SJ (p<0.05), while the performance of the CMJ was significantly higher than the one of the SJ (p<0.05).

It is remarkable that the differences were significant between the total movement times with and without a stimulus (p<0.05).

CONCLUSIONS

The athletic movements, which are performed after an optic and/or acoustic stimulus and characterised as simple reaction movements (e.g. all the starts), are more effective to be performed without countermovement.

In all timing-dependent movements which are characterized as anticipated reactions (e.g. football, basketball, tennis etc.) a countermovement before the acceleration phase is effective, because (a) the rest time (AT + RT) of movement is shorter and (b) the athlete's performance is higher.

The expert athlete has the ability to anticipate and perform the countermovement in time, in order to begin the acceleration phase of the movement simultaneously with the final stimulus.
TABLE 1
The reaction time after predicted and unpredicted stimulus

<table>
<thead>
<tr>
<th></th>
<th>OPTIC</th>
<th>ACOUSTIC</th>
<th>OPTIC</th>
<th>ACOUSTIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREDICTED</td>
<td>186 ± 15</td>
<td>131 ± 11</td>
<td>210 ± 24</td>
<td>141 ± 17</td>
</tr>
<tr>
<td>SN</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>UNPREDICTED</td>
<td>188 ± 41</td>
<td>137 ± 20</td>
<td>207 ± 25</td>
<td>151 ± 31</td>
</tr>
</tbody>
</table>

(P > .05)

TABLE 2
Characteristics of a vertical jump (SJ and CK/J)
MEAN AND STANDARD DEVIATION - N=10

<table>
<thead>
<tr>
<th></th>
<th>RT (ms)</th>
<th>AT (ms)</th>
<th>CMT (ms)</th>
<th>TMT (ms)</th>
<th>1/2 FT (ms)</th>
<th>TAT (ms)</th>
<th>PERFORMANCE (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQUART JUMP</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPTIC STIM</td>
<td>186 ± 15</td>
<td>302 ± 34</td>
<td>NS</td>
<td>554 ± 45</td>
<td>280 ± 17</td>
<td>750 ± 42</td>
<td>.37 ± .04</td>
</tr>
<tr>
<td>ACOUSTIC</td>
<td>131 ± 11</td>
<td>281 ± 43</td>
<td>NS</td>
<td>554 ± 36</td>
<td>262 ± 13</td>
<td>675 ± 33</td>
<td>.37 ± .04</td>
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<tr>
<td>WITHOUT STIM</td>
<td>NS</td>
<td>321 ± 49</td>
<td>NS</td>
<td>594 ± 55</td>
<td>270 ± 15</td>
<td>594 ± 55</td>
<td>.38 ± .05</td>
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<tr>
<td>COUNTER MOVEMENT JUMP</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPTIC STIM</td>
<td>210 ± 24</td>
<td>228 ± 36</td>
<td>406 ± 41</td>
<td>914 ± 89</td>
<td>280 ± 27</td>
<td>1124 ± 98</td>
<td>.43 ± .07</td>
</tr>
<tr>
<td>ACOUSTIC</td>
<td>141 ± 17</td>
<td>220 ± 32</td>
<td>401 ± 58</td>
<td>930 ± 100</td>
<td>279 ± 27</td>
<td>1044 ± 103</td>
<td>.42 ± .05</td>
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<tr>
<td>WITHOUT STIM</td>
<td>NS</td>
<td>247 ± 37</td>
<td>492 ± 49</td>
<td>1021 ± 76</td>
<td>282 ± 22</td>
<td>1021 ± 76</td>
<td>.42 ± .06</td>
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</tbody>
</table>
Figure 1: Counter Movement Jump
Vertical Force - Time Curve

Figure 2: Time Characteristics of a SJ and CMJ
After an acoustic stimulus

VIII Symposium ISBS
- 69 -
Prague 1990
Figure 1a: Contribution to total action time - squat jump

Figure 1b: Contribution to total action time - counter movement jump
**TOTAL MOVEMENT TIME**

![Graph showing total movement time for SJ and CMJ with different conditions like Without Stym, Optic, and Acoustic.](image)

**Figure 4: Total movement time**

### TAB 1

The Reaction Time After Predicted and Unpredicted

<table>
<thead>
<tr>
<th></th>
<th>SQUAT JUMP</th>
<th>COUNTER MOVEMENT JUMP</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>REACTION TIME (ms)</td>
<td>REACTION TIME (ms)</td>
</tr>
<tr>
<td></td>
<td>OPTIC</td>
<td>ACOUSTIC</td>
</tr>
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</tr>
<tr>
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<td>188 ± 11</td>
<td>137 ± 20</td>
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<tr>
<td>(P &gt; .05)</td>
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### TAB 2

Characteristics of a Vertical Jump (SJ and CMJ)

<table>
<thead>
<tr>
<th></th>
<th>OPTIC (ms)</th>
<th>AT (ms)</th>
<th>CMT (ms)</th>
<th>YTH (ms)</th>
<th>1.2 FT (ms)</th>
<th>TAT (ms)</th>
<th>PERFORMANCE (m)</th>
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<tr>
<td></td>
<td>186 ± 15</td>
<td>302 ± 34</td>
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<td>584 ± 15</td>
<td>260 ± 17</td>
<td>750 ± 42</td>
<td>37 ± 0.4</td>
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<tr>
<td>Acoustic</td>
<td>131 ± 11</td>
<td>241 ± 63</td>
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<td>165 ± 36</td>
<td>262 ± 13</td>
<td>718 ± 25</td>
<td>37 ± 0.4</td>
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<tr>
<td>UNPREDICTED</td>
<td>---</td>
<td>321 ± 48</td>
<td>---</td>
<td>594 ± 26</td>
<td>270 ± 15</td>
<td>594 ± 66</td>
<td>38 ± 0.5</td>
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<td>219 ± 24</td>
<td>228 ± 36</td>
<td>408 ± 41</td>
<td>914 ± 69</td>
<td>288 ± 27</td>
<td>1124 ± 96</td>
<td>43 ± 0.7</td>
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<td>229 ± 32</td>
<td>401 ± 58</td>
<td>833 ± 100</td>
<td>270 ± 27</td>
<td>1043 ± 103</td>
<td>42 ± 0.9</td>
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<tr>
<td></td>
<td>---</td>
<td>247 ± 37</td>
<td>492 ± 49</td>
<td>1231 ± 74</td>
<td>281 ± 22</td>
<td>1021 ± 76</td>
<td>42 ± 0.8</td>
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</tbody>
</table>

**VIII Symposium ISBS**  - 71 -
# Identification of Temporal and Dynamic Parameters

<table>
<thead>
<tr>
<th>Vertical (z)</th>
<th>Anteroposterior (y)</th>
<th>Mediolateral (x)</th>
<th>Ternoral (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZA1 - 1st absolute max force</td>
<td>Y4 - 1st max braking peak</td>
<td>X1 - total impulse on the right (+) of the running direction</td>
<td>T1 - abs. time to ZA1</td>
</tr>
<tr>
<td>ZB1 - 1st relative max force</td>
<td>Y5 - min braking peak</td>
<td>X2 - total impulse on the left (-) of the running direction</td>
<td>T2 - rel. time to ZA1</td>
</tr>
<tr>
<td>ZA2 - absolute max force</td>
<td>Y6 - 2nd max braking peak</td>
<td>X3 - algebraic impulse (X1 + X2)</td>
<td>T3 - abs. time to ZA2</td>
</tr>
<tr>
<td>ZB2 - relative max force</td>
<td>Y8 - max propelling peak</td>
<td>X4 - total impulse on the right (+) of the running direction</td>
<td>T4 - rel. time to ZA2</td>
</tr>
<tr>
<td>ZA3 - 2nd absolute max force</td>
<td>Y11 - braking impulse</td>
<td>X5 - algebraic impulse (X1 + X2)</td>
<td>T5 - abs. time to ZA3</td>
</tr>
<tr>
<td>ZB3 - relative max force</td>
<td>Y12 - propelling impulse</td>
<td>X6 - total impulse on the right (+) of the running direction</td>
<td>T6 - rel. time to ZA3</td>
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<tr>
<td>121 - impulse on z axis for braking duration</td>
<td></td>
<td>X7 - algebraic impulse (X1 + X2)</td>
<td>T7 - abs. time of braking phase</td>
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<tr>
<td>122 - impulse on y axis for propelling duration</td>
<td></td>
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<td>TR1 - rel. time of braking phase</td>
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<tr>
<td>123 - total impulse on 2 axes</td>
<td></td>
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<td>T8 - abs. time to Y8</td>
</tr>
<tr>
<td>124 - impulse on z axis to 2nd max force</td>
<td></td>
<td></td>
<td>TR8 - rel. time to Y8</td>
</tr>
<tr>
<td>125 - impulse on 2 axis from 2nd max force to end of the support</td>
<td></td>
<td></td>
<td>ST - support time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TAX1 - abs. time of 1X1</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>TRX1 - rel. time of 1X1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TAX2 - abs. time of 1X2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TRX2 - rel. time of 1X2</td>
</tr>
</tbody>
</table>

* For the vertical force minus BW