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 0.6m) 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 oscilograph 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 + ½ FT) 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

	SQUART JUMP		COUNTER MOVEMENT JUMP	
	REACTION TIME (ms)		REACTION TIME (ms)	
	OPTIC	ACOUSTIC	OPTIC	ACOUSTIC
PREDICTED	186 ± 15	131 ± 11	210 ± 24	141 ± 17
	SN	NS	NS	NS
UNPREDICTED	188 ± 41	137 ± 20	207 ± 25	151 ± 31

(P> .05)

TABLE 2

Characteristics of a vertical jump (SJ and CMJ)

MEAN AND STANDARD DEVIATION - N=10

		RT (ms)	AT (ms)	CMT (ms)	TMT (ms)	1/2 FT(ms)	TAT (ms)	PERFORMANCE (m)
SQUART JUMP	OPTIC STIM	186 ± 15	302±34	—	564±45	260 ±17	750 ±42	.37 ± .04
	ACOUSTIC	131 ± 11	281±43	—	554±36	262±13	675±33	.37± .04
	WITHOUT STIM	—	321±49	—	594±55	270 ±15	594±55	.38 ± .05
COUNTER MOVEMENT JUMP	OPTIC STIM	210±24	228±36	406±41	914±89	280±27	1124±98	.43 ± .07
	ACOUSTIC	141±17	220±32	401±58	930 ±100	279±27	1044±103	.42 ± .65
	WITHOUT STIM	—	247±37	492±49	1021±76	282±22	1021 ± 76	.42 ± .06

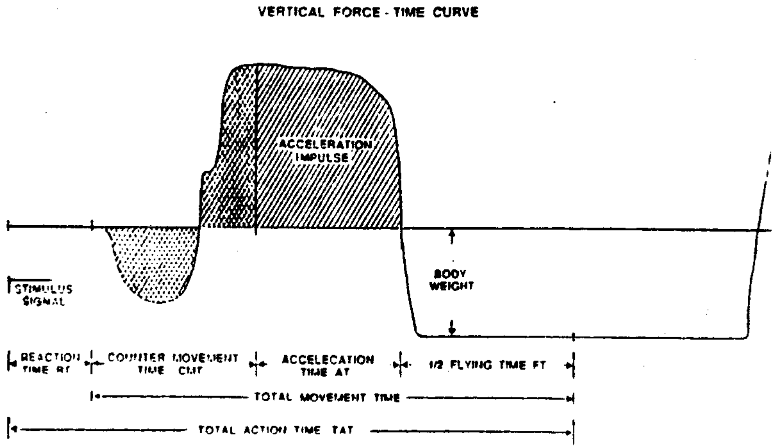

Fig 1

Figure 1: Counter Movement Jump
Vertical Force - Time Curve

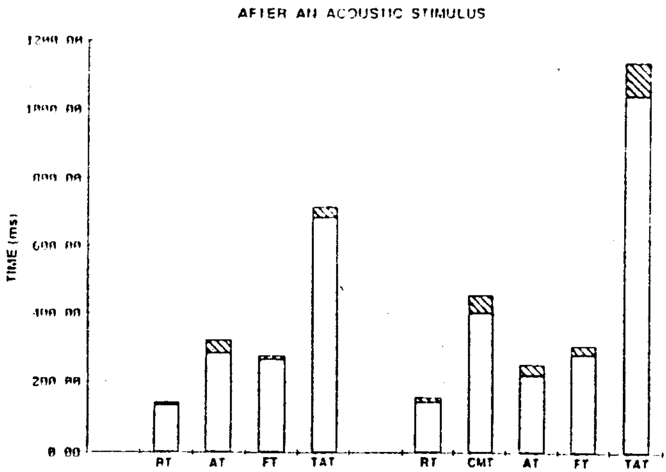

Fig 2

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

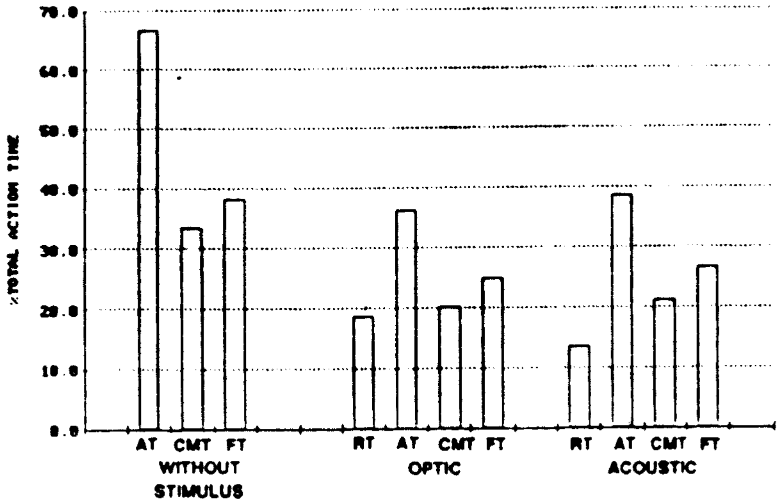

Figure 3a: Contribution to total action time - squat jump

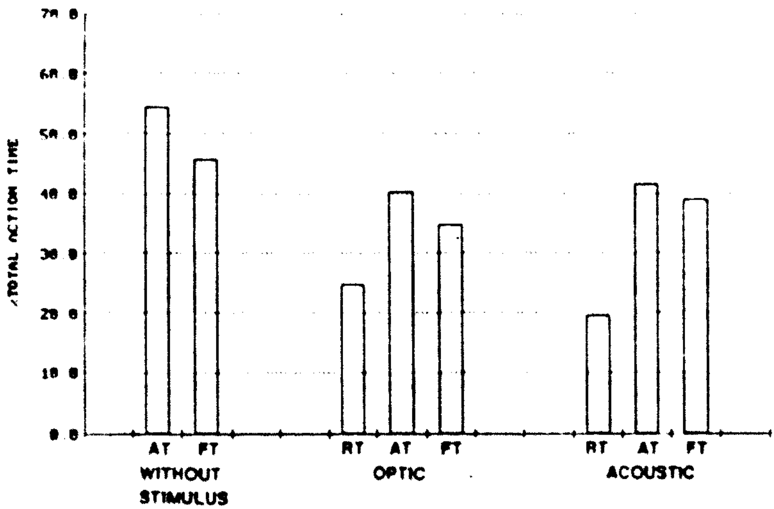

Figure 3b: Contribution to total action time - counter movement jump

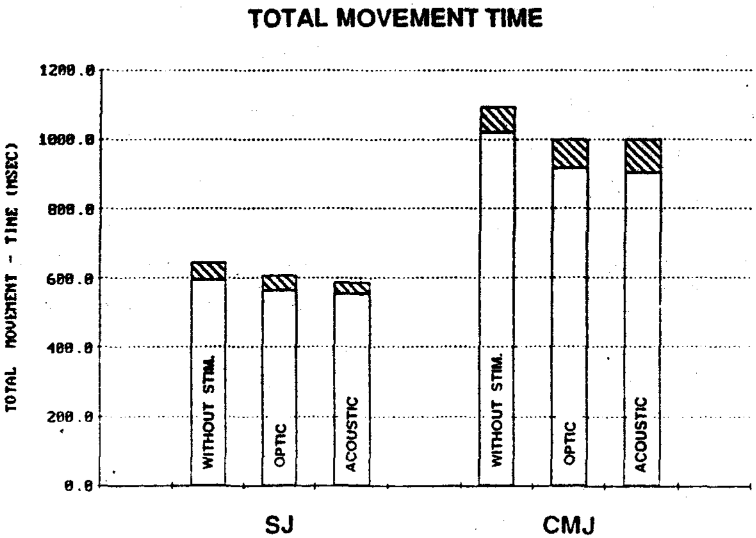

Figure 4: Total movement time

TAB. 1

THE REACTION TIME AFTER PREDICTED AND UNPREDICTED

	SQUART JUMP		COUNTER MOVEMENT JUMP	
	REACTION TIME (ms)		REACTION TIME (ms)	
	OPTIC	ACOUSTIC	OPTIC	ACOUSTIC
PREDICTED	186 ± 15	131 ± 11	210 ± 24	141 ± 17
	SN	NS	NS	NS
UNPREDICTED	188 ± 41	137 ± 20	207 ± 25	151 ± 31

(P> .05)

TAB. 2 CHARACTERISTICS OF A VERTICAL JUMP (SJ and CMJ)
MEAN AND STANDARD DEVIATION - N = 10

		RT (ms)	AT (ms)	CMT (ms)	TMT (ms)	1/2 FT (ms)	TAT (ms)	PERFORMANCE (m)
SQUART JUMP	OPTIC STIM	186 ± 15	302 ± 34	----	564 ± 45	260 ± 17	750 ± 42	.37 ± .04
	ACOUSTIC	131 ± 11	281 ± 43	----	554 ± 36	262 ± 13	675 ± 33	.37 ± .04
	WITHOUT STIM	----	321 ± 49	----	594 ± 35	270 ± 15	594 ± 55	.38 ± .05
COUNTER MOVEMENT JUMP	OPTIC STIM	210 ± 24	229 ± 36	406 ± 41	914 ± 89	280 ± 27	1124 ± 98	.43 ± .07
	ACOUSTIC	141 ± 17	220 ± 32	401 ± 58	933 ± 100	279 ± 27	1044 ± 103	.42 ± .65
	WITHOUT STIM	----	247 ± 37	492 ± 49	1021 ± 78	282 ± 22	1021 ± 78	.42 ± .06

IDENTIFICATION OF TEMPORAL AND DYNAMIC PARAMETERS

VERTICAL (z)	ANTEROPOSTERIOR (y)	MEDIOLATERAL (x)	TERMORAL (T)
ZA1 - 1st absolute max. force	Y4 - 1st max braking peak	IX1 - total impulse on the right (-) of the running direction	TA1 - abs. time to ZA1
			TR1 - rel. time to ZA1
			TA2 - abs. time to ZA2
ZR1 - 1st relative max force	Y5 - min braking peak	IX2 - total impulse on the left (+) of the running direction	TR2 - rel. time to ZA2
			TA3 - abs. time to ZA3
			TR3 - rel. time to ZA3
ZA2 - absolute min force	Y6 - 2nd max braking peak	IX - algebraic impulse (IX1 + IX2)	TA4 - abs. time to Y4
			TR4 - rel. time to Y4
ZR2 - relative min force	Y8 - max propelling peak		TA5 - abs. time to Y5
			TR5 - rel. time to Y5
ZA3 - 2nd absolute max force	IY1- braking impulse		TA6 - abs. time to Y6
	IY2- propelling impulse		TR6 - rel. time to Y6
ZR3 - 2nd relative max force	IY - algebraic impulse (IY1 + IY2)		TA7 - abs. time of braking phase
IZ1*- impulse on Z axis for braking duration			TR7 - rel. time of braking phase
			TA8 - abs. time to Y8
			TR8 - rel. time to Y8
IZ2*- impulse on Z axis for propelling duration			ST - support time
			TAX1- abs. time of IX1
			TRX1- rel. time of IX1
			TAX2- abs. time of IX2
IZ3*- total impulse on Z axis			TRX2- rel. time of IX2
IZ4*- impulse on Z axis to 2nd max force			
IZ5*- impulse on Z axis from 2nd max force to end of the support			

* for the vertical force minus BW