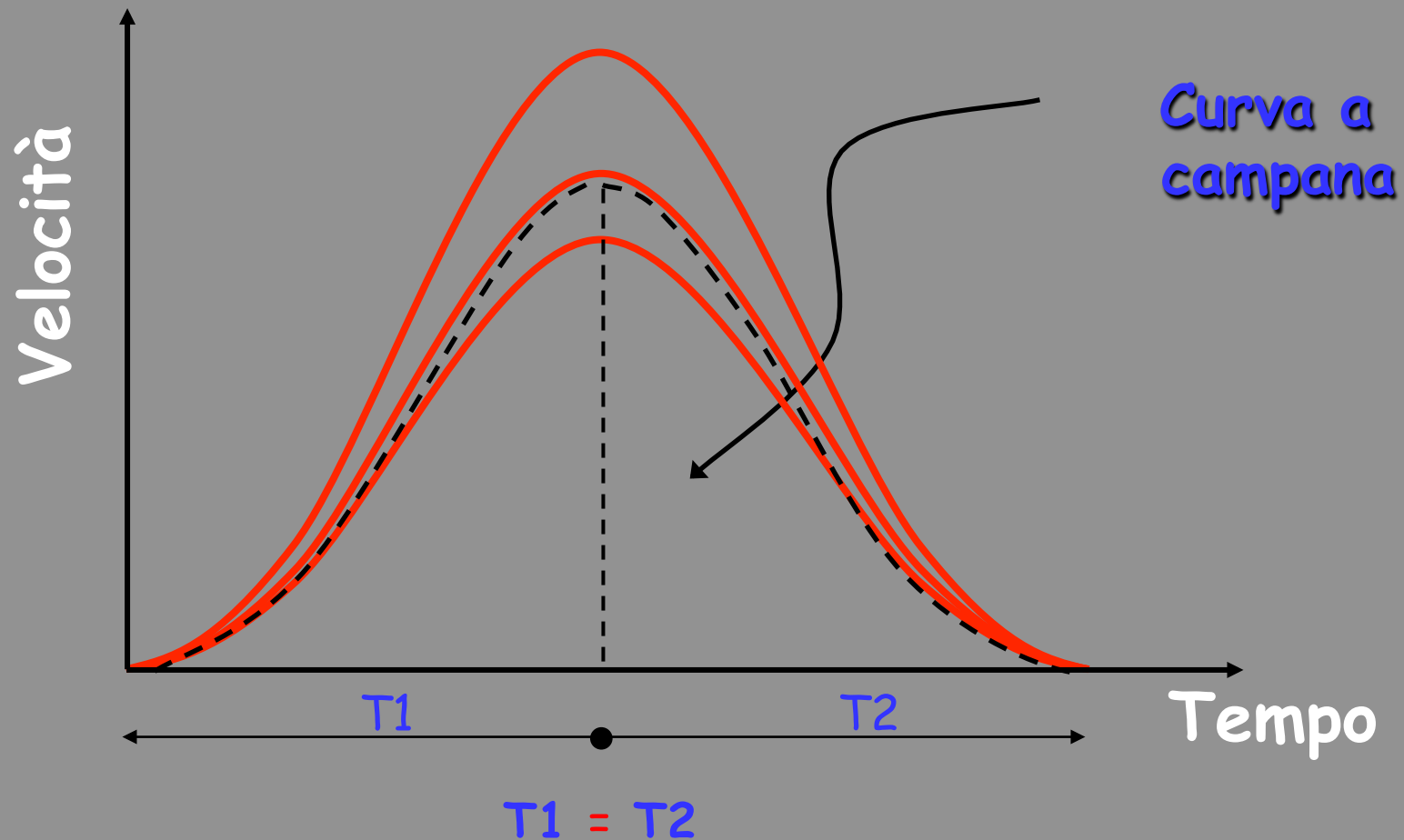


La legge di Fitts

Movimenti balistici

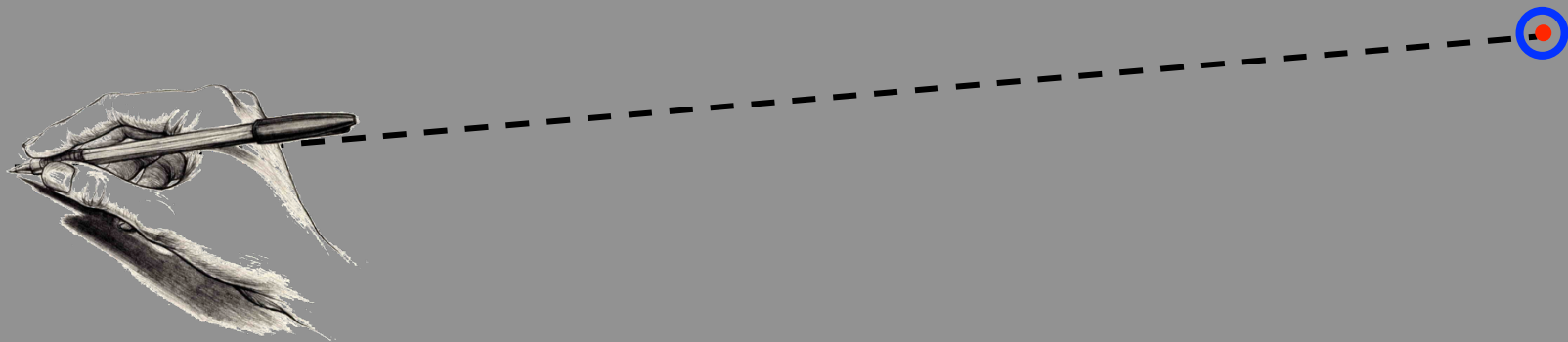


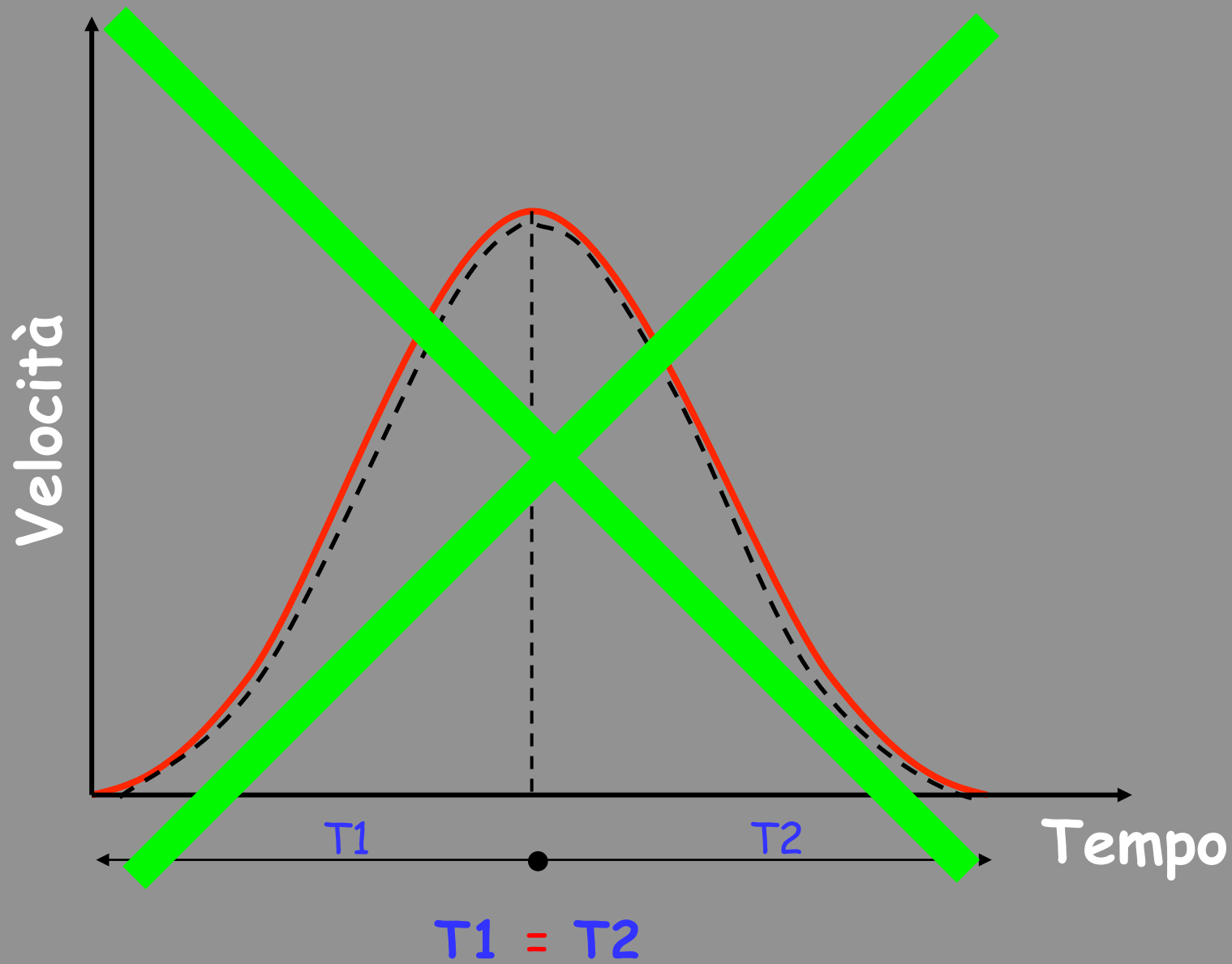
(Morasso, 1981; Abend et al. 1982; Atkenson & Hollerbach, 1985; Flash & Hogan, 1985; Uno et al, 1989)

Movimento

Veloce

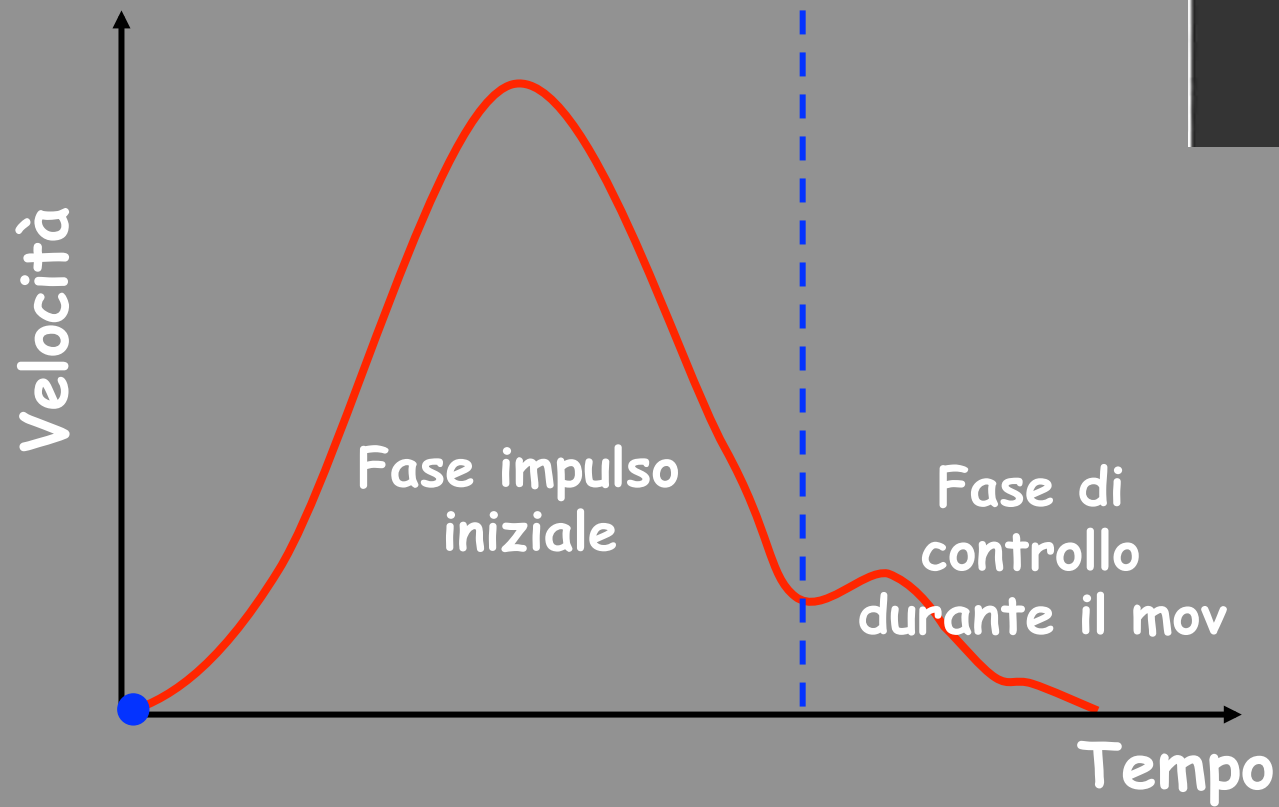
Accurato





Robert S. Woodworth, 1899

- Velocità aumenta precisione diminuisce
- Accuratezza richiesta aumenta velocità diminuisce



Mediazione

Qual'è la relazione fra velocità del movimento e accuratezza?

Paul M. Fitts, 1954



$$MT = a + b \log_2(2A/W)$$

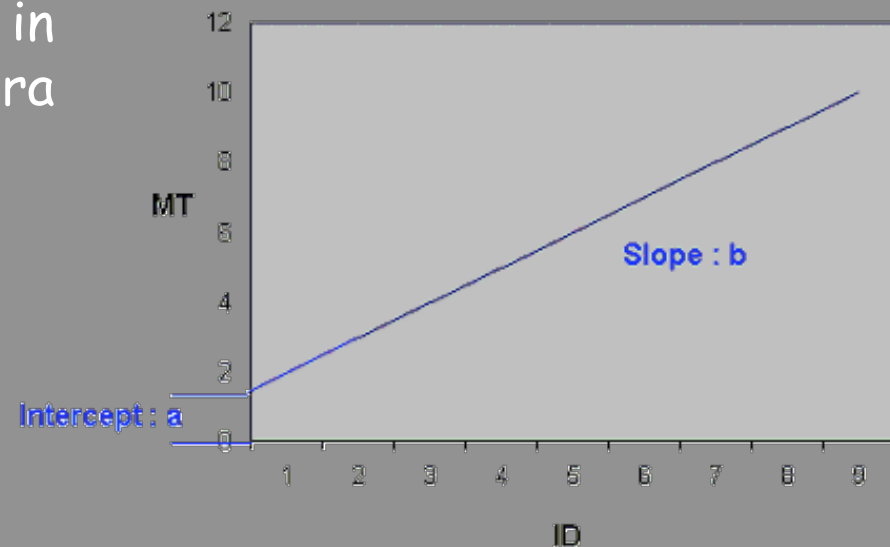
Il tempo del movimento (MT) è in funzione lineare con il rapporto fra ampiezza del movimento e del target

$\log_2(2A/W)$

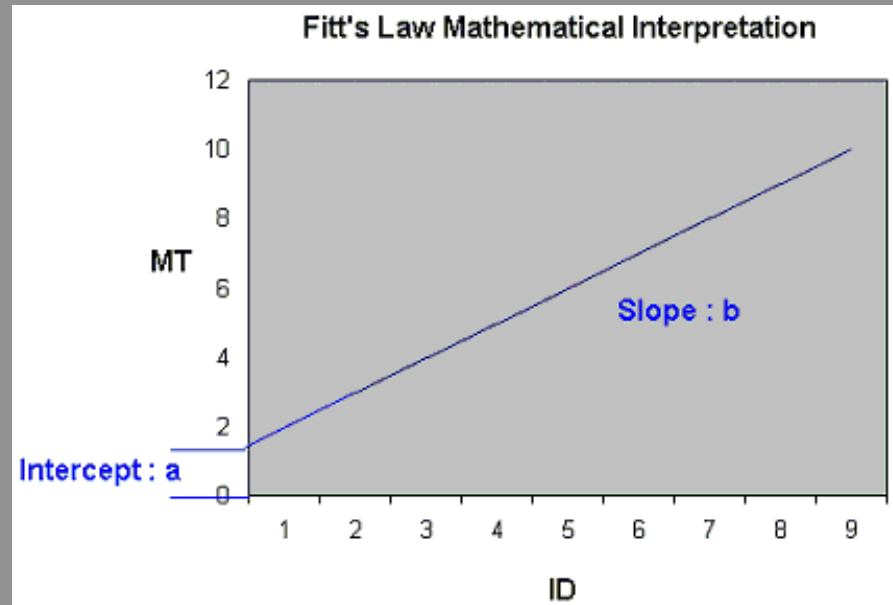
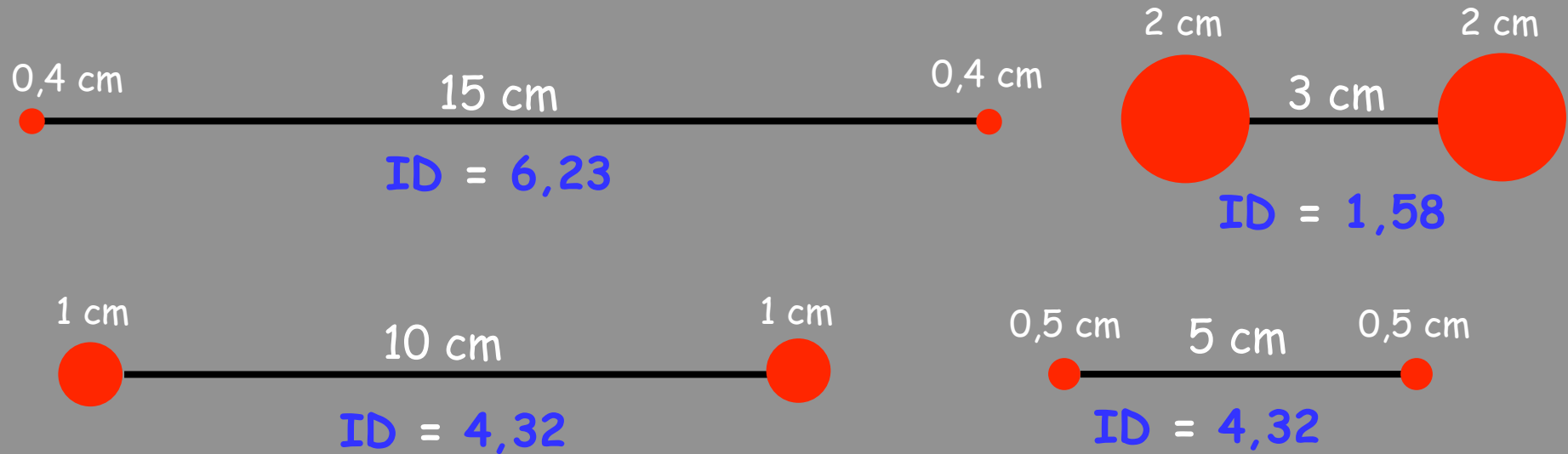


Indice di difficoltà (ID)

Fitt's Law Mathematical Interpretation



$$MT = a + b \log_2(2A/W)$$



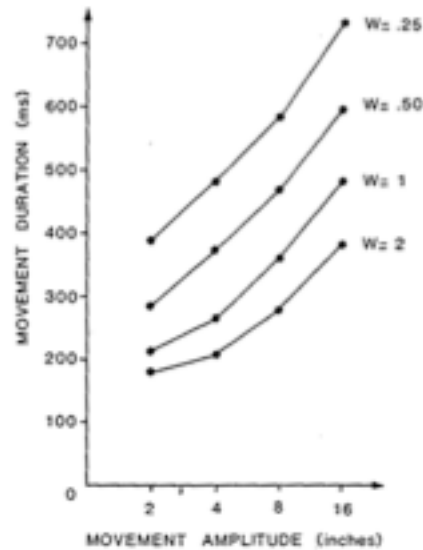


Fig. 3.2. Relationship of movement duration to movement amplitude in the Fitts reciprocal tapping task. Data from Table 1 of Fitts (1954) have been plotted as a function of movement amplitude (in inches) and target width (W , in inches). Note strong movement duration to amplitude relationship for each target width. Also, note global increase in movement duration when target width decreases.

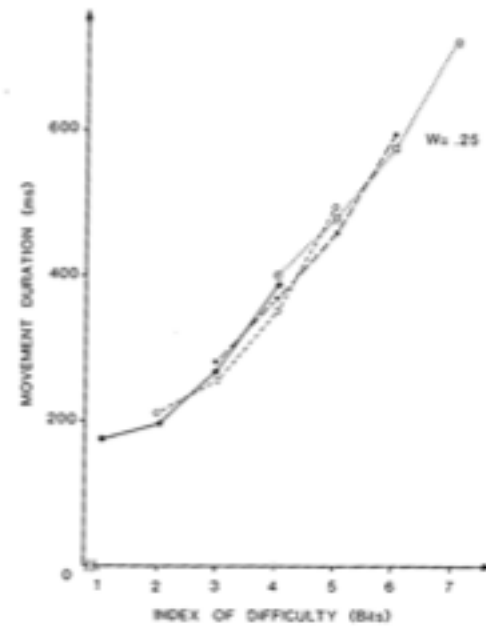


Fig. 3.3. Relationship of movement duration to index of difficulty (Fitts' law). The same data as in Fig. 3.2 have been replotted. Index of difficulty (in bits) is calculated as $I_d = \log_2 2A/W$ (A = amplitude of movements, W = width of targets). Note quasi-linear relationship for I_d above 1. Different lines and symbols represent different target widths. Dark circles: $W = 2$ in. Open circles: $W = 1$ in. Stars: $W = 0.5$ in. Squares: $W = 0.25$ in.

Category	Study	Authors
Movements	a) Serial or continuous	a) Fitts (1954); Kvalseth (1975)
	b) Discrete	b) Carlton (1979; 1980); Fitts & Peterson (1964).
	c) Tapping	c) Fitts (1954); Fitts & Peterson (1964); Kantowitz & Elvers (1988); Megaw (1975);
	d) Object transferral	d) Fitts (1954); Raouf & Tsui (1978)
	e) Dart throwing	e) Kerr & Langolf (1977)
	f) Three-dimensional	f) MacKenzie et al. (1987)
	g) Rotary	g) Knight & Dagnall (1967)
	h) Pointing and dragging	h) Gillan et al. (1990)
Limbs and muscle groups	a) Wrist flexion and rotation	a) Crossman & Goodeve (1963/1983); Meyer et al. (1988); Wright & Meyer (1983)
	b) Foot movements	b) Drury (1975); Hoffmann (1991b)
	c) Head movements	c) Andres & Hartung (1989a; 1989b); Jagacinski & Monk (1985)
	d) Finger manipulation	d) Hoffmann & Sheikh (1991); Langolf et al. (1976)
	e) Arm extension	e) Kerr & Langolf (1977)
	f) Rapid elbow flexion	f) Corcos et al. (1988)
	g) Speech	g) Jafari & Kondraske (1988)
	h) Hand movements	h) Beggs & Howarth (1972); Howarth et al. (1971)
	i) It has been suggest that the law would hold for the mouth or any other organ for which a suitable motor task could be devised	i) Glencross & Barrett (1989); MacKenzie (1992)

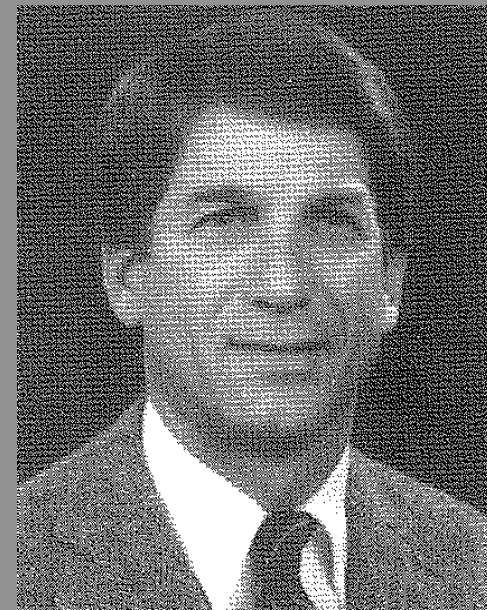
Legge di Fitts \longrightarrow Richiede movimenti veloci



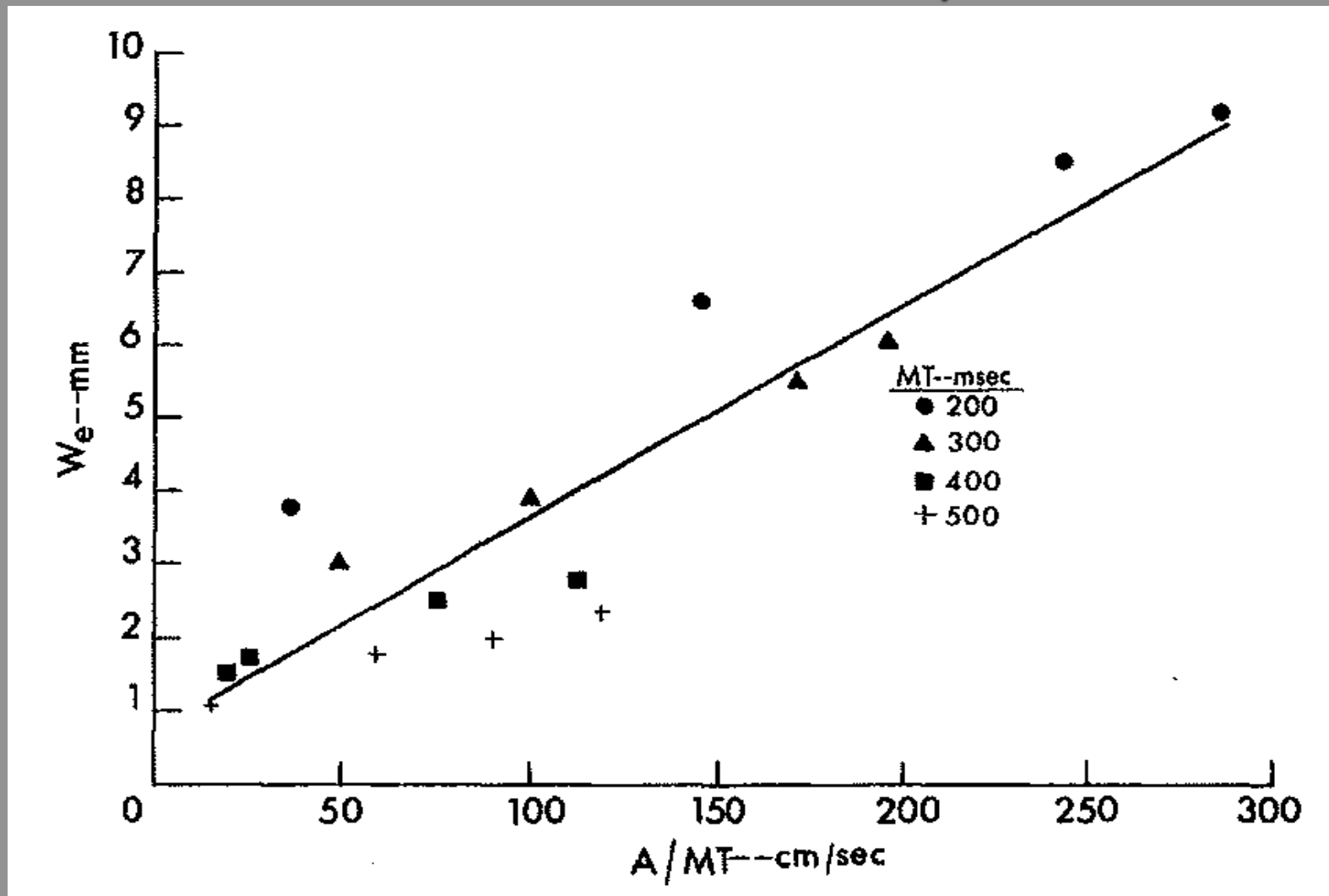
Richard A. Schmidt et al.
(1979)



Modello dell'impulso
(Schmidt's law)



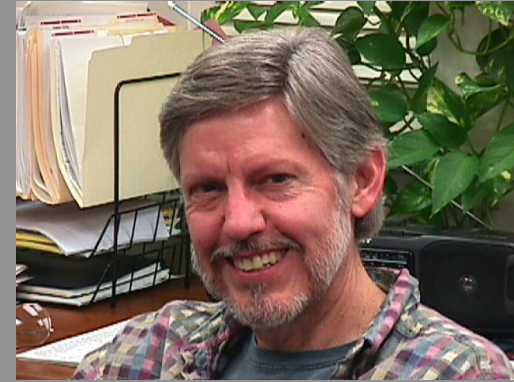
Richard A. Schmidt et al., 1979



La variabilità al target (We) è linearmente correlata con la velocità del movimento (A/MT)

La combinazione fra movimento e percezione

David E. Meyer
(1988, 1990)

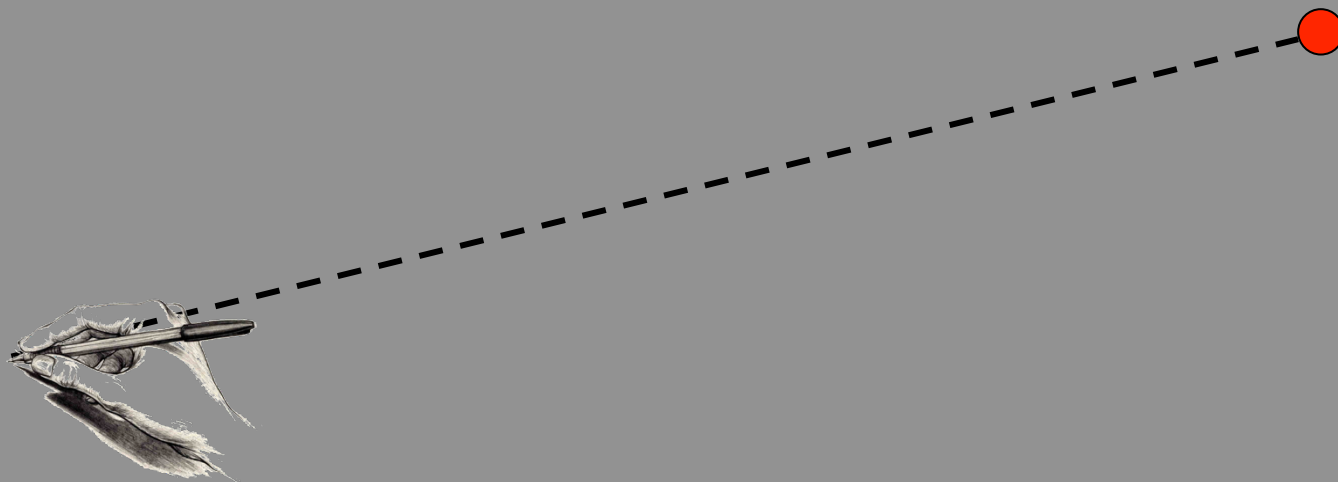
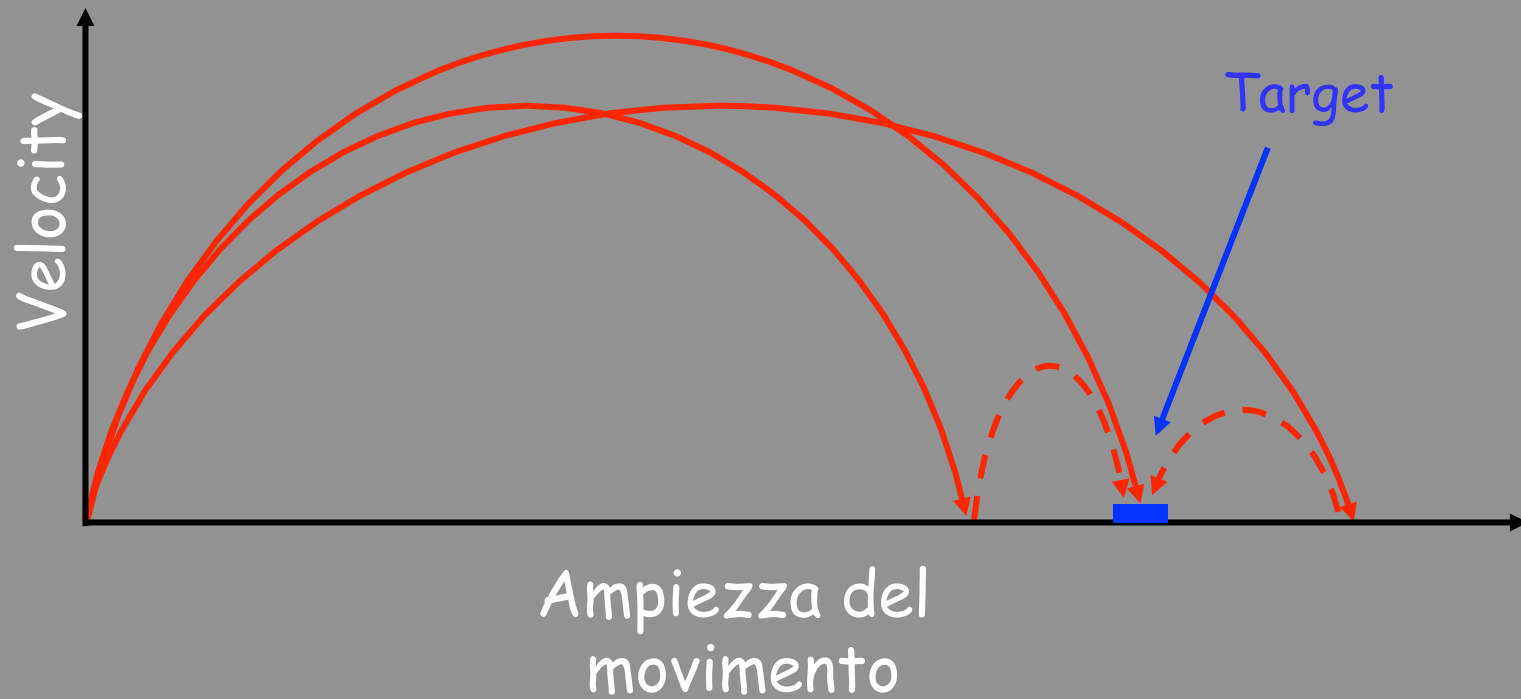


Controllo feedback visivo
(Woodworth, 1899)

Modello dell'impulso
(Schmidt, 1979)

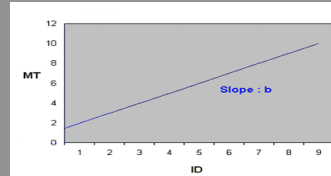
Legge di Fitts = ...
(1954)

I sub movimenti



I submovimenti

Fitts' Law



Il movimento emerge dalla relazione fra l'impulso iniziale e i submovimenti controllati via feedback dalla vista

Che cosa succede a livello della pianificazione del movimento?

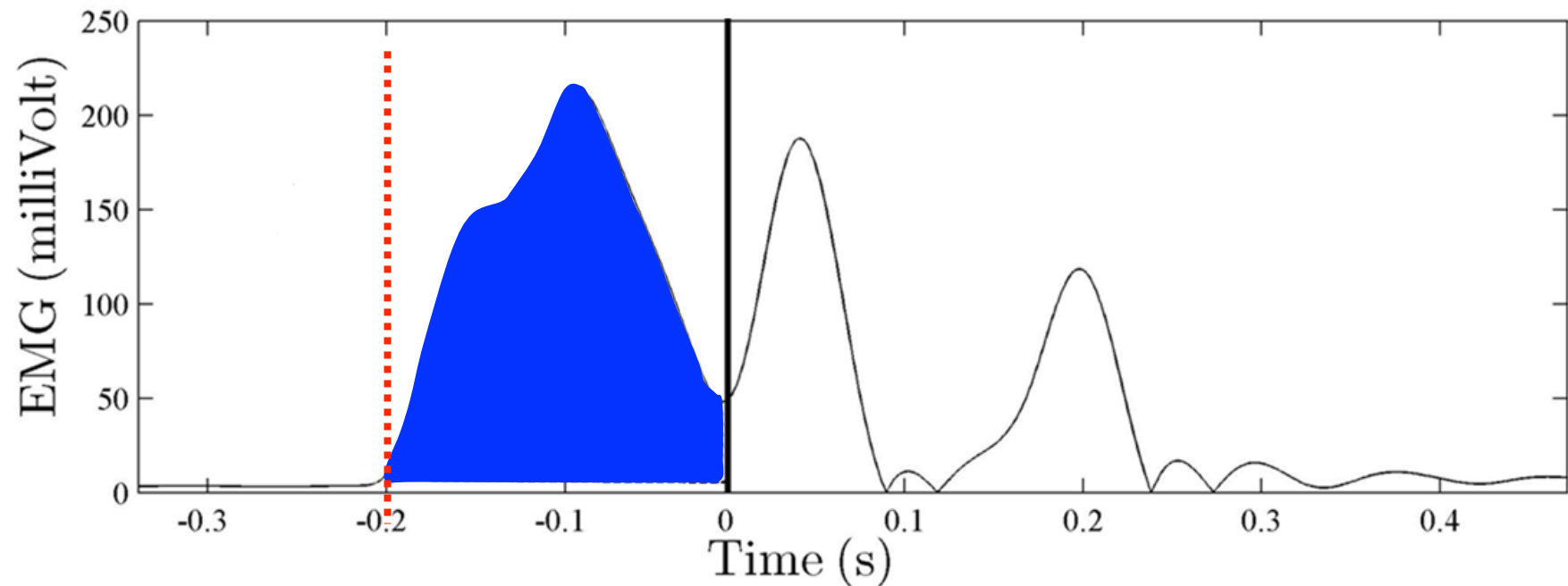
L'impulso iniziale è controllato attraverso un meccanismo a feedforward? Questo tipo di controllo segue la legge di Fitts?

Possiamo studiare gli aggiustamenti posturali anticipati : APA

APA: parametri misurati

Inizio

Ampiezza



Ampiezza: linearmente correlati con la quantità di moto (Aruin & Latash, 1996) e con la velocità del movimento (Horak et al., 1984; Ito et al., 2003)

Inizio: Dipendono dalla difficoltà del compito (Bouisset et al., 2000) e dalla velocità del movimento (Brunt et al., 1999; Ito et al. 2003)

Idea centrale

Possiamo capire come il SNC modula
il tempo e **l'ampiezza** degli APA
rispetto ai parametri del compito
motorio (accuratezza velocità) per
compiere al meglio l'azione

12 ballerine professioniste

età= 26 ± 8 years

altezza= 1.64 ± 0.06 m

peso= 52.4 ± 5.3 kg

Compito: Puntare con l'alluce su di un target, il più velocemente possibile e il più precisamente possibile

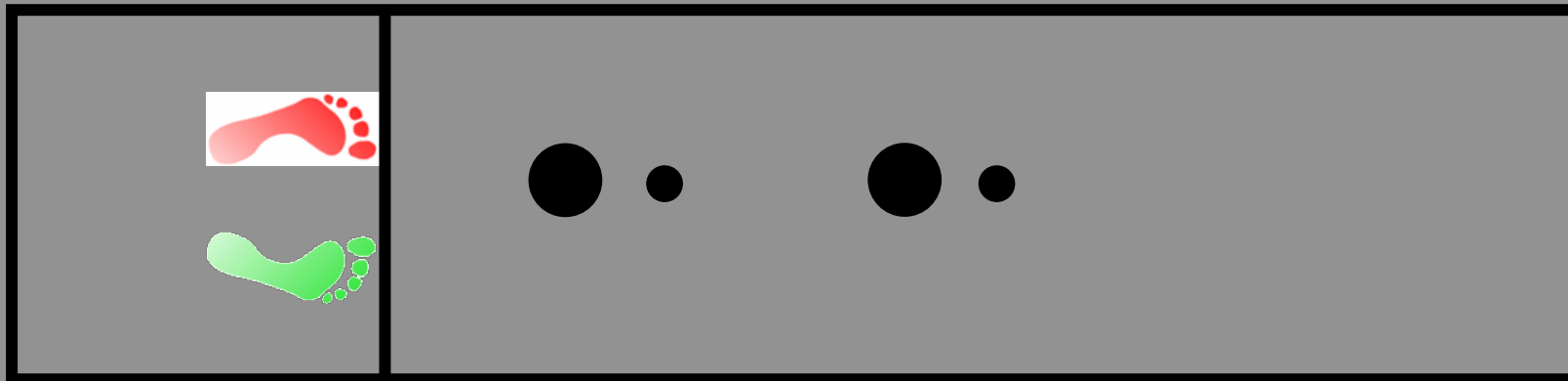
"battement tendu"



Distanze: 10 - 20 - 40 - 60 - 80 - 100 cm

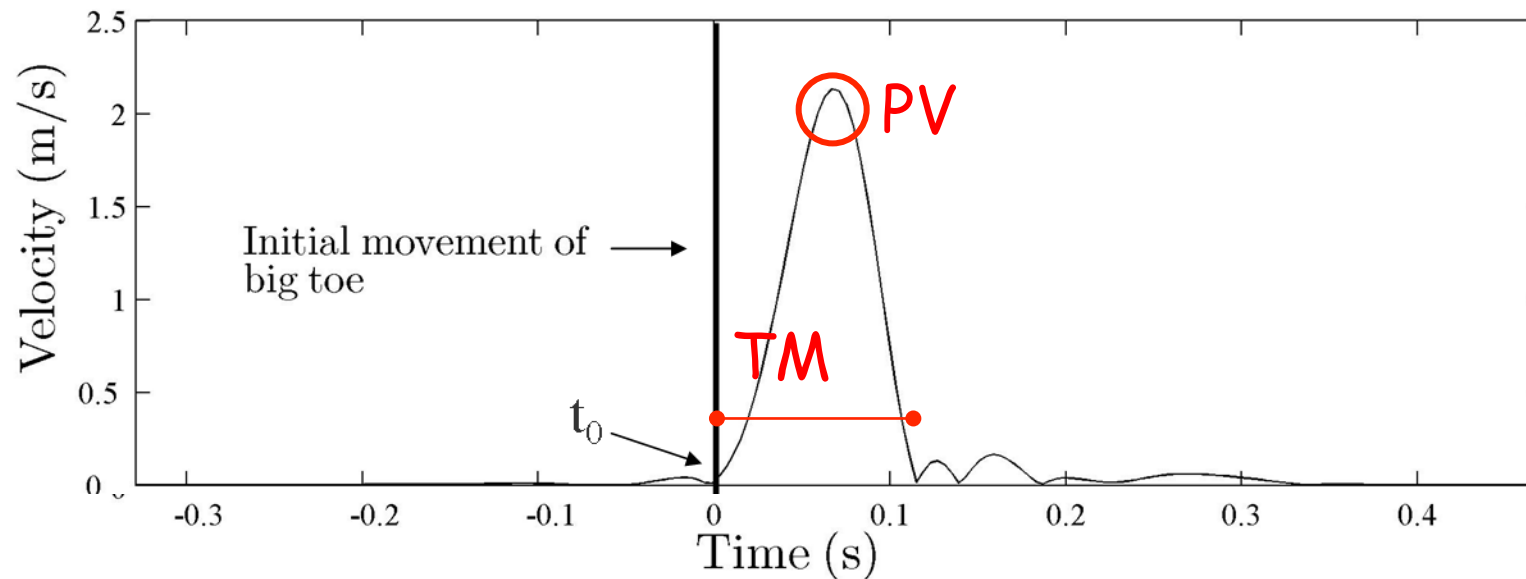
Ampiezze del target: 2 - 4 - 6 - 8 - 10 cm

ID [$\log_2 = (2A / W)$] = da 1.00 a 6.64





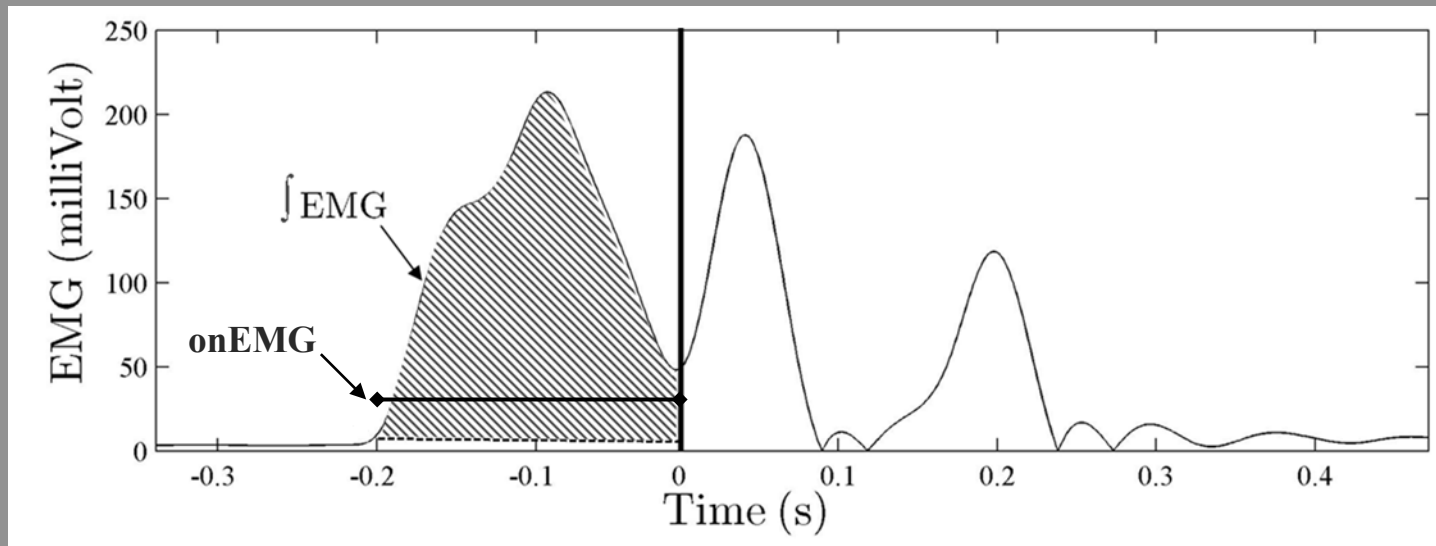
Variabili cinematiche



- Tempo del movimento (**TM**)
- Picco della velocità (**PV**)

EMG

APAs Tibiale anteriore

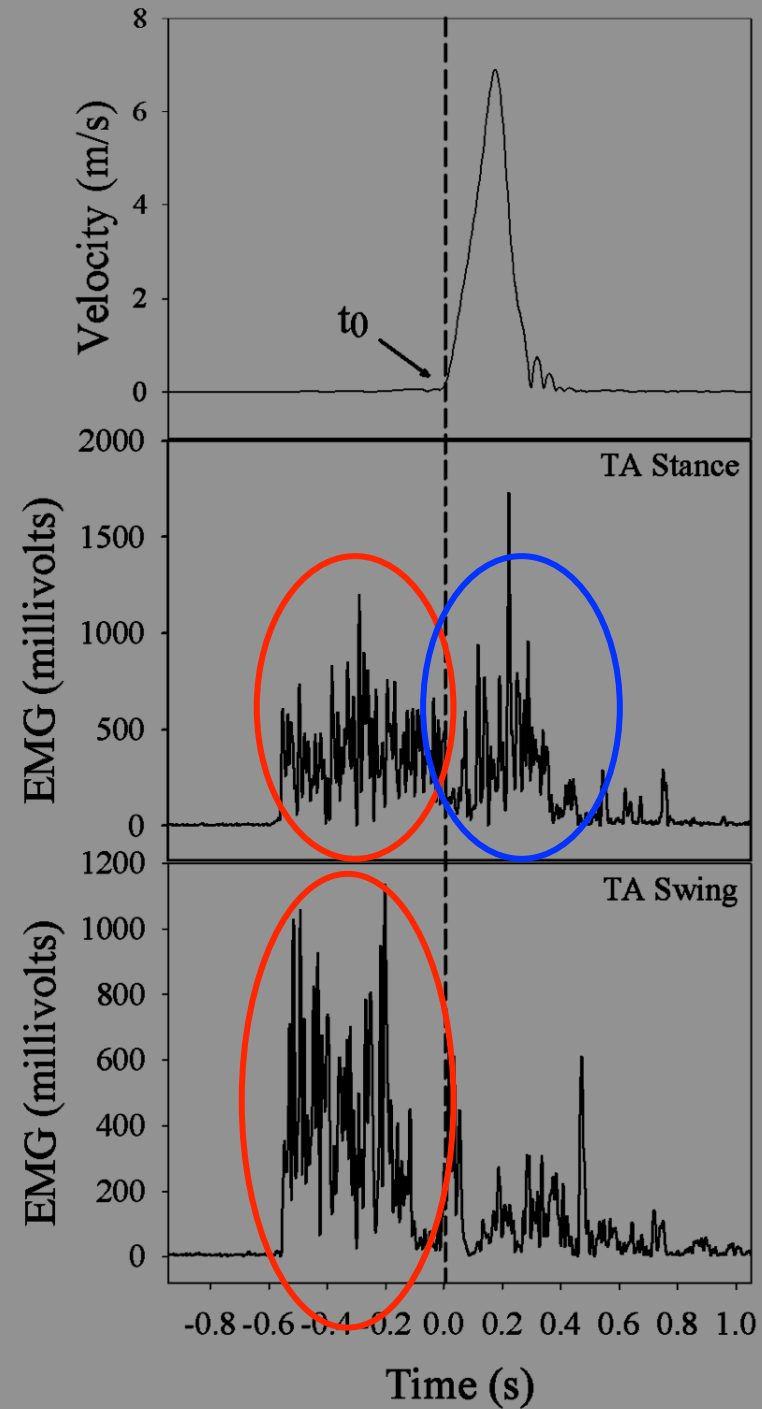


- Ampiezza APA ($\int EMG$)
- Inizio APA (onEMG)

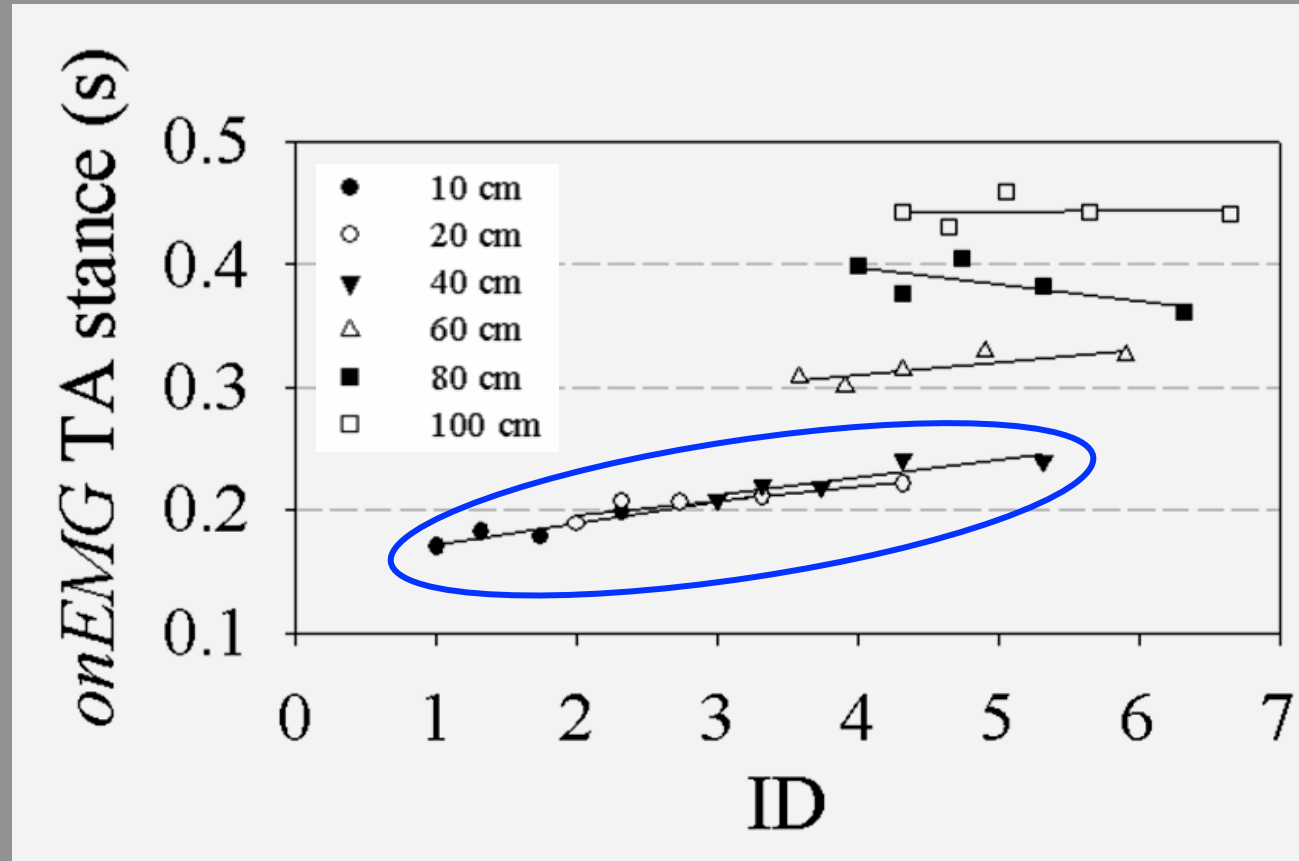
Eble et al., 1994; Brunt et al., 1991, 1999, 2000; Ito et al., 2000

Cinematica

Profilo EMG prima e durante l'azione.



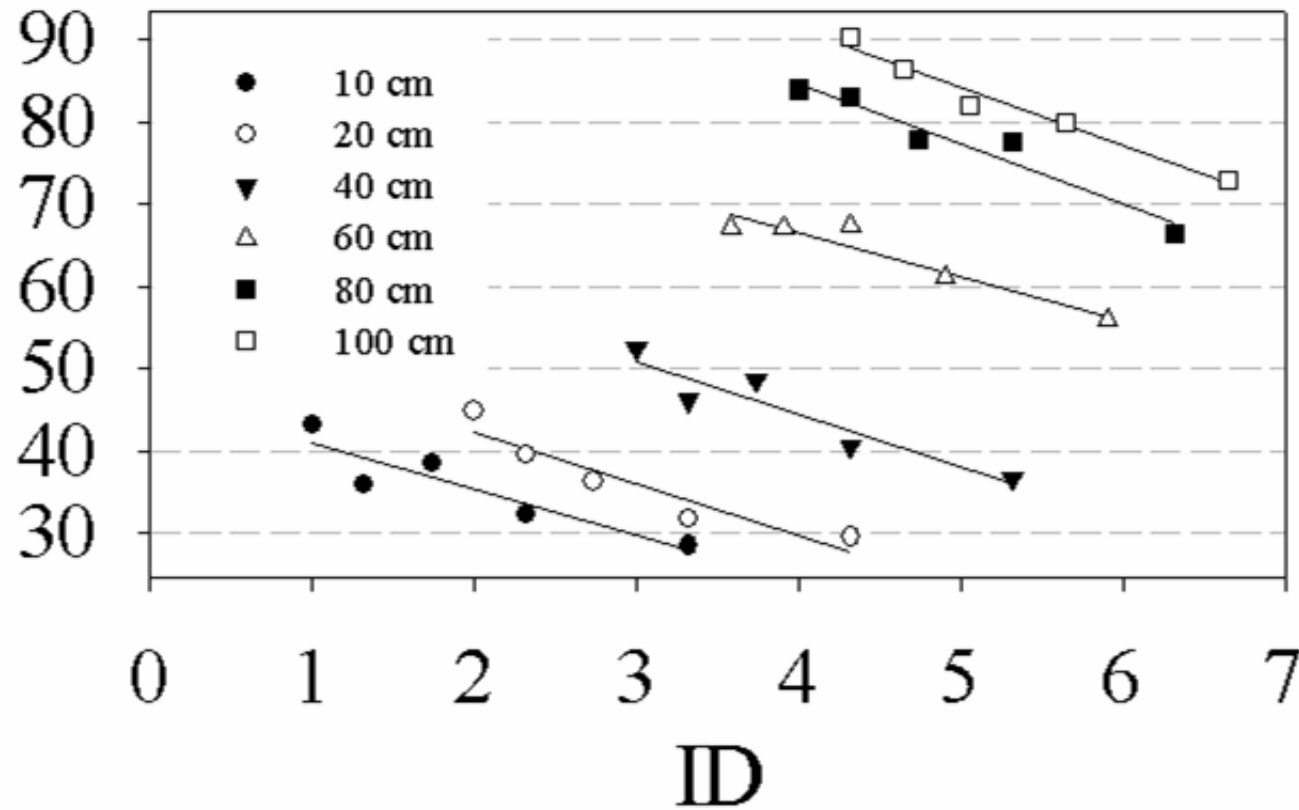
Inizio APA



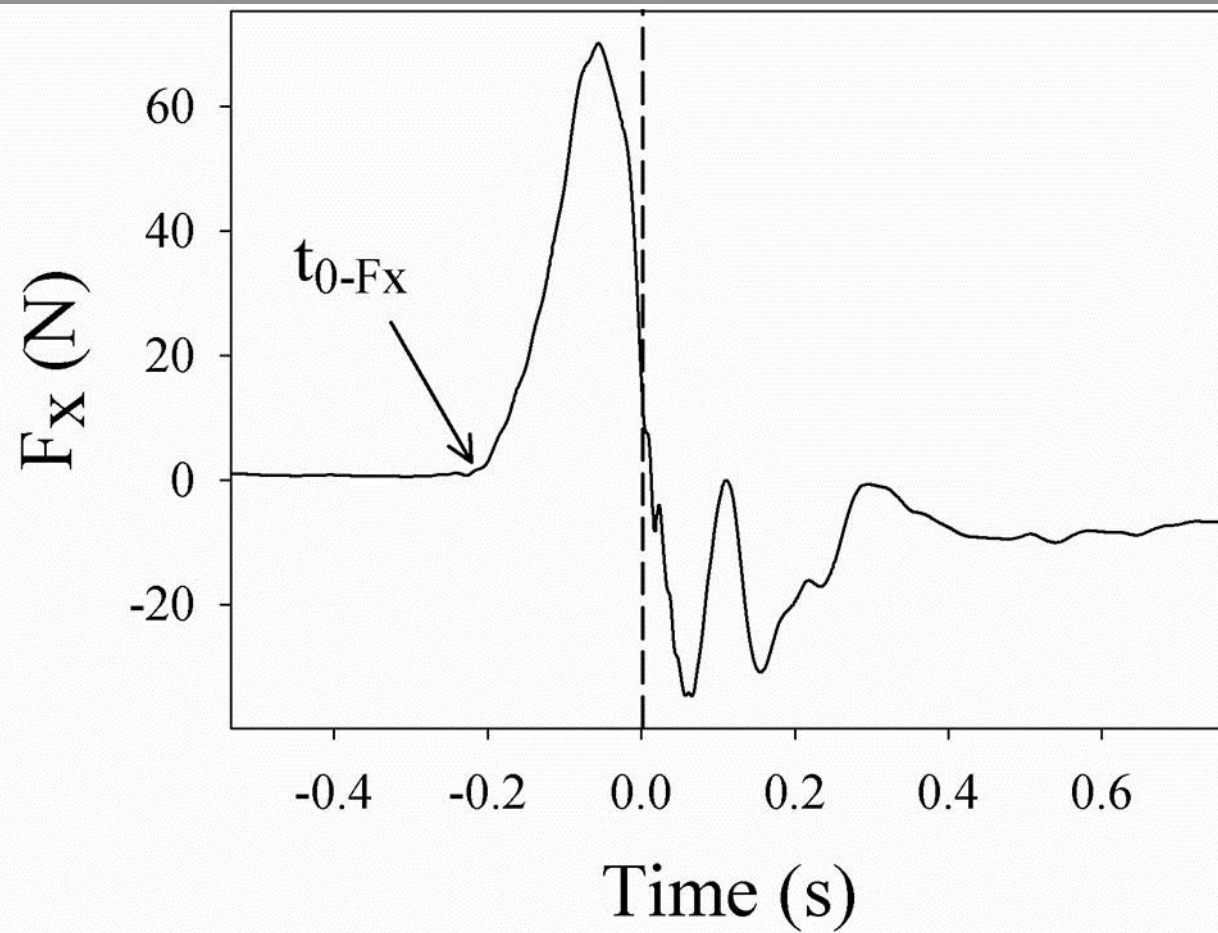
Sotto i 200-250 ms di durata del movimento (Keele and Posner, 1968; Paillard, 1996 for a

Ampiezza APA

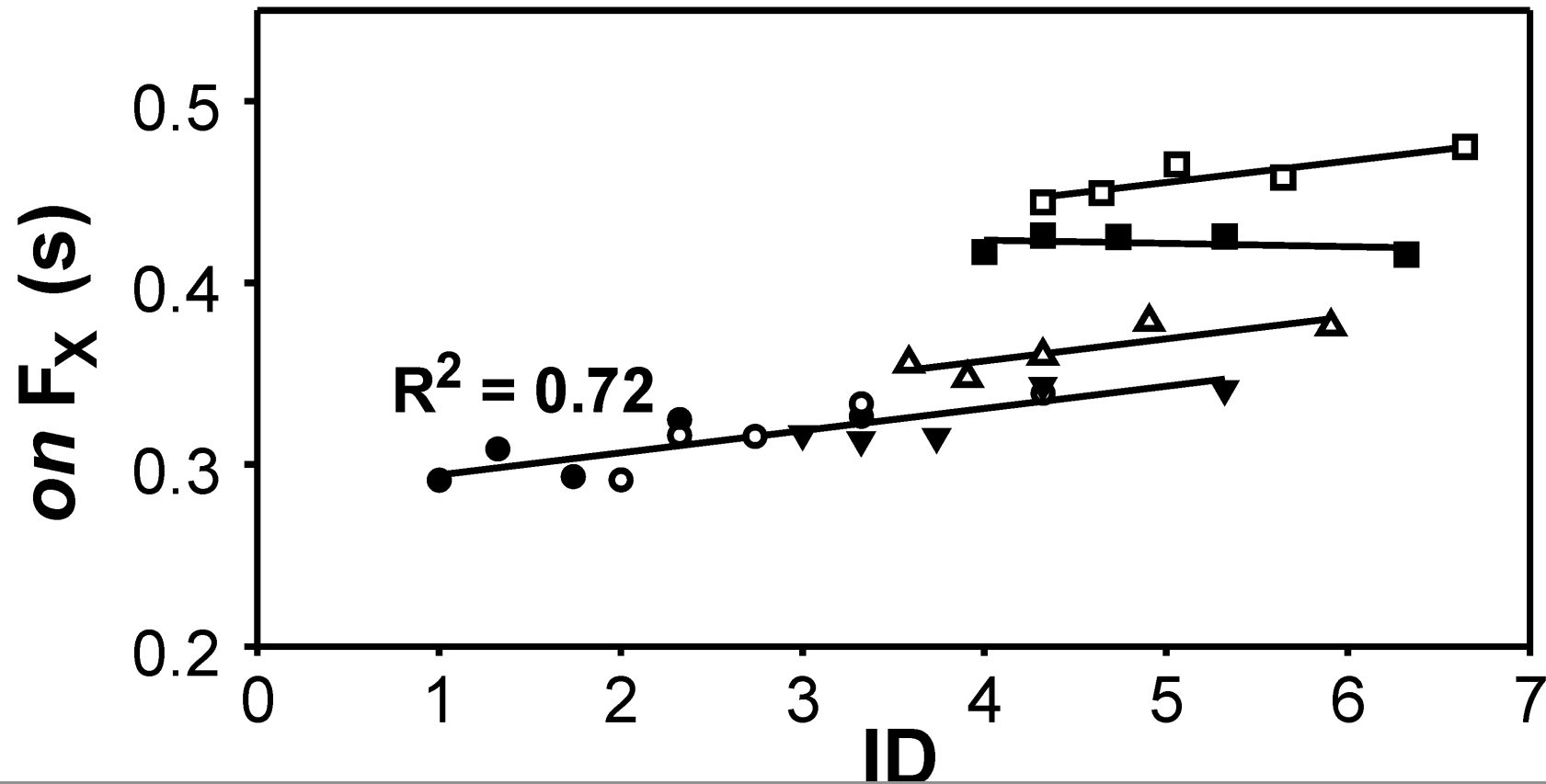
IEMG TA Stance
(% EMGmax)



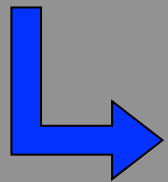
Force platform



Force Platform latero-lateral direction onset



L'inizio degli APA **modulano in funzione dell'ID** quando non è disponibile (non c'è tempo) per ottenere informazioni di ritorno



Più il compito è difficile (alto ID) più gli APA iniziano prima per meglio prepararsi al movimento

La stessa cosa è confermata osservando la migrazione del (COP)

