INTRODUCTION
Training induced increases in the maximal voluntary 'neural drive' to skeletal muscle may arise from neural changes occurring at both spinal and supraspinal (i.e. cortical) levels. The Hoffmann (H) reflex may be used to indirectly assess the excitability levels of the spinal α-motoneurones, both at rest and during natural movement in man (1,4,6). Furthermore, the M-wave may be used to estimate the number of active motor units during maximal voluntary contraction (3). When supra-maximal H-reflex stimulation is applied onto maximal muscle contraction a V wave is elicited (2,4) whose peak-to-peak amplitude, when expressed relative to that of the maximal EMG response, $M_{max}$ indicates the degree of motoneuron activation - the 'neural drive' to the muscle (5). This involves the complete chain of supraspinal-spinal muscle activation. At low submaximal stimulus strengths the size of the H-reflex however reflects spinal mechanisms alone: the excitability of the spinal motoneurones and the amount of presynaptic inhibition present. Performed together V-wave and H-reflex measurements therefore make it possible to estimate the contribution from spinal as well as supraspinal adaptation mechanisms to the gain in human muscle strength induced by training.

METHODS
Evoked reflex responses were obtained in the soleus muscle of 14 male subjects before and after 12 weeks (32 sessions) of heavy-resistance strength training. During isometric contraction at 90% MVC (85° ankle flexion) the tibial nerve was stimulated briefly (1 ms square pulse) with supramaximal stimuli eliciting maximal direct EMG responses, $M^{max}$, and succeeding reflex responses, $V$. H-reflexes were evoked through submaximal nerve stimulations eliciting direct M-wave amplitudes corresponding to 20% of the $M^{max}$ amplitude. Maximal isokinetic plantarflexor moments (KinCom) were obtained during slow (30° • s$^{-1}$) concentric and eccentric muscle contraction.

RESULTS
V-wave registration in the soleus muscle during static plantar flexion at 90% MVC before strength training. As can be seen the ratio of $V/M^{max}$ is about 40-50%. Sampling frequency was 10 KHz. In this particular subject long latency reflex components were also observed ($V_3$, $V_4$). An elevated $V^\alpha M^\alpha$ ratio after training indicates an increase in motor unit activity.
After the period of strength training Vi/Mj increased 55% (p<0.01) while Mmax remained unchanged. The H-reflex response increased 16% (p<0.05). Maximal concentric muscle strength (±sem) increased 23% from 112±17 Nm to 137±11 Nm (p<0.05) (n=9). Maximal eccentric muscle strength increased 30% from 136±19 Nm to 176±8 Nm (p<0.05) (n=9).

DISCUSSION
A significant increase in motoneuron activation was observed after strength training as indicated by an increase in Vi/Mmax. Similar findings have been reported in the few studies which previously have examined the change in motoneuron activation in response to specific types of training in humans (4) and its variation between different types of athletes (5,6). However, in none of these studies maximal contractile strength was measured. In the present study maximal muscle strength increased about 25%. Correspondingly, the evoked reflex responses increased about 30-50%. The relative increase in H-reflex amplitude was about one-third of the increase observed for Vi/M max. Thus, spinal adaptation mechanisms (estimated from increases in H-reflex amplitude) accounted for a substantial part of the total spinal-supraspinal neural enhancement observed (estimated from increases in Vi/M max).

Accordingly, the improved neural function could be ascribed to an enhancement of both spinal and supraspinal factors.

In conclusion, the present data demonstrate that significant neural enhancement may occur in response to intense strength training in humans. This appears to involve both spinal (increased motoneuron excitability and/or reduced presynaptic inhibition) as well as supraspinal (increased descending command) adaptation mechanisms.

REFERENCES
(2) Hultbom H, Pierrot-Deselligney E: Changes in recurrent inhibition during voluntary soleus contractions in man studied by an H-reflex technique. / Physiol 409, 220-251, 1979