NMI

~~Measurements~~ Study of transient post flight weakness

Problem - ~~It is a~~ Being unable to stand up on the first effort after ldg. is a common experience. Other routine muscular efforts on earth are equally difficult but there is a rapid return of strength over the next hours. There is a real question of whether returning crewmen could perform the emergency egress procedures. There should be little doubt that swinging off the bar & dropping to the ground would result in injury.

~~[illegible]~~ Crewmen have recognized this problem and perform exercises during entry to reduce recovery time and pilots have done exercises on the rudder pedals prior to entry to ensure capacity for braking on touchdown. There may be more subtle unrecognized effects on other tasks including inputs to controls. This phenomena has not been documented.

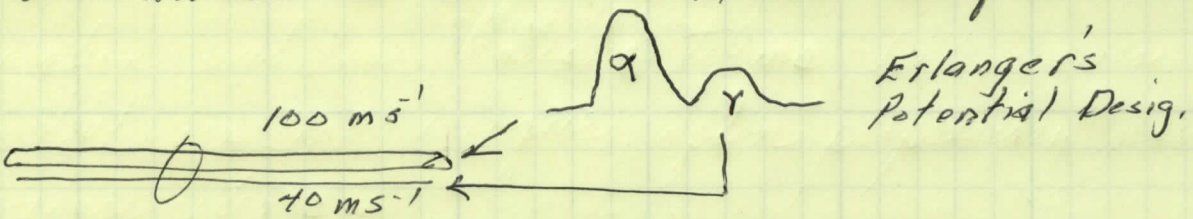
There is a good theoretical basis for such changes. The Generation of muscle force is not an open loop command signal. There are beautiful servo loops at ~~muscle level - spinal cord level~~ several levels which modulates the sensitivity of muscular activity. To quote a standard text "--- the central nervous system can control the flow of information that it receives from skeletal muscles by adjusting the sensitivity of sensory receptors located in the muscles." ~~Eric~~ Kandel, E. & J. Schwartz, eds. 2nd Edition of Sensory Handbook P 442, Elsevier N.Y. 1985

One mechasim to do this is via the intrafusal fibres ( ) which are transducers within muscles, sensitive to stretch of the muscles, which have independent muscle fibres. Independent Contraction or relaxation of these fibres by the Central Nervous System increase or decrease sensitivity of the transducer.(1) Output of the transducer in turn modulates modulates muscle activity and gives conscious recognition to level of effort. (? FV curve)

It is postulated that ~~Centr.~~ ~~X~~ ~~hen~~ ~~relatively~~ only lower forces are required there is a general resetting of the sensitivity. This is compatible c̄ the feeling of extreme weight on return to 1 g. After 7 days there is only a small decrement

1) Hunt, C.C. + S.W. Kuffler
Stretch Receptor Discharges during Musclar Contraction
J. Physiol [London] 113: 298-315, 1951

PCB Matthews - Mammalian Musc. Recptor -



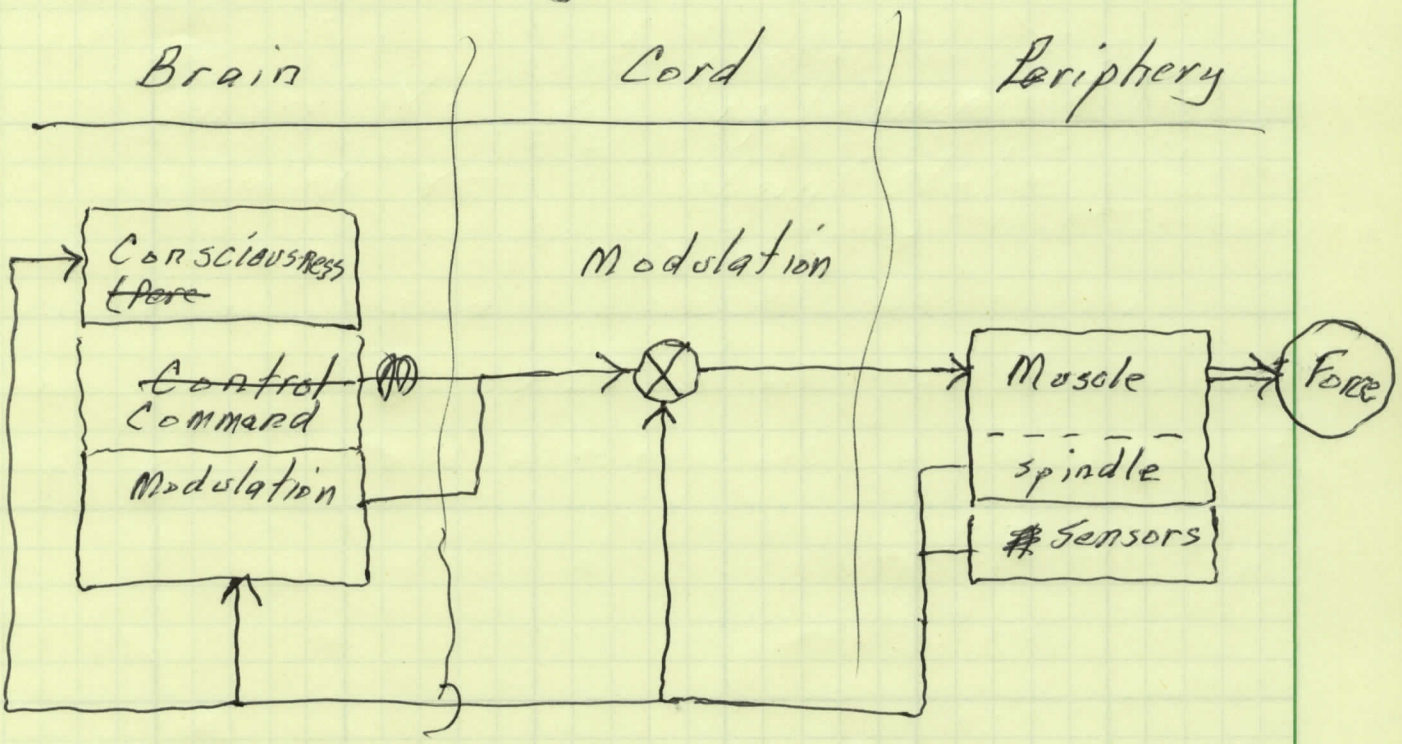
α's to extrafusal muscle fibres
γ's " intra " " "

$\gamma_{1,2}$ = not justified

larger γ's to bag (dynamic fibres)
smaller γ's " chain (static ")

studied sensation ~~sg weight ssn~~ (4.1).

Combining ~~known~~ current knowledge there is a good basis for an elaborate feedback control mechanism ~~wh~~ with conscious sensation of from the sensor elements. A simplified diagram which combines all of the sensory elements & reflex loops for our purpose is shown in Fig 4.1.



~~If~~ It is functionally consistent w what is known.

The next ~~on~~ major question is how

4.1 ~~Sensation Book~~ Geldard, F.A. The Human Senses, Second Ed. John Wiley and Sons. N.Y. USA, 072

large, rapidly charging inhibition & sensation can occur. ~~as~~ Neurological adaptation both sensory (5.1) and reflex (5.2) is ~~the rule as~~ so common as to be unworthy of comment. This often if not usually begins with the sensor (5.3). ~~In the~~ It is also true in muscle receptors where great precaution must be taken to avoid such ~~on exercise~~ adaptation ( ) e. in experimental work (5.4) ~~(ch. 4 5.-)~~ In addition there are many common experiences that demonstrate short term adaptations eg. repetitively throwing a medicine ball and then throwing a basketball under the same conditions. ~~There is to my~~ The very structure of the spindles & their fusiform elastic structure would seem to allow for both short & long term adaptation, especially of the muscle spindle. Matthews gives ~~convincing~~ a striking review of mechanical adaptation to continued stretch which was accompanied by parallel changes in firing rate (5.5). ~~Tendon~~ In contrast Mammalian tendon organs show little adaptation (5.6).

5.4 Chap. 4 Matthews *

5.5 Chap 6 " *

5.6 " 3 " *

another sensory

There is no known counterpart of an adaptation of this magnitude and time frame, hence this phenomena should be of particular interest to those working in proprioception and sensation.

Evidence from Space Programs:

USSR

U.S.

* Feelings of heaviness and weakness were accepted as part of the post flight experience and attributed to disuse atrophy. * My first realization of the nature of these postflight feelings was

move to ast. above

There were * Astrona ** Dr. Joe Kerwin commented on the lack of inflight muscle tone and as a result the a senior author had a lateral compliance gauge built and flown on a number of Shuttle flights beginning c STS-2. This device Fig 6.1, measured the depression produced by a st spring loaded plunger when pressed against the surface of various muscles. Measurements were made throughout several flights in an attempt to document any change in tone and its time course.

resulted from ~~the~~ CDR's graphic description of trying to leave the seat