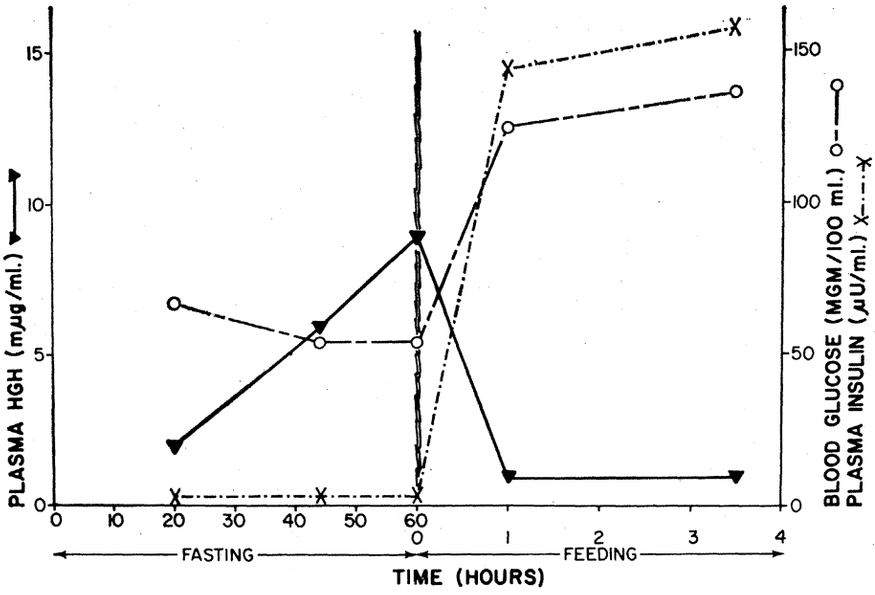

Fig. 3. Blood glucose, plasma insulin, and plasma human growth hormone (HGH) in a normal subject during prolonged fasting and subsequent feeding.

mal. When the hypoglycemia induced with insulin was terminated shortly after onset by the administration of glucose, or when hypoglycemia was prevented by simultaneous administration of glucose and insulin, the plasma hormone remained at the fasting level.

In two patients with tumors (reticulum-cell sarcoma and fibroxanthoma) associated with chronic hypoglycemia, multiple specimens of plasma showed glucose concentrations below 40 mg/100 ml and very high hormone levels (30 to 50 mμg/ml), although endogenous plasma insulin concentrations, measured by immunoassay (see *3*), were lower than normal fasting levels.

In two fasting normal subjects the level of the hormone in plasma did not rise after parenteral administration of glucagon or epinephrine in doses sufficient to produce significant hyperglycemia.

Insulin (0.05 unit/kg body weight) was administered intravenously to a patient totally hypophysectomized for carcinoma of the breast and maintained on replacement doses of adrenal steroids and thyroid hormone. With this dose of insulin, as with the higher dose in normal subjects, blood glucose fell rapidly to less than half the fasting level, but growth hormone was not detected in the plasma (Fig. 2, PAR).

Prolonged fasting (2½ days) of a normal subject was accompanied by a progressive rise in the level of the hormone in plasma, although the level of blood glucose fell only slightly, and the level of endogenous insulin in plasma was zero. Feeding was followed by rapid increases in the levels of blood glucose and plasma insulin and a fall in the plasma growth hormone (Fig. 3).

Thus, hypoglycemia is a potent stimulus to the release of growth hormone. This release is not mediated by insulin, glucagon, or epinephrine. Prolonged fasting also raises the growth hormone level, and the administration of glucose may result in decreased levels of the hormone in plasma. This is the first report of acute changes in endogenous human growth hormone in plasma in response to physiologic stimuli.

The repeated administration of growth hormone produces glucose intolerance (*4*). Appreciation that hypoglycemia and fasting markedly stimulate release of growth hormone may contribute significantly to the understanding of the following clinical phenomena: (i) the temporary glucose intolerance of poorly nourished or fasting subjects ("starvation diabetes"), (ii) the insulin resistance and impaired glucose tolerance of diabetic patients after attacks of insulin hypoglycemia ("Somogyi effect"), (iii) the impaired glucose tolerance of patients with chronic hypoglycemia secondary to functioning islet-cell adenomata.

Endogenous plasma hormone concentration may be properly interpreted only in relation to the subject's blood sugar, recent dietary intake, and perhaps other, as yet undefined, influences.

Measurement of plasma hormone level after hypoglycemia appears to be a specific, sensitive, and direct test of pituitary somatotropic function, which is useful in the differential diagnosis of pituitary disease in the adult. This test may also be valuable in distinguishing pituitary dwarfism from other conditions of retarded growth in children and thereby provide a guide for therapeutic administration of human growth hormone.

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25 February 1963

Implanted Electrodes: Cable Coupler for Elimination of Movement Artifact

Abstract. *The wires in the recording cable are connected to stainless-steel tubes supported by a ball bearing. The tips of the tubes rotate freely in mercury-filled grooves connected to the recorder through stainless-steel screws. No attenuation or distortion of the signal appears on records obtained through the coupler.*

A frequent problem encountered in electrophysiological studies of brain-wave activity in unrestrained conscious animals is one of twisted and kinked recording cables. This results in electrical artifacts, rapid cable deterioration, and restriction of the animal. The device shown in Fig. 1 has proved to be a satisfactory solution to the problem.

It allows the recording cable to turn freely as the animal moves and, at

the same time, maintains electrical continuity. The unit can be clamped in a ring stand or installed in a cross-member built over the cage. The arrangement is particularly useful in experiments involving extended periods of uninterrupted recording (for example, studies of drug effects).

The unit consists of a Plexiglas insert fitted into a ball bearing inside a fixed plastic shell. The wires in the recording cable are connected to the lower end of pieces of insulated stainless-steel tubing (hypodermic needle stock) passing through the insert. At the top these tubes extend upward from the axial hole in the shell. The upper end of each tube is bent to form an inverted "L," and its tip projects into an individual, mercury-filled, circular groove in the top of the shell. Each groove is separately connected with the amplifier of an electroencephalograph or some other recording device through a horizontal contact screw.

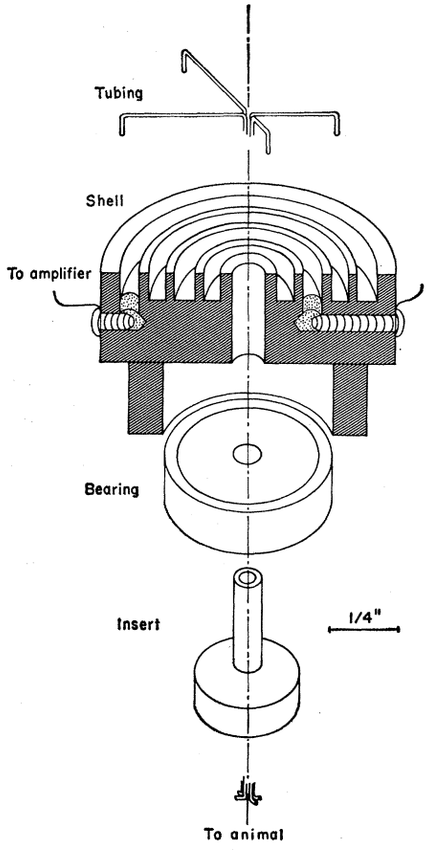

Fig. 1. Exploded view of cable coupler. Wires from recording cable are attached to bottom of tubes. A rubber band to support a loop of recording cable may be attached to the base of the insert. Leads to the recorder are connected to horizontal screws beneath grooves in the shell.

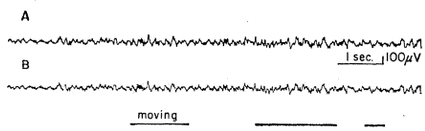

Fig. 2. Electroencephalogram from a bipolar electrode in rat prepyriform cortex. (*A*) Recording leads through cable coupler. (*B*) Leads directly from electrode to amplifier.

When the coupler is in use, torque on the recording cable is transmitted to the bearing. As it turns, the arms of steel tubing move through the mercury in the grooves, so that electrical continuity is maintained while the cable freely follows the animal's movement. Twisting or circling by the animal does not produce kinks in the cable. Figure 2 emphasizes the similarity of records made simultaneously through the coupler and bypassing it. There is no evidence of attenuation or distortion of the signal which passes through the coupler, nor are there distortions attributable to the coupler when movement occurs.

Care in construction will minimize both electrical and mechanical problems. Any of several plastic materials is suitable for the shell, so long as the dielectric quality is adequate. The diameter of the vertical orifice joining a groove in the shell and the hole for its contact screw should be the width of the groove; the mercury will not flow readily into a smaller hole because of high surface tension. The horizontal holes for the contact screws should accommodate large screws (6–32). The screws and the tubes from the recording cable should be stainless steel. Oxidation or amalgamation renders most other metals unsuitable.

Friction in the ball bearing is a potential problem, but this difficulty is minimized by using a precision bearing. The Plexiglas insert is press-fitted to the bearing, which in turn may be either press-fitted into the shell or held in place with screws. Since friction between the tubes and the walls of the grooves would hinder efficient operation of the coupler, the lengths of both limbs of each "L" must be measured accurately. Precise alignment is most easily obtained if the tubes are bent and cemented together before they are placed in the bearing insert. The resulting assemblage can then be accurately positioned for cementing in the insert.

It is helpful to employ a recording cable which is long enough to form a small loop suspended by a rubber band attached to the bearing insert. This arrangement provides both leverage to turn the bearing and a means for removing slack in the cable when the animal moves about the cage.

Care in protecting the unit from dust prolongs its efficiency. Both to eliminate contamination of the mercury by dust and for physical protection of the stainless-steel arms, a slip-on cap can be fitted over the shell (*1*).

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Ascorbic Acid in the Nutrition of Plant-Feeding Insects

Abstract. *Bollworms,* Heliothis zea *(Boddie), and salt-marsh caterpillars,* Estigmene acrea *(Drury) gradually decreased in ascorbic acid content as they matured, even in its presence. Cotton leafworms,* Alabama argillacea *(Hübner), also lost ascorbic acid, although a dietary need for the vitamin was not proved. Pink bollworms,* Pectinophora gossypiella *(Saunders), reared without the vitamin, increased in ascorbic acid content as they matured, an indication that the vitamin was synthesized by the insect.*

Ascorbic acid is an indispensable nutrient for several insects (*1, 2*). All insects known to need a dietary source of the vitamin feed on plants. Common insects such as cockroaches, house flies, and mealworms have been reared in the laboratory for many years on simple diets without added ascorbic acid. The cockroach, *Periplaneta americana* (L.), can synthesize this vitamin (*3*). Analysis of a number of different species of insects showed ascorbic acid in the tissues of all (*4*). Although the exact requirements for this vitamin have not been determined, ascorbic acid is now being added to many diets used in rearing plant-feeding insects.

The boll weevil, *Anthonomus grandis* Boheman, requires ascorbic acid (*2*). When adult weevils were fed an ascorbic