Conclusion. All fats do not bear the same relation to thyroid extract action. Some fats as cod liver oil, olive oil, lard, antagonize to different degrees the action of thyroid extract; others, as cocoanut oil, crisco, do not.

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Homologous (Resonance-like) Function in Supernumerary Fingers in a Human Case.

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In amphibia, a supernumerary muscle during spontaneous and reflex activity contracts simultaneously with the homologous normal muscle of the same name.[1] Since this is true for each individual muscle, a supernumerary limb (or limb fragment) always exhibits the same movements as the nearby normal limb (or corresponding limb fragment) of the same side.[2] From this phenomenon has been derived the concept of a "resonance-like" principle of communication in the nervous system.[3] The experimental evidence has been confined, thus far, to the amphibia, where supernumerary limbs can be produced at will. In order to test the validity of the principle of homologous ("resonance-like") response in higher vertebrates and man, where the transplantation of supernumerary limbs has not yet been possible, we must avail ourselves of those cases in which congenital duplications of limbs or of some of their parts present us with a comparable situation. A human case favorable to such study has recently been described by Halverson and Amatruda,[4] and was re-examined by the author as to its bearing on the problem of homologous function.

The case concerns a girl, L. S., 14 years of age, with congenital duplication of the left forearm and hand. While the radial part of the hand, including the thumb, is absent, its place is taken by a mirror image of the normal ulnar part. The resulting double formation is a symmetrical hand with what appears to be the original

[1] Weiss, P., *Pflüger's Arch. f. d. ges. Physiol.*, 1931, **226**, 600.

[2] Weiss, P., *Roux' Arch. f. Entwmech.*, 1924, **102**, 635.

[3] Weiss, P., *Ergebn. d. Biol.*, 1928, **3**, 1. See summary in P. Weiss, *J. Comp. Neur.*, 1935, **61**, 135.

[4] Halverson, H. M., and Amatruda, C. S., *J. General Psychol.*, 1935, **13**, 140.

index as axis of symmetry and 2 groups of 3 fingers each to either side of this index. The order of the supernumerary fingers being reversed, the 7 fingers of the hand can be identified, beginning with the most lateral one, as (n stands for normal, e for extra fingers) : n5, n4, n3, n2, e3, e4, e5. The supernumerary fingers are well formed but somewhat weaker than the corresponding normal fingers; the anatomical details and general observations concerning the functioning of the member can be found in the report of Halverson and Amatruda.

A re-examination of the voluntary and reflex movements of the fingers at once revealed the validity of the principle of homologous function in this case. Corresponding n- and e- fingers moved in unison, identical muscle groups contracting simultaneously. n2 can be moved independently of the rest. n3 and e3 always work together, and so do n4+n5 and e4+e5 (a dissociation between 4 and 5 has never been clearly observed so that these 2 must be rated as one). When L. was told to clutch a rod or the author's finger with her normal 3rd, 4th, and 5th fingers, the supernumerary 3rd, 4th, and 5th performed the same flexion in the air. When the 3rd was left extended, the supernumerary 3rd also failed to flex. When, after she had taken a firm grip on the rod, she was told to extend the 3 supernumerary fingers, this could not be done without the 3 corresponding normal fingers losing their grip and extending also.

In the absence of special recording apparatus, the following procedure was adopted as the most objective method of testing homology of response: The author had L. clutch one of his hands with her 3 extra fingers and held in his other hand the corresponding normal fingers which were equally flexed. L. was told to resist the passive stretching of any of her fingers by the author. If the author, then, tried to extend, for instance, n3, thus evoking an increased effort to keep this finger flexed, immediately an increased pressure was felt to be exerted by the corresponding e3, which had been quietly resting in the author's other hand. If passive extension was attempted on n4+n5, pressure by e4+e5 was felt to increase correspondingly. In this test the muscular contractions were chiefly isometrical and concealed from the subject.

When L. was ordered to tap the table with n3, keeping all the other fingers quiet, e3 invariably accompanied n3 in the tapping movement, while the other fingers, including the index separating n3 from e3, remained fairly inactive. Abduction of n3 from n2 could not be effected without simultaneous abduction of e3; since

n3 and e3 are mirror images of each other and their abductors lie on different sides, n3 and e3 move in opposite directions, either both away from the central index or both toward it, which clearly proves that the phenomenon is a matter of homologous function and not the result of mechanical association through common tendons.

In all the reported experiments, L. was, of course, prevented from controlling her movements by vision. In addition, the tests taken were absolutely new to her and she did not realize their purpose. Her low I.Q. (70-75) was a welcome safeguard against intentional deception on her part.

In general, we may state then that, concomitant with every movement of the normal part of the hand, a corresponding symmetrical movement appears in the supernumerary part. Only in one instance could a disturbance of this essential symmetry be observed: L., after grasping an object with e3, e4, and e5, whereby n3, n4, and n5 also went into flexion, was told to make efforts to extend n3-5 while leaving e3-5 bent. Under visual control, she could manage, after several futile attempts, to bring n3-5 into some sort of cramp-like extension without corresponding extension of e3-5. However, neither did the flexors of n3-5 relax completely, nor did the flexors of e3-5 remain in their previous vigorous flexion. As soon as the efforts to extend n3-5 were made, the grip of e3-5 lost its power, revealing that although e3-5 did not actually become extended, some reciprocal inhibition of the flexors, which forms part of every extension, had appeared. The residual flexor contraction, present equally in n3-5 and e3-5, was overbalanced, however, in the former group by an extensor contraction for which there was no noticeable counterpart in the latter. Since the flexor muscles of the two sets were found to retain their functional association, and also because in the reciprocal test (see above) independent extension of e3-5 could not be obtained, it is very likely that the apparently independent extension of n3-5 does not represent a real dissociation between 2 sets of homologous muscles. Presumably, the explanation lies in some asymmetry in the development of the long dorsal extensor muscles, some of which may be present in the normal part, absent in the abnormal part of the arm. The external aspect of the hand seems to support this view, although no decision can be reached without a thorough study of the musculature. As an alternative explanation, one might feel tempted to contend that cortical activity (conscious effort) might possibly be able to annul the close association which exists on the spinal level between iden-

tical muscles of the same side. In order to test this possibility, it has been suggested to L. that she continue in her efforts to train the 2 parts of her left hand to independent action. It is intended to re-examine her on later occasion and to ascertain the extent to which her efforts may have been successful. The fact, however, that no independence and dissociation of the 2 parts has developed during the past 14 years of her life, makes it appear rather doubtful that there will be much success in the future.

On the sensory side, the "homologous" function, appearing as "homologous" feeling, was already evident to Halverson and Amatruda in their examination of the case. We can only reiterate that L., without visual control, identifies the supernumerary fingers e3, e4, e5, when touched individually, as middle finger, ring finger, little finger, respectively, (identification by pointing to the finger on her normal right hand which feels like the stimulated one). There is then a definite perception of the organ quality of a finger, irrespective of its place on the hand. This perception is probably mediated by proprioceptive nerves for which it has been demonstrated that something muscle by muscle specific is inherent in their excitations, enabling the centers to identify, and discriminate between, various muscles irrespective of their place.[5] While confounding corresponding fingers of her left hand with respect to their organ quality, L. was yet able to discern whether a stimulated finger was the farther lateral or the farther mesial of the particular pair of identical fingers present. It is most likely that this discrimination was effected through cutaneous stimuli the local signs of which, contrary to the proprioceptive sense, are probably not perceived by means of different constitutional specificities.[6]

In conclusion, this case proves convincingly: that the resonance-like mechanism of nervous communication which makes a given muscle (or rather the nerve specified by the muscle[7]), and at the same time all supernumerary identical muscles, respond whenever an impulse specific for that muscle is generated in the corresponding central district, holds for man as well as for amphibia, hence probably for the whole group of vertebrates; furthermore, that proprioceptive sensations are, in man as well as in amphibia, identified by some specificity of the discharges of the sensory organs (or rather of the proprioceptive nerves specified by them), rather than by local

[5] Verzar, F., and Weiss, P., *Pflüger's Arch. f. d. ges. Physiol.*, 1930, **223**, 671. Weiss, P., *Pflüger's Arch.*, 1931, **228**, 486.

[6] Weiss, P., *Wiener Klin. Wchschr.*, 1931, **39**, 13.

[7] Weiss, P., *Anat. Rec.*, 1934, **60**, Suppl., 30.

signs. Brain activity, guided by sensory control, can in higher vertebrates change the pattern of coordination; but the human case described above does not encourage the view that it can also break down the unfailing obedience of a muscle (or its nerve) to its appropriate central discharges, as would be required in order to dissociate between 2 identical muscles innervated from the same level and the same side of the cord.

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Alterations in Serum Proteins as an Index of Liver Failure.

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For the past two years we have been interested in the study of the blood proteins in known or suspected cases of liver injury. That there is an alteration in the blood proteins in liver injury has been known since Glenet[1] showed a reduction of the total protein and numerous studies established that there was an elevation of the serum globulin (Felinski[2]) and a reversal of the albumin globulin ratio in cirrhosis of the liver with ascites (Abrami and Wallach[3]). Wiener and Wiener[4] obtained a reversal of the A/G ratio in cirrhosis and a hyperglobulinemia in acute infections. Meyers and Keefer[5] and Snell,[6] in cases of decompensated cirrhosis could not attribute the depletion of the serum albumin to its loss in the ascitic fluid.

Serum albumin, serum globulin and total serum protein determinations were made according to the hypobromite gasometric method of Van Slyke in cases of decompensated cirrhosis, cases with choluric jaundice, both intrahepatic and extrahepatic, without ascites, cases of ascites without clinical cirrhosis, a miscellaneous contrast group as well as a control group of normals. These normals served as a check on our technique and established values comparable to the accepted normal values of Peters and Van Slyke.

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1 Grenet, *Mem. Soc. de Biol.*, 1907, **63**, 532.

2 Felinski, *La Presse Medicale*, 1922, **30**, 236.

3 Abrami, P., and Wallech, Robert, *Comp. Rendes Soc. de Biol.*, 1930, **101**, 291.

4 Wiener, H. J., and Wiener, R. E., *Arch. Int. Medicine*, 1930, **46**, 236.

5 Meyers, W. K., and Keefer, C. S., *Arch. Int. Medicine*, 1935, **55**, 349.

6 Snell, A. M., *Proc. Staff, Mayo Clinic*, 1935, **10**, 481.