HUNGER AND APPETITE: A SUGGESTED CORRELATION BETWEEN PHYSIOLOGICAL AND PSYCHOLOGICAL PROCESSES.

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It is a well-known axiom that to know one subject thoroughly entails more than a passing acquaintance with many others. This is especially true of the field of medicine, where neglect of any one related subject may lead to an incomplete, or even to an erroneous solution of a particular problem.

The question then arises how far this holds true for the different medical sciences, *e. g.*, physiology and psychology. These two examples have been cited because, though the subject-matter of the physiologist is not that of the psychologist, yet in some matters they have to face difficulties much akin in character. For instance, the related subjects of hunger and appetite afford suitable material for the physiologist, at the same time that they have been by no means overlooked by the psychologist.

Considerations of this nature, together with the fact that I have a certain amount of personally-observed clinical material illustrative of the psychological side of the picture, have led to the writing of this paper; for they caused me to consider not only the practicability, but also the possible value of collating my own observations with physiological as well as with psychological data. My purpose in so doing is to determine, as far as possible, to what extent the independent findings in the one field confirm or contradict those in the other.

The Distinction between Hunger and Appetite.

Prof. Carlson, whose extensive researches on the subject have been largely drawn upon in this investigation, has come to the conclusion that there is a real qualitative distinction between hunger and appetite. Thus appetite, he says, is essentially pleasant, and

https://doi.org/10.1192/bjp.76.315.724 Published online by Cambridge University Press

never at any time painful, whereas hunger is always unpleasant, and when intense it may even be felt as pain.*

He bases his conclusions not only upon theoretical considerations, but also upon objective results, for he claims to have obtained successive contrast of the two sensations experimentally. Thus he found that the introduction of, *e.g.*, weak acids or wine into the stomach by means of the stomach-tube (in order to avoid stimulation of the nerve-endings of the mouth) gives definite results, both physical and psychological. Objectively, the gastric hunger contractions, previously present, are temporarily inhibited, owing, he supposes, to the stimulation of the gastric mucosa. Subjectively, the unpleasant tense sensations associated with hunger give place to a pleasant tingling in the stomach, and the thoughts tend to revert to the dinner-table—phenomena which he thinks are characteristic of appetite.†

On the other hand, it must be admitted that E. G. Boring, the eminent psychologist, was unable completely to confirm these findings. He failed even to detect appetite by Carlson's method, though it is true that under normal conditions of meals his observers had no difficulty in differentiating hunger from appetite or the " desire for food " as he calls it.‡

Hunger he found to be a complex of kinæsthetic pressure and pain, felt predominatingly in the region of the stomach. In the case of appetite, however, stomachic sensations were not always prominent, nor even always felt. This finding, together with others of a more positive nature, led him to the conclusion that " oral complexes " constitute the most generally recognized basis for appetite, meaning, *e.g.*, sensations arising from increased saliva tion, together with certain pressures and aches, indicating a desire for food, similar to the sensory basis for thirst.§

But apart from such experimental work, to which more detailed reference will be made later, there is much well-known physiological and psychological material which goes far to support the existence of a qualitative distinction between hunger and appetite.

In the first place, whereas hunger is almost if not entirely dependent upon internal stimuli, appetite is also largely concerned with those of external origin. In the second place, the crude, unpleasant

* Carlson, A. J., "A Method of Obtaining Successive Contrasts of the Sensations of Hunger and Appetite," *Amer. Journ. of Physiol.*, xxxiii, 1914, p. xvi.

† *Idem, The Control of Hunger in Health and Disease*, p. 116.

‡ Boring, E. G., and Luce, A., "The Psychological Basis of Appetite,' *Amer. Journ. of Psychol.*, 1917, xxviii, p. 443 *ff.*

§ Boring, E. G., "Processes Referred to the Alimentary and Urinary Tracts," *Psychol. Review*, 1915, xxii, p. 310.

https://doi.org/10.1192/bjp.76.315.724 Published online by Cambridge University Press

character of hunger forms a contrast with the pleasant, more delicately discriminating nature of appetite.

Again it is common knowledge that appetite, unless intense at the outset, is increased by the very act of eating—as a well-known proverb reminds us, "l'appétit vient en mangeant." Hunger, on the contrary, is always decreased, if it does not entirely cease with eating.* This suggests that hunger and appetite have to some extent contrasting functions.

Hunger is essentially katabolic, in correspondence with the very end for which it exists—that of urging the organism to active search for food. This aim reached, *i.e.*, the nourishment procured, it is advantageous that the hunger and associated katabolism should give place to the more pleasant sensations of appetite and the related processes of digestion and anabolism. It is a commonplace of medicine that appetite aids digestion; this alone indicates that it is of value that it should increase at meal-times.

The Psychological Aspect of Hunger and Appetite.

There is much therefore to support the truth of an important hypothesis with which I shall be much concerned in this paper, namely that appetite is more nearly related to the conscious, and hunger to the unconscious aspects of the mind.

Hunger, like pain, may be said to be a biological necessity, called into existence in the interests of self-preservation. Essentially connected with primitive instinctive activities, it resembles an emergency call in the way it forces itself upon consciousness, sweeping away all irrelevant considerations. This accounts for its sudden onset, and its relative independence of the type of food required—the nourishment is gulped down, all attention being concentrated upon the satisfaction of this one urgent primitive need.

The study of a case of my own, in this paper referred to as "Z—," illustrates some of these features very clearly.

Z—, at the time that he first came for treatment, was a young man, æt. 27. He had been a "difficult" child. Intelligent and imaginative, but passionate and self-willed, he had reacted badly both to the indulgence of his mother and the severity of his father. Thus his narcissism, his exaggerated estimate of his own capacities, were only equalled by the fear which may be said to have been one of the ruling principles of his life. Take, for instance, the degree of fear with which

* This is due to the simultaneous inhibition of gastric hunger contractions, which Carlson found took place upon the mastication of palatable food, or when liquid food was poured into the stomach.

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he regarded the two main symptoms for which he came for treatment, *i.e.*, masturbation and inability to have some decayed teeth extracted. On the other hand, his inability to give free play to his feelings of hostility and thwarted self-love found indirect expression in other symptoms of various kinds, of which perhaps the most noteworthy were the attacks of compulsive hunger from which he suffered.

His bulimia appears for several reasons to represent the activity of the primitive unconscious processes. This is most obviously demonstrated by the fact that it was especially frequent at periods of emotional stress. In addition, on some occasions, when it was even noticeably unconnected with the bodily needs of the moment, it was nevertheless of such strength as to almost paralyse all other thoughts, feelings and actions. Every other matter was swallowed up in one absorbing thought, that of food, in the manner typical of the "All or none principle" so characteristic of unconscious processes. In this way his bulimia served an obvious negative function by inhibiting temporarily the fulfilment, even the consideration of the opposing conscious desires; and this, of course, apart from the fact that it might in itself have been furthering the wishes of the unconscious through the operation of important symbolical relationships.

Hunger is thus brought to some extent into line with the primitive unconscious. That appetite bears a similar relationship to the conscious is at once suggested by the fact that whereas internal phenomena are all that are necessary for the existence of hunger, in the case of appetite external stimuli, present or remembered, are also required. As Carlson says, given a certain complex from the viscera, and an approximately normal state of central correlations—all that is necessary for the existence of hunger—the central and essential element in appetite is the memory of past experiences (sight, taste, smell, etc.) of palatable foods. Incidentally, as he remarks, these memories may be reinforced by external factors, which is of course to be expected.*

The Physiological and Anatomical Basis of Hunger and Appetite.

The fact that outer stimuli make their appeal by way of the special senses indicates the direct connection of appetite with the cerebral cortex—a matter which, doubtful in the case of hunger, thus becomes a certainty here. But after all, this is but to repeat what has already been implied in another form, since the very

* Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 98.

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discrimination which contrasts appetite with hunger at the same time allies it to the finer and more delicate epicritic sensations characteristic of the sensory cortex.

On the other hand, the typically crude and undiscriminating nature of hunger goes far to justify Carlson's classification of this sensation as protopathic.* It is true that in so doing he does not wish to deny the possibility of cortical connection, but strictly speaking, the term "protopathic" as used by Head does carry with it this implication. For these sensations are thought by Head and Sherren to be anatomical as well as distinct functional entities.† They consider that their nature excludes all possibility of any direct cortical connection, at the same time that it differentiates them from the finer and more delicate epicritic sensations.

Whether or no we agree with Head as to the existence of protopathic nerve-fibres, yet there can be no doubt but that the "essential organ" of the thalamus is the end-station for very similar types of sensation, and it seems possible that hunger may have such a subcortical end-station rather than a cortical, which seems properly to belong to appetite. Thus the thalamus has been found to be the centre of "awareness" for certain sensory aspects.‡ This applies especially to the recognition of the coarser sensation of heat and cold, and, of more interest in connection with hunger, that of painful or uncomfortable stimuli. The latter, it may be noted, are thought to be only slightly, if at all, under cortical control.§

Now the circumstance that hunger may have its sensory end-station in the thalamus, and is also connected with the primitive emotions, is in harmony with the fact that the thalamus is the centre for feeling.‖ So the thalamus, even apart from its possibly intimate connection with the emotions and the cruder aspects of sensation, gives independent support to the hypothesis regarding

* *Idem*, "A Method of obtaining Successive Contrasts of the Sensations of Hunger and Appetite," *Amer. Journ. of Physiol.*, 1914, xxxiii, p. xvi.

† Head, H., and Sherren, J., "The Consequences of Injury to the Peripheral Nerves in Man," *Brain*, 1905, xxviii, p. 291.

‡ Head, H., "Studies in Neurology," *Sensation and the Cerebral Cortex*, p. 664.

§ *Ibid.*, p. 665.

‖ The thalamus indeed derives its importance less from its position as a sensory end-station than from the fact that it constitutes the centre for feeling. Thus, while a destructive lesion may cause any degree of sensory disturbance, the release of the thalamus from the controlling and inhibitory influence of the cerebral cortex, *e.g.*, by the severance of the cortico-thalamic fibres by injury or disease, invariably results in an exaggeration of the feeling-tone accompanying sensation. From this the general principle has been deduced, that the greater the affective reaction to any stimulus, the more certain its connection with the thalamus. Conversely, the more entirely any aspect of sensation depends upon discrimination, the less its thalamic, and the greater its cortical appeal. (*Ibid.*, p. 664.)

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the closer association of hunger and appetite with the unconscious and conscious respectively.

This consideration also reinforces Freud's contention as to the prime importance of the emotions; for just as the coarser sensations form the basis upon which the later evolved epicritic sensations rest, so, from analogy alone, the emotions, rather than the later evolved intellectual processes, would be expected to act as ultimate determinants of conduct. Similarly it seems possible that just as the cortex is associated with the more purely intellectual processes, so the thalamus may be in some sort regarded as an anatomical centre of the emotional life.*

In this way anatomy and physiology alike give independent confirmation to the view that it is by way of the emotions that the more primitive mental processes, included by Freud under the name of the unconscious, find expression. In much the same manner, as physiologist and psychologist agree, reason and intellect indicate the action of those processes—included by Freud under the term of "the conscious"—by means of which the more recently evolved and more highly developed elements of the cerebral cortex give evidence of their presence.

Hunger and Appetite in Connection with Further Psychological Considerations.

These considerations go far to support the view that appetite may be connected with hunger in much the same way that the conscious rests upon the unconscious aspects of the mind.

Indeed in many respects appetite seems to partake of the nature of Freud's "ego." Thus the fact that it owes its origin and many of its distinctive characteristics to the influence of the environment acting upon the special senses offers a point of resemblance; for the ego is described as being "ultimately derived from bodily sensations, chiefly from those springing from the surface of the body."†

Then again, owing to the instinctive basis upon which each rests, in the case neither of the ego nor of appetite can internal stimuli be left entirely out of account. Appetite is of necessity a more limited concept in correspondence with the fact that its instinctual

* It is interesting to recall in this connection that destructive lesions of the thalamus may be accompanied by impairment of the emotional movements of the face, while those of volition remain intact.

† Freud, S., *The Ego and the Id*, p. 31. (Authorized note by the translator.)

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elements are related to hunger. The ego, on the other hand, represents the whole of that part of the personality whose formation is due to the influence of external factors; this is in agreement with the circumstance that its ultimate foundation is the totality of the emotional and instinctive life, termed by Freud the "id."

The function of the ego and of appetite are also similar, depending as they both do upon internal and external stimuli. In a sense they act as intermediaries between inner and outer reality, so enabling the organism to adjust itself to both. This is most markedly the case with the ego; for, owing to its direct connection with the cerebral cortex, it possesses considerable powers of inhibition over the otherwise relatively uncontrolled instinctual activities.

It is true that this does not hold in quite the same way for appetite, but even here, in virtue of its relations with the cerebral cortex, it necessarily becomes associated with certain inhibitory factors inoperative in the case of hunger. Witness its powers of discrimination, which distinguish it from hunger at the same time that they ally it to the ego. Indeed when Freud says "in the ego perception plays the part which in the id devolves upon instinct"* he might have been referring to appetite and hunger respectively.

The Relation of Appetite to Hunger.

In this way psychology, in common with physiology, alike supports the view that there is a qualitative distinction between hunger and appetite. The error of regarding them as merely different intenrities of the same sensation curve has probably arisen, as Carlson suggests, from the fact that appetite is usually present at the same time as hunger.† When hunger is mild, then appetite is the more prominent in consciousness, whereas when hunger is powerful attention becomes focused upon this sensation.

In other words, at periods of strong instinctive need, the delicate discrimination associated with appetite gives place to the relatively uncontrolled urge of hunger. After all, it is in much the same way that the ego, which Freud regards as the representative of reason and sanity, may on occasion be overpowered by the id, which contains the passions.‡

This corresponds with the fact that though reason would be impossible in the absence of the cerebral cortex, yet at bottom the

* *Ibid.*, p. 30.
† Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 99.
‡ Freud, S., *The Ego and the Id*, p. 30.

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most intellectual and logical argument has to some extent an emotional basis. As Bernard Hart has pointed out, the conclusions of the politician are obtained less by the application of sound logical principles than by the mental set given to his way of thinking by his emotionally-toned bias.*

So with appetite, true as it is that the presence of the more recently developed cerebral cortex is essential for its presence—as possibly contrasted with hunger—yet even here the emotional factor cannot be left entirely out of account. Thus the mood of the moment, the society, and the surroundings generally, must be to some extent taken into consideration here, so indicating the ultimate instinctive basis upon which each rests.

" Better is a dinner of herbs where love is, than a stalled ox and hatred therewith."

The subject of hunger and appetite will now be discussed in greater detail. Especial reference will be made to hunger, since on the physiological side the more elementary processes are more particularly dealt with here, while from the psychological point of view the clinical material is concerned with the pathological phenomenon of compulsive hunger.

The Stimulus for the Sensation of Hunger.†

Cannon and Washburn, as a result of their investigations on the subject, state definitely that the cause of the sensation of hunger is the contractions of the empty stomach. They base their conclusion on their experimental finding of the close concomitance of the two;

* Hart, B., *The Psychology of Insanity*, p. 131.

† A clear account of the three methods utilized by Carlson for the determination of the tonus and contractions of the empty stomach, both in man and animals, is to be found in chap. 3 of his work entitled *The Control of Hunger in Health and Disease*.

The following are the three methods employed by him in his experimental work (*ibid.*, p. 30):

(*a*) Direct inspection through a permanent opening in the stomach-wall (gastric fistula).

(*b*) The introduction of a balloon into the stomach either through the œsophagus or through a gastric fistula, and the recording by the distended balloon of the variations in pressure of the gastric contractions.

(*c*) The introduction into the stomach of a balloon covered with bismuth paste on the inside. This makes possible the graphic record of the stomach movements synchronously with X-ray photography, or inspection by aid of the fluoroscope, together with the recording, in man, of subjective sensations.

The principal subject of the experiments was a healthy young man, æt. 31, with complete closure of the œsophagus, and a permanent gastric fistula of twenty years' standing.

Experiments were also made upon Carlson himself and some of his co-workers (*ibid.*, chap. 9), upon infants (*ibid.*, chap. 8), and upon the lower animals (*ibid.*, chap. 9).

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in addition they think that the subject's inability to control these movements in any way excludes all possibility of suggestion.*

Though Carlson does not consider that this evidence is complete in itself, yet he is on the whole in agreement with this view, for his own independent observations show that, when the stomach is normal, strong contractions of the empty stomach are productive of hunger pains.† Besides this he also found, although it is true some difficulty arose from the occurrence of " spontaneous " stomach movements,‡ that in general inhibition of such gastric activity and cessation of the hunger sensation run parallel.§

The stimulus itself, in so far as it is a mechanical one, he thinks is variation in tension rather than actual pressure, in which case hunger contains kinæsthetic sensations as well as pain, the latter predominating in strong hunger.‖

The Origin of the Gastric Hunger Contractions.

With regard to the actual origin of the hunger contractions themselves, Carlson enumerates as the four most probable conditions which may be responsible¶ :

1. A primary mechanism in the stomach-wall.
2. The condition of the gastric mucosa.
3. Motor impulses through the vagi.
4. The condition of the blood.

Of these he considers that the first is the essential factor.** Before arriving at his final decision, however, he first excluded the other three alternatives.

With regard to these he found that stimulation of the gastric mucosa has a negative function, since far from exciting, it actually has an inhibitory effect upon the contractions.††

The vagus nerve, on the other hand, he found has a direct positive action, since strong contractions of the stomach, full or empty, can be induced by stimulation of this nerve.‡‡ Nevertheless, since the

* Cannon, W. B., and Washburn, A. L., " An Explanation of Hunger," *Amer. Journ. of Physiol.*, 1911–12, xxix, p. 451.
† Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 69.
‡ *Idem*, " The Contractions of the Empty Stomach Inhibited Reflexly from the Mouth," *Amer. Journ. of Physiol.*, 1912–13, xxxi, p. 213.
§ *Idem*, *The Control of Hunger in Health and Disease*, p. 64.
‖ *Ibid*, p. 69.
¶ *Ibid.*, p. 169.
** *Ibid.*, pp. 170–183.
†† *Ibid.*, p. 182.
‡‡ Carlson, A. J., " The Influence of Stimulation of the Gastric Mucosa on the Contractions of the Empty Stomach (Hunger Contractions) in Man," *Amer. Journ. of Physiol.*, 1913, xxxii, p. 246.

https://doi.org/10.1192/bjp.76.315.724 Published online by Cambridge University Press

movements of digestion can be carried out fairly efficiently after section of both vagus and sympathetic,* he therefore thinks that the vagus acts merely as an accessory to the primary neuro-muscular mechanism in the stomach-wall.

As to the condition of the blood, he considers it most likely that this is normally of secondary importance.†

The Gastric Mucosa and Appetite.

The *rôle* played by the gastric mucosa is of especial interest in view of the additional support which it gives to the possibility of a real qualitative distinction between hunger and appetite; for though, as already mentioned, with regard to hunger the results are negative, yet in the case of appetite they are on the whole positive.

Thus Carlson found that stimulation of the gastric mucosa inhibits both the sensation of hunger‡ and the gastric hunger contractions.§ On the other hand, with the stomach normal, chemical (and possibly mechanical) stimulation of the nerve-endings of the gastric mucosa‖ initiates or augments the sensation of appetite, at the same time that it favours if it does not increase the movements of digestion. In view of the fact that appetite also assists digestion, the possibility suggests itself that stimulation of the stomach mucosa may be the gastric component of this sensation, in much the same way that the gastric hunger contractions are that of hunger. How far this is the case is by no means at present decided—there is even doubt as to whether gastric sensation plays an essential part at all in the production of appetite.

Pavlov thinks there is a definite connection. Thus he attributes some of the satisfaction caused by eating to stimulation of the stomach as well as to that of the buccal cavity. As he points out, cases of anorexia have been known, which were apparently due to gastric anæsthesia. To quote his words, "Such patients . . . dislike the idea of eating, because the food, as they express it, appears to fall, as it were, into an empty sack."¶ He also cites a personal experience of anorexia following an illness, when recovery of appetite followed the swallowing of a mouthful of wine. He

* *Idem, The Control of Hunger in Health and Disease*, p. 159.
† See pp. 735, 736.
‡ Carlson, A. J., and Braafladt, L. H., "The Sensibility of the Gastric Mucosa," *Amer. Journ. of Physiol.*, 1914, xxxvi, p. 164.
§ Carlson, A. J., "The Control of Hunger in Health and Disease, p. 182.
‖ Carlson, A. J., and Braafladt, L. H., "The Sensibility of the Gastric Mucosa," *Amer. Journ. of Physiol.*, 1914, xxxvi, p. 169.
¶ Pavlov, I. P., *The Work of the Digestive Glands*, p. 109.

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observes that at the very moment that he felt the liquid pass along the œsophagus into the stomach, he perceived the onset of a keen appetite. He thinks, however, that under normal conditions the gastric sensations are so weak that they are as a rule disregarded in the ordinary course of digestion.*

Carlson appears to be of much the same opinion, for he says that when foods or liquids are swallowed in the usual way the nerve-endings in the mouth are the chief sensory factors in appetite, and that these have to be excluded for the gastric component to be clearly distinguished.†

The personal element obviously enters in here, and with it those individual differences, both objective and subjective, which complicate psychological to an even greater extent than physiological experimental work. It may be that here we have the explanation of the different conclusion reached by Boring as a result of his experiments on appetite.‡ Unlike Carlson he does not think that the stomachic complex is an essential component of this sensation. Thus not only did two of his observers never base appetite upon this foundation, but in some instances such gastric sensations were not observed at all.

In spite of this, however, he considers that in so far as appetite has a stomachic sensory pattern, it is akin to, though not identical with, that of hunger. On the whole, therefore, the views of the experimental psychologist have much in common with those held by the experimental physiologist.

Rôle of Extended Vagus and Sympathetic.

Carlson thinks that the gastric functions of the extended vagus, taken in conjunction with that of its antagonist the sympathetic, are largely if not entirely concerned with the regulation and control of the automatic neuro-muscular apparatus in the stomach-wall.§

Beneficial, however, as are the results associated with well-balanced co-operation between these two opposing forces, they are paralleled by the malfunction to which disturbance of this equilibrium may give rise. Indeed there is much to justify Eppinger

* *Ibid.*, p. 108.

† Carlson, A. J., and Braafladt, L. H., "The Sensibility of the Gastric Mucosa," *Amer. Journ. of Physiol.*, 1914, xxxvi, p. 165.

‡ Boring, E. G., and Luce, A., "The Psychological Basis of Appetite," *Amer. Journ. of Psychol.*, 1917, xxviii, p. 453.

§ Carlson, A. J., "A Study of the Mechanisms of the Hunger Contractions of the Empty Stomach by Experiments on Dogs," *Amer. Journ. of Physiol.*, 1913 xxxii, p. 388.

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and Hess in their attempt to divide neurotics into two main classes, the sympatheticotonic and the vagotonic, according to the tendency to overaction of the sympathetic and extended vagus respectively.*

Of such disturbances by no means the least is the dissociation of emotion from the normally resulting activity; thus the substitution of enforced passivity for the activity which should follow sympathetic action may do positive as well as negative harm.

On the negative side it requires no great amount of mental acumen to perceive that it is such inhibition of sympathetic expression which differentiates the comparatively cold and reserved vagotonic from the more emotional and excitable sympatheticotonic. Such indeed is the picture presented by Z—, with his desire to suppress all feeling, since, as he says, "to show emotion is so undignified."

But not only the negative, the positive aspect of such vagal activity is to be found in Z—'s case. This manifested itself especially in his bulimia, to which we have already referred. The fact that this result of vagal stimulation was most frequent at times of mental conflict in itself suggests the possibility that such attacks of compulsive hunger may have represented one of the means by which, through the medium of the extended vagus, the repressed forces found some outlet for their needs. That they expressed themselves in such an unsatisfactory manner corresponds to the well-known fact that neurotic gratification is often felt as pain—though the repressed are able to escape to some extent from the bonds in which they are held, they have to pay dearly for their partial release.

The probable validity of this hypothesis is further supported by a patient A—, who contrasts with Z— in being a sympatheticotonic. If she is obliged to disguise her feelings—especially those of a negative type—*e. g.*, those of hatred and hostility—she tends to be attacked by bulimia. This is well illustrated by the overwhelming and insatiable hunger she experienced during the air-raids which occurred in the Great War. At the moment she not only felt no conscious fear, but was also filled with scorn—which significantly enough she did not openly express—for a relative who behaved in a wildly hysterical manner.

Condition of the Blood.

Another possible cause of the hunger contractions—the condition of the blood—Carlson discounts on the ground that on the whole

* Eppinger, H., and Hess, L., *Vagotonia*.

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the composition of this fluid is more constant than that of the tissues.*

He acknowledges that experimental hyperglycæmia inhibits the normal gastric hunger contractions, and that insulin hypoglycæmia (in normal dogs) tends to be associated with gastric tetany. These phenomena, however, he ascribes to the state of the tissues rather than to that of the blood; thus he suggests that under ordinary conditions the gastric tonus and contractions of the stomach increase parallel with the reduction of the tissue glycogen, and an enforced energy metabolism of lipoids by the motor tissues of the stomach.†

He considers, in short, that it is only under abnormal circumstances that the blood has a directly stimulating effect upon the hunger contractions. Take for instance the increase which is induced by the intravenous injection of blood from a starved into a normal animal, together with the similar action of diabetic blood.‡ These findings he attributes to some substance in the blood, both of the starved and the diabetic animal, which is either normally absent, or is present in only relatively small amount. As he points out, the transfusion of blood from normal dogs, or from dogs whose digestion was at its height, has either no effect, or else has but a slight and transient one, upon the motor condition of the empty stomach.§ In further corroboration of his position are the findings that glucose and insulin have initial effects of an opposite character on the gastric hunger contractions of the normal and diabetic dog.‖

But apart from these observations the relative constancy of the composition of the blood in itself renders it unlikely that there occurs in it a periodic fluctuation parallel with the periodicity of the gastric hunger contractions.¶

Possibly, however, of greater significance is the fact that in young vigorous animals hunger contractions begin as soon as the stomach is empty, while digestion and absorption in the intestine are still in progress.**

* Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 169.

† Bulatao, E. J., and Carlson, A. J., "Influence of Experimental Changes in Blood-Sugar Level on Gastric Hunger Contractions," *Amer. Journ. of Physiol.*, 1924, lxix, pp. 114–15.

‡ Luckhardt, A. B., and Hamburger, W. H., "A Note on the Movements of the Empty Stomach in Certain Pathological States," *Journ. Amer. Med. Assoc.*, 1916, lxvi, p. 1833.

§ Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 221.

‖ Bulatao, E., and Carlson, A. J., "Influence of Experimental Changes in Blood-Sugar Level on Gastric Hunger Contractions," *Amer. Journ. of Physiol.*, 1924, lxix, p. 111.

¶ Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 170.

** *Idem, ibid*, p. 169.

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This latter observation is of especial interest in connection with Z—, in that his attacks of hunger seemed to show an approximation to an infantile form of reaction. Thus they tended to occur about two hours after a meal, even if this had been of such an ample character that, as he himself said, he cannot have been really hungry. In other words it seems possible that this premature hunger may have been a translation into physiological terms of an attempt on the part of the more primitive mental processes to return to the days of childhood, when they were allowed fuller play, less trammelled by the inhibitory forces of conscious control.*

Effects of Sleep.

It is interesting that Luckhardt, though it is true in a rather different connection, has come to a somewhat similar conclusion. For he attributes his experimental finding—that the hunger contractions are either unaffected or are increased during sleep—to the relative freedom of the gastric motor mechanism from such inhibitory restraint as is exercised during waking life by the exteroceptor field (ears, eyes and so on).†

But this conclusion, to which this author has been led by the results of his experimental work, does not seem to Carlson to afford an adequate explanation for what, from physiological investigation alone, certainly does appear to be an anomaly. Thus, as he points out, except for this one case, sleep is associated with decreased activity of the cerebro-spinal system.‡

Closer examination, however, of the question in connection with the psychological aspects of the subject presents a possibly more satisfactory solution to the problem.

In the first place, on the purely psychical plane, the whole of the nervous system is not involved in increased passivity during sleep, since it is at this time that the activities of the unconscious are increased at the expense of the conscious. In the second place, the presence of the gastric hunger contractions is compatible with

* This inference is further reinforced by the above-noted tendency to regularity in the occurrence of Z—'s hunger states. For such regularity is consistent with the lower, more instinctive reactions to which habit is more nearly allied, rather than with that capacity for adaptation characteristic of more intelligent action. This is corroborated by Cannon and Washburn, who regard the appearance of hunger at meal-times as one of the habits of the alimentary canal, of which the regular occurrence of defæcation is another noteworthy example. ("An Explanation of Hunger," *Amer. Journ. of Physiol.*, 1912, xxix, p. 452.)

† Luckhardt, A. B., "The Effect of Dreaming on the Gastric Hunger Contractions," *Amer. Journ. of Physiol.*, 1915–16, xxxix, p. 334.

‡ Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 151.

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vagal stimulation as well as with sympathetic depression—that usual if not constant concomitant of elimination of gastric impulses arising from mental activity.

These two facts together suggest that we may have here a more general application of a hypothesis previously brought forward with regard to Z—'s attacks of compulsive hunger. It was then suggested that his bulimia might be the subjective experience of gastric contractions due to the stimulating action of his repressed unconscious upon the extended vagus. If this is the case, it may also be that the apparently inconsequent stomach movements during sleep may similarly be psychologically determined. In other words it is conceivable that they may be the objective expression at such periods of those activities of the repressed unconscious which find outlet by way of the extended vagus. Should future research verify this theory, psychology will thus have supplied the key to a riddle which physiology unaided could not solve.*

Hunger causing Insomnia.

This possibility finds unexpected confirmation from a further conclusion arrived at by Carlson as a result of some experiments on sleeping dogs.† Since it was found that the animals were awakened when the contractions were too vigorous—and he thinks that the same probably applies to man—he considers that the ability to sleep depends upon the relation between the intensity of the hunger contractions and the depth of sleep.

This connection of hunger with insomnia—given that the previous association between certain repressed and vagal activities is correct—may well be an illustration of the way in which neurotic gratification causes pain rather than pleasure.

Incidentally it is in agreement with the psycho-analytic theory brought forward by Eisler, that the more active an individual has been in the oral phase, and the more this has been later repressed, the greater the liability to sleep disturbances if the libido afterwards regresses to this earlier stage of development.‡

* Otherwise, as Carlson says, this absence of gastric depression during sleep seems to indicate that the vago-gastric mechanism holds a unique position in the organism, a degree of independence of afferent impulses (exteroceptors) and central processes not known in the case of any other neuromuscular apparatus.

† Carlson, A. J., "A Study of the Mechanisms of the Hunger Contractions of the Empty Stomach by Experiments on Dogs," *Amer. Journ. of Physiol.*, 1913, xxxii, p. 381.

‡ Eisler, M. J., "Pleasure in Sleep, and Disturbed Capacity for Sleep," *Internat. Journ. of Psycho-Analysis*, 1922, iii, p. 39.

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It is but natural that the repressed oral libido—or for that matter any other repressed force—unable to express itself in the normal and satisfactory way, when freed to some extent by sleepiness from the ordinary control of waking consciousness, should seek outlet by any other easily available channel. But in so far as this is connected with vagal activity and a consequent increase of hunger contractions, a paradoxical result may occur; for the means of escape thus obtained by the unconscious may disturb, even prevent, the very sleep which has allowed it this freer play. What wonder, then, that where expression of the inhibited forces leads to such discomfort, repression comes to be looked upon as the best method for meeting their demands.

It seems probable that we may have here a reason which in part accounts for the mental attitude betrayed by the advice to "forget your troubles in work," and so on. At the same time it may also explain how it happens that work, which in the well-adapted individual affords an outlet for instinctual tendencies, in these cases is looked upon, and to some extent with justice, as an opponent of the primitive desires and needs.

Effects of Dreaming.

Since the gastric hunger contractions, when too strong, are disturbers of sleep, their inhibition when there is much dreaming,* suggests that the dream is the guardian of sleep. In this way physiological experiment supports a view deduced by Freud from material of a purely psychological nature.†

Of course it may be argued in opposition to this that the inhibition is due to some cause other than a mental one: but this seems improbable for physiological as well as psychological reasons. Thus the physiologist Luckhardt—to whose experimental work on dogs we owe our knowledge of the effect of dreaming on the gastric hunger contractions—considers that the inhibition is cerebral, or, as he puts it, "purely central in origin.‡

* Luckhardt, A. B., "The Effect of Dreaming on the Gastric Hunger Contractions," *Amer. Journ. of Physiol.*, 1915–16, xxxix, p. 334.

† Freud, S., *The Interpretation of Dreams*, p. 197.

‡ He comes to this conclusion after fully weighing the pros and cons of the whole matter. Thus he points out that there is no known sensory nerve which is able to convey such an inhibitory impulse into the central nervous system. To a like effect is his statement that the same cerebral states which effect the movements of the limb and facial muscles are also responsible for inhibition of the hunger contractions.

For various reasons he rejects other possibilities. Thus he dismisses a gastric origin on the grounds that the sensation of hunger, even when painful, does not inhibit the movements of the empty stomach. He thinks that a nervous rather

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It is of further interest in this connection that Weygandt ascertained, in the course of his investigation of the mental effects of hunger, that during periods of starvation the tendency to dream is increased.*

On the other hand it is certainly true that the dream, in spite of its ability to inhibit these disturbing movements, may not achieve its purpose of preserving sleep. This may be ascribed generally speaking to one of two causes.

The first is an example of a partial failure on the part of those mechanisms, included under the heading of the "dream-work," to disguise from consciousness those repressed desires which in the dream are striving for expression. The conscious disturbed, even shocked by these revelations, is roused to the full consciousness of waking life.

This argument necessitates, it is true, acceptance of the psycho-analytic opinion that the dream expresses the workings of the unconscious tempered to a greater or less extent by the necessity for disguising from consciousness the full import of its wishes. But the probability that this construction is correct is reinforced by the fact that it accounts equally well for the other possible cause of such sleep disturbance—the over-alertness of the conscious. For the activity of unconscious wishes may lead to such a heightening of these inhibitory censoring factors, more active in waking life, but still present even in dreams, that a degree of cerebral activity is aroused incompatible with the condition of sleep.

This is illustrated by consideration of Z—'s case. Thus when he is making determined efforts to resist masturbation he is liable to commit the act in his sleep, or, presumably when the conscious is more on the alert, he may awake just as he is about to do so. This circumstance has a further interest in connection with the subject-matter of this paper, since the onset of the habit of masturbation

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than a chemical origin is indicated by the abruptness with which the contractions cease. For this reason an increased output of adrenalin is not implicated—of interest, since Cannon and de la Paz have shown that it is this secretion which inhibits the movements of digestion when the emotions of fear, rage and pain are aroused. (*Amer. Journ. of Physiol.*, 1911, xxviii, p. 64.)

Other possibilities he discounts by evidence chiefly of a negative nature. For example, he discards in this way the action of the splanchnic nerves on the stomach musculature, and that of afferent impulses from the sensory nerve-endings in the muscles, skin and joints, which in turn have been excited by active movements dependent upon impulses of cerebral origin. (*Amer. Journ. of Physiol.*, 1915–16, xxxix, pp. 330–334.)

* Weygandt, W., "Ueber die psychische Wirkungen des Hungers," *Münch. med. Wochenschr.*, 1898, xlv, p. 388.

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coincided with that of his bulimia. The probable significance of this association is emphasized by the fact that not only is his compulsive hunger more frequent at times of mental stress, but it is also one of the pre- and post-masturbation symptoms of which he complains.

Vaso-Motor Changes.

Moreover the hunger which occurs on these occasions seems to indicate indirectly the degree of mental conflict that is raging round the " habit " as he calls it, since it is especially apt to lead at these times to an almost incapacitating weakness and faintness.

Carlson points out that these concomitants of hunger states are not improbably associated with synchronous vaso-motor changes. Thus plethysmographic records of the arm show that in most cases the volume of the limb increases to an amount parallel with strong contraction of the stomach, and diminishes correspondingly during a pause.*

The character of these alterations has led him to think that there may be a close connection between the vaso-motor centre and the bulbar tonus centre of the stomach.† It is of interest that this suggestion, deduced from physiological observations, finds independent support from the consideration of Z—'s case. Thus certain definite vaso-motor signs of a transitory description, as well as disabling attacks of hunger, were some of the post-masturbation symptoms of which he complained; his hands were then apt to become unpleasantly swollen and hot, and he suffered from an irregular flushing of the face, often uni-lateral in distribution.‡

The degree of variability shown by these vaso-motor changes, however, renders it doubtful, as Carlson says, whether they constitute a necessary part of the hunger complex.§ But since they do occur in some cases it would be satisfactory if they could be accounted for. It is true that their variation, both in different persons and in the same person at different times, is in part

* Carlson, A. J., " The Influence of the Contractions of the Empty Stomach in Man on the Vaso-Motor Centres, on the Rate of the Heart-Beat, on the Reflex Excitability of the Spinal Cord," *Amer. Journ. of Physiol.*, 1913, xxxi, p. 321.

† Carlson, A. J., " The Character of the Movements of the Empty Stomach in Man," *Amer. Journ. of Physiol.*, 1912, xxxi, p. 152.

‡ It would be of interest to know whether the increase in volume of the limbs is equal, or whether there is a difference to be detected by the use of the plethysmograph.

§ Carlson, A. J., " The Influence of the Contractions of the Empty Stomach in Man on the Vaso-motor Centre, on the Rate of the Heart-Beat, on the Reflex Excitability of the Spinal Cord," *Amer. Journ. of Physiol.*, 1912, xxxi, p. 324.

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explained by the fact that the vaso-motor centres are acted upon by practically all afferent impulses. But though physiology enables us in this way to account to some extent for the how of this variability, it brings us little nearer to the comprehension of its why.

It is here that appeal to psychology seems to meet with better reward, for material provided by Z—'s case appears to throw some light upon the subject. Thus the association of his pathological attacks of hunger with vaso-motor changes suggests that just as the one, that is, his bulimia, so the other may be the expression in vasomotor terms, so to speak, of the activities of his repressed unconscious.

The probability of this suggestion is increased by the consideration that the weakness and faintness which he might experience on these occasions, altogether out of proportion as they might be to his physical needs, even at the most rationalizing level possible, yet did seem to correspond closely to the strength of the unconscious trends which were in opposition to the course which he might be consciously pursuing at the time.

This was especially noticeable on one occasion when the moment seemed particularly favourable for pressing his suit with a girl of whom he had become fond. He suddenly not only became aware of a hunger so intense that the whole of his conscious attention became fixed upon this sensation, but he also felt so weak and faint that he was unable to conceal his feelings in any way. And this at a time when an attitude of dull, limp will-lessness was all against his conscious interests. But it was very much in line with his, at times, openly expressed reluctance to curtail his freedom by marriage. He resented having to consider the girl. "Why should *I* have to beg and implore? It is not right that I should have to feel the misery of suspense." He would stamp out his feelings of love, and become purely intellectual without any emotion, were not the price for this "cold-bloodedness," as he termed it, too heavy; for his ideal of life, governed entirely by "logic," entailed a loss of all values, so that life became entirely worthless. Yet his narcissism, his infantile desire for omnipotence, was not compatible with disappointment, with those wounds to his self-love to which rebuffs of his advances rendered him liable—repulses which would be felt all the more keenly the greater his affection for the person responsible for such cuts to his feelings. The driving force, as well as the presence of such wishes, was demonstrated by the onset of these temporarily disabling symptoms.

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Reflex Excitability of the Cord.

These, however, were by no means the only concomitants of Z—'s attacks of hunger. At such times he was not infrequently the victim of that irritability, restlessness and inability to concentrate so often observed in strong or even moderate hunger states.*

The probability that these symptoms are more nearly allied to the unconscious than to the conscious, may be gathered on general grounds from Carlson's finding that the reflex excitability of the cord—which he tested by means of the knee-jerk—increases simultaneously with strong contractions of the empty stomach.† For such heightened reflex excitability, being an indication of a certain freedom of the spinal centres from cortical control, is compatible with a similar release of the unconscious from the inhibiting influence of the conscious. The probable accuracy of this deduction is demonstrated by the observation that these symptoms of restlessness and so on occur in decerebrate pigeons. Thus a decerebrate pigeon, which Carlson kept for about a year, moved about restlessly when its crop was empty, but rested as soon as it was fed—the length of time that it remained quiet depending upon the amount that it had eaten.‡

Rogers, also, as a result of a similar set of experiments performed upon normal and decerebrate pigeons§ has noted the same phenomena. But of equal interest is his observation, to which Carlson refers,‖ that removal of the thalamus results in the loss of the behaviour characteristic of hunger in decerebrated pigeons. This finding is important as evidence of the dependence of the hunger sensation upon a subcortical rather than a cortical centre, at the same time that it confirms the suggestion made in an earlier part of the paper that the thalamus may be an end-station for this sensation.

Effects of Exercise.

But whereas restlessness is associated with an increase of hunger contractions, standing or walking *in situ* has no effect at all, except that perhaps walking prolongs a hunger period. But running *in*

* *Idem, ibid.*, p. 327.
† *Idem, ibid.*, p. 324.
‡ *Idem*, "The Relation between the Contractions of the Empty Stomach and the Sensation of Hunger," *Amer. Journ. of Physiol.*, 1912 xxxi, p. 178.
§ Rogers, F. T., "The Hunger Mechanism in Birds," *Proc. of the Soc. for Exper. Biol. and Med.*, 1915–16, xiii, pp. 119–21.
‖ Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 215.

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situ has an opposite effect from restlessness, since it promptly inhibits the contractions, the degree and duration of the inhibition being on the whole proportional to the speed of the running.*

Now such specific exercise not only contrasts with aimless wandering in its connection with the hunger movements, but also in its direct relations to the more consciously ordered activities as contrasted with those of the unconscious. In other words, just as we have found that heightened activity of the repressed unconscious tends to be associated with—may even at times cause—an increase in the gastric hunger movements, so correspondingly we seem to see here that decreased activity of the inhibited unconscious may give rise to, or at any rate is accompanied by, a diminution of these hunger contractions.

These observations are of interest, since they offer an explanation of the use of hard physical exercise as a means of diversion from mental conflict and difficulty. Z— regards exercise as a definite means of defence: in the winter evenings he longs for the summer because of the greater opportunities it affords for those outdoor activities which help him to forget his troubles.

On the other hand, it is a matter of everyday observation that at best exercise provides no more than a temporary relief from conflict, and in some cases does not bring any alleviation whatsoever. This, again, is to some extent met by Carlson's finding that the after-effects of exercise are on the whole of a stimulating nature, the gastric hunger contractions usually being more intense on the days of specific exercise than on the controls. There was, however, no constancy in the results. But this, far from causing Carlson surprise, is, he says, one which is only to be expected, in view of the partial dependence of the gastric motor mechanism upon a factor neither controlled nor understood.†

It seems impossible, however, to leave the matter at this point; rather does it raise the question as to the nature of this factor. In what follows we shall attempt to make some progress towards the solution of the problem.

The Metabolic Factor.

From the physiological point of view alone there is much to be considered. In the first place exercise not only causes a decrease in the gastric hunger contractions, but also an increase in metabolic

* *Idem, ibid.*, p. 210.
† *Idem, ibid.*, p. 211.

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rate. On the other hand, increased metabolism in itself is associated with an increase, not a decrease, in the gastric hunger contractions.*

Thus while the direct effect of exercise is a decrease in these movements, its indirect result (through the influence of heightened metabolism) is an increase of these contractions. Under certain circumstances it may therefore follow that the indirect effect may predominate over the direct, as the increased need for food after exercise clearly demonstrates.

This probability—*i.e.*, that a heightened metabolism may now and then counterbalance or even annul the direct effects of exercise—is rendered all the more likely by the fact that its elevation is maintained for some time after the causative exertion has ceased. This of course applies equally to the psychological as to the physiological effects of exercise, for that exertion has a psychic influence is certain if it is able to influence the unconscious in the ways indicated above.

But this is not all. The known interaction between mind and body makes it reasonable to suppose that under certain circumstances the state of the gastric hunger contractions may promote a corresponding psychic reaction, *i.e.* their increase on the whole tends towards a relative freedom, and their decrease towards a like inhibition of the repressed unconscious.

Consideration of Pavlov's work on conditioned reflexes goes far to reinforce this proposition. It is true that, for obvious reasons, he uses an external stimulus as the signal for the formation and later production of a given conditioned reflex.† But, by analogy, it seems possible that in the course of life internal stimuli may come to hold a like position.

This consideration brings with it the possibility that in a case of bulimia we are dealing less with a normal manifestation of instinctual activity and with hunger aroused by real physical need, than with a relatively abnormal expression of unconscious processes and the resultant psychologically conditioned gastric hunger contractions.

That the alteration in the metabolic rate tends to be associated with, if it is not at times a factor in the evolution of, a definite type of reaction, both psychological and physiological, seems to be illustrated by the picture presented by melancholia. Here the characteristically low metabolic rate is accompanied not only by inhibition both in thought and feeling, but also by a distaste for food, in itself suggestive of a decrease in the hunger movements.

* Patterson, T. L., "The Cause of the Variations in the Gastric Hunger Contractions with Age," *Amer. Journ. of Physiol.*, 1915, xxvii, p. 322.

† Pavlov, I. P., *Conditioned Reflexes*, p. 26.

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It is true that the contrasting picture of mania, though it certainly exemplifies the association of a raised metabolic rate with lack of repression, does not give such a consistent gastric picture. Nevertheless the possibility of an associated increase in the hunger contractions is not entirely negatived. Thus appetite, or perhaps more correctly hunger, is voracious in some cases. It must be confessed, however, that more often the desire for food is uncertain, spasmodic, and may be for long periods completely non-existent. On the other hand, it must be remembered that the deranged condition of the association areas, as illustrated by the "flight of ideas" characteristic of this type of patient, renders any degree of attention a matter of difficulty. This brings with it the likelihood that anorexia in these patients may be due less to an absence of gastric hunger contractions than to the deranged condition of the central connections.

But apart from such conditions in which the metabolic rate is but one feature of the whole, there is much to show that metabolism, when taken in connection with no matter what other related factor —of which perhaps the most important is age—still exerts a specific influence upon the body-complex as a whole, and upon the gastric mechanism in particular. Indeed Patterson, as a result of his researches on the cause of the variations in the gastric hunger movements which may occur with age, has come to the conclusion that metabolism is of even greater importance than age in the determination of the activity of the gastric motor mechanism.*

Influence of Age.

This opinion carries all the more weight in that he by no means minimizes the importance of age—in fact it is to his experimental work that we owe the knowledge that the gastric hunger contractions, which in young dogs are practically continuous, decrease as life advances.† It is true that he attributes this retarded activity to a slower rate of metabolism, yet surely this fact is of little real value if the metabolic factor is, as he says, to a large extent brought about and controlled by the age factor.‡

However this may be, it is probably not without psychological significance that the gastric hunger contractions are less active in

* Patterson, T. L., "The Cause of the Variations in the Gastric Hunger Contractions with Age," *Amer. Journ. of Physiol.*, 1915, xxxvii, p. 328.
† *Idem, ibid.*, p. 316.
‡ *Idem, ibid.*, p. 322.

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the old than in the young,* since it agrees with the fact that the forces of repression, less powerful in childhood, tend to increase with age. This introduces the possibility that the factor of repression may be added to those of exercise, metabolism and age in connection with gastric motility.

Now repression, owing to its position as an essential constituent of the neuroses,† has a close connection with conflicting tendencies. It is known that these in turn may affect conduct in a superficially incalculable manner. It seems possible, therefore, that among the activities of the repressed unconscious may be found that factor in the causation of the gastric hunger movements described by Carlson as being one which is neither controlled nor understood.

The Relation of Hunger to the Emotions and the Instincts.

It is of interest that physiological research should have led Cannon to hold a somewhat similar view of the subject, for he gives it as his opinion that some psychic action is responsible for those cases in which emotion and excitement do not increase a man's efficiency.‡ On the other hand, it must be borne in mind that the paralysing effect of one emotion may be more than annulled by the energizing influence of one that is stronger—the most timid animals become bold when driven by the pangs of hunger, the growing demands for food only ceasing with the onset of incapacitating weakness.§

Hunger, indeed, seems to show its relation to the emotional and instinctual life at every turn, so that much that Freud says of the sexual instinct applies equally well to hunger. For example, his statement in connection with sex that "extreme measures are more likely to be successful in repressing the instinct than are moderate ones"‖ is certainly corroborated by the effects of total and partial starvation upon the sensation of hunger.

Thus though complete absence of food causes real and increasing pain for the first three or four days, yet, after this, provided that liquid of some sort is allowed, as a rule comparatively little discomfort is felt.¶ If, however, privation is not complete, a very

* Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 119.
† Freud, S., *Introductory Lectures on Psycho-Analysis*, p. 289.
‡ Cannon, W. B., *Bodily Changes in Pain, Hunger, Fear and Rage*, note, p. 198.
§ Carlson, A. J., "The Hunger Contractions of the Empty Stomach during Prolonged Starvation (Man, Dog)," *Amer. Journ. of Physiol.*, 1914, xxxiii, p. 118.
‖ Freud, S., "'Civilized' Sexual Morality and Modern Nervousness," *Collected Papers*, ii, p. 92.
¶ Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 138.

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insufficient amount of food being given at intervals, then the painful feelings of hunger are apt to be very intense. The desperate straits to which an individual may be reduced, and the deterioration, emotional, moral, intellectual and physical, which may result from such a chronic state of hunger, are graphically described in Knut Hansun's *Hunger*.

The Sensation of Hunger during Partial Abstinence.

It is an age-old tradition which brings hunger and sex into apposition with one another as mutually adjuvant and complementary factors in life. It is of interest therefore that some modern authorities should consider that the reasons for the different effects of total and partial abstinence are somewhat similar in the two cases.

Thus anxiety neurosis is thought by Freud to be dependent upon frustrated excitation, as when a powerful stimulation is followed by an insufficient discharge.* Similarly with the pain of long-continued starvation, the initial pleasure aroused by the reception of food renders all the more acute the subsequent disappointment when an inadequate amount is obtained; at the best it merely damps, but more frequently it increases the appetite for food, and in every case leads to no real satisfaction.

It is possible that the food, in spite of its inadequacy, may have an energizing effect, sufficient to arouse the hope for, and therefore the efforts to obtain, more nourishment.

The Sensation of Hunger during Total Abstinence.

In the absence of such stimulation we appear to have a condition in which the urge is more or less abandoned or paralysed. That this is a factor in the decrease in disquieting symptoms after the first few days of total abstinence from food is suggested by the similar findings in the sexual life.† Indeed, as Ernest Jones points out, the decrease in hunger in the complete absence of food illustrates the psycho-analytic doctrine of aphanasis.‡

It is interesting that the physiologist, Cannon, when dealing with

* Freud, S., *Introductory Lectures on Psycho-Analysis*, p. 336.

† Since, however, the need for food is more immediately necessary for the maintenance of life, the time factor is, of course, usually different in the two cases.

‡ Jones, Ernest, "Fear, Hate and Guilt," *The Internat. Journ. of Psycho-Analysis*, 1929 x, part 4, p. 393.

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the emotions in general, should hold a somewhat similar opinion. He thinks that those cases in which pain and the major emotions have a depressing, not a stimulating effect, are related to the recognition of the impossibility of obtaining satisfaction.*

His use of the word "recognition" at first sight suggests the influence of the ego, with its ability to learn by experience, as contrasted with the instinctual id. But the association of this realization with emotional paralysis implies in addition the presence of considerable, even severe, repression of important instinctual components.

Further justification for this supposition is afforded by the consideration that the deleterious results of pathological anorexia are due less to the accompanying decrease in muscular energy, serious as this may be, than to the loss of that "drive" to action which constitutes the very reason and purpose for the existence of hunger in its relation to life. Carlson, indeed, is of opinion that only pathological complications can account for that total loss of appetite and hunger which occurs in some cases of complete starvation.† Thus he found that though the discomfort due to starvation diminished after the first few days, yet it was never wholly absent.‡

The Gastric Hunger Contractions during Total Abstinence.

But even so we are faced by the problem of why the sensation of hunger should decrease after the first few days of total abstinence, a phenomenon rendered all the more remarkable by the fact that its physiological stimulus, the gastric hunger contractions, far from being decreased, either tend to remain constant, or may even show an increase. Thus Carlson found that the empty stomach of men and dogs during starvation periods of from five to fifteen days usually exhibited normal or greater than normal hunger contractions.§ Still more surprising, Dr. Luckhardt found that the gastric hunger movements and the gastric tonus of two diabetic dogs persisted, and even increased to within a few hours of death, when the animals were too feeble to stand without support or even to masticate food without taking an occasional rest.‖¶

* Cannon, W. B., *Bodily Changes in Pain, Hunger, Fear and Rage*, note on p. 198.
† Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 148.
‡ *Idem, ibid.*, p. 138.
§ *Idem, ibid.*, p. 141.
‖ Luckhardt, A. B., "The Cause of the Polyphagia in Pancreatic Diabetes," *Amer. Journ. of Physiol.*, 1914, xxxiii, p. 322.
¶ These latter cases, however, are complicated by the definitely pathological condition of the blood (see p. 736).

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These findings indicate that there is an actual decrease in the sensitivity to the sensation of hunger after the first few days of total abstinence. Carlson suggests that this is due to the depression of the central nervous system resulting from lack of food.* In the event of this being in fact the case, which seems to be not unlikely, further possibilities at once present themselves.

In the first place the depression arising from privation is not limited to one system in particular, but rather tends to involve the body complex in its entirety. It is therefore possible that the diminution in the sensation of hunger may be a form of adaptation in conformity with the lessened efficiency of the organism as a whole, and of the digestive organs in particular.

Furthermore, a reduction of the stimulus which arouses the conscious desire for food may be of indirect service in yet another way. There is no absorption of material for repairing the waste of tissues; it is consequently of importance that there should be no misapplication of energy, which a fruitless search for food would certainly involve. In corroboration of this suggestion is the fact that stimulation of the special senses by the sight or smell of food, tends to excite the latent sensation of hunger, at a time when, other things being equal, the quest for food will most probably be rewarded.

But in whatever way the phenomenon is to be accounted for, the fact remains, that the sensory threshold for hunger is raised after the first few days of total abstinence. In view of the importance of the sensation of hunger as a driving force in life, it seems possible that we may have here the physiological basis for the way in which the muscular power of the stomach—in relation to the hunger movements—is especially safeguarded during periods of starvation. For since without the necessary stimulus there can be no sensation, it is certainly of advantage that there should be some increase of the stimulus at the same time that the sensory threshold is raised.

Since the muscular activity of the stomach forms the basis for the sensation which arouses the individual to attempt to procure the needful food, it is therefore directly in the interests of self-preservation that atony should be least in the organ during starvation periods. After all it is in much the same way that the brain, heart and lungs, in times of vital stress, are supplied with blood at the expense of organs of less physiological importance.

But of what biological use is the stimulus if it is not sensed in consciousness? It is here that the entrance of psychological factors,

* Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 136.

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such as repression, may interfere with the normal processes of stimulus and response.

The Psychological Factor in Starvation.

To begin with, it is undeniable that the mental factor is of considerable importance in the determination of the subjective experiences which occur during starvation. Thus, as Carlson points out, feelings of exaltation, visual and auditory hallucinations and so on are more frequently reported by religious ascetics than by worldly-minded men starving for purposes of health or science.*

It is interesting that he should be of the opinion that these phenomena are due to depression, not to increase in cerebral excitability, being as he thinks rather akin to dreaming. For these views of the physiologist certainly coincide to some extent with those of the psychologist who attributes dreams, hallucinations, and similar appearances to the action of unconscious forces, which, owing to their partial release from the strict control of the conscious, are able to express themselves in these ways.†

It would be useful to know whether analogous factors operate in the dreams of food which some starving Arctic explorers and hunger-strikers are said to experience. However this may be, they certainly approximate to those " convenience dreams " which are more characteristic of childhood than of adult life.

Carlson's suggestion that the mental phenomena which occur when an insufficient amount of food is taken are due rather to starvation change in the brain and blood than to the action of the gastric motor mechanism has much to support it.‡ Take for instance the fact that in pathological cases no hunger may be felt in spite of strong hunger movements, so also the reverse may hold. Thus Carlson reports that one old dog was eager for food, though it showed virtually no gastric hunger contractions after the third day of starvation, and the stomach appeared distinctly hypotonic.§

This recalls a somewhat similar phenomenon which may occur in old age. As already said, the gastric hunger movements diminish with advancing years. Yet there can be no doubt as to the greed exhibited by some old persons. That their excessive desire for food may be of psychic origin is supported by their generally childish

* Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 136.
† Freud, S., *The Interpretation of Dreams.*
‡ Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 136.
§ *Idem, ibid.*, p. 140.

https://doi.org/10.1192/bjp.76.315.724 Published online by Cambridge University Press

behaviour, and the growing tendency to egocentricity and selfishness which is found in these cases; for these latter characteristics, indicating as they do an attempt to return to the narcissistic, even auto-erotic mental attitude of earlier life, at the same time suggest that the avidity for food which these old people display is due to a regression from the genital, or at any rate a later level, to the first or oral stage of libidinal development.

The reverse consideration of the features which may be displayed by the individual as he passes from childhood to the full maturity of adult life shows that this is not merely a theoretical conception. Take, for example, the way in which the eagerness for food commonly displayed during the prepubertal period may be succeeded by the opposite tendency after the onset of puberty, when the step from almost complete self-love to an object-love is in progress.

The distaste for food evinced by the love-sick swain may from this point of view be regarded as an indication of the partial displacement of unconscious factors connected with the instincts of self-preservation by those connected with race-preservation, *i.e.*, the erotic life of the more fully developed personality. In the same way it seems possible that the greed of old age may be the manifestation of similar unconscious processes, working, however, in the reverse direction to a lower, *i.e.*, to an earlier stage of development.

Hunger and Acceleration of the Heart-Beat.

These considerations illustrate the fact that the appreciation of the sensation of hunger is psychologically as well as physiologically determined. At the same time it is also true that the gastric hunger contractions, whether detected or no in consciousness, may have results both physical and psychical.

The mental aspect of the matter has already been referred to in the sections dealing with dreams and sleep. With regard to the physiological side, attention is called to Carlson's finding that an increase in the amplitude of the gastric hunger contractions is accompanied by an approximately proportional acceleration of the heart-beat.*

It is of interest that the physiological stimulus for the sensation of hunger has thus an influence upon the heart's action similar to that of the emotions in general, because such a cardiac response

* Carlson, A. J., "The Influence of the Contractions of the Empty Stomach in Man on the Vaso-motor Centre, on the Rate of the Heart-beat, on the Reflex Excitability of the Cord," *Amer. Journ. of Physiol.*, 1913, xxxi, p. 320.

https://doi.org/10.1192/bjp.76.315.724 Published online by Cambridge University Press

serves the purpose of hunger in its relation to instinctual life—namely that of stimulating the organism to seek for food; the increased supply of blood to the muscles which such a quest involves is well met by this quickening of the heart.

In spite, however, of these points of contact there is evidence that the tachycardia of emotional origin, and that which accompanies an increased amplitude of the hunger movements, are dependent upon mechanisms of a somewhat different character.

The stimulating effect of the emotions upon the sympathetic, which in turn causes an acceleration of the heart, offers a satisfactory explanation of the phenomenon in the one instance. But the tachycardia in the second case is not so easily accounted for. Thus sympathetic stimulation, which quickens the heart, inhibits the hunger movements, in the same way that vagal stimulation, which excites the gastric hunger movements, has a depressing action on the heart.

These considerations indicate either that the associative mechanism in question has a somewhat complex relation to the extrinsic nerves—the vagus and sympathetic—or else that it is replaced by some other connection. These two alternatives will now be referred to here.

With regard to the first, it is true that the quickening of the heart which accompanies an increase in the amplitude of the gastric contractions may be an example of depression following vagal stimulation—a phenomenon which is thought to be present in association with the receptive relaxation of the stomach which occurs on swallowing.*

On the whole, however, it seems more probable that the mechanism involved is independent of both vagal and sympathetic influence. Most significant in this connection is the fact that the muscular power of both heart and stomach is ultimately governed by an automatic neuro-muscular apparatus in their walls;† to this primitive organization the vagus and sympathetic are in each case merely accessory, useful for its more efficient regulation and control. This suggests that there may exist an associative mechanism between the two organs which antedates the influence of the extrinsic nerves.

However the phenomenon is accounted for, the fact remains that the vagus, in exciting the gastric hunger contractions, is responsible for an associated acceleration of the heart-beat. Thus the unconscious, in expressing itself through the medium of this nerve,

* May, W. P., "The Innervation of the Sphincters and Musculature of the Stomach," *Journ. of Physiol.*, 1904, xxxi, p. 264.

† Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 160.

https://doi.org/10.1192/bjp.76.315.724 Published online by Cambridge University Press

may lead not only to an accession of gastric hunger contractions, but also to tachycardia. In this way we have, paradoxically enough, an acceleration of the heart, which is, though secondarily, a vagotonic symptom.

Similar and Contrasting Effects of Fear and Hunger.

This circumstance derives additional interest in view of the over-sensitivity to changes in the action of the heart which is especially characteristic of certain anxiety neurotics. This fact is again of importance, since, as is well known, the disordered action of the heart in these " functional " cases is not merely perceived—it is also sensed with fear.

Fear in such patients has a double significance. In the first place it is representative of the pathological situation underlying the neurosis, and secondly it is both directly and indirectly an important determinant of much of the symptomatology of these cases. The exaggerated sensitivity to the action of the heart referred to above is clearly an instance of the latter point.

These considerations have a further value here in view of the explanation which they offer for the fact that hunger is neither a constant, nor even a usual, feature in these cases. To enter into more detail. The gastric hunger contractions must reach a certain intensity before they are perceived in consciousness ; it thus happens that an exaggerated sensitivity to the accompanying acceleration of the heart may cause the cardiac action to be perceived first. Complications are introduced by the fact that the fear aroused by this perception stimulates the sympathetic, which at the same time that it maintains, even augments, the rate of the heart, inhibits the gastric movements

The workings of the unconscious seem to be seen plainly in this fear and its results, removing as they do the focus of attention from the real cause, in this case from the psychological to the physiological, so incidentally adding both to the difficulties of diagnosis and of successful therapy.

Z— appears to be an example of such a case. It has been pointed out that vagotonic symptoms, both negative and positive, characterized his history. Nevertheless apparently causeless acceleration of the heart was an occasional symptom which gave him acute anxiety. Its prominence in consciousness, and its occurrence at times of mental rather than physical stress, seemed to him good grounds for thinking that the cause was organic.

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His whole history serves to indicate that the distress which this possibility aroused in him was to be attributed to the factors, the whole situation, underlying the fear. Thus fear, which in his case was part of a general mental tendency, betrayed in many ways the influence of unconscious factors. Take, for example, the feelings of guilt and the associated desire for self-punishment which he exhibited, and the active expression which these found in his excessive concern in all matters connected with his health, together with the constant dread in which he lived, lest, significantly enough, some action of his own might do him harm.

His liability to fear and the attacks of compulsive hunger from which he suffered are of further interest as an example of symptoms whose physiological results are in some respects similar, and in others are opposed. The possible reasons for their similar action upon the heart have already been discussed. Those connected with their antagonistic effects upon the stomach which remain for consideration, do not, however, appear to offer the same difficulty.

It is obviously to the advantage of the individual that the emotions associated with the sensation of hunger should promote the gastric hunger contractions, since these are the stimuli for the very sensation which is such an important driving force when there is need for food.

In the case of fear, on the other hand, all energy is needed for purposes of flight or defence. It is, therefore, in the interests of self-preservation that all blood available should be diverted to the organs and muscles which subserve this end. The alimentary canal being in no way concerned here, it is therefore to the animal's advantage that all movements of the filled and empty stomach should be temporarily inhibited until the need is passed—and this we find to be the case.

Appetite and the Movements of the Stomach.

This recalls to our notice the well-known fact that the gastric hunger contractions are not the only stomach movements—those of digestion must also be taken into account. As their different functions would alone suggest, these two phases of gastric motility are to a large extent distinct. Nevertheless there is much to indicate that in some ways they are intimately connected. Thus Rogers and Hardt have come to the conclusion that the gastric

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hunger contractions are strong peristaltic contractions in a stomach which is hypertonic as compared with its normally filled condition.*

It is of interest, in view of the subject-matter of this paper, that hunger and appetite to some extent illustrate these points of similarity and of difference.

It has already been indicated that appetite usually, if not always, accompanies the sensation of hunger. Nevertheless the entrance of food into the stomach, which inhibits the gastric hunger contractions, and therefore the sensation of hunger, not only tends to excite the movements of digestion, but also favours for a while the continued presence of, and may even cause an initial increase in, the sensation of appetite.

The contrast which appetite thus offers to hunger seems to be connected with its physiological function of assisting the processes of digestion. Thus the psychic secretion of juice, which Pavlov found, results when appetite is aroused by the sight, smell and taste of palatable foods is of direct chemical assistance to digestion.†

More than this, it is also probable that this secretion promotes the movements of digestion. Thus the fact that the intensity of the movements of the gastric antrum increases as digestion advances‡ in itself suggests that they are facilitated by a certain degree of acidity. Similarly, the use of acids for the purpose of promoting appetite may also be recalled here. On the other hand, gastric juice of full normal acidity and other similar acid solutions inhibit the gastric hunger contractions.§

These considerations serve to explain an apparent anomaly It is well known that alcohol, in small quantities before a meal, has a stimulating effect upon appetite. Nevertheless, when introduced into the stomach in quantities and concentrations that directly affect the tonus and contractions of the stomach, it causes inhibition and inhibition only.‖

The similarity of its action in these ways to that of acids and palatable foods renders it likely that it may also favour the movements of digestion. However this may be, it seems certain that it does not inhibit them, for if it did, as Carlson says, even moderate drinking with meals would cause acute indigestion.¶

* Rogers, F. T., and Hardt, L. L. J., "The Relation Between the Digestion Contractions of the Filled, and the Hunger Contractions of the 'Empty' Stomach," *Amer. Journ of Physiol.*, 1918, xxxviii, p. 283.

† Pavlov, I. P., *The Work of the Digestive Glands*, p. 89.

‡ Carlson, A. J., *The Control of Hunger in Health and Disease*, p. 176.

§ *Idem, ibid.*, p. 175.

‖ *Idem, ibid.*, p. 179.

¶ *Idem, ibid.*, p. 180.

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Appetite, therefore, contrasts strongly with hunger in the close connection which it presents both with the processes of digestion and with the special senses—for instance in its relation to palatable foods, acids and so on. Additional evidence is thus supplied in support of the existence of a real qualitative distinction between the two sensations, allying hunger to the more primitive, and appetite to the more highly developed and more recently evolved aspects of the mind.

The Mechanism of the Filled and Empty Stomach.

The distinction between these two types of gastric movement is further emphasized by the finding that they are to some extent localized in different regions of the stomach. Thus, whereas the gastric hunger-contractions involve largely the cardiac region,* the movements of digestion are primarily connected with the pyloric portion of the stomach.†

These facts appear to indicate that the empty and the filled stomach involve in part different mechanisms. Nevertheless, as W. P. May pointed out more than twenty years ago, this variation in motor response to otherwise similar stimuli may be due to what may be called a regional distinction which is dependent upon the gastric function concerned.‡

Take, for example, that receptive relaxation which occurs on swallowing. Probably confined to the cardiac portion of the stomach, this reciprocal innervation of antagonistic muscles is controlled reflexly by the vagus nerve; it therefore seems that we may have here an instance of vagal stimulation which is followed initially by inhibition. The possibility that this phenomenon is secondary to gastric function is confirmed by the subsequent slow augmentor effect; for the resultant closure of the cardiac sphincter prevents the food from passing back into the œsophagus, at the same time that the contraction of the cardiac region presses the food forward into the pyloric portion of the stomach.

This temporary depression following vagal stimulation, like the acceleration of the heart-beat which accompanies an increased amplitude of the gastric hunger contractions referred to above, is to be sharply distinguished from the effects of sympathetic stimulation. This is not only of theoretical, it is also of practical importance,

* *Idem, ibid.*, p. 79.
† *Idem, ibid.*, p. 176.
‡ May, W. P., "The Innervation of the Sphincters and Musculature of the Stomach," *Journ. of Physiol.*, 1904, xxxi, p. 264.

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since it draws attention to the part which function may play in the determination of both mechanism and structure. That the converse also holds it is hardly necessary to point out.

Appreciation of the action and interaction which takes place between these components—structure, mechanism and function—brings us to the further consideration of the far-reaching effects which may result from what was initially, perchance, of but small pathological import. It is for this reason that though the differential characters which the viscera contribute to an emotional complex are probably in general of but relatively small significance, yet the fact that they may come into operation must not for that reason be neglected. This consideration is all the more important in view of the fact that factors of but slight or negligible concern in one patient may assume considerable prominence in another. The psychological as well as the individual element is undoubtedly of great importance here.

The Muscle Tonus of the Stomach.

Take, for example, the question of the muscle tonus of the stomach, the exact origin of which is not definitely known.

Cannon, upon the analogy with the psychic secretion of gastric juice, postulates the existence of a " psychic tonus." It is especially interesting that he, a physiologist, should hold this opinion, in view of the fact that, as he says, he has no direct evidence to support his position.*

But surely he himself supplies an even stronger argument than that of mere similarity in favour of his assumption, at any rate in certain pathological cases, when he points out that bulimia is a neurotic disturbance of the tonic innervation of the alimentary canal ;† for the question of neurotic malfunction introduces the mental factor, and with it the possibility that psychological investigation may be necessary to demonstrate the existence of a psychic tonus inaccessible to methods of a purely physiological nature.

Certainly consideration of Z—'s case tends to support Cannon's hypothesis, since in him we find that repressed, *i.e.*, psychic factors, are responsible for the derangement of his gastric motor mechanism which is dealt with here.

* Cannon, W. B., *The Mechanical Factors of Digestion*, p. 200.
† *Idem, Bodily Changes in Pain, Hunger, Fear and Rage*, p. 294.

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Effects of Different Stimuli upon the Gastric Hunger Contractions.

The predominating importance of the psychological factor in his case is still further emphasized by the fact that his attacks of compulsive hunger, and the related incapacity, are often relieved by quite a little food, *e.g.*, a banana or a biscuit.

This observation has an additional interest, since it brings his case once more into line with physiological research, for Carlson found that the degree of inhibition of the gastric hunger-contractions is unconnected with the amount eaten. Rather does it appear to be governed by the vigour of the stomach activity—the gastric inhibition varying inversely with this component—and with the concentration and type of the food eaten, it being found to be in the latter case proportional to the concentration of the substance tasted. Sweet, sour, salt or acid articles are definitely inhibitory,* chewing indifferent substances has a less pronounced effect,† while masticating with the mouth empty causes no observable change at all.‡

The last point is interesting, since it seems to confirm the psycho-analytic theories as to the erotic significance of sucking§, indicating as it does that pleasure may be derived from active movement of the mouth, independently of the satisfaction which is derived from the food as such.

The possibility that the enjoyment so obtained has an erotic significance is also supported by the observation that children who suck the finger, in adult life show a fondness for kissing.‖ In addition the severity with which adults suppress sucking the finger and other so-called " bad habits " of children, otherwise somewhat surprising, is, significantly enough, in keeping with the degree of repression of the sexual instinct which characterizes present-day civilization.

The Interdependence of Hunger and Sex.

In this way both psychological and physiological observation seem to draw a somewhat sharp distinction between the enjoyment

* Carlson, A. J., " The Contractions of the Empty Stomach Inhibited Reflexly from the Mouth," *Amer. Journ. of Physiol.*, 1913, xxxi, p. 215.
† *Idem, ibid.*, p. 217.
‡ *Idem, ibid.*, p. 217.
§ Freud, S., *Three Contributions to the Theory of Sex*, 1925, p. 42.
‖ *Idem, ibid.*, p. 44.

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derived from the satisfaction of hunger, *i.e.*, by the taking of food, and that obtained by the gratification of the oral or sexual libido, *e.g.*, by contact and so on.

At the same time it seems certain that the two types of pleasure are never entirely independent. It appears, indeed, that, as in earliest infancy, so to some extent in later life, the sexual libido never ceases entirely to lean upon the instinct of self-preservation, in much the same way that narcissism is never wholly swallowed up in object love.

Thus the lack of appetite characteristic of the anxious lover is normally of but short duration. Again, other things being equal, the man tortured by the pangs of starvation is unlikely to attend to his more directly libidinal needs before he has satisfied his hunger.

The degree of interdependence and interaction which exist between self and race preservation is illustrated in many ways. Take, for example, Z—'s case, where, as already mentioned, the onset of his bulimia coincided with the time at which he began his habit of masturbation. That the simultaneous disturbance of these two instinctual mechanisms, biologically of the first importance, was not " mere chance," is justified by the fact that the same association was repeated in the two main symptoms for which he came for treatment, namely masturbation and inability to have several badly decayed teeth extracted. With regard to the latter question, the mere thought of the dentist caused him discomfort, while closer consideration of the matter threw him into such a state of terror that he was utterly incapable of proceeding further. He realized, indeed, that unless his mental attitude changed, the only force which could make him go to the dentist was unbearable toothache.

The possibility that his unconscious was utilizing for its own ends such organic disease as was present, is suggested by the fact that not infrequently he had slight toothache when the desire to masturbate, which consciously he wished to resist, was becoming imperative. Significantly enough, compliance with this demand was followed by almost simultaneous relief of the pain.

At other times, more especially when he had " given way to the habit " as he put it, toothache would be associated with an attack of hunger. In this case a small amount of food sufficed to put an end to both, indicating that the food acted more in virtue of its secondarily acquired psychological characteristics than of its physiological properties.

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General Review.

Thus once more the importance of the psychological factor is brought to our notice—the more remarkable when it occurs in a matter which would appear to belong rather to the sphere of physiology. Not that the action is one-sided. On the contrary, as the findings recorded in this paper serve to indicate, the perplexities of medical diagnosis are largely due to the action and interaction which so constantly takes place between mind and body.

It may be urged that this is but a commonplace of medicine—the difficulty in differentiating functional from organic disease has for so long been recognized. Nevertheless, not only does the tendency to specialization in present-day medicine in itself suggest the advisability of a corresponding correlation of the independent results so obtained, but the findings of this paper have seemed to indicate that such an undertaking may have a real value of its own. How far this is the case may perhaps be best shown by a reference to some of the more important conclusions which have been reached in this survey.

In the first place we have seen that though there are many points of similarity and connection between hunger and appetite, nevertheless, data, both physiological and psychological, support the proposition that there is a qualitative distinction between the two sensations.

From the physiological standpoint it has been shown that the cerebral cortex is essential for the existence of appetite. This, however, is not the case with hunger—it is even doubtful whether it possesses a cortical connection at all. For several reasons, which have been mentioned, it seems likely that its end-station is some lower nerve centre—in all probability the optic thalamus.

Psychological investigation also demonstrates the more primitive nature of hunger. The greater readiness with which it finds expression in bodily reactions is largely due to its closer contact with the life of the instincts and emotions. Appetite, on the other hand, in consequence of its connection with the processes of perception and cognition, is considerably affected by external stimuli, and is to that extent less influenced by those of internal origin.

Such physiological and psychological observations have led to the formation of the hypothesis brought forward in this paper that hunger is related to the unconscious and appetite to the conscious aspects of the mind. Supported alike by physiology and psychology, this proposition is further reinforced by the consideration

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that it offers a feasible explanation of certain phenomena in connection with hunger and appetite, for which it is otherwise difficult to account. In addition it appears to afford insight into a possible mechanism governing the interplay between mind and body.

Take, for example, the physiological finding that the gastric hunger contractions are not only the stimulus for the sensation of hunger, but may also be excited by vagal action. These observations, taken in conjunction with the hypothesis under consideration, suggest the possibility that at least some cases of compulsive hunger may be due to the influence of certain repressed unconscious desires, which, unable to express themselves in the normal way, find some outlet by their stimulating action on the vagus.

New possibilities are opened up by this premise. Carlson found, in the course of his experimental work on hunger, that the gastric hunger contractions, unlike other organic functions of like nature, are maintained, even augmented, during sleep. Psychology, however, is able to offer a solution for this apparently anomalous physiological finding. During sleep the unconscious is allowed freer play than during waking life; it follows, therefore, that the gastric hunger contractions should be undiminished, possibly increased, at this time.

Then, again, the possibility has been advanced that certain cases of disordered action of the heart may be primarily due to a neurotic disturbance of the hunger mechanism. This phenomenon may be accounted for as follows: There is a known association between the rate of the heart and the amplitude of the gastric hunger contractions. In this way tachycardia may be induced by an increase in these stomach movements, even when the latter have been caused by vagal action, owing, for example, to the activity of unconscious forces. Further complications arise in those instances where fear is evoked by the perception of the heart's action. Thus the resultant stimulation of the sympathetic, at the same time that it maintains, maybe augments, the quickening of the heart, inhibits the gastric movements. The complexity introduced by the interplay between psychological and physiological factors is well illustrated here.

As physiology is assisted by psychology, so the converse also holds. Thus Freud's dictum that the dream is the guardian of sleep is supported by Carlson's experimental finding that the gastric hunger contractions, which, when strong, may disturb sleep, are inhibited when there is much dreaming.

It is also noteworthy that the correspondence which has been traced in this paper between the main aspects of appetite and hunger

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and Freud's concept of the ego and the id, is supported quite as much by physiological as by psychological considerations.

Conclusion.

Other examples could be cited, but those already given suffice to show that considerable correspondence obtains between the independent findings of physiology and psychology on the related topics of hunger and appetite. Before, however, leaving this aspect of the matter, I should like to point out that the latter part of this paper has tended to confirm the accuracy of these and similar considerations.

It is, however, not for this reason alone that the present method of investigation would seem to be of value.

In the first place, where there has not been complete accord in the conclusions reached by the two sciences, attention has thus been drawn to the need for a revision here—a fact of especial importance in those cases where the requirement for further scrutiny was not so immediately obvious. Furthermore, it has been possible by this means to suggest on occasion another line of approach, even a tentative solution, to certain problems which have been raised, but have not been satisfactorily solved by the sister science.

There appears, therefore, to be justification on several counts for the present attempt to correlate the findings of physiology and psychology in connection with hunger and appetite. Of service to the individual sciences immediately concerned, it has also thrown light upon these related subjects in association with medicine as a whole.

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