THE SUPERFICIAL ABDOMINAL REFLEXES.

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The contractile response of the anterior abdominal wall to the stimulus of a scratch or stroke has become an observation of great value in the routine examination of the nervous system.

Normally, when the anterior abdominal wall is stimulated mechanically there is an immediate muscular contraction made obvious by the movement of the skin, usually towards the point stimulated. Under various conditions, some of which are physiological, others pathological, this muscular response does not occur and its absence is recognized as a sign of either loss of integrity of the lower reflex arcs, on which the movements depend, or of disease of the cortico-spinal pathway, unless its absence can be explained by some evident physiological cause, such as extreme obesity, muscular wasting, or rigidity, etc. Rosenbach, as early as 1876 (1), was the first to draw attention to its absence in cases of hemiplegia though absence of the cremasteric reflex in similar cases had been noted by Jastrowitz, who had, however, attributed it erroneously to paralysis of the abdominal muscles.

Subsequent observations led Rosenbach (2) three years later to postulate a lesion in the cortico-spinal fibres as a cause for the absence of the reflex, a view which has been confirmed by later writers. In fact the absence of this particular reflex is accepted as one of the early reliable signs of multiple sclerosis, one of the most constant of syndromes, with a pathological basis in damage to the cortico-spinal paths. Potts and Drake (3) in a paper on the diagnosis of multiple sclerosis, when referring to the difficulties of diagnosing atypical cases in the early stages, write: "... The following symptoms should be looked for: absence of the abdominal reflexes and evidence of either optic atrophy or retro-bulbar neuritis. Absence of the abdominal reflex when no signs of a focal lesion involving the lower dorsal segments of the cord are present is very significant. It was absent in all the cases of the series (35 cases)".

The reflex is the contractile response of the internal oblique muscle and Soderbergh (4) describes four areas on the abdomen where the reflex can be

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elicited. These areas are formed by drawing three horizontal lines across the front of the abdomen, the upper one through the tip of the ensiform cartilage, the middle one at the level of the lower costal margins, whilst the lower one passes through the crest of the ilia. He refers to the four resulting areas as the epigastric, and the superior, middle and inferior abdominal zones.

Anatomy.

The antero-lateral wall of the abdomen consists of three thin superimposed muscular sheets, the external and internal oblique muscles and the transversalis lying deep to the other two. The external oblique, which is the most superficial, takes origin from the lower ribs, and its muscular fibres run in a downward and forward direction to be inserted into the sheath of the rectus, the crest of the ilium and the pubis, between which two latter points its lower edge helps in the formation of Poupart's ligament. The internal oblique, which is rather thicker than the external, takes origin from the dorso-lumbar fascia behind and from the crest of the ilium and Poupart's ligament below, and from this origin its fibres spread out in a fan-shaped manner, running upwards and forwards to a long line of insertion into the rectus sheath, whilst its lowest fibres, which have been displaced downwards by the descent of the testicle, constitute the cremasteric muscle. From the direction of the movement of the overlying skin in the various areas within which the abdominal reflex occurs, it appears certain that the contraction takes places in the internal oblique muscle. For instance, when the upper part of the reflex is elicited the skin of the abdominal wall is pulled upwards and outwards, stimulation of the middle portion produces movement directly outwards, whilst in the lower segment the skin moves outwards and a little down. All these movements can be accounted for by the direction of the fibres of the internal oblique, whereas the other two muscles could only bring about one each of these movements. Moreover, when, by scratching the inner side of the thigh, the cremasteric muscle is thrown into contraction, very often the lowest part of the abdominal reflex appears. This contraction is even seen in women at times on scratching the inner side of the thigh, so it is reasonable to conclude that the reflex movement is due to contraction of the internal oblique.

These muscles are innervated by roots from the 5th thoracic to the 2nd lumbar segment, and Soderbergh, in the paper already quoted, gives the following as the distribution, though the exactness of this detailed scheme is a little doubtful:

Epigastric area	by	5th	to	9th	thoracic.
Superior	,,	7th	,,	9th	,,
Middle	,,	8th	,,	10th	,,
Inferior	,,	10th	,,	12th	,,
Cremasteric	,,	11th	,,	2nd	lumbar.

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The frequency with which this reflex mechanism is thrown out of gear constitutes an interesting problem, and Byrnes (5) writes: "Evidence of the nature of the abdominal reflex, its connection with the cortico-spinal system, and its analogy to the cremasteric and plantar reflexes is found not only in its alteration in disease of the pyramidal fibres, but in its evolution and behaviour under certain conditions in the normal individual."

Thus, whilst Bychowski failed to elicit it in the new-born, and Astwazatorow (6) states that it does not appear till the eighth month, Angelis (7) found it present in early infancy if sought for during sleep.

It is clear that disease or injury implicating the reflex arcs of any of the lower thoracic or upper lumbar segments will prevent the appearance of the reflex, and when attempts to elicit the superficial reflex are being made it is well to make sure that the reflex arc is intact by eliciting the "periosteal" rib reflex (by tapping sharply with a light percussion hammer over the lower rib margins). A contraction of the abdominal wall occurs, due to stimulation of the tendinous attachment of the external oblique muscle, where it takes origin from the lower ribs, and the contraction is comparable with the knee-jerk or any of the other deep reflexes.

Even when the reflex arc is intact, the superficial reflex may not appear. For instance, it is often absent in acute appendicitis, where the abdominal muscles are already firmly contracted as a guard to the damaged area beneath. Again, the anterior abdominal wall may be so wasted that the muscles appear to be incapable of contraction, a state of affairs seen in emaciating diseases and senility, but here the age-factor must be taken into account, for, as will be mentioned later, the reflex lessens in intensity as age progresses.

Pregnancy, ascites and obesity may also be a reason for the non-appearance of the reflex though it is quite often present in all these conditions.

Emotion may act as an inhibitor, apprehension always rendering it extremely difficult to obtain the reflex, whilst fixing the attention of the subject on the elicitation usually has the effect of increasing the response. Occasionally there appears a kind of inversion, and Soderbergh (8) quotes two cases, both the subjects of spinal cord tumour, in whom contraction of the abdominal muscles occurred on the side opposite to the one stimulated. He also noted that not only was there inversion, but that the stimulus required to be stronger and that the response was slow and "lazy", appearing after a long latent period.

Unfortunately the term "inversion" is used in two different senses. Thus Soderbergh uses it to refer to the contraction of the muscle of the side opposite to the one stimulated, as in the cases quoted above, and as sometimes seen in cases of hemiplegia of long standing, whilst Monrad-Krohn uses the term differently. He describes a case of a tumour of the left hemisphere, with its consequent right-sided symptoms, but in which the abdominal reflex was present on the right side and absent on the left, the converse of the usual

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findings. These exceptional types of the reflex, however, are of such rare occurrence that they do not invalidate its usefulness as a clinical guide.

TECHNIQUE.

In investigating the motor response to a nervous stimulus, it is clear that constancy of stimulus is very desirable, and as it is possible to excite the abdominal reflexes electrically as well as by mechanical stimulation, electrical stimulation appears to offer an admirable means of producing a fixed stimulus. Stern-Piper (9) uses the faradic current, placing the indifferent electrode on the sternum, whilst the stimulating electrode, in the form of a small roller or faradic brush, is used in the same manner and over the same areas as when mechanical stimulation is being employed. Electrical stimulation has the advantage of absence of friction, which in people with lax obese abdominal walls sometimes produces a kind of ripple on mechanical stimulation.

Constancy of stimulus, however, is the only real advantage of the electrical method and the rather elaborate preparations necessary in using this method often raise the sensory threshold of the reflex, and thus invalidate this " constant value ". Stern-Piper admits that at times fairly strong currents are needed, and since with a little care and practice a very constant type of mechanical stimulus can be given, the simplicity of the mechanical method makes it the most generally used.

The ripple in obese abdomens and the friction produced by mechanical stimulation when the surface of the abdomen is moist, may often be got rid of by drying the surface and dusting with talcum powder.

Monrad-Krohn (10) and Goldflam (11) describe the various ways of eliciting the reflex, but the former states that in his opinion the *normal* reflex is only obtained by mechanical means. He also draws attention to a variation in the reflex, which is accompanied by a tendency to flexion of the hip and knee. This type of reflex, which occurs in complete transverse lesions of the cord and also occasionally in hemiplegia, differs in the following respects from the normal abdominal response :

(1) It appears after a long (1 to 2 sec.) latent period.

(2) Contraction of the abdominal wall may be bilateral or the muscle of the opposite side (the one not stimulated) may contract more forcibly than the stimulated side, thus drawing the umbilicus away from the point of stimulation.

(3) The stimulus required to produce the response on the affected side is much greater than that required to elicit it on the unaffected side.

This type of reflex has been described by Babinski (12), and appears to depend on lower spinal centres alone.

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Stern-Piper, in the paper quoted above, after references to the various non-nervous pathological conditions in which the abdominal reflex is absent, mentions examples of asymmetry of the reflex. For instance, he finds one-sided absence or diminution in idiopathic epilepsy, in infantilism, and various other forms of degenerative changes, and says that in these latter conditions there is often also some other bodily asymmetry, kyphotic or facial, etc. At times, he says, he has found the plantar response flexor on one side and extensor on the other, or the pupils may be unequal and reacting poorly on one side and well on the other, and so on, and he suggests that the presence of these variations point to phylogenetically recent development, and thinks that the abdominal reflex is, therefore, a recently acquired response. Further reference will be made to this point later.

Cremasteric Reflex.

As mentioned earlier, the cremasteric muscle is part of the internal oblique, and not infrequently, when made to contract by external stimuli, the lower fibres of the latter muscle contract in sympathy. The response to the stimulus in both cases is rapid and identical in kind, so that there are *a priori* grounds for considering the cremasteric reflex as homologous with the superficial abdominal reflexes. Monrad-Krohn and Kornfeldt (13), however, contest this *a priori* reasoning, and give a series of cases in which there were considerable differences in the responses of the two reflexes. The following table is extracted from this paper:

Diagnosis.	Abdominal reflex.		Cremasteric reflex.		Pereosteal reflex.		Plantar reflex.	
	R.	L.	R.	L.	R.	L.	R.	L.
Neurosis	++	++	++	++	..		↓	↓
Paralysis agitans	+	+	o	+	..		↓	↓
Encephalomyelitis	o	o	++	++	+	+	↑	↑
Myelitis	o	o	o	o	±	±	↑	↑
General paralysis	++	++	++	++	++	++	↓	↓
Disseminated sclerosis	++	++	o	o	..		↑	↑

Since this response tends to vary very considerably under ordinary conditions it would appear that the arguments in this paper are not very convincing; for instance, in the table above, there is complete positive correlation in three cases out of six, 50%, and a partial correlation in one case, so that complete negative correlation exists only in two cases, 33%.

In a paper on the reflexes of the new-born, Angelis (14) states with reference to the superficial reflexes that the abdominals are present, though difficult to elicit owing to constant movement, etc., and that the plantar response is one of "flexion", contrary to the generally accepted view. He examined

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88 new-born infants within two days of birth and gives the following figures with regard to the superficial reflexes:

Abdominal:		*Cremasteric:*	
Hardly perceptible	77%	Present	92%
Distinct	16%		
Absent	7%		

It will be seen later that the author's observations do not support Angelis's views.

In the paper quoted by Goldflam, mentioned previously, this author refers to a curious antagonism between the superficial and deep reflexes sometimes seen in various diseased conditions; for instance, he has found the deep reflexes abolished in diabetes mellitus whilst the superficial ones remained, and gives details of a case of this kind which he published, in which the superficial reflexes were present up till death (15). This is the reverse of the opinion generally held, namely, that the superficial reflexes disappear in serious illness before the deep ones. Goldflam supports his view by references to cases of carcinoma of the internal viscera, liver, stomach, pancreas, etc., where the deep reflexes had failed, though the superficial ones remained present till death. He concludes another (11) of his papers as follows: "Since in none of these cases was there any symptom of neuritis, and since the hypothesis of toxic action on peripheral nerves could not have explained the continued presence of the cutaneous reflexes, we must conclude that the cause of the unequal resistance of the two types of reflex must be sought in the central stations, that for the deep reflexes in the spinal cord, whilst that for the superficial ones is in all probablility in the cerebral cortex."

The importance of this antagonism is stressed by Crouzon (17), who says, "the general absence of cutaneous reflexes in severe central lesions, cerebrospinal injuries, comas and encephalitis, is of more serious import than the absence of deep reflexes".

Ranbers (18) has claimed a definite relationship between the abdominal reflexes and the internal viscera. He states that the response depends on the tone of the muscle which in turn depends on the state of the segmental organ beneath, so that the increase or diminution in the superficial reflex may be brought about by over or under-activity of the corresponding underlying segmental organ.

Author's Observations.

That there is still a certain amount of ambiguity about the superficial abdominal reflex will be gathered from the foregoing extracts from the literature, nor can the observations carried out by the writer do more than emphasize

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some of the points already mentioned. Most of the observations were made prior to the perusal of the literature, and therefore some of the results obtained are, perhaps, redundant, but they are retained for completeness.

During the ordinary routine examination of patients the marked variation in the response of the superficial abdominal reflex had often been noted, and it was with a view to checking the clinical conclusions to which this variation had given rise that the following observations were made in 1930. They were carried out on patients presenting various diseased conditions as well as on normal people, the latter observations being particularly stressed, as it was felt that the behaviour of the reflexes in normal individuals might give suggestions as to its physiological meaning.

Technique.

Various methods of stimulation were tried; for example, a brush (camel hair) to imitate the tickle of an insect, as speculation had suggested that the superficial reflex might be comparable with the fly-reflex-skin-ripple seen in horses (contraction of panniculus carnosus). This form of stimulus was quite unsatisfactory, producing a reaction in only a very small number of cases in quite young children. The usual pin-point also appeared to give rather inconstant results, since the stimulus was felt as pain by some, and repetition of the stimulus was rendered anomalous by psychical reactions of apprehension. The pin was therefore abandoned, also the hot and cold points, as responses were too variable to be easily interpreted. Electrical stimulation, both faradic and galvanic, was tried, since such stimuli are easily standardized; but again it was found that fairly strong currents were often required, and these, at times, produced the same apprehension, and, moreover, the apparatus required rendered the observation much more elaborate, and this in itself was often sufficient to raise the sensory threshold of the reflex very materially.

After trying many forms of mechanical stimulus the writer has found that the point of the "Eversharp" pencil gives the best and most consistent results. The point is not sharp enough to scratch the skin and is blunt enough to slip easily over it, and so convenient has this simple stimulus proved that a solid steel rod of exactly the same thickness and length, with the same point as the pencil was made, and it has been used in all the observations except where stated to the contrary. The best method of eliciting the reflex is by a light "flicking" stroke carried from without inwards on the lateral portion of the abdominal wall, which appears to be the more generally sensitive reflexogenous area. The actual flick should be sharp and sudden, so that the point is in contact with the skin for as short a time as possible, and with a little practice a very constant stimulus can be given. The cremasteric portion of the reflex is obtained by flicking the skin of the inner side of the thigh and the reflexogenous area for this reflex is very wide, in children may extend as

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low as the ankle and even in young adults the response may often be obtained by stimulating the skin as low as the knee-joint.

Each observation was recorded at the time on a standard form. The abdominal reflexes were always examined first, three areas being chosen—upper, middle and lower abdomen—then the cremasteric, and finally the plantar responses, which were recorded as usual by small vertical arrows pointing up or down. Any special conditions of the subject, e.g., whether standing or lying down, whether the abdominal wall was lax or of good tone, obese or spare, etc., were noted on the chart used for the record. The form of this record is shown below :

FORM FOR RECORDING SUPERFICIAL REFLEXES.

Notes.—The stimulus should be a light flicking stroke with the point of an " Eversharp " pencil.

Any conditions should be noted—e.g., flaccid muscle, obesity, etc. The following signs should be used :

++ Very brisk.
\+ Brisk.
± Feeble.
? Doubtful response.
o No response.
↑ Toe " extension " (Babinski's sign).
↓ Toe " flexion ".

The following is a typical chart from a normal subject :

Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
W.	28	M.	Supine	++ ++ ++	++ ++ ++	+	+	↓	↓
			Erect	++ ++ ++	++ ++ ++	+	+	Not observed.	
			Hands and knees	++ ++ ++	++ ++ ++	+	+	↓	↓
			Supine (auto-flick)	±	±	+	+	Not observed.	

Observer : D. R. *Date :* 1.vi.30.

It will be noted in the above result that although stimulation by the observer produced very active responses in all the abdominal areas, stimulation by the subject himself (" auto-flick ") produced only feeble responses. This is almost constantly found, and in many people it appears quite impossible for them to obtain any response at all from their own stimulus. The following is an observation carried out by the writer and a senior medical student, only the abdominals being tested.

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Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
A. R—	25	M.	Supine in all tests; "flick"	+	±				
				+	±				
				+	±				
			Faradism	+	+				
				+	+				
				+	+				
			Galvanism	o	o				
				±	o				
				o	o				
			Auto-flick	+	+				
				+	+				
				+	+				

Observer : E. F. S. *Date :* 2.i.31.

Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
E. F. S—	50	M.	"Flick"	+	+				
				o*	+				
				o*	+				
			Faradism	o	o				
				o	o				
				o	o				
			Galvanism	o	o				
				o	o				
				o	o				
			Auto-flick	o	o				
				o	o				
				o	o				

Observer : A. F. *Date :* 2.i.31.

* The two o's are due to the scar of appendix wound.

The above observation emphasizes a point of clinical importance, namely, that the reflex is much stronger in younger people; it appears to get progressively weaker as age advances.

One of the difficulties in making any observations on human beings is the extreme difficulty in preventing suggestions of the observer acting on the subject. This difficulty is particularly striking in observations in which any emotional change may play a part, and the following examination of a perfectly normal young man shows how suggestion resulted in causing a reaction of extreme kind.

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Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
H. H—	21	M.	Supine in all tests; "flick"	++ ++ ++	++ ++ ++	+	+	↓	↓
			Brush	+ ± ±	± o o	±	±	o	o
			Faradic*						

* On testing with a current the man became extremely emotional and even when no current passed, as soon as the electrode touched the skin he writhed in agony, began to sweat, and became pale and collapsed. Observation broken off.

In the opinion of the writer, observations of the abdominal reflexes are particularly liable to produce emotional disturbances for three reasons, firstly, the subject is lying down and the observer standing, a relative arrangement of posture which always produces in the mind of the patient a subjective idea of inferiority, helplessness, or even fear (a feeling which is always made use of in ordinary clinical examination, though the examining doctor may not be aware of it). Secondly, the abdomen is uncovered—that is, it is exposed to attack; and thirdly, approach to the genitals is rendered easy, which latter idea often provokes a definite unconscious motor response which is a true defence mechanism; one will often see a man cover the genital region with his hands during ordinary routine examination.

For these reasons the clinical observation of the abdominal reflexes, quite apart from any actual stimulation, must be considered in the light of the whole responsive behaviour at the time.

A number of observations were made on normal people who had, however, physiological alterations in the abdominal wall, such as moderate obesity, pregnancy, senile changes in the muscle, etc., and some of the results were not such as might have been expected *a priori*. The reflexes are present at times with extremely lax abdominal walls or even in late pregnancy or marked ascites, and are absent, on the other hand, when one would expect them to be present, i.e., when all the conditions appear normal. Here, for instance, are two or three observations to exemplify this variability.

Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
N. E—	32	F.	Very fat, pendulous abdomen; supine	+ + +	+ + +	..	..	↓	↓
E. C—	20	F.	Pregnant (at term); multipara; sitting	+ + +	+ + +	..	..	↓	↓
M. L—	40	F.	Mitral disease; No ascites; supine	o o o	o o o	..	..	↓	↓

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There appeared no reason why the reflexes should be absent in the last case, though there was every reason to expect them to be absent in the first two cases. Alteration in the tension of the abdominal wall alone does not appear to be sufficient to prevent the appearance of the reflex, as was pointed out by Jamin (19), who writes: "I have seen well-marked reflexes in abdomens distended with ascites, in chronic tuberculous peritonitis, and often in advanced pregnancy."

In contrast with the observation on the pregnant woman above is the following case, also of pregnancy, but in a primipara:

Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
A. B—	20	F.	Pregnant (in labour)	±	±				
				±	±	.	..	↑	↓
				±	±				

Observer: E. F. S. *Date:* 21.vi.31.

Here is a similar condition to the case above in a woman of the same age, but the responses are quite different. It would appear as if the emotional strain of parturition were having the effect of diminishing the strength of the response. It will be noted that the plantar response was equivocal, being "extensor" on one side and "flexor" on the other. It may be stated here that one of the conclusions drawn from the present observations has been that the reflex is part of a defence mechanism, and that it is only elicited with difficulty or sometimes not at all if the subject is apprehensive. The least suspicion of fear, producing perhaps only a slight increase in the tone of the muscle, may entirely abolish the reflex, whereas the defensive contraction in acute abdominal disease, e.g., appendicitis, though much more intense, does not always abolish it. Strong voluntary contraction, on the other hand, has the result of preventing the reflex from appearing.

Goldflam does not attribute defensive function to the reflex, since stimulation only produces a one-sided contraction, an argument which does not appear to be very convincing, since the stimulus may be looked upon as a partial one, producing only a partial response.

It is well known that after an epileptic fit, where there has been an extremely violent emotional upheaval, the plantar reflex is quite often for a time of the extensor type. The ordinary path for pyramidal voluntary impulses is blocked for the moment, and lower centres take charge of the reflexes. In this connection the appearance of an "extensor" response in one of the pregnancy cases is interesting.

The writer's feeling is that the defence reaction is motivated by higher psychical centres and only under such motivation will the response be a general one, in other words, the ordinary method of eliciting it is merely a means of demonstrating that such a motor mechanism exists and is comparable to

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eliciting a spark from the plug of a motor-car engine by turning it over by hand ; it demonstrates the potentiality of the mechanism, but the latter will not work automatically in the absence of an explosive mixture. The higher psychical impulses constitute the explosive mixture in the case of the abdominal reflex.

That this is not altogether beside the point can, I think, be seen from the behaviour of the lower component of the reflex, namely, the cremasteric response. In small boys it is not at all infrequent to see the testes being pulled up by contraction of the cremaster muscle under the influence of emotion, particularly apprehension, whether this emotion is a true fear reaction or only a simulated one in play. It represents psychologically an expected attack on the abdominal wall and is defended by tightening of the muscles and withdrawal of the testes.

The above considerations suggest that the reflex, depending as it appears to do on emotion, is probably of recent phylogenetic origin, a point to which further reference will be made later.

From these observations it appeared that the superficial reflexes were more active in young children than in adults, and that they became progressively less active as age advanced, and it seemed desirable to ascertain whether the reflexes are present at birth, or if not, at what age they make their appearance. For this purpose a number of examinations were made on new-born infants at the Jessop Hospital, and the following figures are extracted from these results.

Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
..	7 days	F.	Quiet	o	o	..		↑	↑
..	6 ,,	F.	,,	o	o	..		↑	↑
..	6 ,,	M.	Feeding	o	o	±	±	↑	↑
..	6 ,,	M.	,,	o	o				
				±	±	+	+	↑	↑
				o	o				
..	24 hours	M.	Quiet	o	o	+	+	↑	↑
..	18 ,,	M.	,,	o	o	o	o	↑	↑
..	18 ,,	M.	,,	o	o	+	+	↑	↑
..	18 ,,	F.	,,	o	o	..		↑	↑
..	12 ,,	M.	,,	o	o	o	o	↑	↑
..	60 mins.	F.	,,	o	o	..		↑	↑

Observer : E. F. S. *Date :* 2.vii.30.

These cases, together with a second series examined at the Maternity and Child Welfare Centre, where the ages varied from two months to two years, form a fairly comprehensive scale, and so far as these observations go, it may be stated that though well-developed abdominal reflexes may be elicited occasionally as early as the third month, the sixth or seventh month appears to be the age at which it usually makes its appearance, whilst its absence was noted in one case as late as the tenth month, and in another it was only just perceptible at the end of the first year.

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The following is a small group of cases from the Maternity and Child Welfare Centre :

Name.	Age.	Sex.	Conditions.	Abdominals. R.	Abdominals. L.	Cremasterics. R.	Cremasterics. L.	Plantars. R.	Plantars. L.
..	4 yrs.	M.	Quiet	+	+	Testes not down		↓	↓
				+	+				
				+	+				
..	2 ,,	F.	,,	+	+	..		↓	↓
				+	+				
				+	+				
..	16 mths.	M.	,,	+	+	..		↓	↓
				+	+	+	o		
				+	+				
..	13 ,,	M.	,,	+	+	Testes not down		↓	↓
				+	+				
				+	+				
..	12 ,,	M.	,,	o	o	..		↑	↑
				+	o	+	+		
				o	o				
..	10 ,,	M.	,,	o	o	..		↓	↓
				o	o	o	o		
				o	o				
..	7 ,,	M.	,,	+	+	..		↑	↓
				+	+	+	+		
				o	o				
..	7 ,,	M.	,,	+	+	Testes not down		↑	↑
				+	+				
				+	+				
..	7 ,,	M.	,,	o	o	..		?	?
				o	o	+	+		
				o	o				
..	5 ,,	M.	,,	+	+	..		↓	↓
				+	+	+	+		
				+	+				
..	4 ,,	F.	,,	+	+	..		↑	↑
				+	+				
				+	+				
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Observer : E. F. S. *Date :* 3.vii.30.

The late ontogenetic appearance of the reflex suggests that it is a recent phylogenetic development. Its contemporaneity with the change in the plantar reflex and the dependence of the latter on the maturity of the pyramidal cortico-spinal path also points to a recent evolutionary change as determining the reflex. The assumption of the erect posture is the obvious evolutionary change, which at once suggests itself as a possible cause for this developmental step.

In the quadrupedal animal the anterior abdominal wall is not subject to direct attack, whereas the assumption of the erect posture lays this part of the animal open to direct assault, and since it possesses no bony skeleton the

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muscles provide what protection they can by means of reflex contraction, a contraction, however, which is not only brought into activity by direct contact, but may be activated by emotion, especially fear.

The cremasteric reflex appears much earlier than the other reflexes, being present as early as the fifth day of extra-uterine life (possibly earlier) whereas the earliest record of an active abdominal response, in this series at least is the third month. The change in the superficial plantar reflex may appear earlier than is usually stated. As can be seen in the above table, three cases have the " toe down " response before the age of 12 months, one as early as the fifth month, though the average for the whole series seems to be about the seventh month. Thus it will be noted that from the sixth or seventh month the active abdominal reflex appears and the plantar response tends to assume the " flexor " type.

Babies begin to make efforts to creep about and get on to their hind-limbs, using the fore-limbs to pull themselves up, and thus raise the trunk from the ground, that is to say, make the first efforts to assume the erect posture about the seventh month.

The change in the two reflexes noted above is interesting when considered in this connection.

Although many attempts have been made to elicit the abdominal response in domestic animals the writer has never been able to produce the slightest suggestion of a contraction. In 1930, through the kindness of Dr. Zuckerman, Anatomist to the Royal Zoological Society, he was able to examine a number of animals of various kinds and the observations made on that occasion confirm the view expressed above. Not one of the quadrupedal animals showed any superficial abdominal response, whereas the primates all gave the same type of superficial reflex as do human beings, the responses in the chimpanzee being astonishingly identical with those met with in the routine examination of patients. Detailed tests were made on three chimpanzees, and whether lying, sitting or standing, all the tests were just as obtained in human subjects.

If it can be assumed from the above that the presence of the superficial reflexes depends on the maturation of the pyramidal tract, one further anatomical fact may be noted as of some interest. Cunningham (20) states that there is no direct pyramidal tract in mammals until the anthropoid stage is reached, and a speculation might be made that the presence of the reflex depends on this portion of the pyramidal tract. Furthermore, about 15% of *homo sapiens* do not possess a direct pyramidal tract, so that a further speculation might be adduced here to account for the small number of people who, for no apparent reason, never seem to have any superficial abdominal reflexes.

The conclusions which consideration of the foregoing suggest are as follows :

(1) The superficial abdominal reflex, including the cremasteric, is a defensive reflex executed by the lower spinal centres, but motivated by higher psychical centres.

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(2) It is directly associated with the assumption of the erect posture.

(3) It is possible that it depends on the myelinization of the direct pyramidal tract.

Consideration of the foregoing facts and inferences cannot as yet lead to definite conclusions, but they make it possible to bring forward one or two speculations. Human behaviour can only be explained, as a rule, on speculative grounds, so that we need not be unduly cast down if we have no surer ground than a speculation to explain the behaviour of the superficial abdominal reflex; further observation may and probably will lead to an alteration in the views concerning other reflexes beside the one under discussion.

Two hypotheses seem possible to account for the "absent reflex": (1) To consider it as a release phenomenon, and (2) as the direct result of loss of innervation.

Considered as a release phenomenon.—The impulses reaching the final common path are partly segmental and partly supra-segmental, most of which latter impulses come from the brain. These may be divided roughly into two groups of impulses (*a*) archaic, and (*b*) recent. The essential difference between these two types of impulses is that they give rise to two different orders of motor activity. The "archaic" impulses activate movements of a coarse type compatible with simple necessities, primitive movements which, though simple, must be executed with the extreme of vigour and speed, whilst the recent impulses are concerned with movements of a more deliberate kind, and are made up of more finely integrated components, the outcome of conceptual choice. These "recent" impulses probably find their way to the final common path viâ the pyramidal tract, the most recently developed cortico-spinal tract, whilst the archaic impulses pass down those paths which leave the basal nuclei in the mid-brain stem, e.g., the posterior longitudinal bundle, the tecto-spinal tract, etc.

Thus far the ground is fairly safe.

How the impulses act, or of what nature they are, constitute as yet unsolved problems, but the comparison of the nervous impulse with an electric discharge has proved useful in the past, and it may be invoked once more in this connection.

It may be assumed for the moment that the archaic impulses dealing with suddenly-produced and vigorous muscular action will be more highly charged than the less explosive impulses concerned with deliberate purposive nicely adjusted muscular movements. We might say the first set of impulses work at a high voltage, the second at a much lower one. The anterior horn cells will be charged from two distinct sources, and some of these cells will be at a high and others at a low potential. The balance of these two types of discharges into the neuro-muscular junctions will constitute what is termed tone in muscle. If the balance is right the muscle is in the optimum tone for meeting environmental changes, whilst upset in this balance may render the

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animal quite unable to deal effectively with a change in its situation. This line of argument, purely speculative, of course, may be applied to the problem of the abdominal reflex.

The conditions under which the reflexes are absent, excluding segmental damage to neurons, when all reflexes are in abeyance, are as follows:

1. Infancy up to the seventh month.
2. Sleep and surgical anæsthesia.
3. Cerebral disease of various kinds.
4. Violent emotion, especially fear.

In infancy the "recent" pyramidal pathway is non-functional, so that practically all the impulses reaching the cells of the final common path arrive viâ the archaic paths, rubro-spinal, etc. The resulting motor activities are due to movements of muscles innervated at a high potential and are, therefore, sudden, vigorous and explosive. One has only to watch a young baby, unhampered by clothes, to note how extremely sudden and explosive are its actions, the stimulus of a touch on the abdomen will not provoke a reflex in the segment stimulated only, but will probably start a widespread motor action. The cells are so highly charged that there is no selectivity and the result is general not local. If no action results at all it may be said that the neurons are too highly charged to respond to a mild stimulus, and are awaiting an appropriately important one.

Sleep.—Whatever the nature of sleep, it is certain that during sleep all vital processes are occurring at a lowered degree of activity. If Pavlov's view is correct, sleep represents a very complete withdrawal of receptivity, and it is reasonable to assume that the stream of impulses normally passing down all the cephalo-caudal paths are very much diminished, so that a touch on the abdominal wall is insufficient to activate the motor neuron of the common path, since the latter's nervous tone is too low to accept the stimulus.

Cerebral disease.—The classical example is that of hemiplegia, in which the superficial abdominal reflex is found to be absent on the affected side. In this condition the impulses passing down the pyramidal tract are cut out. There remain to charge the neurons of the common path, those high-voltage archaic paths, the rubro-spinal, etc. The release of these impulses, that is their unimpeded action, produces a hypertonicity in the neuro-muscular junction, which renders the muscle unable to respond to mild stimulation; just as a string may be so tightly stretched that it will not vibrate to a gentle pull, and when it does vibrate its excursions may be so small as to be scarcely visible.

Fear.—This acts in the same way. It is essentially a sudden cessation of voluntary movement, allowing the archaic motor mechanism to take charge, with its more efficient potentialities for sudden explosive movement in the face of danger.

Thus the absence of the superficial abdominal reflex may be accounted for by a speculative reference to a release phenomenon.

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The same observed facts may be accounted for more simply perhaps by assuming that the reflex is really one which involves the cortico-spinal pathway as well as the segmental one, that is to say, the sensory impulse travels by way of the sensory roots to the cord, then viâ (probably) the posterior columns of the cord to the cortex and down again viâ the pyramidal tract to the anterior horn cells. This appears to be the view of most of the authors whose papers have been consulted in this communication, and according to this view of the case the absence of the reflex in infancy is quite straightforward, the pyramidal tract is not functioning, and so the reflex cannot occur. In sleep again the pyramidal tract is temporarily out of action, so that the stimuli pass unnoticed.

The unilateral absence on the affected side in hemiplegia fits quite simply into the hypothesis and even the effect of fear is easily explained by assuming the psychological inhibition of voluntary movement. But although the hypothesis appears to fit the case well, there is one fact which in the writer's opinion renders the acceptance of this view impossible, namely, the immediateness of the response in the abdominal reflex. With the exception of the pupillary light reflex it appears to be one of the quickest of all reflex actions which are observed clinically. It occurs too quickly for the impulse to have travelled up and down the tracts of the cord. The instantaneous contraction of the abdominal wall on stimulation gives the impression of a neuronic discharge by a neuron which has been previously charged up, that the stimulus to the segmental spinal arc is merely a trigger which explodes a mine already laid. The rapidity with which the reflex becomes fatigued further supports this view.

The writer is of the opinion that the superficial abdominal reflex is of the nature of a release phenomenon and that the lower neurons, the segmental spinal arc, are kept in a state of constant balance by two sets of impulses of different modality, as suggested above.

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