activity reflects a reduction in the number of effective aggressor cells, rather than an inhibition of some recruitment phase of the response. In the presence of ARA, two to three times as many Lewis aggressor cells are required to achieve the same graft-versus-host response as that observed in control hosts. Therefore, the presence of ARA correlates with a selective antireceptor effect in this assay (*13*).

3) Additional evidence for the antireceptor effect of ARA was obtained by measurements of the hemagglutinin antibody response (*14*) of Lewis animals passively immunized with ARA before receiving an intraperitoneal injection of 10^7 LBN spleen cells. Groups of four or five Lewis animals were injected intravenously with 1 ml of either ARA, normal LBN serum, or serum from LBN animals injected subcutaneously 7 days before exsanguination with 1 ml of the Lewis alloantiserum. This last group of control animals was included in order to evaluate the possibility that passive carry-over of Lewis serum components might be responsible for the biological effects of ARA. In three experiments the effect of ARA on the hemagglutinin antibody response of 53 Lewis rats was measured. The results of one such representative experiment are shown in Fig. 3. Passive immunization with ARA suppressed the hemagglutinin response of Lewis animals to LBN antigens. There is some indication that the effect of ARA given 24 hours before antigen was more pronounced than that produced by injection 1 hour before antigen administration.

Lewis animals were also immunized with 10^8 sheep erythrocytes 24 hours after passive immunization with 1 ml ARA. As shown in Fig. 3B, ARA did not affect the hemagglutinin response of Lewis animals to sheep erythrocytes. The ARA-induced suppression of the hemagglutinin response to BN antigens represents a specific suppression of the immune response.

These results indicate that LBN animals can produce antibody against the Lewis alloantibody, and that this anti-antibody has the properties of an antireceptor antibody. Antireceptor activity is indicated by selective inhibition of Lewis antibody response to BN antigens as well as by inhibition of the response of Lewis lymphoid cells, in the local graft-versus-host reaction against BN antigens. The graft-versus-host response is generally thought to require participation of those thymus-derived lymphoid cells involved in cell-mediated immunity (*15*). It is possible, therefore, that antireceptor antibody may control or inhibit some cell-mediated immune responses. Moreover, recent studies have established that Lewis animals produce an "ARA-like" material upon prolonged immunization with BN antigen (*16*). Thus, ARA may occur naturally in the course of immunization with antigen, and it may well participate in the control or limitation of the Lewis response to BN antigens.

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16. Hyperimmune serums from Lewis animals injected six times with 10^8 x-irradiated BN fibrosarcoma cells at weekly intervals develop a precipitin line in gel diffusion against serum from Lewis animals injected twice with the same tumor cells at an interval of 1 month. The precipitin line between the two Lewis serums formed a line of identity in gel with that line formed between ARA from L × BN F_1 hybrids (see text) and the Lewis antiserum to BN obtained after two antigen injections. Hyperimmune serum did not form precipitin lines with ARA. Thus it would appear that under appropriate conditions the antigen may induce not only an antibody response but also the formation of anti-antibody.
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Neural Pathways from Thalamus Associated with Regulation of Aggressive Behavior

Abstract. *Small electrolytic lesions were made through electrodes in the thalamus of cats at sites where electrical stimulation elicited attack on a rat. Staining by modified Nauta reduced silver methods revealed that significant degeneration passed caudally from the lesions and entered the midbrain dorsal central gray region. Electrical stimulation of this dorsal midbrain region elicited attack on a rat, and destruction of this region suppressed the attack elicited by thalamic stimulation.*

Although medial and midline thalamic structures are involved in the elaboration of aggressive behavior (*1, 2*), little is known of the neural pathways through which such effects on aggressive behavior are mediated. In an attempt to reveal the neural pathways from the thalamus which are involved in the elicitation of aggressive behavior, we made small electrolytic lesions through electrodes in the thalamus of cats at sites where electrical stimulation elicited attack on a rat, and traced the resultant degeneration by use of modifications of Nauta reduced silver staining procedures for degeneration. Since not all of the degeneration after lesion of thalamic attack sites is necessarily related to attack, we also examined the effects on attack of electrical stimulation and lesions of areas suggested by the degeneration to be involved in attack.

The anatomic observations were

made on 11 cats. Each cat was fitted under aseptic conditions with one electrode guide mounted stereotaxically on the skull over the thalamus. Approximately 1 week after surgery, each cat was placed in a large observation cage with a deeply anesthetized rat and a bowl of food. None of the cats spontaneously attacked the rat. A sterile calibrated monopolar electrode (insulated except for 0.60 mm at the tip) was then advanced in approximately 0.25-mm steps through the guide into the thalamus of each cat. The animal was stimulated at each step and its behavior was noted. Stimulation consisted of biphasic square-wave pulses (1-msec half cycle) repeated at a frequency of 62.5 hertz (*3*).

When a biting attack on the rat was elicited, the electrode was temporarily held at that point with bone wax and 6 to 12 more trials were given to ascertain the stability of the behavior. The attack observed was similar to the quiet biting attack elicited by electrical stimulation of the lateral hypothalamus (*4*). However, whereas biting attack elicited from the lateral hypothalamus is usually accompanied by stalking about the cage, the cats stimulated at thalamic attack points sat quietly in place and did not approach or attack the rat until it was pulled into their field of vision (*5*).

Immediately after testing for attack was completed, small electrolytic lesions were made through the stimulating electrodes. Each cat was then stimulated through its electrode at intensities two to three times higher than those that previously elicited attack. If attack could not be elicited at the higher intensities, the electrode was removed and the guide was cemented over to prevent infection. If stimulation still resulted in attack, the lesion was made larger in small steps until attack could no longer be elicited at the higher intensities. Our aim was to destroy as many fibers associated with attack as possible with a relatively small lesion. The diameter of the lesions varied from 0.50 to 2.0 mm. After lesions that eliminated attack, stimulation elicited only mild alerting.

At 2 to 14 days after the lesions were made, the cats were anesthetized and perfused with physiological saline and 10 percent formalin. The brains were cut at 26-μm thickness, and adjacent sections were stained with cresyl-echt violet or a modified Nauta stain for degenerating axoplasm and axon terminals (*6*).

All lesions of thalamic attack sites were located in the posterior midline thalamic region in the general area of the junction of nucleus centralis medialis and nucleus medialis dorsalis. The degeneration resulting from lesions of biting attack sites in the thalamus of two cats is shown (Fig. 1; Fig. 2, A to C). A similar picture of degeneration was seen in all animals sustaining lesions. Coursing rostrally from the lesion, some degeneration was observed in rostral midline thalamic regions, and additional bundles of degenerated fibers could be traced within the inferior thalamic peduncle to the internal capsule (Fig. 1, A to D). In two cats, this latter degeneration could be followed within the internal capsule to lateral and medial portions of the caudal orbitofrontal cortex. However, since electrical stimulation of the rostral midline thalamus (*2*) and caudal orbitofrontal cortex (*2*, *7*) suppresses hypothalamic attack, it is unlikely that these pathways are directly involved in the elicitation of thalamic attack behavior. Laterally, from nearly the entire extent of the lesions, degeneration spread into the internal medullary lamina and nucleus paracentralis and centralis lateralis (Figs. 1C and 2A). Again, however, this pathway is probably not directly involved in the elicitation of attack, inasmuch as stimulation in the region of these intralaminar nuclei leads to an arrest of all movement and not to attack (*2*). Passing caudally from the lesions, degeneration followed a dorsal periventricular course, pierced the ventral portion of the posterior commissure, and entered the dorsal portion of the midbrain central gray substance (Fig. 1B; Fig. 2, B and C). This degeneration, which was completely confined to the nucleus dorsalis of the periaqueductal gray substance (*8*), diminished in intensity as it proceeded caudally and disappeared at the level of the middle portion of the red nucleus. That thalamic attack might be mediated, at least in part, by these caudally directed periventricular fibers is suggested by the fact that the degeneration observed in the thalamic periventricular region just caudal to the

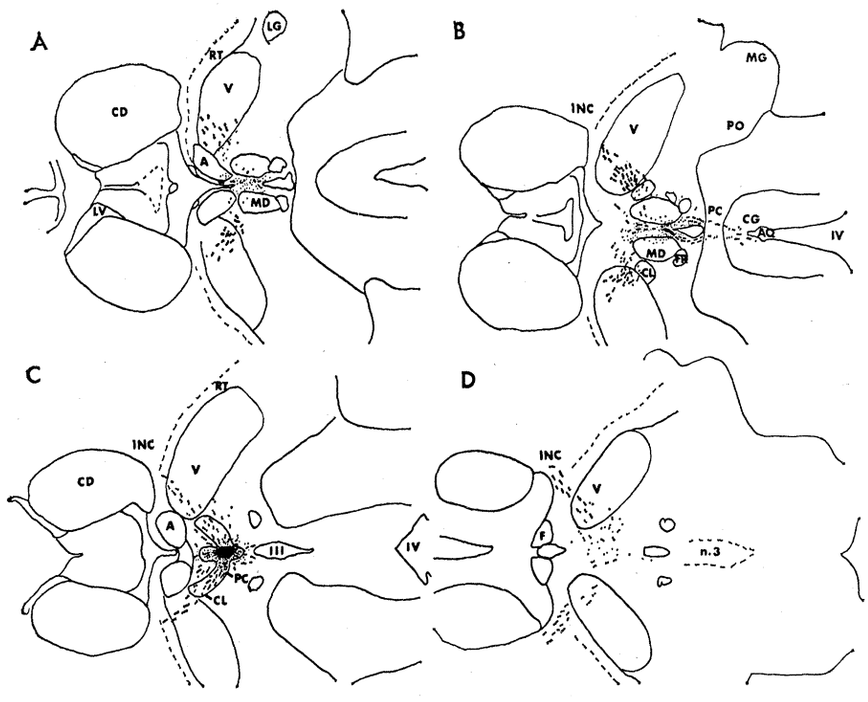

Fig. 1. Degeneration resulting from a lesion of a thalamic attack site in cat 05232B (14-day survival time) plotted on charts of horizontal sections. The sections (A, most dorsal; D, most ventral) were cut at a slight angle so that the rostral portion of each section is slightly dorsal to the caudal portion of the same section. Heavy dots represent degenerating fibers of passage, and small dots indicate degenerating terminal fibers. Abbreviations: *A*, anterior nuclei of thalamus; *AQ*, aqueduct of Sylvius; *CD*, caudate nucleus; *CG*, central gray substance of midbrain; *CL*, central lateral nucleus; *F*, fornix; *FR*, fasciculus retroflexus; *III*, third ventricle; *IV*, fourth ventricle; *INC*, internal capsule; *LG*, lateral geniculate body; *LV*, lateral ventricle; *MD*, dorsomedial nucleus; *MG*, medial geniculate body; *RT*, reticular nucleus; *PC*, posterior commissure [in (B)] and paracentral nucleus [in (C)]; *PO*, posterior nuclei of thalamus; *V*, ventral nuclei of thalamus; and *n.3*, oculomotor nucleus.

lesions (Fig. 2B) lies in a region in which stimulation facilitates hypothalamic attack (*2*). In no cats was there any evidence of degeneration within the hypothalamus. This observation is consistent with MacDonnell and Flynn's report (*2*) that large bilateral lesions at the caudal border of the hypothalamus which completely blocked biting attack elicited by hypothalamic stimulation did not block biting attack elicited by stimulation of the thalamus, and supports their suggestion that the attack elicited by thalamic stimulation is not due to transsynaptic activation of a hypothalamic attack zone.

In previous anatomic studies of the connections of the posterior medial and midline thalamic regions, projections to rostral midline thalamic nuclei, to the orbitofrontal cortex, and to intralaminar nuclei (*9*) were reported. For reasons detailed above, however, it seems unlikely that rostral midline thalamic regions, orbitofrontal cortical regions, or lateral intralaminar nuclei are directly involved in the elicitation of thalamic attack behavior. Yet, thalamic attack might be mediated, at least in part, by the caudally directed periventricular fiber system reported here. In order to determine if the dorsal periventricular-periaqueductal pathway was involved in the mediation of attack, we examined the effects of electrical stimulation along this pathway. A preliminary study of the effects of destruction of the dorsal periaqueductal region on thalamically elicited attack behavior was also made.

Observations were made on 19 cats. Surgical and implantation procedures were similar to those previously described. A quiet biting attack similar to that elicited by stimulation of the thalamus was elicited by stimulation of the dorsal periventricular-periaqueductal region in six cats (*10*) (Fig. 2). As with thalamic attack, the approach to the rat appeared to be visually dependent; blindfolding the cat always eliminated the attack. Also, the stalking about the cage which is characteristic of hypothalamic biting attack was not observed. In addition, in contrast to the hissing, spitting, growling, baring of the teeth, laying back of the ears, and striking with the paws characteristic of attack elicited by electrical stimulation of the ventrolateral central gray region (*11*), the biting attack elicited by rostral dorsal central gray stimulation was not accompanied by signs of autonomic arousal other than pupillary dilation and some piloerection along the back and tail. Thus, within the rostral midbrain central gray region there appear to be two quite distinct zones, a dorsomedial zone in which electrical stimulation elicits a quiet form of biting attack and a ventrolateral zone in which stimulation elicits an affective paw strike attack–affective defense reaction.

In three additional cats the effects of lesions of the dorsal periaqueductal region on attack elicited from the thalamus were also examined. Two of the cats also had two hypothalamic attack electrodes each. Lesions (2.0 to 4.0 mm in diameter) in the dorsal periaqueductal gray region suppressed or completely blocked the attack elicited by thalamic stimulation. For these three cats, however, thalamic stimulation that failed to elicit biting of the rat often elicited approach to the rat and even rubbing of the cat's muzzle against the rat. This suggests that, for thalamic attack, the neural pathways that direct the approach to a target and the biting attack on that target may be separable. The biting attack elicited by hypothalamic stimulation was not affected by the lesions.

The dorsal periventricular-periaqueductal region from which attack was elicited and in which lesions suppressed thalamic attack corresponds well with the midbrain area in which degeneration was observed after lesion of thalamic attack sites. This indicates that the degeneration that descends to the dorsal midbrain central gray region after lesion of thalamic attack sites is involved in the elaboration of thalamic attack behavior. It also indicates that the use of brain stimulation and anatomical techniques in the same animal to trace the neural pathways related to a particular behavior, and the subsequent use of brain stimulation and lesion to determine the behavioral function of the indicated pathways, provides an effective means for defining the neural basis of a particular behavior, in this case a pathway for attack and its possible function.

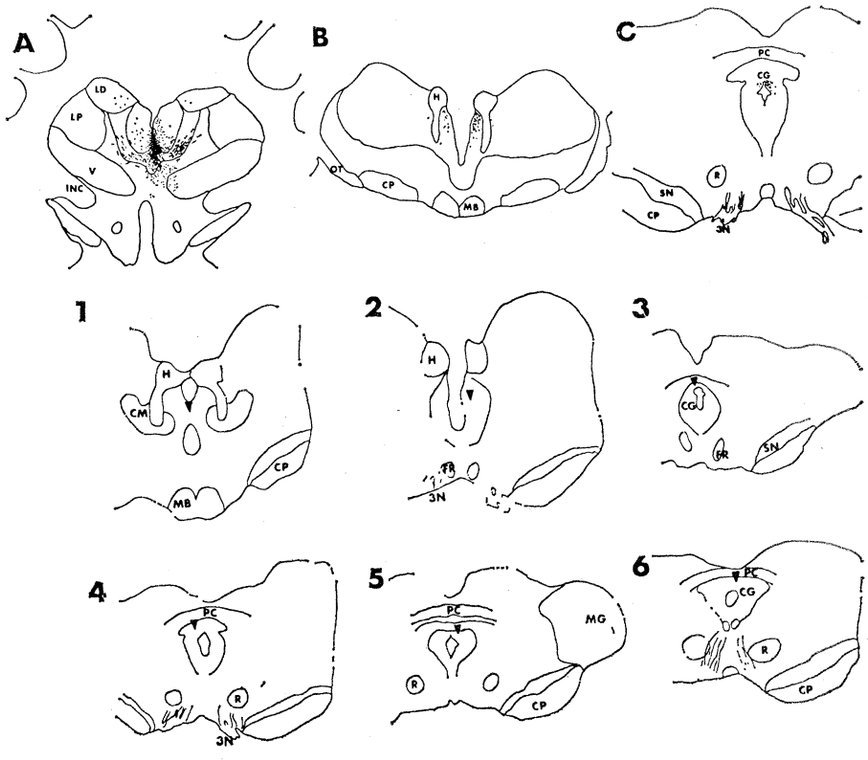

Fig. 2. Correspondence between the region from which attack was elicited and the midbrain area where degeneration is observed after lesion of a thalamic attack site. Caudally directed degeneration (B and C) resulting from a lesion (A) of a thalamic attack site (7-day survival time) is plotted on charts of frontal sections, cat brain 01122B. Midbrain electrode tip locations at which electrical stimulation elicited attack are indicated by solid triangles. Animal identification numbers are to the upper left of each brain section. Abbreviations: *CM*, centrum medianum nucleus; *CP*, cerebral peduncle; *H*, habenula; *LD*, lateral dorsal nucleus; *LP*, lateral posterior nucleus; *MB*, mamillary body; *OT*, optic tract; *PC*, posterior commissure; *R*, red nucleus; *SN*, substantia nigra; and *3N*, third nerve. See Fig. 1 legend for additional abbreviations.

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10. However, the dorsal periaqueductal gray region from which electrical stimulation elicited attack extended only to the level of the middle of the red nucleus. This is consistent with the anatomic data; after lesions of thalamic attack sites, the degeneration traced to the dorsomedial portion of the central gray substance could not be followed caudal to the level of the middle portion of the red nucleus. Electrical stimulation of the continuation of this dorsomedial central gray region into the caudal half of the midbrain elicited affective defense and affective flight reactions. This was determined by examination of the histology for four of the thirteen cats in which stimulation failed to elicit biting attack. Histology was not available for the other nine cats. Further, as stimulation along the dorsal periventricular-periaqueductal pathway proceeded into the midbrain, the distance at which visual cues were effective in eliciting approach diminished. Stimulation of sites 1 and 2 (Fig. 2) elicited an attack upon a rat placed 0.9 to 1.5 m from the cat, whereas stimulation of sites 3 to 6 (Fig. 2) elicited attack only if the rat was within 30 cm of the cat.
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Neonate Movement Is Synchronized with Adult Speech: Interactional Participation and Language Acquisition

Abstract. *As early as the first day of life, the human neonate moves in precise and sustained segments of movement that are synchronous with the articulated structure of adult speech. These observations suggest a view of development of the infant as a participant at the outset in multiple forms of interactional organization, rather than as an isolate.*

In the discipline of kinesics, methods of microanalysis of sound films of human communication have revealed that key elements of interaction exist in the gestures, postures, and configurations of movement accompanying speech (*1–3*). These methods, applied to interaction between neonate and caretaker, have revealed a synchronization of infant movement organization with the articulatory segments of adult speech as early as the first day of life.

Frame-by-frame microanalysis of sound films of adult interaction has led to study of the organization of events within intervals of 1 and 2 seconds—the domain of microkinesics (*2*). A Bell and Howell 16-mm projector (time-motion analyzer) is used to segment and transcribe body motion (*4*). With this projector, film can be manually transported, one frame at a time, or series of frames can be scanned and contrasted with each other. Each film frame has an identifying number at the top (*5*). Body movements—of an arm for example—can be repeatedly reexamined by varying the number of frames scanned until the frame is located in which change in direction occurs. All body parts detected to be moving—including brows, eyes, and mouth—are systematically analyzed in this fashion. Notations are made for each part: lines for frames in which movement in a particular direction is sustained and arrows for the frame in which movement terminates or changes direction. An acoustic sound reader permits location of the film frame numbers of the boundaries of speech segments, such as phones, syllables, and words (*4*). Frame-numbered sound films of the oscilloscope display of the speech provide a check on the accuracy in locating speech segment boundaries in relation to frame numbers. Since the same speech is recorded again on the sound track that accompanies the film of speech visual dislay, the investigator can both hear and see the speech change points in relation to frame numbers.

These procedures permit an analysis of the relation of body movements to each other and to speech in both speaker and listener during interaction. As a person speaks, several body parts are usually moving. Units of behavior were observed: Several body parts, which might be moving in different directions and with different speeds, maintain those directions and speeds in relation to each other for a brief time, usually 0.04 to 0.16 second. This patterning of movement appears to be panhuman in that it has been observed in all films studied, including cross-cultural films. Several of these quantal configurations in infant behavior are circled in Fig. 1. These quantal forms of microorganization of a speaker's motion are isomorphic with the articulated structure of his speech. This has been called self-synchrony (*2*). Further, the configurational organizations or "units" of the listener's body motion are synchronous with the speaker's speech. This has been called "interactional synchrony" (*3*). These synchronies are not readily detectable at normal communication speed, appear to occur primarily in relation to speech,

Table 1. Correspondence of infant movements with live speech. Baby E's motion segmentation was compared with speech segmentation of the adult for the total sequence (study 1) and for the first 336 frames only (study 2). In study 3, baby C's motion segmentation during 336 frames of silence was compared to the first 336 frames of speech segmentation on the sound track of baby E.

Study	Total frames	Total discrepancies	Agreement (%)	Estimated range of agreement* (%)	Breakdown of discrepancies by linguistic categories		
					Within phone	Phone boundary	Word boundary
1	892	65	93	91.3–94.5	55	5	4
2	336	21	94	90.7–96.4	14	5	2
3	336	119	65	59.0–70.0	51	38	30

* This column gives, for $P = .025$, the maximum risks of overestimating the lower limit and of underestimating the upper limit for random samples having the percentage of misses in studies 1 to 3. Values obtained from (*10*).