

# Appendix

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TABLE A1 (a)

*Anatomical studies of the septal afferents to the hippocampus*

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Daitz and Powell 1954  
McLardy 19551a  
Cragg and Hamlyn 1957\*  
Votaw 1960b  
Powell 1963  
Votaw and Lauer 1963a  
Alksne and Blackstad 1965  
Raisman *et al.* 1965  
Anden *et al.* 1966  
De Vito and White 1966  
Petsche, Gogolak, and Stumpf 1966\*<sup>\*\*</sup>  
Raisman 1966  
Lewis and Shute 1967  
Lewis *et al.* 1967  
Genton 1969  
Storm-Mathisen 1970  
Ibata *et al.* 1971  
Siegel and Tassoni 1971b<sup>\*\*</sup>  
Storm-Mathisen and Fonnum 1972  
Hjorth-Simonsen 1973  
Mosko *et al.* 1973  
Sethy *et al.* 1973  
Srebro *et al.* 1973  
Mellgren and Srebro 1973  
Oderfeld-Nowak *et al.* 1974  
Segal and Landis 1974  
Srebro and Mellgren 1974  
Storm-Mathisen and Guldborg 1974

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\* Combined electrophysiological and histological study.

\*\* Indicates disagreement with majority of studies that septo-hippocampal projection originates in the medial septum and diagonal band of Broca.

TABLE A1 (b)

*Physiological studies of septal afferents to the hippocampus*


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Cragg and Hamlyn 1957  
 Andersen *et al.* 1961a,b  
 Brucke *et al.* 1963  
 Shaban 1970  
 Brust-Carmona *et al.* 1973 \*  
 De France *et al.* 1973  
 Dudar 1975

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\* Indicates disagreement with majority of studies that the septo-hippocampal projection originates in the medial septum and diagonal band of Broca.

TABLE A2

*Anatomical studies of the efferent connections of the hippocampus*


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Allen 1944  
 Simpson 1952  
 Sprague and Meyer 1950  
 McLardy 1955b  
 Powell and Cowan 1955  
 Guillery 1956  
 Nauta 1956  
 Powell *et al.* 1957  
 Nauta 1958  
 Johnson 1959  
 Valenstein and Nauta 1959  
 Votaw 1960a  
 Powell 1963  
 Votaw and Lauer 1963a  
 Johnson 1965  
 Raisman *et al.* 1966  
 Raisman 1969  
 Van Buren 1970  
 De France *et al.* 1971  
 Hjorth-Simonsen 1971  
 Siegel and Tassoni 1971a  
 Pepeu *et al.* 1973  
 Segal and Landis 1974  
 Siegel *et al.* 1974  
 Meibach and Siegel 1975  
 Swanson and Cowan 1975a,b

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TABLE A3

*Physiological studies of the efferent connections of the hippocampus*


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Kaada 1951  
 Kaada *et al.* 1953  
 Adey, Segundo, and Livingston 1957  
 Adey, Sunderland, and Dunlop 1957  
 Adey *et al.* 1958  
 Cazard and Buser 1958  
 Cragg and Hamlyn 1959\*  
 Livingston 1959  
 Cragg and Hamlyn 1960\*  
 Flynn and Wassman 1960  
 Akert and Gernandt 1962  
 Feldman 1962  
 Parmeggiani 1962  
 Cazard and Buser 1963  
 Fox *et al.* 1967  
 Gergen 1967  
 Parmeggiani 1967  
 Redding 1967  
 Yamaguchi *et al.* 1967  
 Psatta, Sirian, and Ungher 1968  
 Psatta, Ungher, and Sirian 1968  
 Sierra and Fuster 1968  
 Vanegas and Flynn 1968  
 Yokota and MacLean 1968  
 Parmeggiana and Rapisarda 1969  
 Redding 1969  
 Ungher *et al.* 1969  
 Kerr and Dennis 1970  
 Poletti *et al.* 1970  
 Golden and Lobar 1971  
 Grillo 1971  
 Kaada *et al.* 1971  
 Bland and Vanderwolf 1972b,  
 De France *et al.* 1972  
 Grantyn *et al.* 1972  
 McKenzie and Gilbert 1972  
 Andersen *et al.* 1973  
 Culberson and Bach 1973  
 De France, Kitai, Hatada, and Christensen 1973  
 De France, Kitai, and Shimono 1973a,b  
 De France, Kitai, McCrea, Kocsis, and Hatada 1973  
 Edinger *et al.* 1973  
 Gambarian *et al.* 1973  
 Poletti *et al.* 1973  
 Mok and Mogenson 1974  
 De France, McCrea, and Yoshihara 1975  
 De France and Yoshihara 1975  
 De France, Yoshihara, McCrea, and Kitai 1975

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\* Combined electrophysiological and histological study.

TABLE A4

*Studies on the brainstem pathways involved in generating hippocampal theta and desynchronization*

Kawamura <i>et al.</i> 1961
Torii 1961
Corazza and Parmeggiani 1963
Yokota and Fujimori 1964
Stumpf 1965a,b
Parmeggiani 1967
Kawamura and Domino 1968
Anchel and Lindsley 1972
Macadar <i>et al.</i> 1974
Coleman and Lindsley 1975
Lindsley and Wilson 1975
Paiva <i>et al.</i> 1976

TABLE A5

*Hippocampal EEG during exploration, orientation reflex, and searching behaviour*

Theta	Theta frequency	LIA or SIA
<i>Rat</i>		
Brugge 1965	6-8	
Routtenberg 1968	6-8	
Gray and Ball 1970	7.5-8.5	
Irmis <i>et al.</i> 1970	7-8	
Komisaruk 1970 <sup>b</sup>		
Pond <i>et al.</i> 1970 <sup>c</sup>	8-9	
Pond and Schwartzbaum 1970 <sup>c</sup>	8-10	
Routtenberg <i>et al.</i> 1970		
Albino and Caiger 1971	7.0-7.5	
Irmis <i>et al.</i> 1971 <sup>a</sup>		
Morales <i>et al.</i> 1971	4-8	
Whishaw and Vanderwolf 1971 <sup>d</sup>		
Gray 1972	7.5-8.5	
Gray <i>et al.</i> 1972	7.5-8.5	
Feder and Ranck 1973		
Kurtz and Adler 1973		
Ranck 1973		
Schwartzbaum and Kreinick 1973	8-9	
Whishaw and Vanderwolf 1973		
Kimsey <i>et al.</i> 1974	7-9	
Winson 1974		
Coenen 1975	8	
Kurtz 1975		
Schwartzbaum 1975	8	

TABLE A5 - cont.

*Hippocampal EEG during exploration, orientation reflex, and searching behaviour*

Theta	Theta frequency (Hz)	LIA or SIA
<i>Gerbil</i>		
Kramis and Routtenberg 1969	7-9	
<i>Hamster</i>		
Macrides 1975 <sup>b</sup>	8.1-8.7	
<i>Rabbit</i>		
Torii and Sugi 1960	8	
Polc and Monnier 1970 <sup>c</sup>	6-7	
<i>Dog</i>		
Yoshii <i>et al.</i> 1967	5-6	
<i>Cat</i>		
Grastyan <i>et al.</i> 1959	5	
Adey <i>et al.</i> 1960	4.0-7.5	
Lissak and Grastyan 1960		
Adey <i>et al.</i> 1962		
Brown and Shryne 1964 <sup>g</sup>	3-6 early, 3.5-4.8 late	
Porter <i>et al.</i> 1964	4-5	
Karmos <i>et al.</i> 1965		
Grastyan <i>et al.</i> 1966 <sup>h</sup>		
Brown 1968	4.3-4.7	
Bennett 1970		
Anchel and Lindsley 1972 <sup>f</sup>		
Bennett <i>et al.</i> 1973	4.7	
Grastyan and Vereczkei 1974	4-5	
Coleman and Lindsley 1975	4.5-5.5	
Kemp and Kaada 1975	up to 8.5	

a Good correlation between theta frequency during low-voltage fast sleep, amount of exploration in a novel environment, and amount of response to an auditory stimulus.

b Theta sometimes synchronizes to vibrissa twitch and sniff and (Komisaruk only) heart beat during exploratory sniffing.

c Elicited by stimulation of the lateral hypothalamus.

d No synchronization between theta and exploratory sniffing.

e Elicited by stimulation of the raphe nucleus and reticular formation.

f Elicited by stimulation of medial hypothalamus as well as occurring naturally.

g Early orienting involves whole-body exploration; late orienting involves primarily visual searching.

h Elicited by hypothalamic stimulation.

TABLE A6(a)  
Hippocampal EEG during motor behaviours: spatial displacement<sup>a</sup>

Theta	Behaviour <sup>a</sup> and theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
Vanderwolf and Heron 1964		Routtenberg 1968
Vanderwolf 1969	w 8.0-8.3; rr 8.0-8.3; j 8-12	
Gray and Ball 1970	r 8-10	
Irmis <i>et al.</i> 1970	m 8-9	
Paxinos and Bindra 1970	8	
Albino and Caiger 1971	cl 7.5	
Teitelbaum and McFarland 1971	7	
Whishaw and Vanderwolf 1971	sw 7.5-8.3	
Bland and Vanderwolf 1972a <sup>b</sup>	r 8-9; j 9-11	
Gray 1972	8.5-10	
Gray <i>et al.</i> 1972	8.5-10	
Whishaw <i>et al.</i> 1972 <sup>c</sup>		
Pond and Schwartzbaum 1972	w 8-10	
Feder and Ranck 1973		
Ranck 1973		
Vanderwolf <i>et al.</i> 1973		
Whishaw and Vanderwolf 1973	r 7.7; sw 7.6; j 9-11	
Kurtz and Adler 1973	w 8-10; m 7.9	
Fleming and Bigler 1974		
Kimsey <i>et al.</i> 1974	r 9.1	
Robinson and Whishaw 1974 <sup>c</sup>	w 7.6	
Winson 1974		
Coenen 1975	8	
Kurtz 1975	r 8.5; m 8	
McFarland <i>et al.</i> 1975		
Vanderwolf 1975 <sup>d</sup>	j 8	
Vanderwolf <i>et al.</i> 1975		
Myhrer 1975 <sup>d</sup>		
Morris, Black, and O'Keefe 1976		
<i>Gerbil</i>		
Whishaw 1972	r 7.7	
<i>Guinea pig</i>		
Sainsbury 1970	w 8.3	

TABLE A6-cont.  
Hippocampal EEG during motor behaviours: spatial displacement<sup>a</sup>

Theta	Behaviour <sup>a</sup> and theta frequency (Hz)	LIA or SIA
<i>Rabbit</i>		
Sadowski and Longo 1962 <sup>f</sup>	8-9	
Klemm 1970		
Harper 1971	8	
Klemm 1971	5-9	
Kramis <i>et al.</i> 1975	hp 8; r up to 12	
<i>Dog</i>		
Lopes da Silva and Kamp 1969	5-6	Yoshii <i>et al.</i> 1967 <sup>h</sup>
Yoshii <i>et al.</i> 1967	w 6-7	
Kamp <i>et al.</i> 1971	r 6-7; circle 4-5	
Arnolds <i>et al.</i> 1975 <sup>g</sup>		
<i>Cat</i>		
Adey <i>et al.</i> 1960	r 5-6	Grastyan <i>et al.</i> 1959 Grastyan <i>et al.</i> 1966 <sup>i</sup> Bennett 1970 Bennett and Gottfried 1970 Bennett <i>et al.</i> 1973
Holmes and Adey 1960	w 5-6	
Adey <i>et al.</i> 1962	r 6	
Porter <i>et al.</i> 1964	w 6	
Radulovacki and Adey 1965	r 6	
Grastyan <i>et al.</i> 1966 <sup>i</sup>	w	
Elazar and Adey 1967	r 5-6	
Whishaw and Vanderwolf 1973	w 5	
Grastyan and Vereczkei 1974 <sup>i</sup>	6-7	

- a Including walking (w), running (r), swimming (sw), jumping (j), rearing (rr), climbing (cl), male mounting during sex (m), and hopping (hp).
- b Elicited by stimulation of the posterior hypothalamus.
- c Theta frequency during walking is lowered to 6.6 Hz after posterior hypothalamic lesions.
- d Two types of theta: non-movement theta is abolished by atropine and is elicited by eserine, ether, or mid-brain reticular stimulation; movement-related theta is not affected by atropine, and is stimulated by amphetamine and depressed by phenothiazines.
- e Elicited by stimulation of the lateral hypothalamus.
- f Theta during walking not affected by scopolamine but theta during alert immobility is (see Table A8(b)).
- g Shifts in theta frequency are related to changes in mode of behaviour, e.g. from standing to walking.
- h SIA recorded when animal abruptly changes direction of movement.
- i Occasionally SIA during approach in early stages of conditioning.
- j Stimulation through some hypothalamic placements causes running associated with hippocampal theta: at higher levels of stimulation very fast running was associated with SIA.

TABLE A6(b)  
Hippocampal EEG during motor behaviours: non-spatial, non-consummatory<sup>a</sup>

Theta	Behaviour and theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
Vanderwolf 1969 <sup>b</sup>	hm 6.6-7.1; hfp 6.6-7.1	Vanderwolf 1969 <sup>b</sup>
Whishaw and Vanderwolf 1971 Bland and Vanderwolf 1972a Whishaw <i>et al.</i> 1972 Feder and Ranck 1973 Ranck 1973 Vanderwolf <i>et al.</i> 1973 Whishaw and Vanderwolf 1973 <sup>b</sup> Frederickson <i>et al.</i> 1974 Vanderwolf 1975 Vanderwolf <i>et al.</i> 1975	bx st 8.2	Whishaw and Vanderwolf 1973 <sup>b</sup>
<i>Gerbil</i>		
Whishaw 1972		
<i>Guinea pig</i>		
Sainsbury 1970	dg 8.3; hm 7.3	
<i>Dog</i>		
Yoshii <i>et al.</i> 1967	hm 5-6	
<i>Cat</i>		
Sakai <i>et al.</i> 1973 Whishaw and Vanderwolf 1973 Glotzbach 1975	em 3.5-4.3	Grastyan <i>et al.</i> 1959 Kemp and Kaada 1975

a Including head movements (hm), eye movements (em), limb movements as when an animal boxes during fighting (bx), rotates a food pellet during eating (hfp), or digs (dg), postural adjustments (pa), and struggling while held (st).

b During small head movements and food pellet manipulation theta was recorded at some hippocampal placements and not others.

TABLE A6(c)  
Hippocampal EEG during motor behaviours: lever pressing

Theta	Schedule and theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
Bremner 1964 Yoshii <i>et al.</i> 1967 Vanderwolf 1969 Pond and Schwartzbaum 1972 <sup>c</sup> McGowan-Sass 1973 <sup>b</sup> Whishaw and Vanderwolf 1973 <sup>d</sup> Frederickson 1974a Bennett 1975	SA 5-7 CRF 7-8 CRF FR SA 6.6 CRF FR CRF 6.6 c-CRF 6.6; DRL 6.8; c-DRL 6.2	Feder and Ranck 1973 (CRF & FR50) Whishaw and Vanderwolf 1973 (CRF)
<i>Gerbil</i>		
Kramis and Routtenberg 1969		
<i>Cat</i>		
Bennett <i>et al.</i> 1973 Hatfield 1975	CRF; c-DRL CRF 3.5-5.5	Bennett 1970 (discriminated CRF) Bennett and Gottfried 1970 (CRF-DRL)
<i>Dog</i>		
Dalton and Black 1968 Black and Young 1972a	CRF 4.5-5.0	Yoshii <i>et al.</i> 1967 (CRF) Lopes da Silva and Kamp 1969 (CRF)

a Abbreviations: DRL (differential reinforcement of low rates of lever pressing); c-DRL (cued DRL); CRF (reinforcement for each lever press); FRx (reinforcement for each xth lever press); SA (Sidman avoidance schedule in which each lever press postpones a shock for a given period of time).

b Theta disappears over time from the ventral, but not the dorsal, hippocampus.

c More theta during lever presses 1-8 than during lever presses 9-16 of FR16.

d Theta during lever pressing from some hippocampal placements but not others.

TABLE A7  
Hippocampal EEG during consummatory behaviours<sup>a</sup>

Theta	Behaviour <sup>a</sup> and theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
Gray and Ball 1970 <sup>i</sup>	d 6-7.5	Routtenberg 1968
Irmis <i>et al.</i> 1970	ej 8-9	Vanderwolf 1969
Pond <i>et al.</i> 1970 <sup>c</sup>	e 6-8	Routtenberg <i>et al.</i> 1970
Gray 1972i	d 6-7.5	Pond <i>et al.</i> 1970 <sup>c</sup>
Gray <i>et al.</i> 1972 <sup>i</sup>	d 6-7.5	Albino and Caiger 1971
Kurtz and Adler 1973	in 8.2; ej 7.2	Whishaw and Vanderwolf 1971
Kimsey <i>et al.</i> 1974 <sup>i</sup>	d 6.5	Black and Young 1972b <sup>b</sup>
Kurtz 1975	li 7; lej 6.5	Whishaw <i>et al.</i> 1972 <sup>d</sup>
		Bland and Vanderwolf 1972a
		Pond and Schwartzbaum 1972
		Feder and Ranck 1973
		Ranck 1973
		Whishaw and Vanderwolf 1973
		Robinson and Whishaw 1974
		Coenen 1975
<i>Gerbil</i>		
		Kramis and Routtenberg 1968
		Whishaw 1972
<i>Guinea pig</i>		
		Sainsbury 1970
<i>Cat</i>		
		Whishaw and Vanderwolf 1973
<i>Rabbit</i>		
Torii and Sugi 1960	a 5-7; g 5-7	Kramis <i>et al.</i> 1975 <sup>c</sup>
Sadowski and Longo 1962	e 4-6	
Huston and Brozek 1974	d 5.4; e 6.2-6.4	
Kramis <i>et al.</i> 1975	d 5.8 <sup>f</sup> ; e 6.5 <sup>g</sup> ; g 6.5	
<i>Dog</i>		
Yoshii <i>et al.</i> 1967 <sup>h</sup>		Yoshii <i>et al.</i> 1967 <sup>h</sup>
Konorski <i>et al.</i> 1968	e 4.3	Lopes da Silva and Kamp 1969

TABLE A8(a)  
Hippocampal EEG during immobility prior to jumping

Theta	Theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
Vanderwolf 1969	6.7	
Vanderwolf <i>et al.</i> 1973		
Whishaw and Vanderwolf 1973	7	
Vanderwolf and Cooley 1974		
Myhrer 1975 <sup>d</sup>	8-10	
Vanderwolf 1975	6	

a Including eating (e), drinking (d), grooming (g), chewing (ch), male intromission (in) and ejaculation (ej) during sexual intercourse, female lordosis during male intromission (li) and ejaculation (lei), sniffing without movement, teeth chattering, vomiting, yawning, shivering, urination, defecation, vocalization, salivation, piloerection, and foot stomping in gerbils.

b Water licking used as operant to avoid shock.

c Normal eating in the unstimulated condition is associated with LIA, but agitated eating elicited by lateral hypothalamic stimulation is associated with theta but the frequency is 1-2 Hz below that elicited by the same stimulation in the absence of consummatory behaviour.

d Eating, drinking, and grooming elicited by lateral hypothalamic stimulation accompanied by LIA unless rat is 'fidgety' when theta occurs (see note c).

e LIA during chewing without head movements.

f Theta during drinking in 7 of 11 rabbits.

g Theta during eating with head movements.

h Theta during mastication, LIA during eating, drinking, urination, and barking.

i Recording electrodes in the subiculum.

TABLE A8(b)  
*Hippocampal EEG: animal immobile, alert, and attentive*

Theta	Theta frequency (Hz)	LIA or SIA	
<i>Rat</i>			
Robinson and Whishaw 1974 <sup>a</sup>	4-6	Brugge 1965 <sup>b</sup> Vanderwolf 1969 Paxinos and Bindra 1970 Albino and Caiger 1971 Ranck 1973 Vanderwolf <i>et al.</i> 1973 Whishaw and Vanderwolf 1973 Frederickson <i>et al.</i> 1974 <sup>c</sup> Robinson and Whishaw 1974 <sup>a</sup> Coenen 1975 Kurtz 1975 Vanderwolf 1975	
Black 1975	< 7		
<i>Gerbil</i>			
<i>Rabbit</i>			
Green and Arduini 1954	5-7		Whishaw 1972
Torii and Sugi 1960	5-7		
Sadowski and Longo 1962	4-6		Torii and Sugi 1960 Kramis <i>et al.</i> 1975
Klemm 1970 <sup>d</sup>			
Harper 1971	7		
Klemm 1971 <sup>d</sup>			
Huston and Brozek 1974	7.1		
<i>Cat</i>			
Porter <i>et al.</i> 1964	4		Anchel and Lindsley 1971 <sup>e</sup> Grastyan and Vereczkei 1974 Hatfield 1975
Radulovacki and Adey 1965	3-7		
Brown 1968	4.4		
Bennett 1969			
Bennett 1970			
Whishaw and Vanderwolf 1973			
Coleman and Lindsley 1975			
Kemp and Kaada 1975			
<i>Dog</i>			
Urban <i>et al.</i> 1974 <sup>d</sup>	5	Dalton and Black 1968 Black and Young 1972a	

a Following large posterior hypothalamic lesions, rats sometimes show 4-6 Hz theta during alert immobility.  
b Occasionally theta when animal fails to orient to a stimulus.  
c LIA when immobile rat is bitten during fighting.  
d Theta during immobility associated with phasic increases in EMG and brainstem multi-unit activity.  
e Associated with cold block of the medial hypothalamic pathway or stimulation of the lateral hypothalamic pathway.  
f ACTH<sub>4-10</sub> reduces theta frequency while dog waits for cue to press lever from above 5 Hz to below 5 Hz.

TABLE A9  
*Hippocampal EEG during sensory stimulation*

Theta (sensory modality <sup>a</sup> )	Theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
Bremner 1968 (v) <sup>b</sup>	5	Whishaw 1972(a) <sup>c</sup> Ranck 1973
Bremner and Ford 1968 (v)	5-6	
Irmis <i>et al.</i> 1970 (a) <sup>d</sup>	6.7-8.5	
Whishaw 1972 (a) <sup>c</sup>		
Schwartzbaum and Kreinick 1973 (v)	5	
<i>Rabbit</i>		
Jung and Kornmuller 1938 (a, n)	5-6	Jung and Kornmuller 1938 (v, l, t)
Green and Arduini 1954 (o, v, a, ta, n)	3-6	
Eidelberg <i>et al.</i> 1959 (a)		
Costin <i>et al.</i> 1967 (1)		
Harper 1971		
Kramis <i>et al.</i> 1975	7	
Martin <i>et al.</i> 1975 (a) <sup>e</sup>		
<i>Cats</i>		
Green and Arduini 1954		Grastyan <i>et al.</i> 1959 (a) <sup>f</sup> Karmos <i>et al.</i> 1965 <sup>f</sup>
Grastyan <i>et al.</i> 1959 (a) <sup>f</sup>	5	
Karmos <i>et al.</i> 1965 <sup>f</sup>		
Kemp and Kaada 1975 Kramis <i>et al.</i> 1975		
<i>Dogs</i>		
		Lucas <i>et al.</i> 1974 <sup>g</sup>

a Abbreviations: v (visual), a (auditory), n (noxious), l (labyrinthine), t (thermal), o (olfactory), ta (tactile)  
b No change in theta with habituation to the stimulus.  
c Theta if rat moves in response to tone; LIA if no movement.  
d Decrease in theta with habituation to the stimulus. Animals explore stimulus.  
e No change in theta elicited by auditory stimulus after injection of glucocorticoids.  
f Theta during orienting response to stimulus; no theta if no orienting.  
g Hippocampal EEG desynchronized by unfamiliar but not by familiar stimulus.

TABLE A10

Hippocampal EEG in response to cues used in appetitive and aversive tasks<sup>a</sup>

Theta (task)	Theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
Pickenhain and Klingberg 1967 (jump avoid)		
Bremner 1968 (cued ESB)	6	
Albino and Caiger 1971 (ap)	6.5	
Whishaw 1972 (av)	5.9	
McGowan-Sass 1973 (SA lever press)	6.6 dorsal; 6.2 ventral	
Bennett 1975 (lever press)	6.6 CRF; 6.2 DRL	
Schwartzbaum 1975 (CER)	6	
<i>Rabbit</i>		
Sadowski and Longo 1962 (cued ring pull)		
Powell and Joseph 1974 (conditioned eye blink)		
<i>Cat</i>		
Grastyan <i>et al.</i> 1959 (ap) <sup>b</sup>	4-7	Grastyan <i>et al.</i> 1959 (ap) <sup>b</sup>
Radulovacki and Adey 1965 (cued start in Y maze)	4-5	Lissak and Grastyan 1960 (ap & av) <sup>b</sup>
Elazar and Adey 1967b (cued start in T maze)	5	Holmes and Beckman 1969 (go-no-go runway) <sup>c</sup>
Holmes and Beckman 1969 (go-no-go runway) <sup>c</sup>		Bennett 1970 <sup>b</sup>
Bennett 1970 <sup>b</sup>		Bennett and Gottfried 1970 (DRL lever press)
Bennett <i>et al.</i> 1973 (CRF & DRL lever press)	5.5	Grastyan and Vereczkei 1974 (ap) <sup>b</sup>
Grastyan and Vereczkei 1974 (ap) <sup>b</sup>	4-5	Hatfield 1975 (conditioned immobility)
Hatfield 1975 (CRF lever press)		
<i>Dog</i>		
Dalton and Black 1968 (CRF lever press and hold still)		Dalton and Black 1968 (CRF lever press and hold still) <sup>e</sup>
Ellison <i>et al.</i> (delayed lever press)		Lopes da Silva and Kamp 1969 (CRF)

TABLE A10 - cont

Hippocampal EEG in response to cues used in appetitive and aversive tasks<sup>a</sup>

Theta (task)	Theta frequency (Hz)	LIA or SIA
Konorski <i>et al.</i> 1968 (ap & lever press)		
Dalton 1969 (op. reinforcement of theta)	4-6	Black <i>et al.</i> 1970 (operant reinforcement of theta and LIA) <sup>d</sup>
Black <i>et al.</i> 1970 (operant reinforcement of theta and LIA) <sup>d</sup>		Black and Young 1972a (conditioned immobility)
Black and Young 1972a (CRF lever press)	4.5-5	
Preobrazenskaya 1974 (av)	5-5.5	

- a Abbreviations: ap (appetitive), av (aversive), ESB (electrical stimulation of the brain), SA (Sidman avoidance in which the animal must do something, such as press a lever, to delay the onset of shock), CER (conditioned emotional response), CRF (continuous reinforcement), DRL (differential reinforcement of low rates of lever pressing).
- b LIA elicited by the cue in approach or avoidance tasks when no investigative orientation response occurs; theta when an orientation response does occur.
- c One stimulus signals the onset of a go trial, another a no-go trial; theta during the first but not the second.
- d Curarized dogs were operantly reinforced for producing theta in the presence of one stimulus and LIA in the presence of a second; in the unparalysed state the animals moved more during the first stimulus than during the second.
- e Dogs were reinforced for lever pressing to one stimulus and for holding still to a second stimulus; the first stimulus elicited theta and the second LIA.

TABLE A11(a)  
*Hippocampal EEG during slow wave sleep*

Theta	Behaviour and theta frequency	LIA or SIA
<i>Rat</i>		Morales <i>et al.</i> 1971 Olmstead <i>et al.</i> 1973 Winson 1974 Coenen 1975
<i>Rabbit</i>		Torii and Sugi 1960 Harper 1971
<i>Cat</i>		Brown and Shryne 1964 Karmos <i>et al.</i> 1965 Brown 1968 Glottzbach, 1975

TABLE A11 (b)  
*Hippocampal EEG during low-voltage fast sleep*

Theta	Behaviour and theta frequency (Hz)	LIA or SIA
<i>Rat</i>		
	Irmis <i>et al.</i> 1971	6-8
	Morales <i>et al.</i> 1971	5-8
	Kurtz and Adler 1973	6.5-9.5
	Sano <i>et al.</i> 1973	6.8-8.5
	Whishaw and Vanderwolf 1973	6.7 (7.6 during twitches)
	Winson 1974	
	Coenen 1975	8
<i>Cat</i>		
	Jouvet and Mounier 1962	5
	Brown and Shryne 1964 <sup>a</sup>	4.5-5.5
	Karmos <i>et al.</i> 1965	
	Brown 1968	5
	Sakai <i>et al.</i> 1973	4.2-6.2
	Glottzbach 1975	
	Kemp and Kaada 1975	7.5
<i>Rabbit</i>		
	Harper 1971	8
	Winson 1976 a, b	

a SIA, not theta, is seen for the first few episodes of lvf sleep in timid fearful cats in a new environment

TABLE A 12  
*Hippocampal EEG during electric stimulation of the brain<sup>a</sup>*

Theta	Reinforcement	Brain area	LIA or SIA	Reinforcement	Brain area
<i>Rat</i>					
Ito 1966 <sup>b</sup>	o	mrf, mh	Ito 1966 <sup>b</sup>	+	lpo, lh, s
Yoshii <i>et al.</i> 1967	-	lh	Gray and Ball 1970	+	s
Routtenberg and Kramis 1968	-	dmt	Paxinos and Bindra 1970 <sup>d</sup>	+	lh
Paxinos and Bindra 1970 <sup>d</sup>	+	lh	Pond and Schwartzbaum 1970	+	s
Pond <i>et al.</i> 1970	+	lh			
Pond and Schwartzbaum 1970	+, -	lh, dmt	Gray <i>et al.</i>	-	s
Routtenberg 1970	+, -, o	mbs	Frederickson 1974b <sup>c</sup>	+	
Gray 1972		s			
Sinnamon and Schwartzbaum, 1973	+, -	lh, dmt			
<i>Gerbil</i>					
Kramis and Routtenberg 1969	+	ph			
<i>Car</i>					
Grastyan <i>et al.</i> 1966	+	h	Grastyan <i>et al.</i> 1966	-	h
Anchel and Lindsley 1972 <sup>e</sup>		mh	Grastyan <i>et al.</i> 1968	+	h
Coleman and Lindsley 1975 <sup>e</sup>		mh	Anchel and Lindsley 1972 <sup>f</sup>		lh
			Coleman and Lindsley 1975 <sup>f</sup>		lh
<i>Rabbit</i>					
Polc and Monnier 1970 <sup>b</sup>		r, mrf			

a Abbreviations: + (positively reinforcing), - (negatively reinforcing), o (non-reinforcing), lh (lateral hypothalamus), mh (medial hypothalamus), ph (posterior hypothalamus), dmt (dorsal mid-brain tegmentum), mbs (mesencephalic brain stem), mrf (mesencephalic reticular formation), s (septum), h (hypothalamus), r (raphe).

b ESB elicits attentive sniffing and searching; ESB in lateral hypothalamus and lateral preoptic region elicits self-stimulation in 7 of 16 rats; ESB in septum elicits self-stimulation in 2 of 20 rats.

c ESB reinforced rat for holding still.

d Theta if ESB reinforces movement; LIA if ESB reinforces immobility.

e ESB elicited head turning; also produced by cold block of lateral hypothalamus (in Anchel and Lindsley 1971 only).

f ESB elicited arrest of ongoing activity attentive fixation of gaze; also produced by cold block of medial hypothalamic pathway (in Anchel and Lindsley 1972 only).

TABLE A13  
*Reactions to novel items after hippocampal lesions*

	Normal	Decreased	Increased
NONCOMPETITIVE			
<i>Rat</i>	Kaplan 1968 Crowne and Riddell 1969 Hendrickson <i>et al.</i> 1969 Sanwald <i>et al.</i> 1970 <sup>a</sup> Kemble and Ison 1971 Dawson <i>et al.</i> 1973 Olton and Gage 1974 Groves <i>et al.</i> 1974 <sup>b</sup>		Coover and Levine 1972
<i>Cat</i>	Rogozea and Ungher 1968 Ungher <i>et al.</i> 1971 Nonneman and Kolb 1974	Rogozea and Ungher 1968 Ungher <i>et al.</i> 1971	
<i>Guinea pig</i>	Ireland and Isaacson 1968		Ireland and Isaacson 1968
<i>Gerbil</i>		Glickman <i>et al.</i> 1970	
<i>Monkey</i>	Bagshaw <i>et al.</i> 1965		Hara and Myers 1973 <sup>c</sup>
COMPETITIVE			
<i>Rat</i>		Wickelgren and Isaacson 1963 Raphelson <i>et al.</i> 1965 <sup>d</sup> Kaplan 1968 Hendrickson <i>et al.</i> 1969 Crowne and Riddell 1969 Cohen 1970 Cohen and Swenson 1970 Gustafson 1975	

a Normal cardiac deceleration and habituation of deceleration, but absence of late acceleration.

b Normal intrasession, but deficient intersession, habituation of acoustic startle response.

c Only a slight increase in some reactions.

d No group responded to the introduction of sandpaper floors.

TABLE A 14  
*Reactions to novel places after hippocampal lesions*

	Normal	Increased	Decreased	
<i>Rat</i>	Douglas and Isaacson 1964 <sup>a</sup> Spiegel <i>et al.</i> 1966 Hostetter and Thomas 1967 Haddad and Rabe 1967 Boitano and Isaacson 1967 Jackson 1967 Bender <i>et al.</i> 1968 Kaplan 1968 Boitano <i>et al.</i> 1968 Rabe and Haddad 1969a Jarrard and Korn 1969 Strong and Jackson 1970 <sup>b</sup> Campbell <i>et al.</i> 1971 Moorcroft 1971 Alvarez-Pelaez 1973 Greene and Stauff 1974 Kearley <i>et al.</i> 1974 Lanier and Isaacson 1975 Lanier <i>et al.</i> 1975 Murphy <i>et al.</i> 1975 Myhrer and Kaada 1975 Myhrer 1975a Myhrer 1975b	Kim 1960a Niki 1962 Roberts <i>et al.</i> 1962 Kimble 1963 Teitelbaum and Milner 1963 Douglas and Isaacson 1964 Leaton 1965 Stein and Kimble 1966 Leaton 1967 Jackson 1967 Kirkby <i>et al.</i> 1967 Jarrard 1968 Jarrard and Bunnell 1968 Bermant <i>et al.</i> 1968 Sengstake 1968 Kaplan 1968 Nadel 1968 Gotsick 1969 Strong and Jackson 1970 Clark 1970 Kim <i>et al.</i> 1970 Winocur and Mills 1970b Eichelman 1971	Moorcroft 1971 Means <i>et al.</i> 1971 Campbell <i>et al.</i> 1971 Capobianco and Hamilton 1973 Alvarez-Pelaez 1973 Dawson <i>et al.</i> 1973 Bayer <i>et al.</i> 1973 Alexander <i>et al.</i> 1974 Kearley <i>et al.</i> 1974 Lanier <i>et al.</i> 1974 Lanier and Isaacson 1975 Murphy <i>et al.</i> 1975 Jacobs <i>et al.</i> 1975 Myhrer and Kaada 1975 Myhrer 1975b Myhrer 1975a Peters and Brunner 1976 Wallace <i>et al.</i> 1976 Ely <i>et al.</i> 1976 Iuvone and Van Hartesveldt 1976	Jarrard 1968 Jarrard and Bunnell 1968
<i>Gerbil</i>		Glickman <i>et al.</i> 1970		
<i>Cat</i>		Kim <i>et al.</i> 1971		
<i>Hamster</i>	Jarrard and Bunnell 1968			

a Increase with electrolytic, but not aspiration, lesions.

b Decrease in one study; no effect in another.



TABLE A 16  
*Spatial discrimination after hippocampal lesions*

Normal	Deficient
Kimble and Kimble 1965	Greene 1971
Niki 1966	Samuels 1972
Uretsky and McCleary 1969	Means <i>et al.</i> 1972
Brown <i>et al.</i> 1969	Jones and Mishkin 1972
Means and Douglas 1970 <sup>a</sup>	Mikulka and Freeman 1975 <sup>b</sup>
Mahut 1971	
Cohen <i>et al.</i> 1971	
Hirsch and Segal 1972	
Mahut 1972	
Cohen and LaRoche 1972	
Cohen and LaRoche 1973	
Mahut and Zola 1973	
Riddell <i>et al.</i> 1973	
Greene and Stauff 1974	
Thomas and McCleary 1974	

<sup>a</sup> A subgroup trained against preference had a deficit.

<sup>b</sup> Deficit with 10 s delay between response and reinforcement; normal without delay.

TABLE A 17  
*Non-spatial discrimination after hippocampal lesions*

Normal	Deficient
Kimble 1963	Niki 1962
Kimble and Pribram 1963	Pribram <i>et al.</i> 1962
Teitelbaum 1964	Andy <i>et al.</i> 1967 <sup>a</sup>
Webster and Voneida 1964	Douglas <i>et al.</i> 1969 <sup>b</sup>
Douglas 1966	Duncan and Duncan 1971
Stein and Kimble 1966	Woodruff and Isaacson 1972
Kimble and Zack 1967	Woodruff <i>et al.</i> 1972 <sup>c</sup>
Silveira and Kimble 1968	Olton 1972b <sup>d</sup>
Winocur and Salzen 1968	Bauer 1974 <sup>f</sup>
Isaacson <i>et al.</i> 1968	
Truax and Thompson 1969	
Kimble and Kimble 1970	
Winocur and Mills 1970a	
Mahut 1971	
Jones and Mishkin 1972	
Samuels 1972	
Mahut 1972	
Mahut and Zola 1973	
Harley 1972	
Zola and Mahut 1973 <sup>e</sup>	
Nonneman and Isaacson 1973	
Riddell <i>et al.</i> 1973	
Alexander <i>et al.</i> 1974	
Anton and Bennett 1974	
Stevens and Cowey 1974 <sup>g</sup>	

a Normals also did not learn; hippocampals had position habit.

b Lesioned animals normal with one negative cue, but defective with two or four negative cues.

c Animals were pretrained on CRF; hippocampals had higher inter-trial response rate.

d Hippocampals had pronounced position habit.

e Hippocampals were facilitated.

f See p. 279 of text for discussion of this study.

g Slight deficit in compound cue discrimination.

TABLE A 18  
*Spatial discrimination reversals after hippocampal lesions*

Normal	Deficient
Cohen <i>et al.</i> 1971	Thompson and Langer 1963
Stevens 1971 <sup>b</sup>	Kimble and Kimble 1965
Cohen and LaRoche 1972	Thompson <i>et al.</i> 1964 <sup>a</sup>
Cohen and LaRoche 1973	Niki 1966
Stevens 1973b <sup>d</sup>	Samuels and Valian 1968 <sup>c</sup>
	Uretsky and McCleary 1969
	Brown <i>et al.</i> 1969
	Greene 1971
	Mahut 1971
	Cohen <i>et al.</i> 1971
	Hirsch and Segal 1972
	Samuels 1972
	Cohen and LaRoche 1972
	Gaffan 1972
	Mahut 1972
	Jones and Mishkin 1972
	Cohen and LaRoche 1973
	Mahut and Zola 1973
	Greene and Stauff 1974
	Nonneman <i>et al.</i> 1974
	Thomas and McCleary 1974

a 30 s inter-trial interval ameliorates deficit.

b Deficit with 4 min inter-trial interval and reversal to non-preferred side.

c Deficit is ameliorated by added visual cues.

d Massed trials improve reversal.

TABLE A19

*Non-spatial discrimination reversals after hippocampal lesions*

Normal	Deficient
Isaacson <i>et al.</i> 1968	Teitelbaum 1964
Mahut 1971	Webster and Voneida 1964
Mahut 1972	Douglas and Pribram 1966 <sup>a</sup>
Jones and Mishkin 1972	Silveira and Kimble 1968
Mahut and Zola 1973	Isaacson <i>et al.</i> 1968
Zola and Mahut 1973 <sup>c</sup>	Hsiao and Isaacson 1971
	Samuels 1972 <sup>b</sup>
	Nonneman and Isaacson 1973 <sup>d</sup>

a Mild deficit on 100 per cent vs. 0 per cent task; large deficit on 70 per cent vs. 30 per cent probability task.

b Small lesions yielded no deficit; larger lesions yielded deficit.

c Lesioned monkeys were better than normal at reversal.

d Neonatal lesions did not retard reversal.

TABLE A20

*Complex maze learning after hippocampal lesions*

Normal	Deficient
Gross <i>et al.</i> 1965	Thomas and Otis 1958b
Ellen and Bate 1970 <sup>b</sup>	Kaada <i>et al.</i> 1961
	Kimble 1963
	Kveim <i>et al.</i> 1964
	Madsen and Kimble 1965
	Hughes 1965
	Stein and Kimble 1966
	Spiegel <i>et al.</i> 1966
	Niki 1966
	Jarrard and Lewis 1967
	Hostetter and Thomas 1967
	Bender <i>et al.</i> 1968
	Zack 1968
	Jackson and Strong 1969 <sup>a</sup>
	Winocur and Breckenridge 1973 <sup>c</sup>
	Myhrer and Kaada 1975
	Myhrer 1975a
	Myhrer 1975c

a See text, p. 289.

b Very small lesions.

c No deficit if cues added at choice points; see text p. 290.

TABLE A21

*One-may active avoidance after hippocampal lesions*

Normal	Deficient	Mixed
Niki 1962	McNew and Thompson 1966	Liss 1968 <sup>a</sup>
Kirkby and Kimble 1968	Olton and Isaacson 1968a	Nadel 1968 <sup>b</sup>
Winocur and Mills 1970a	Coscina and Lash 1969 <sup>c</sup>	Olton and Isaacson 1969 <sup>d</sup>
Thomas and McCleary 1974	De Castro and Hall 1974	
Haggbloom <i>et al.</i> 1974		
Klein <i>et al.</i> 1975		
Ross <i>et al.</i> 1975		
Myhrer 1975b <sup>e</sup>		

a Normal with 5 s inter-trial interval; deficit with to min inter-trial interval.

b Dorsal lesions yield deficit; ventral lesions do not.

c Aspiration lesions yield deficit; ventral electrolytic lesions do not.

d Lesioned rats affected by prior pairing of CS and US or by pseudo-pairing.

e Jump-avoidance task.

TABLE A22

*Two-may active avoidance after hippocampal lesions*

Normal	Facilitated	Deficient
Andy <i>et al.</i> 1967	Isaacson <i>et al.</i> 1961	Thomas and Otis 1958a
Schmaltz 1971	Green <i>et al.</i> 1967	Andy <i>et al.</i> 1968
Molino 1975 <sup>c</sup>	Liss 1968	Eckersdorf <i>et al.</i> 1973
	Olton and Isaacson 1968b	Myhrer 1975a <sup>b</sup>
	Rabe and Haddad 1969a	Myhrer 1975b
	Ackil <i>et al.</i> 1969	
	Van Hoesen <i>et al.</i> 1969	
	Ireland <i>et al.</i> 1969	
	Papsdorf and Woodruff 1970	
	Lovely <i>et al.</i> 1971	
	Antelman and Brown 1972	
	Woodruff and Isaacson 1972	
	Van Hoesen <i>et al.</i> 1972	
	Alvarez-Pelaez 1973	
	Bayer <i>et al.</i> 1973	
	Ross <i>et al.</i> 1975	
	Myhrer 1975a <sup>b</sup>	
	Lovely 1975a	
	Ross and Grossman 1975	
	Wallace <i>et al.</i> 1976	

a Facilitation is removed by hypophysectomy.

b Deficit with medial fimbrial lesions; facilitation with lateral or total fimbrial lesions.

c Both neonatal and adult dorsal lesions had no effect; neonatal ventral lesions had no effect but adult ventral lesions yielded facilitation.

TABLE A23  
Passive avoidance after hippocampal lesions

	Normal	Deficient	Mixed <sup>e</sup>
Step-down or step-through	Kimble <i>et al.</i> 1966 Nadel 1968 Riddell 1968 <sup>a</sup> Winocur and Mills 1969 Blanchard, Blanchard and Fial 1970 Brunner <i>et al.</i> 1970 Riddell 1972 Dawson <i>et al.</i> 1973 <sup>h</sup>	Glick <i>et al.</i> 1974	Boast <i>et al.</i> 1975 <sup>f</sup>
Drinking	Kaada <i>et al.</i> 1962 Kveim <i>et al.</i> 1964 Boitano and Isaacson 1967 Boitano <i>et al.</i> 1968 Brunner and Rossi 1969 De Castro and Hall 1975 Ross <i>et al.</i> 1975 Myhrer 1975a Myhrer 1975b Myhrer and Kaada, 1975	Riddell 1968 Wishart and Mogenson 1970 Best and Orr 1973 Bayer <i>et al.</i> 1973 Lanier <i>et al.</i> 1974	Kimura 1958 <sup>b</sup> Isaacson and Wickelgren 1962 Snyder and Isaacson 1965 Kimble <i>et al.</i> 1966 Andy <i>et al.</i> 1967 Stein and Kirkby 1967 <sup>c</sup> Van Hoesen <i>et al.</i> 1969 Fried 1970 Fried 1971 Fried 1972 Fried 1973 <sup>d</sup> Nonneman and Isaacson 1973 Greene and Stauff 1974
Running and drinking	Boitano and Isaacson 1967 Hostetter 1968 Van Hoesen <i>et al.</i> 1972		

TABLE A23 – cont.  
Passive avoidance after hippocampal lesions

	Normal	Deficient	Mixed
Escape then step down		Teitelbaum and Milner 1963 Blanchard and Fial 1968 Blanchard, Blanchard, and Fial 1970	
Punished 1-way active or escape	Nadel 1968 Liss 1968 Coscina and Lash 1969 Thomas and McCleary 1974	Isaacson, Olton, Bauer and Swart 1966 Liss 1968 Coscina and Lash 1969 De Castro and Hall 1975	McNew and Thompson 1966
Taste aversion	McGowan <i>et al.</i> 1972 Murphy and Brown 1974 Nachman and Ashe 1974 De Castro and Balagura 1975 Miller <i>et al.</i> 1975 Thomka and Brown 1975	Miller <i>et al.</i> 1971	Best and Orr 1973 <sup>g</sup>

a Two separate studies.  
b Deficit with posterior lesions; normal with anterior lesions.  
c Normal with 5 days training on running task; deficit with 10 days training.  
d Deficit only with combined dorsal and ventral lesions.  
e Deficit with one measure, typically latency; no deficit with another, typically shocks taken.  
f Deficit at immediate retest only with fascia dentata lesions, at 24 h retest with all lesions.  
h One subgroup had deficit.

TABLE A24  
*Effect of hippocampal lesions on lever-press rates in operant tasks*

	Normal rates	Increased rates	Decreased rates
CRF	Schmaltz and Isaacson 1966a Swanson and Isaacson 1967 Schmaltz and Isaacson 1967 Means <i>et al.</i> 1970 Henke and Bunnell 1971 Van Hartesveldt 1973	Rabe and Haddad 1968 <sup>a</sup> Haddad and Rabe 1969 <sup>a</sup> Winocur and Mills 1970a	Clark and Isaacson 1965 Jackson and Gergen 1970
FR	Carey 1969 Van Hartesveldt 1973 Schmaltz <i>et al.</i> 1973 <sup>b</sup>	Rabe and Haddad 1968	
FI, VI	Ellen and Powell 1962	Jarrard 1965 Beatty and Schwartzbaum 1968 Haddad and Rabe 1969a, b Jackson and Gergen 1970 Ross and Grossman 1975	
DRL	Gol <i>et al.</i> 1963 Ellen <i>et al.</i> 1964 Ellen and Aitken 1970 Pellegrino and Clapp 1971 <sup>c</sup> Rickert <i>et al.</i> 1973 <sup>e</sup> Ellen <i>et al.</i> 1973 <sup>g</sup>	Clark and Isaacson 1965 Schmaltz and Isaacson 1966a Schmaltz and Isaacson 1966b Haddad and Rabe 1967 Schmaltz and Isaacson 1968 Isaacson and Schmaltz 1968 MacDougall <i>et al.</i> 1969 <sup>d</sup> Carey 1969 Nonneman and Isaacson 1973 Schmaltz <i>et al.</i> 1973 <sup>f</sup> Riddell, Malinchoc, and Reimers 1973 Nonneman <i>et al.</i> 1974 Kearley <i>et al.</i> 1974 Ross and Grossman 1975	

a Increases with total lesions; normal with anterior lesions only.

b Some increases on FR80, FR160.

c Increased rate on the DRL task indicates a deficit.

d Total fornix lesion yields deficit; medial fornix lesion alone does not.

e Normal with cue; increased rate and deficit without cue.

f Deficit unassociated with increased rate.

g Deficit only with total dorsal plus ventral lesion and extensive pretraining on CRF.

TABLE A25  
*Delayed response, alternation, and go-no-go after hippocampal lesions*

	Normal	Deficit	Facilitated
Delayed response	Mahut 1971	Mishkin 1954 Mishkin and Pribram 1954 Orbach <i>et al.</i> 1960 Niki 1962 Karmos and Grastyan 1962 Ungher and Sirian 1970	
Spatial alternation-maze		Racine and Kimble 1965 Means <i>et al.</i> 1971 Greene 1971 Greene <i>et al.</i> 1972 Greene and Stauff 1974	
Spatial alternation-operant chamber	Brown <i>et al.</i> 1969 Waxler and Rosvold 1970 <sup>a</sup> Mahut 1971 Stevens and Cowey 1972 Stevens and Cowey 1973 <sup>b</sup>	Pribram <i>et al.</i> 1962 Rosvold <i>et al.</i> 1964 Niki 1966 Correll and Scoville 1967 Riddell, Malinchoc, and Reimers 1973	
Go-no-go alley	Mering and Mukhin 1973 <sup>c</sup> Brunner <i>et al.</i> 1974	Franchina and Brown 1970	
Go-no-go operant chamber	Gaffan 1973 Freeman <i>et al.</i> 1973 <sup>d</sup> Freeman and Kramarcy 1974	Niki 1965 Swanson and Isaacson 1967 Schmaltz <i>et al.</i> 1973 Woodruff <i>et al.</i> 1973 <sup>e</sup> Buerger 1970	
Go-no-go alternation-operant chamber		Warburton 1969 Walker <i>et al.</i> 1972 <sup>f</sup> Walker and Means 1973 White 1974	Means <i>et al.</i> 1970 Walker, Means, and Isaacson 1970

a Some hippocampals normal; some deficient.

b Without cue: dorsals facilitated, ventrals normal. With cue: dorsals facilitated, ventrals deficient.

c Deficit with temporal cue only.

d Normal when tone is S+; deficit when tone is S-.

e No deficit relative to cortical controls.

f Facilitated with 10s ITI; normal with 20s ITI; deficient with 40, 80 s ITI.

TABLE A26  
*Extinction after hippocampal lesions*

Normal	Deficient
Niki 1962 (one-way active avoidance)	Isaacson <i>et al.</i> 1961 (two-way active avoidance)
Schmaltz and Isaacson 1967b (CRF-lever press)	Webster and Voneida 1964 (non-spatial discrimination)
Nadel 1968 (CER)	Jarrard, Isaacson, and Wickelgren 1964 <sup>a</sup> (runway)
Kaplan 1968 (CER)	Jarrard and Isaacson 1965 (runway)
Ackil <i>et al.</i> 1969 <sup>c</sup> (two-way active avoidance)	Niki 1965 (CRF-lever press)
Gaffan 1972 <sup>e</sup> (nose poke)	Peretz 1965 (WGTA)
Schmaltz and Theios 1972 <sup>f</sup> (classical conditioning)	Douglas and Pribram 1966 (discrimination)
Nonneman <i>et al.</i> 1974 (DRL-lever press)	Raphelson <i>et al.</i> 1966 (runway)
Thomas and McCleary 1974 (one-way active avoidance)	Jarrard and Lewis 1967 (maze)
Murphy and Brown 1974 (taste aversion)	Isaacson <i>et al.</i> 1968 (runway)
Kearley <i>et al.</i> 1974 (DRL-lever press)	Rabe and Haddad 1968 (FR-lever press)
Ross <i>et al.</i> 1975 (runway-lever press)	Brown <i>et al.</i> 1969 (modified WGTA)
	Winocur and Mills 1969 (runway)
	Kimble 1969 (Y-maze non-spatial discrimination)
	Cohen 1970 (runway)
	Franchina and Brown 1970 (runway)
	Kimble and Kimble 1970 (Y-maze non-spatial discrimination)
	Greene 1971 (T-maze discrimination)
	Coover <i>et al.</i> 1971b (CRF-lever press)
	Lovely <i>et al.</i> 1971 <sup>d</sup> (two-way active avoidance)
	Henke and Bunnell 1971 (CRF-lever press)
	Gaffan 1972 <sup>e</sup> (runway)
	Fried 1972 (runway)
	Warburton 1972 (lever press)
	Amsel <i>et al.</i> 1973 (FR-lever press)
	Brunner <i>et al.</i> 1974 (runway)

a Deficit with spaced trials; normal with massed trials.

b Deficit on first day of first extinction; normal for remainder of this and subsequent extinctions.

c Deficit if there is adaptation to CS prior to training.

d No deficit in terms of responses made after first non-response on two-way active avoidance task.

e Deficit on alley; normal on operant task.

f Normal on first extinction; deficit on subsequent extinctions.

TABLE A27  
*Species-typical behaviour after hippocampal lesions*

	Normal	Increased	Decreased
Eat or drink	Kim 1960a Niki 1962 Jarrard 1965 Haddad and Rabe 1967 Boitano <i>et al.</i> 1968 Beatty and Schwartzbaum 1968 Gotsick 1969 Haddad and Rabe 1969 Murphy and Brown 1970 <sup>a</sup> Glickman <i>et al.</i> 1970 <sup>b</sup> Holdstock 1972 <sup>c</sup> Boitano <i>et al.</i> 1973 Donovick and Burright 1973 Brown and Murphy 1973 Ross <i>et al.</i> 1975 Murphy <i>et al.</i> 1975 <sup>d</sup> Thomka <i>et al.</i> 1975	Kimble and Coover 1966	
Maternal, sexual, social	Kling 1964 Kimble <i>et al.</i> 1967 <sup>e</sup> Bermant <i>et al.</i> 1968 <sup>f</sup> Glickman <i>et al.</i> 1970 <sup>h</sup> Capobianco and Hamilton 1973	Kim 1960b	Kim 1960a Peretz 1967 Kimble <i>et al.</i> 1967 <sup>e</sup> Dewsbury <i>et al.</i> 1968 <sup>g</sup> Michal 1973 Kolb and Nonneman 1974 Nonneman and Kolb 1974 Ely <i>et al.</i> 1976

- a Increased intake of glucose + saccharine, salt water after formalin pretreat.  
b Some increase after ventral lesions in long sessions.  
c Hippocampal females drink more often when food is available.  
d Normal on post-operative days 6-10 ; increase on days 18-22.  
e Normal sexual; decreased maternal.  
f Only dorsal lesions, not ventral nor dorsal + ventral, increase sex.  
g Only dorsal + ventral lesions, not dorsal, increase latency to first copulation.  
h Some decrease in shredding

TABLE A28

*List of hippocampal steroid studies*

## I. Uptake and unit studies

- McEwen *et al.* 1969  
 McEwen *et al.* 1970  
 McEwen and Pfaff 1970  
 McEwen *et al.* 1970a  
 McEwen *et al.* 1970b  
 Kawakami and Kubo 1971  
 Pfaff *et al.* 1971  
 Ford *et al.* 1971  
 Stumpf and Sar 1971  
 Gerlach and McEwen 1972

## II. Resting levels

- Mason 1958  
 Mason 1959  
 Endroczi and Lissak 1960  
 Knigge 1961  
 Slusher and Hyde 1961  
 Endroczi and Lissak 1962  
 Mandell *et al.* 1963  
 Nakadate and de Groot 1963  
 Galicich *et al.* 1965  
 Slusher 1966  
 Rubin *et al.* 1966  
 Fendler *et al.* 1961  
 Bohus *et al.* 1968
- Knizley 1972  
 Dafny *et al.* 1973  
 Stevens *et al.* 1973  
 Luttge *et al.* 1973  
 McEwen and Wallach 1973  
 Luttge *et al.* 1974  
 McEwen *et al.* 1974  
 Michal 1974  
 Warembourg 1975

## III. Behavioural studies

- Porter 1954  
 Endroczi *et al.* 1959  
 Knigge 1961  
 Kim and Kim 1961  
 Endroczi and Lissak 1962  
 Knigge and Hays 1963  
 Davidson and Feldman 1967  
 Coover *et al.* 1971b
- Kawakami *et al.* 1968  
 Kawakami, Seto and Yoshida 1968  
 Van Wimersma Griedanus and de Wied 1969  
 Endroczi and Nyakas 1971  
 Moberg *et al.* 1971  
 Coover *et al.* 1971b  
 Endroczi 1972  
 Kawakami *et al.* 1973  
 Lengvari and Halasz 1973  
 Wilson and Critchlow 1973/1974  
 Kearley *et al.* 1974  
 Jackson and Regenstein 1974  
 Lanier *et al.* 1975

TABLE A29

*List of hippocampal stimulation studies*

## I. General effects

- Kaada 1951  
 Kaada *et al.* 1953  
 MacLean 1957a  
 MacLean 1957b  
 Fisher and Coury 1962  
 Andy *et al.* 1962  
 Votaw and Lauer 1963b  
 Ursin *et al.* 1966  
 Feldman *et al.* 1967  
 Coury 1967  
 Musty *et al.* 1967  
 Grant and Jarrard 1968  
 Siegel and Flynn 1968  
 Rogozea *et al.* 1969  
 Mountford 1969
- Milgram 1969a  
 Milgram 1969b  
 Gumulka *et al.* 1970  
 Kaada *et al.* 1971  
 Rogozea *et al.* 1971  
 Bland and Vanderwolf 1972b  
 Levitt and O'Hearn 1972  
 Brown and Winocur 1973  
 Oliver *et al.* 1974  
 Jackson and Gardner 1974  
 Nagy and Decsi 1974  
 Lico *et al.* 1974  
 Huston *et al.* 1974  
 Siegfried *et al.* 1975  
 Milgram *et al.* 1975

## II. Effects on performance

- Bures *et al.* 1960  
 Weiskrantz *et al.* 1962  
 Stein 1965  
 Erickson and Chalmers 1966  
 Andy *et al.* 1968  
 Szekely *et al.* 1968a  
 Szekely *et al.* 1968b  
 Margules and Stein 1968
- Leaton 1968  
 Vanegas and Flynn 1968  
 Siegel and Flynn 1968  
 Vergnes and Karli 1969  
 Van Abeelen *et al.* 1972  
 Oliver *et al.* 1973  
 Overstreet 1974  
 Ross and Grossman 1974

## III. Effects on learning

- Correll 1957  
 Olds and Olds 1961  
 Weiskrantz *et al.* 1962  
 Rabe 1963  
 Grossman and Mountford 1964  
 Hirano 1966  
 Kesner and Doty 1968  
 Avis and Carlton 1968  
 Wyers *et al.* 1968  
 Stein and Chorover 1968  
 Grossman 1969  
 Brunner and Rossi 1969  
 Erickson and Patel 1969  
 Hughes 1969  
 Psatta *et al.* 1970  
 Greene and Lomax 1970
- Greene 1971  
 Nakajima 1972  
 Wilson and Vardaris 1972  
 Kesner and Conner 1972  
 Shinkman and Kaufman 1972a  
 Shinkman and Kaufman 1972b  
 Bresnahan and Routtenberg 1972  
 Livesey and Wearne 1973  
 Weiss and Hertzler 1973  
 Henderson *et al.* 1973  
 Ott and Matthies 1973  
 Zornetzer and Chronister 1973  
 Zornetzer *et al.* 1973  
 Landfield *et al.* 1973  
 Haycock *et al.* 1973  
 Wiener and Messer 1973

TABLE A29-*cont.*  
*List of hippocampal stimulation studies*

III. Effects on learning- <i>cont.</i>		
Brunner <i>et al.</i> 1970	Singh <i>et al.</i> 1974	Soumireu-Mourat <i>et al.</i> 1975
Lidsky and Slotnick 1970	George and Mellanby 1974	Gustafson <i>et al.</i> 1975
Barcik 1970	Kesner and Conner 1974	Kesner <i>et al.</i> 1975
Nyakas and Endroczi 1970	Destrade and Cardo 1974	Livesey and Bayliss 1975
Vardaris and Schwartz 1971	Sideroff <i>et al.</i> 1974	Daniels 1971
Kapp and Schneider 1971	Kapp <i>et al.</i> 1974	Schmaltz 1971
Shinkman and Kaufman 1970	Leith and Barrett 1975	Serota 1971
McDonough and Kesner 1971	Livesey and Meyer 1975	Whishaw and Deatherage 1971

TABLE A30  
*Retention after hippocampal lesions*

Normal	Deficient
Mishkin 1954 <sup>f</sup> (delayed response, colour and brightness)	Kimura 1958 <sup>a</sup> (passive avoidance)
Orbach <i>et al.</i> 1960 <sup>f</sup> (visual discrimination)	Niki 1962 (maze, brightness discrimination)
Niki 1962 (one-way active avoidance)	Pribram <i>et al.</i> 1962 (delayed alternation)
Kimble and Pribram 1963 <sup>g</sup> (pattern discrimination)	Raphelson <i>et al.</i> 1965 (runway)
Schwartzbaum <i>et al.</i> 1964 (go-no-go)	Isaacson <i>et al.</i> 1966 (successive discrimination)
Correll and Scoville 1965 (matching to sample)	Olton and Isaacson 1968a (one-way active avoidance)
Breen and Thompson 1966 (two-way approach task)	Thomas 1971 (maze)
Raphelson <i>et al.</i> 1966 (runway)	Wild and Blampied 1972 (go-no-go)
Olton and Isaacson 1968a (two-way active avoidance)	Riddell <i>et al.</i> 1973 (position reversal learning set)
Winocur and Salzen 1968 (visual size discrimination)	Eckersdorf <i>et al.</i> 1973 <sup>c</sup> (two-way avoidance)
Truax and Thompson 1969 (brightness discrimination)	Thompson 1974 (maze)
Uretsky and McCleary 1969 <sup>d</sup> (one-way active avoidance)	Jarrard 1975 (Y-maze spatial alternation)
Winocur and Mills 1970a (brightness discrimination)	
Buerger 1970 (go-no-go)	
Schmaltz 1971 (two-way active avoidance)	
Schmaltz and Giulian 1972 (lever-press avoidance)	
Fried 1973 <sup>d</sup> (passive avoidance)	
Glick and Greenstein 1973 <sup>c</sup> (passive avoidance)	
De Castro and Marrone 1974 (shock-induced fighting)	

a Deficit with posterior lesions; normal with anterior lesions.

b Normal with massed trials; deficit with spaced trials, except with ventral lesions.

c Deficit when lesion made just after training, but not if made 1 h later.

d Deficit if lesion made 8 h after training, but not at 3 days.

e Deficit if trained to low criterion only.

f Mild deficit only on retention of pattern discrimination.

g Mild deficit on self-ordered sequential task only.

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