Appendix

TABLE A1 *(a)*

Anatomical studies of the septal afferents to the hippocampus

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*, **
Raisman 1966
Lewis and Shute 1967
Lewis *et al*. 1967
Genton 1969
Storm-Mathisen 1970
Ibata *et al*. 1971
Siegel and Tassoni 1971b**
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 Guldberg 1974

* 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

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

* 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

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

TABLE A3

Physiological studies of the efferent connections of the hippocampus

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

* Combined electrophysiological and histological study.

TABLE A4

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

Kawamura *et al*. 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 *et al* 1974
Coleman and Lindsley 1975
Lindsley and Wilson 1975
Paiva *et al*. 1976

TABLE A5

Hippocampal EEG during exploration, orientation reflex, and searching behaviour

Theta	Theta frequency	LIA or SIA
Rat		
Brugge 1965	6-8	
Routtenberg 1968	6-8	
Gray and Ball 1970	7.5-8.5	
Irmis *et al*. 1970	7-8	
Komisaruk 1970[b]		
Pond *et al*. 1970[c]	8-9	
Pond and Schwartzbaum 1970[c]	8-10	
Routtenberg *et al*. 1970		
Albino and Caiger 1971	7.0-7.5	
Irmis *et al*. 1971[a]		
Morales *et al*. 1971	4-8	
Whishaw and Vanderwolf 1971[d]		
Gray 1972	7.5-8.5	
Gray *et al*. 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 *et al*. 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
Gerbil		
Kramis and Routtenberg 1969	7-9	
Hamster		
Macrides 1975[b]	8.1-8.7	
Rabbit		
Torii and Sugi 1960	8	
Polc and Monnier 1970[c]	6-7	
Dog		
Yoshii *et al*. 1967	5-6	
Cat		
Grastyan *et al*. 1959	5	
Adey *et al*. 1960	4.0-7.5	
Lissak and Grastyan 1960		
Adey *et al*. 1962		
Brown and Shryne 1964[g]	3-6 early, 3.5-4.8 late	
Porter *et al*. 1964	4 -5	
Karmos *et al*. 1965		
Grastyan *et al*. 1966[h]		
Brown 1968	4.3-4.7	
Bennett 1970		
Anchel and Lindsley 1972[f]		
Bennett *et al*. 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 [a]

Theta	Behaviour[a] and theta frequency (Hz)	LIA or SIA
Rat		
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 *et al*. 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[b]	r 8-9; j 9-10	
Gray 1972	8.5-10	
Gray *et al*. 1972	8.5-10	
Whishaw *et al*. 1972[e]		
Pond and Schwartzbaum 1972	w 8-10	
Feder and Ranck 1973		
Ranck 1973		
Vanderwolf *et al*. 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 *et al*. 1974	r 9.1	
Robinson and Whishaw 1974[c]	w 7.6	
Winson 1974		
Coenen 1975	8	
Kurtz 1975	r 8.5; m 8	
McFarland *et al.* 1975		
Vanderwolf 1975[d]	j 8	
Vanderwolf *et al.* 1975		
Myhrer 1975[d]		
Morris, Black, and O'Keefe 1976		
Gerbil		
Whishaw 1972	r 7.7	
Guinea pig		
Sainsbury 1970	w 8.3	

TABLE A6-*cont.*
Hippocampal EEG during motor behaviours: spatial displacement[a]

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

Theta	Behaviour and theta frequency (Hz)	LIA or SIA
Rat		
Vanderwolf 1969[b]	hm 6.6-7.1; hfp 6.6-7.1	Vanderwolf 1969[b]
Whishaw and Vanderwolf 1971		Whishaw and Vanderwolf 1973[b]
Bland and Vanderwolf 1972*a*		
Whishaw *et al*. 1972		
Feder and Ranck 1973		
Ranck 1973		
Vanderwolf *et al*. 1973		
Whishaw and Vanderwolf 1973[b]		
Frederickson *et al*. 1974	bx	
Vanderwolf 1975	st 8.2	
Vanderwolf *et al*. 1975		
Gerbil		
Whishaw 1972		
Guinea pig		
Sainsbury 1970	dg 8.3; hm 7.3	
Dog		
Yoshii *et al*. 1967	hm 5-6	
Cat		
Sakai *et al*. 1973	em 3.5-4.3	Grastyan *et al*. 1959
Whishaw and Vanderwolf 1973		Kemp and Kaada 1975
Glotzbach 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
Rat		
Bremner 1964	SA 5-7	Feder and Ranck 1973 (CRF & FR50)
Yoshii *et al*. 1967	CRF 7-8	
Vanderwolf 1969	CRF	Whishaw and Vanderwolf 1973 (CRF)
Pond and Schwartzbaum 1972[c]	FR	
McGowan-Sass 1973[b]	SA 6.6	
Whishaw and Vanderwolf 1973[d]	CRF	
Frederickson 1974*a*	FR	
Bennett 1975	CRF 6.6	
	c-CRF 6.6; DRL 6.8; c-DRL 6.2	
Gerbil		
Kramis and Routtenberg 1969		
Cat		
Bennett *et al*. 1973	CRF; c-DRL	Bennett 1970 (discriminated CRF)
Hatfield 1975	CRF 3.5-5.5	Bennett and Gottfried 1970 (CRF-DRL)
Dog		
Dalton and Black 1968		Yoshii *et al*. 1967 (CRF)
Black and Young 1972a	CRF 4.5-5.0	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[a]

Theta	Behaviour[a] and theta frequency (Hz)	LIA or SIA
Rat		
Gray and Ball 1970[i]	d 6-7.5	Routtenberg 1968
Irmis *et al*. 1970	ej 8-9	Vanderwolf 1969
Pond *et al*. 1970[c]	e 6-8	Routtenberg *et al*. 1970
Gray 1972i	d 6-7.5	Pond *et al*. 1970[c]
Gray *et al*. 1972[i]	d 6-7.5	Albino and Caiger 1971
Kurtz and Adler 1973	in 8.2; ej 7.2	Whishaw and Vanderwolf 1971
Kimsey *et al*. 1974[i]	d 6.5	Black and Young 1972b[b]
Kurtz 1975	li 7; lej 6.5	Whishaw *et al*. 1972[d]
		Bland and Vanderwolf 1972a
		Pond and Schwartzbaum 1972
		Feder and Ranck 1973
		Ranck 1973
		Whishaw and Vanderwolf 1973
		Robinson and Whishaw 1974
		Coenen 1975
Gerbil		
		Kramis and Routtenberg 1968
		Whishaw 1972
Guinea pig		
		Sainsbury 1970
Cat		
		Whishaw and Vanderwolf 1973
Rabbit		
Torii and Sugi 1960	a 5-7; g 5-7	Kramis *et al*. 1975[c]
Sadowski and Longo 1962	e 4-6	
Huston and Brozek 1974	d 5.4; e 6.2-6.4	
Kramis *et al*. 1975	d 5.8[f]; e 6.5[g]; g 6.5	
Dog		
Yoshii *et al*. 1967[h]		Yoshii *et al*. 1967[h]
Konorski *et al*. 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
Rat		
Vanderwolf 1969	6.7	
Vanderwolf *et al*. 1973		
Whishaw and Vanderwolf 1973	7	
Vanderwolf and Cooley 1974		
Myhrer 1975[d]	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
Rat		
Robinson and Whishaw 1974[a]	4-6	Brugge 1965[b]
Black 1975	< 7	Vanderwolf 1969
		Paxinos and Bindra 1970
		Albino and Caiger 1971
		Ranck 1973
		Vanderwolf *et al*. 1973
		Whishaw and Vanderwolf 1973
		Frederickson *et al*. 1974[c]
		Robinson and Whishaw1974[a]
		Coenen 1975
		Kurtz 1975
		Vanderwolf 1975
Gerbil		
		Whishaw 1972
Rabbit		
Green and Arduini 1954	5-7	Torii and Sugi 1960
Torii and Sugi 1960	5-7	Kramis *et al*. 1975
Sadowski and Longo 1962	4-6	
Klemm 1970[d]		
Harper 1971	7	
Klemm 1971[d]		
Huston and Brozek 1974	7.1	
Cat		
Porter *et al*. 1964	4	Anchel and Lindsley 1971[e]
Radulovacki and Adey 1965	3-7	Grastyan and Vereczkei 1974
Brown 1968	4.4	Hatfield 1975
Bennett 1969		
Bennett 1970		
Whishaw and Vanderwolf 1973		
Coleman and Lindsley 1975		
Kemp and Kaada 1975		
Dog		
Urban *et al*. 1974[d]	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 $ACTH_{4\text{-}10}$ 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[a])	Theta frequency (Hz)	LIA or SIA
Rat		
Bremner 1968 (v)[b]	5	Whishaw 1972(a)[c]
Bremner and Ford 1968 (v)	5-6	Ranck 1973
Irmis *et al*. 1970 (a)[d]	6.7-8.5	
Whishaw 1972 (a)[c]		
Schwartzbaum and Kreinick 1973 (v)	5	
Rabbit		
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 *et al*. 1959 (a)		
Costin *et al*. 1967 (1)		
Harper 1971		
Kramis *et al*. 1975	7	
Martin *et al*. 1975 (a)[e]		
Cats		
Green and Arduini 1954		Grastyan *et al*. 1959 (a)[f]
Grastyan *et al*. 1959 (a)[f]	5	Karmos *et al*. 1965[f]
Karmos *et al*. 1965[f]		
Kemp and Kaada 1975		
Kramis *et al*. 1975		
Dogs		
		Lucas *et al*. 1974[g]

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[a]

Theta (task)	Theta frequency (Hz)	LIA or SIA
Rat		
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	
Rabbit		
Sadowski and Longo 1962 (cued ring pull)		
Powell and Joseph 1974 (conditioned eye blink)		
Cat		
Grastyan *et al.* 1959 (ap)[b]	4-7	Grastyan *et al.* 1959 (ap)[b]
Radulovacki and Adey 1965 (cued start in Y maze)	4-5	Lissak and Grastyan 1960 (ap & av)[b]
Elazar and Adey 1967*b* (cued start in T maze)	5	Holmes and Beckman 1969 (go–no-go runway)[c]
Holmes and Beckman 1969 (go–no-go runway)[c]		Bennett 1970[b]
Bennett 1970[b]		Bennett and Gottfried 1970 (DRL lever press)
Bennett *et al.* 1973 (CRF & DRL lever press)	5.5	Grastyan and Vereczkei 1974 (ap)[b]
Grastyan and Vereczkei 1974 (ap)[b]	4-5	Hatfield 1975 (conditioned immobility)
Hatfield 1975 (CRF lever press)		
Dog		
Dalton and Black 1968 (CRF lever press and hold still)		Dalton and Black 1968 (CRF lever press and hold still)[e]
Ellison *et al.* (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[a]

Theta (task)	Theta frequency (Hz)	LIA or SIA
Konorski *et al*. 1968 (ap & lever press)		
Dalton 1969 (op. reinforcement of theta)	4-6	Black *et al*. 1970 (operant reinforcement of theta and LIA)[d]
Black *et al*. 1970 (operant reinforcement of theta and LIA)[d]		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
Rat		
		Morales *et al*. 1971
		Olmstead *et al.* 1973
		Winson 1974
		Coenen 1975
Rabbit		
		Torii and Sugi 1960
		Harper 1971
Cat		
		Brown and Shryne 1964
		Karmos *et al*. 1965
		Brown 1968
		Glotzbach, 1975

TABLE A11 (b)

Hippocampal EEG during low-voltage fast sleep

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

Theta	Reinforcement	Brain area	LIA or SIA	Reinforcement	Brain area
Rat					
Ito 1966[b]	o	mrf, mh	Ito 1966[b]	+	lpo, lh, s
Yoshii *et al.* 1967	-	lh	Gray and Ball 1970	+	s
Routtenberg and Kramis 1968	-	dmt	Paxinos and Bindra 1970[d]	+	lh
Paxinos and Bindra 1970[d]	+	lh	Pond and Schwartzbaum 1970	+	s
Pond *et al.* 1970	+	lh			
Pond and Schwartzbaum 1970	+, -	lh, dmt	Gray *et al.*	-	s
Routtenberg 1970	+, -, *o*	mbs	Frederickson 1974b[c]	+	
Gray 1972		s			
Sinnamon and Schwartzbaum, 1973	+, -	lh, dmt			
Gerbil					
Kramis and Routtenberg 1969	+	ph			
Car					
Grastyan *et al.* 1966	+	h	Grastyan *et al.* 1966	-	h
Anchel and Lindsley 1972[e]		mh	Grastyan *et al.* 1968	+	h
Coleman and Lindsley 1975[e]		mh	Anchel and Lindsley 1972[f]		lh
			Coleman and Lindsley 1975[f]		lh
Rabbit					
Polc and Monnier 1970[b]		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			
Rat	Kaplan 1968 Crowne and Riddell 1969 Hendrickson *et al.* 1969 Sanwald *et al.* 1970[a] Kemble and Ison 1971 Dawson *et al.* 1973 Olton and Gage 1974 Groves *et al.* 1974[b]		Coover and Levine 1972
Cat	Rogozea and Ungher 1968 Ungher *et al.* 1971 Nonneman and Kolb 1974	Rogozea and Ungher 1968 Ungher *et al.* 1971	
Guinea pig	Ireland and Isaacson 1968		Ireland and Isaacson 1968
Gerbil		Glickman *et al.* 1970	
Monkey	Bagshaw *et al.* 1965		Hara and Myers 1973[c]
COMPETITIVE			
Rat		Wickelgren and Isaacson 1963 Raphelson *et al.* 1965[d] Kaplan 1968 Hendrickson *et al.* 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
Rat	Douglas and Isaacson 1964[a]	Kim 1960a	Moorcroft 1971	Jarrard 1968
	Spiegel *et al*. 1966	Niki 1962	Means *et al*. 1971	Jarrard and Bunnell 1968
	Hostetter and Thomas 1967	Roberts *et al*. 1962	Campbell *et al*. 1971	
	Haddad and Rabe 1967	Kimble 1963	Capobianco and Hamilton 1973	
	Boitano and Isaacson 1967	Teitelbaum and Milner 1963	Alvarez-Pelaez 1973	
	Jackson 1967	Douglas and Isaacson 1964	Dawson *et al*. 1973	
	Bender et al. 1968	Leaton 1965	Bayer *et al.* 1973	
	Kaplan 1968	Stein and Kimble 1966	Alexander *et al*. 1974	
	Boitano et al. 1968	Leaton 1967	Kearley *et al*. 1974	
	Rabe and Haddad 1969a	Jackson 1967	Lanier *et al.* 1974	
	Jarrard and Korn 1969	Kirkby *et al*. 1967	Lanier and Isaacson 1975	
	Strong and Jackson 1970[b]	Jarrard 1968	Murphy *et al*. 1975	
	Campbell *et al*. 1971	Jarrard and Bunnell 1968	Jacobs *et al.* 1975	
	Moorcroft 1971	Bermant *et al*. 1968	Myhrer and Kaada 1975	
	Alvarez-Pelaez 1973	Sengstake 1968	Myhrer 1975b	
	Greene and Stauff 1974	Kaplan 1968	Myhrer 1975a	
	Kearley *et al*. 1974	Nadel 1968	Peters and Brunner 1976	
	Lanier and Isaacson 1975	Gotsick 1969	Wallace *et al.* 1976	
	Lanier *et al*. 1975	Strong and Jackson 1970	Ely *et al.* 1976	
	Murphy *et al*. 1975	Clark 1970	Iuvone and Van Hartesveldt 1976	
	Myhrer and Kaada 1975	Kim *et al*. 1970		
	Myhrer 1975a	Winocur and Mills 1970b		
	Myhrer 1975b	Eichelman 1971		
Gerbil		Glickman *et al.* 1970		
Cat		Kim *et al*. 1971		
Hamster	Jarrard and Bunnell 1968			

a Increase with electrolytic, but not aspiration, lesions.
b Decrease in one study; no effect in another.

TABLE A 15

Spontaneous alternation after hippocampal lesions

Alternation			Random			Repetition		
	ITI	*confine*[a]		*ITI*	*confine*[a]		*ITI*	*confine*[a]
Kirkby *et al*. 1967	50 min	50 min	Roberts *et al*. 1962	10-480 s	0 s	Lash 1964[b]	5 min	0 s
Gross *et al.* 1968	0 s	0 s	Lash 1964[b]	5 min	0 s	Kirkby *et al*. 1967	50 s	50 s
Stevens 1973a	51 min	50 min	Douglas and Isaacson 1964			Dalland 1970	1 min	0 s
Stevens and Cowey 1973[c]	51 min	50 min	Gross *et al*. 1968	5-15 min	0 s	Greene 1971		
Myhrer 1975a[f]	1 min	0 s	Ellen and De Loache 1968[d]	1 min	15 s	Stevens 1973a	50 s	50 s
			Means *et al*. 1971	20 s	10 s	Stevens and Cowey 1973[c]	50 s	50 s
			Means *et al*. 1972	20 s	20 s	Stevens and Cowey 1973[e]	51 min	50 min
			Stevens 1973a	51 min	50 s	Dawson *et al.* 1973[g]	30 s	0 s
			Stevens and Cowey 1973	50 s	50 s	Dalland 1976		
			Bayer *et al*. 1973					
			Myhrer and Kaada 1975[h]	1 min	0 s			
			Myhrer 1975a[i]	1 min	0 s			
			Douglas 1975[j]					

a Inter-trial interval (ITI) and confinement time in arm chosen on first trial (confine). Time in seconds (s) or minutes (min). ITI includes confinement time.
b Repetition in two different shaped mazes; random choice in a third.
c Ventral hippocampal lesions.
d Random choice to spatial cues but alternation to brightness cues.
e Dorsal hippocampal lesions.
f CA1 or medial fimbrial lesions,
g 1 stage or seriatim lesions.
h Dorsal fornix lesions.
i Lateral or total fimbrial lesions.
j Random choice after bilateral lesions, one stage or two stage, adult or neonatal; some alternation with small electrolyte lesions.

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 *et al.* 1972
Brown *et al.* 1969	Jones and Mishkin 1972
Means and Douglas 1970[a]	Mikulka and Freeman 1975[b]
Mahut 1971	
Cohen *et al.* 1971	
Hirsch and Segal 1972	
Mahut 1972	
Cohen and LaRoche 1972	
Cohen and LaRoche 1973	
Mahut and Zola 1973	
Riddell *et al.* 1973	
Greene and Stauff 1974	
Thomas and McCleary 1974	

a A subgroup trained against preference had a deficit.
b 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 *et al*. 1962
Teitelbaum 1964	Andy *et al*. 1967[a]
Webster and Voneida 1964	Douglas *et al*. 1969[b]
Douglas 1966	Duncan and Duncan 1971
Stein and Kimble 1966	Woodruff and Isaacson 1972
Kimble and Zack 1967	Woodruff *et al.* 1972[c]
Silveira and Kimble 1968	Olton 1972b[d]
Winocur and Salzen 1968	Bauer 1974[f]
Isaacson *et al.* 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[e]	
Nonneman and Isaacson 1973	
Riddell *et al.* 1973	
Alexander *et al.* 1974	
Anton and Bennett 1974	
Stevens and Cowey 1974[g]	

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 l8
Spatial discrimination reversals after hippocampal lesions

Normal	Deficient
Cohen *et al*. 1971	Thompson and Langer 1963
Stevens 1971[b]	Kimble and Kimble 1965
Cohen and LaRoche 1972	Thompson *et al*. 1964[a]
Cohen and LaRoche 1973	Niki 1966
Stevens 1973b[d]	Samuels and Valian 1968[c]
	Uretsky and McCleary 1969
	Brown *et al*. 1969
	Greene 1971
	Mahut 1971
	Cohen *et al*. 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 *et al*. 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 *et al*. 1968	Teitelbaum 1964
Mahut 1971	Webster and Voneida 1964
Mahut 1972	Douglas and Pribram 1966[a]
Jones and Mishkin 1972	Silveira and Kimble 1968
Mahut and Zola 1973	Isaacson *et al*. 1968
Zola and Mahut 1973[c]	Hsiao and Isaacson 1971
	Samuels 1972[b]
	Nonneman and Isaacson 1973[d]

a Mild deficit on 100 per cent vs. o 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 *et al*. 1965	Thomas and Otis 1958b
Ellen and Bate 1970[b]	Kaada *et al*. 1961
	Kimble 1963
	Kveim *et al*. 1964
	Madsen and Kimble 1965
	Hughes 1965
	Stein and Kimble 1966
	Spiegel *et al.* 1966
	Niki 1966
	Jarrard and Lewis 1967
	Hostetter and Thomas 1967
	Bender *et al*. 1968
	Zack 1968
	Jackson and Strong 1969[a]
	Winocur and Breckenridge 1973[c]
	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[a]
Kirkby and Kimble 1968	Olton and Isaacson 1968a	Nadel 1968[b]
Winocur and Mills 1970a	Coscina and Lash 1969[c]	Olton and Isaacson 1969[d]
Thomas and McCleary 1974	De Castro and Hall 1974	
Haggbloom *et al.* 1974		
Klein *et al*. 1975		
Ross *et al*. 1975		
Myhrer 1975b[e]		

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 *et al*. 1967	Isaacson *et al*. 1961	Thomas and Otis 1958a
Schmaltz 1971	Green *et al.* 1967	Andy *et al*. 1968
Molino 1975[c]	Liss 1968	Eckersdorf *et al.* 1973
	Olton and Isaacson 1968b	Myhrer 1975a[b]
	Rabe and Haddad 1969a	Myhrer 1975b
	Ackil *et al.* 1969	
	Van Hoesen *et al*. 1969	
	Ireland *et al*. 1969	
	Papsdorf and Woodruff 1970	
	Lovely *et al*. 1971	
	Antelman and Brown 1972	
	Woodruff and Isaacson 1972	
	Van Hoesen *et al.* 1972	
	Alvarez-Pelaez 1973	
	Bayer *et al*. 1973	
	Ross *et al.* 1975	
	Myhrer 1975a[b]	
	Lovely 1975a	
	Ross and Grossman 1975	
	Wallace *et al*. 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[e]
Step-down or step-through	Kimble *et al*. 1966 Nadel 1968 Riddell 1968[a] Winocur and Mills 1969 Blanchard, Blanchard and Fial 1970 Brunner *et al*. 1970 Riddell 1972 Dawson *et al*. 1973[h]	Glick *et al*. 1974	Boast *et al*. 1975f
Drinking	Kaada *et al*. 1962 Kveim *et al*. 1964 Boitano and Isaacson 1967 Boitano *et al*. 1968 Brunner and Rossi 1969 De Castro and Hall 1975 Ross *et al*. 1975 Myhrer 1975a Myhrer 1975b Myhrer and Kaada, 1975		
Running and drinking	Boitano and Isaacson 1967 Hostetter 1968 Van Hoesen *et al*. 1972	Riddell 1968 Wishart and Mogenson 1970 Best and Orr 1973 Bayer *et al*. 1973 Lanier *et al*. 1974	Kimura 1958[b] Isaacson and Wickelgren 1962 Snyder and Isaacson 1965 Kimble *et al*. 1966 Andy *et al*. 1967 Stein and Kirkby 1967[c] Van Hoesen *et al*. 1969 Fried 1970 Fried 1971 Fried 1972 Fried 1973[d] Nonneman and Isaacson 1973 Greene and Stauff 1974

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 *et al*. 1972 Murphy and Brown 1974 Nachman and Ashe 1974 De Castro and Balagura 1975 Miller *et al*. 1975 Thomka and Brown 1975	Miller *et al*. 1971	Best and Orr 1973[g]

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 *et al.* 1970 Henke and Bunnell 1971 Van Hartesveldt 1973	Rabe and Haddad 1968[a] Haddad and Rabe 1969[a] Winocur and Mills 1970a	Clark and Isaacson 1965 Jackson and Gergen 1970
FR	Carey 1969 Van Hartesveldt 1973 Schmaltz *et al*. 1973[b]	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 *et al*. 1963 Ellen *et al*. 1964 Ellen and Aitken 1970 Pellegrino and Clapp 1971[e] Rickert *et al*. 1973[e] Ellen *et al*. 1973[g]	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 *et al*. 1969[d] Carey 1969 Nonneman and Isaacson 1973 Schmaltz *et al*. 1973[f] Riddell, Malinchoc, and Reimers 1973 Nonneman *et al*. 1974 Kearley *et al*. 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 *et al.* 1960 Niki 1962 Karmos and Grastyan 1962 Ungher and Sirian 1970	
Spatial alternation-maze		Racine and Kimble 1965 Means *et al.* 1971 Greene 1971 Greene *et al.* 1972 Greene and Stauff 1974	
Spatial alternation-operant chamber	Brown *et al.* 1969 Waxler and Rosvold 1970[a] Mahut 1971 Stevens and Cowey 1972 Stevens and Cowey 1973[b]	Pribram *et al.* 1962 Rosvold *et al.* 1964 Niki 1966 Correll and Scoville 1967 Riddell, Malinchoc, and Reimers 1973	
Go–no-go alley	Mering and Mukhin 1973[c] Brunner *et al.* 1974	Franchina and Brown 1970	
Go–no-go operant chamber	Gaffan 1973 Freeman *et al.* 1973[d] Freeman and Kramarcy 1974	Niki 1965 Swanson and Isaacson 1967 Schmaltz *et al.* 1973 Woodruff *et al.* 1973[e] Buerger 1970	
Go–no-go alternation-operant chamber		Warburton 1969 Walker *et al.* 1972[f] Walker and Means 1973 White 1974	Means *et al.* 1970 Walker, Means, and Isaacson 1970

a Some hippocampals normal; some deficient.
b Without cue: dorsals facilitated, ventrals normal. With cue: dorsals facilitated, ventrals dificient.
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 *et al.* 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[a] (runway)
Kaplan 1968 (CER)	Jarrard and Isaacson 1965 (runway)
Ackil *et al.* 1969[c] (two-way active avoidance)	Niki 1965 (CRF-lever press)
Gaffan 1972[e] (nose poke)	Peretz 1965 (WGTA)
Schmaltz and Theios 1972[f] (classical conditioning)	Douglas and Pribram 1966 (discrimination)
Nonneman *et al.* 1974 (DRL-lever press)	Raphelson *et al.* 1966 (runway)
Thomas and McCleary 1974 (one-way active avoidance)	Jarrard and Lewis 1967 (maze)
Murphy and Brown 1974 (taste aversion)	Isaacson *et al.* 1968 (runway)
Kearley *et al.* 1974 (DRL-lever press)	Rabe and Haddad 1968 (FR-lever press)
Ross *et al.* 1975 (runway-lever press)	Brown *et al.* 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 *et al.* 1971b (CRF-lever press)
	Lovely *et al.* 1971[d] (two-way active avoidance)
	Henke and Bunnell 1971 (CRF-lever press)
	Gaffan 1972[e] (runway)
	Fried 1972 (runway)
	Warburton 1972 (lever press)
	Amsel *et al.* 1973 (FR-lever press)
	Brunner *et al.* 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 *et al.* 1968 Beatty and Schwartzbaum 1968 Gotsick 1969 Haddad and Rabe 1969 Murphy and Brown 1970[a] Glickman *et al*. 1970[b] Holdstock 1972[c] Boitano *et al*. 1973 Donovick and Burright 1973 Brown and Murphy 1973 Ross *et al*. 1975 Murphy *et al*. 1975[d] Thomka *et al*. 1975	Kimble and Coover 1966	
Maternal, sexual, social	Kling 1964 Kimble *et al*. 1967[e] Bermant *et al*. 1968[f] Glickman *et al*. 1970[h] Capobianco and Hamilton 1973	Kim 1960b	Kim 1960a Peretz 1967 Kimble *et al*. 1967[e] Dewsbury *et al.* 1968[g] Michal 1973 Kolb and Nonneman 1974 Nonneman and Kolb 1974 Ely *et al.* 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
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

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
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

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*. 19716
Bohus 1971
Dupont *et al*. 1972
Endroczi 1972
Wilson and Critchlow 1973/1974
Kearley *et al*. 1974
Lovely 1975
Iuvone and Van Hartesveldt 1976

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 19726
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-cont.

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

TABLE A30

Retention after hippocampal lesions

Normal	Deficient
Mishkin 1954[f] (delayed response, colour and brightness)	Kimura 1958[a] (passive avoidance)
Orbach *et al*. 1960[f] (visual discrimination)	Niki 1962 (maze, brightness discrimination)
Niki 1962 (one-way active avoidance)	Pribram *et al*. 1962 (delayed alternation)
Kimble and Pribram 1963[g] (pattern discrimination)	Raphelson *et al*. 1965 (runway)
Schwartzbaum *et al*. 1964 (go-no-go)	Isaacson *et al*. 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 *et al*. 1966 (runway)	Wild and Blampied 1972 (go–no-go)
Olton and Isaacson 1968a (two-way active avoidance)	Riddell *et al*. 1973 (position reversal learning set)
Winocur and Salzen 1968 (visual size discrimination)	Eckersdorf *et al*. 1973[e] (two-way avoidance)
Truax and Thompson 1969 (brightness discrimination)	Thompson 1974 (maze)
Uretsky and McCleary 1969[d] (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[d] (passive avoidance)	
Glick and Greenstein 1973[c] (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.