Notebook # 7

NAME Animal Behavior

ADDRESS Univ of Chicago - 1939

Roger Sperry
Zoology. / Univ. of Calif.

2nd Wednes.

Damm. 1927 J. Exptl Zool. v. 48, no 1,

Verworn - General Physiol. 1899

Jennings - Bhr of Lower Org.s 1906 [1st 2 weeks] minor classic

Mast - Light & the bhr of org.s 1911 heat as much as light! historical interest

Holmes - Evol. of Anim Intell. 1911 rev.

" - Studies on " bhr. 1916 (1st essay on hist of anim. bhr)

Loeb - Forced Movt.s, Tropisms, & Anim. Conduct 1918

Mac Dougall - Outlines of Psych. 1923 — 1st 3rd of bk. concludes how to use "psychic" methods.

Child - Found.s of Anim Bhr. 1924 — general implications

Washburn - Anim mind (2nd ed) 1936 - mine of information but not organized.

* Maier & Schneirla - Princ.s of Anim. Psych 1935 } modern anim. behavior

Warden, Jenkins, Warner - Comp Psych. 1935 } read 1st ½ of this book.

E.S. Russell - The Bhr of Animals 1934 to read after the course

Gen'l background, diff't viewpts. — have to study behr as-a-whole.

Objective language may understate the facts, but it is more accurate and dependable.

Don't read human motives into anim. bhr.
Watch the humanistic language in discussion, reports, and write-up.

Carnap & Morris are trying to build up a new language where each word will have but one meaning.

Interrupt lectures anytime.

Jennings on Anim. Bhr which have flourished and gradually died.

Animal Behavior — Dr. Allee 1939

3 lect.s M.T.W. conf. before. 2 wks project accdg to own interest.
oral Report on the work done = Fri. lecture. Exam 2 wks fr. today
wr. of work done as if for publication. carbon copy + original

— x — x — x — x — x — x —

J. of Cytin Psychology — on vertebrates
Physiol. Zoölogy, } inv.t.s
Ecology

This = daily course on Anim. Bhr in country given in Dept of Zoology. Beloit also has a course this year Parker used to give a course.

Dr. Allee scarcely recognizes this course from what started.

Three Approaches & Bhr Problems

1) Three ecology. ① Rs of orgs serve to distrib. them in envir. & ② indic. in part the method by which envir affects the organisms.
—under ecology — or organism as whole in the biological abstracts

2) Comparative physiology — Rs of org.. studied as indic.s of physical activities of animals. & cf. w. Richet & Lamer. Heidenmann's support 1889 — 1923 Loeb's tropisms

3) Comparative psychology — Rs for light they shew on origins of human behavior. & cf. of human & non-human capabilities.
Tremendous lit.. on rat bhr maybe seman pure w/out ref.ces to man.

Two methods of studying behavior

1) Observational – older, not good repute now. more repute than it deserves. much bird & other study could be done. Brit. bird watchers.

2) Experimental – modern, began in post-Darwinian period. began in choice or preference situations. The "preference method."

Necessary to have as uniform material as possible animals such as "clone" = all from same parent by asexual division. or use inbred strains that are homozygous by ½ dozen generations. [may be weaker]

Environment – need to control that also – rooms with constant temper. or w. constant humidity. (controlled) (controlled)

With both of these controlled may still verify Harvard law.

We are interested in behavior of small populations [I'm afraid].

Try to vary only one factor at a time and so arrange conditions that there are no limiting factors.

? (T = 10° – 35° = a limiting factor)

Need several controls in many cases.
Run controls & experimentals simultaneously.
Statistical evaluation of behavior problems.

Statistical methods: Finkel.

↓ diff'ce between controls & exp.'s signif.

If $\frac{\bar{X}}{SE_{\bar{X}}}$ = 2 or more = signif. good for large no's above 30

Amer. "Student's" method for biol. probs w. small no.s of cases.

n = no. of cases
σ = standard deviation
$\bar{X}$ = mean diff'ce

$$\frac{\bar{X}}{SE} = \frac{\bar{X}}{\sigma/\sqrt{n}} = \frac{\bar{X}}{\sqrt{\frac{\Sigma(x-\bar{x})^2}{n}}/\sqrt{n}} = \frac{\bar{X}}{\sqrt{\frac{\Sigma(x-\bar{x})^2}{n(n-1)}}}$$

Allee 1927
J.E.Z. 46: 475-

list of expts	list of controls	diff'ce between 'em
means		$\bar{X}$

$x - \bar{x}$ | $(x-\bar{x})^2$ | x^2

$(x-\bar{x})^2$

$$t = \frac{\bar{X}}{\sqrt{\frac{\Sigma(x-\bar{x})^2}{n(n-1)}}}$$

$n \to n(n-1)$ as n grows large so $n(n-1)$ = correction for small numbers.

If t = above 2 = signif for cases above 30

But for values below 30, then use the table that "Student" worked out and get values for "P."

P = .05 = limit of significance, or say P below .01 = quite significant. means there's only 1 chance in a 100, of chance giving same result. P = .005 means only 5 chances in a thousand of chance doing it.

$$t = \frac{\bar{X}}{\sqrt{\frac{\Sigma X^2 - \bar{X}\Sigma X}{n(n-1)}}}$$

= a simplified formula derived from the "t" formula above. don't need to calculate so many lists of X, $x-\bar{x}$, $(x-\bar{x})^2$ etc.

No	Exp.'s	Contr.	$X = E_o - C_o$	X^2
1	—	—	—	—
2	—	—	—	—
3	—	—	—	—
4	—	—	—	—

$n = 4$ | ΣX | ΣX^2

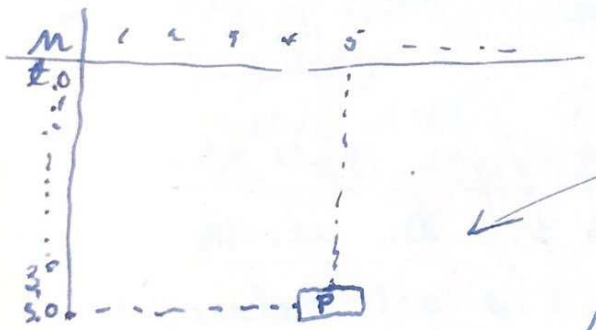
$\frac{\Sigma X}{n} = \bar{X}$

} these values are substituted in "t" formula and P looked up for t.

If get a 5th case can easily add it into the calculat.'s w'out much work. So they feel that the second formula is simpler in application.

The Tables are a bit scarce tho by Pelaar kept in Whitman Hall. can be consulted.

Enter at n-1. [n = 6]



When have a minus value, go thru same steps remembering it's a minus sign. Treat it algebraically.

If P = .05, prob. error = $\frac{1}{3}$ diff of mean, or $\frac{1}{2}$ Standard error or sem. pie.

about experimentation.

When possible run in nature & check lab results & vice versa use lab observ.s & check natural observations Check back & forth between lab & nature.

Phases of Activities of Living Organisms

1) Reproductive Activities.
2) Nutritive "
3) Protection & Survival.

} more or less separate. "physiological life-history" of the organism.

To understand "phy. life hist" have to know developmental physiol." & "reproductive physiol":

Devel. physiol is that part of R. physiol in which growth processes predominate.

Rep. physiol - as a result of a stimulus.

Devel physiol = fert. cleav. gastrul, etc. + amt of H.O. necessary, temper. requir.s, O² requirements, & other requirem.s Purely a part of animal life, but taken over by the field of general embryology.

In larval period devel. begins to merge with reproduc — have to consider larval organs, the environment how far go on stored nutrition, activities leading to dissemination of species

Then comes adult life & R. phys. w. all the physiol. constants at work.

Complicating factors - no. of species, Somatypic (same species) group physiol. Var. inter-physiol.

Homotypic grp physiol → homo-typic grp psychology
as go up to Reptiles/animals.
When homo no. of species = inter-mores (grp) psychology
Bibl of Heterotypic grps is diff't from Homotypic.

Activities of Reproduction

1) Conditions that start
   Internal - rhythms
   External - extern. - seasonal Δs, lunar (marine) rhythm,
2) Sexual products union
3) Union of adults for " " ...

All of this might be included in animal bibl. We're going to limit to certain phases of "R. physiol."

Another approach - mechanical models, etc. that mimic the living systems. Lillie's iron-wire model, and mitosis models, mimic of colloidal systems.
Results in finding that many activities can be mimicked and therefore living is not separate from non-living - began concept further substantiated by phy. chem. analysis

Living Reactions:

1) Irritability - small Δ release enormous trigger R's
2) Metabolism + effects so far as affect powers + irritability of organisms
3) Adaptations - toward more stable rather than unstable equilibrium. equilibration

There are others, but

* Tendency to show automatic coöperations
(a group is beneficial to each other in long run)
the old Cliff Ott example = Mass Action Law of Chem.

Adaptation cont. Paley said "watch adapted for keeping time had intellig. expended on it". So animals have had intellig. expended upon them — no biologist does not imply the organism has had intell expended upon it. Pearse Am. Nature. v56

Once that every structure, every action of an animal had to be adapted, acc'g to Darwinian notions. But we now accept idea that nature makes inefficient steps. Types & life history's are selected as wholes so animal does not have to be 100% adapted - if so it would perish as soon as environment changed. Those adapted to about 75% = best — such stuff!!

Adaptation does not have to have evolved thru direct causal interrelationship w. environment. It occurs purely as matter of chance in gene mixture & then selected by envir.

An animal may undergo evolution which is not favorable to one environ. & it migrates to another that is satisfactory.

Adapt.s have a broad generic — may rest on cumulative or chance relations. Minute details of structure & behav. may be entirely accidental & merely tolerated

Flight necessary but peculiar methods of flight may be incidental.

Henderson of Harvard & Bernard, Claude 1850 say physiol. should accept idea of adaptation as its basic principle.

What is an Organism? Def.

1) Physico chemical mechan in state of dynamic equilib. or
2) such a mechan. + some substance or energy unknown to physics & chemistry.

Question of whether all living activity can be explained in terms of phys & chem.

Mechanistic vs. Vitalism in Jenkins, Warner text. no new chem. elements in protoplasm, the bulk of protoplasm is composed of the commoner elements, but many rare elements that play some role.

Herbarium 60%

Invariable Primary Elements

H
C
N
O
P

ave 5/1000 %

Invariable 2ary Elements

Ca
Mg
Na
K
Fe
S
Cl

1/20 - 1%

Variable in protoplasm of diff. cells 2ary Elements

Zn
Ti
V
Br

Invariable micro-constit.s

Cu
B
Si
Mn
F
I

Variable micro-const.s

Li
Rb
Cs
Ag
Ba
Sr
Cd
Ga
Pb
As
Cr
Co
Ni

Contaminants

A
Ba
Hg
Tl
Sc
Au

All these imbedded in and working upon a colloidal substrate so effect is diff. from that in solution.

Philosophical Points on Behavior

Phil. Am. Nat. v58 / 1934

Prob. of relation of living & non-living:

living surrounded by non-living Universum. also incorporate non-living in themselves & return to " w. reduced potential energy.

metabolism & fund. process of life
Natural transformation. Emerges under highly exceptional conditions as contrasted with all possible range of natural cond.

Life appeared late - from non-living antecedents.
so non-living is potentially alive, requiring only a reorganization of components
" as yet unmastered by man.

Can we define life qualities in nature that made life possible?
What distinguishes living from non-living?

(We know from both objectively & subjectively
we know no other form from both of these angles.)

Temptation to modern physicists to read subjectivity into action of inanimate things.

The subjective central position of observer is an integral part of geometric position of -

Physical world = real & autonomous w. existence and independence outside the observer.

Philosophy questions this assumption of the scientist.

Ans = 1. faith
of sci. 2. Statistical probability.

Realm disappears when observers go? / probably not.

Evolution of living organism began & proceeded in a world that already was there. / Non-living univ. evolved long before life, living.

Properties of phys. universe consist of 2 types.

1. Stability conservative, natural constants, etc.
2. Originative, factors of Δ, produce novelty

Stability & regularity = same thing. day-night rhythm
devel of organisms, etc.
processes may have some stability.
life - as integration of active processes = complex system that maintains & reproduces w. regularity
regularity increases as get a wider, broader view.

Such stabilities are fundamental & necessary for the originating factors of change.

Closed system, conception of universe in which no change is ever possible. A rational system, so if knew enough about one process, could explain whole universe. explains old-time confinement to detailed specific problems. Pennsylvania farmer. Could reconstruct whole from a knowledge of the part. Every event presupposes every other. Lewis idea that time is reversible. There is no "time's arrow" as per Eddington.

Lewis had trouble w. biological phase - said it must be exempt from idea that time is reversible.
sunsets run forward & back - basis of Lotka

Modern physics have broken this idea of a closed universe. 2nd law = entropy. 1st = conservation of energy energy can be so minutely distributed that it's impossible to reconstruct. "3rd law = innate randomness in inanimate matter"

Two factors in any event.
1.) The determinant factors.
2) " spontaneous " " , novel.

Novel aspects
a. such appear spontan. because of our ignorance. (classical physics)
b. are spontaneous result of inherent character of matter. (principle of indeterminancy)

Diff. :. bet. liv & non-liv.g "Living = a R.s system so delicately organized as it can pick up minor spontaneities & transform them into major bibl. diff.ces that anyone can recog."

mod. physics

Internal processes may assume upper hand indep. of external conditions.

Spontaneity of living organisms = highest expression of the "will" of nature.

Due to small scale intra-atomic factors pick up & transform to large scale blips by nervous system.

Football game outcome is not predictable tho all is acctg to rules

Wow!

Analysis

1) Particle mechanics.
2) Wave "

Rules are adaptive, not chance resulting.

See Sci. summer 1934 by Jeans.

Either cause of lack of finiteness

Both matter & energy appear to be made up of units. called atoms or electrons (of matter) or quanta (of energy). The two have many characters in common.

Some evidence that there do unpredictable things may be true, may be due to instruments

If so then "times arrow" has to point in one direction.

N. Syst. is organized to capitalize these small scale chance activities. Thus see Harvard Law to be an extension of modern physics

Still materialistic, may be mechanistic, but is chance. Uncertainty principle used in a part of vitalistic way.

Catholicity can be present throughout all matter as per Compton & Millikan or between living & non-living as in classical physics, or there ain't no such thing (sic pitch)

Biol.s take ⊖ viewpt on intrinsicky say there can't be.
Allee - answer lies nearer physicists because of their
mathematical certainty & fail to large element of
unknown in biol.'s problems
so biol. more critical of "unknown"

Aristotle 350 BC.
Plutarch
Albertus Magnus 13th C
Thomas Aquinas
Gesneri Historia Animalium
Belon
Rondolet

Turner
Vesalius
Descartes
Malebranche
Borelli
Müller 1801-1858
Wohler
Liebig
Helmholtz 1821-94
Lotze
Weber

Fechner
Erasmus Darwin
Reimarus
Spallanzani
Reamer
Barnet
Buffon

Lamark
Herbert Spencer

Implications of yesterday - leads up to emergent evolution
(obviously) Wright 1935 J. of Gen. - evolution does not (?)
arise as a natural consequence Allee - it does not arise
suddenly, but gradually, logically, not much of novelty
minor factors of novelty (indeterminism prime).
Claude Bernard - case of emergent evolution. H + O - H_2O
whole = more n sum of parts. Chemist can't predict
water from part. Chemists say they could if they
knew enough about H & O. Dr Bowman all about
H_2O you couldn't know of parts - "no sum of parts
= more than whole" Allee.
Allee - diff levels of organ. in lower sub-social forms.
1. Osteria produced collections
2. Definite toleration for other individuals.
3. Positive R. for each other
Above this not def. levels of organ.

1. Subordination, domination peck-order exist in vertebrates
2. Young & adults leads to division of labor
3. Divis of labor

Each step could have emerged easily out of the preceding in the series.

Wheeler says social behv = last great emergence.

Historical Sketch of Anim Bhv.

Aris. Do they have souls? Continue after death? How souls differ from those of men?
Do they reason?

Modern: subst. consciousness for souls.

Aris answers: Anims exhib. sensit, like a rational cause wh. differs in degree rather than kind.

Nature of Wards & Mans: Allen Evol. of Invert.s Judd: Diff in quality between non-humans & man. Allen opposed & averred

Aris. relatn of infants to animals souls = alike.
Physiol. processes due vital spirits.
anim & plants have souls.
Had no conception of reflex action, nerves, that brain cooled heart heat.
Divided life into procreation & feeding.
Work marred by vitalism, theology, & anthropomorphism
extensive use of anecdotes

Plutarch leader among early Romans
said animals reason, outlined instinct concept.
Christianity deprecated animals' intell. & souls
Magnus & Aquinas - animals have sensitive soul, but man has an intellectual soul.

Encyclopedists went back to Aris. & went go.
Neo-Scholastics & others still go back to "I" rather than to his spirit of inquiry.

16th C Reformation: Geners, Bel. Rondel, Turner etc. transition to experimentation.

DesCartes 16th C laid foundation of modern work on anim. life — finest form of the nervous system. Bodies = machines work'g accord'g to mechan. laws. no emotions, know nothing, Automatons

Borelli - reduced to purely mechanical. Malbranche also explained it all in terms chem.

Cartesian Doctrine accepted by these men — animals belonged to diff't categ. from man. dualism, bet. man & anim.

Allee says they were crude & yet — "interest" that they could explain life in purely mechanistic terms."
Facts explanat.s were too simple. Crozier of Harvard & Hecht of Columbia = refinements of these old mechanists]

Church Author's & Philos took to Cartesian Doctrine. course it separated beasts from men.

Reaction inevitable Quig life = more complicated than that, introduced old Greek idea of vital force. Some vitalists that it above analysis. Others that it might be catalogued. Condorcet & Müller tried to analyze psychic & physical. Wöhler who synthesized urea. Liebig, Helmholtz, Ludwig, Virchow, turned to physics, chem., & pure psychol. accepted Cartesian Doctrine.

Rise in Erasmus Darwin (Forerunner of Lamarck in evolut.) Tried to show that "instinct" life was actually learned in early development. Opposed by Pennants (Reamur made thermometer) Réaumur was 1st class naturalist as the Brit. find.) who proved instincts = inherited. Bonnet, Buffon, & Spallanzani f's in line.

Lamarck - scientific study of evolution of instincts.

Effort of will & desire of the animal emphasized by Lamarck
Animal feel need of long neck so get it. Divides all
anim into 3 groups

Lamarck
1) Apathetic - spider w. eyes
2) Sensitive anim. - better ...
3) Intelligent " - still "

Gradual evolution of consciousness

Spencer	Romanes	Bain	Loeb
Berger	Haeckel	Bell	Vernon
Romanes	Wundt	Espinas	Claparide
Paul Bert		Brehm Durleben	Bethe
Lubbock		Preyer	Von Uexkull
Graber		Binet	Vernon Prohiten Studies 1889
Preyer		Fabre	Claparide
Wesserman		Peckhams	Lubbock
Lloyd Morgan		Knight	Lloyd Morgan
Whitman		De Candolle	Jennings
Baldwin		Pfeffer	
Haas		Jaffe	
Spencer			

Worth reading
- Whitman Anim. Behav. Woods Hole Biol. Lect. 1899 pp 285-338
- Romanes Anim. Intell. N.Y. 1883
- Mental Evol. in Anim.s Lond. 1885
- Morgan, Lloyd Anim. Life Lond. 1900

Lubbock = Lord Avebury

Wallace
Huxely
Hudson.

Lamarck's ideas had little effect till Darwinism, except their influence on Spencer's psychol. wh. was based on idea of inherit. of acq. char.s, no dist. between instincts & acquired habits. Passed on thru race.

Bergson has same idea & Bernard Shaw in Back to Methuselah plays w. idea.

Spencer's Prin. of Psych. 1859 & then came Orig. of Species.

New impetus to study anim. bhv. Race evolut. of n. syst. & habits etc. Darwin tried it w. chap. on devel. of instinct (explained as natur. selectn.) & man's differed from anim. only in degree.

Romanes — thru — Preyer tried to trace evolut'n. of mental phenom. "Anim. have memory, sensation, reason" concluded a diff.ce in quantity not quality.

Used human problems & try relating Hymans on same animal scale on same animal problem. Man doesn't do too well in a maze.

Division between Weismann's who believed there were no transmissions of acquired bhv any more than structure & the acquired transmissionists.

Prof. Darwin to last & kept open the possibility that acquired habits may be transmitted.

F's of Weismann = "Neo-Darwinians" who believed in transm. of acq. char.s Morgan, Whitman, Osborn, Baldwin, Spencer, Romanes, Haeckel & Wundt believed in transmission of acquired char.s

1859-1909 Concerned w. evolution of mental behavior. Same for this psych. today + same pure psych.s. same man.

Interpretation in anthropomorphic manner was one of dangers of these times. Much of work then & worth reading. Don't get idea that nothing worth reading except last 10 yrs.

Morgan & insisted on part of psych traits referred to man.

Morgan's canon. "In no case can we interpret in terms of higher psychical faculty if can interpret it in terms of lower."

When full implications of Darwinism understood, it became storm center of the theory. Even Huxley & others didn't accept it completely. — idea that mans spirit etc. evolved from animals man.

Collected anecdotes to prove man-like life of mammals. Impassable barrier bet. animals & human beings; if could be bridged next easy. Romanes, Romanes, reasoning, special life, ingenuity.

"If another animal acted like a man, he must feel like one"

Vs. anecdotes: unskilled observer, interpretn, even if interpreted it is separate from phylogen & ontog. antecedents, since it makes good anecdote prob. represents atypical life, errors of memory & transmission, diff. in selecting material.

Ornithological literature at present time.

"Ontogeny repeats phylogeny" used in great amt at this period. Romanes. Birth man = echinoderm level etc. dog, anthropoid ape, still a problem as to what stage the reflexes became unified.

Based on anecdotes.

Sturdy contributions by the naturalists at this time Darwin, Huxley, Bell + lesser known animals seen on expeditions Capenias, Brehm "Tierleben", Romanes, Prayer Darwin wrote a small classic on earthworm. Binet investigates ---> Peckhams on insect life. Fabre on insects instincts separated from mans life.

Experiments began among the botanists

Zoology coming more & more to practical medicine

hooray!

De Candolle 1835 introd's word "trapism" for plant.
"Unterschiedsempfindlichkeit"
Darwin inferred tropistic Rs = due to internal agents, recog'd special sensitive zones in plant.
Loeb - plants R to light as result of direction of rays of light thru the tissues.
Loeb + student of Loeb + carried over botanical view. 1888-1923 = separate period dominated by "tropism theory".
Forced movt. to light, temp, etc. The structure & physiol of animal is such that it has no choice.
Didn't believe in "preference" in "pleasurable sensations" etc. Here at Chicago in physiol. dept. Used to keep worms in test tubes.
Vernorn preceded Loeb and quit sooner. 1886 Bildr in protozoa. Thought bildr principle common to all animals & better studied in lower forms - That Rs = adaptive & Loeb Rs were forced upon 'em. Vernorn emphasized the internally controlled aspects. Protist Studies 1st to Jennings Book.
"Tropism" theory emerged holding that animal behav. is largely tropistic & ∴ unconscious. Could be explained in physico-chem. terms. Such explanations = sound for bits of behavior. Sensitive plants move because of Δ in permeability so get a rush of cell sap in one direction. Primarily. Same for sleep movt.s produced by light temper. etc.
Return to DeCartes' ideas. Surprised the anecdotal bildr. & somewhat shocking to many. Many still like to say P. prefers to do what it does.
Clapparede made satirical descript.n of tropism.
From Loeb's work came a new Gr in Psychol. Bethe & Von Uexkull for whom higher animals same cannot & lower do not. Operated on objective terms
Warner. Jenkins etc. are doing same.

Physico-chem. studies caused △ in anim. behavior & psych did much to clarify a lot of loose thinking.

Rubbach = a founder of modern expt'l psych. He orig'd the maze as a study of behavior. Also used problem situation w. a more/or less simple objection in front of goal. Marked indiv. diffs. Used preference method of two alternatives. Insisted R's = real choice, but differential sensibility.

Lloyd Morgan = a ff'r of Rubbach in way. Both studied behavior of animals for its own sake. Romanes anec. humanizing tendencies. Less radical than Loeb and less op. to train. Trial & practice. Maturation of structure affecting instincts.

All = abhor / vs. anthropomorphism. Loeb restricted consciousness to higher animals. Said much of human bhr = unconscious. / Rubbach became Ford Authority.

Jennings comes in here. Worked at Michig. & w. Reigard who & Jennings - Anat. of the Cat. = specialist on rodents studied under Verworn at Jena > bhr of lower organisms. Lot of emphasis on effect of internal states & less emphasis on organism as direct simple machine.

1900-1915 in U.S. = controversy over forced moves vs. trial purposive. Loeb - direct action of effectors either directly or thru sense organs. Recognized there a time factor in stimulus application. > Called "intermittent stimulation"

J's based on:

1. Selection of random moves
2. Results of p. sts after repet.

Loeb's group studying taxes instead of tropisms. Allee lined up / w. Loeb rather than J.'s

Now we want an evaluation of the two.

The behavior reported by both schools were true. The caterpillar in light trap. A good many of J.'s bhrs would be called tropistic by Loeb. //

Swarm spores & Arenicola larva show tropistic bits.
Euglena's K's = direct Kin
Mast = most bitter critic of Loeb. 1911 bk = modern
Cicero's oration.

There are cases where forced movt occurs.
& " " " selection of random movt occurs.
Trial & error bits of p. = a stereotyped reflex Kin.

Alike marks on common fresh H2 trapped ocellus.

H+ along edge & finally comes to rest away from light. leaving a trial & error pathway.
If blacken one eye, it swims in a circle, circus movt.s. If get + H light then it spirals in opposite direction.

Chiasma-like crossing over of visual tracts to motor organs on opposite side. Right depresses than the good eye for -. & stimulates then + antpm.s.

Now trial & error & tropistic both in same animal. Can produce mechanical devices which show same thing. Daylog w. selenium eye spot. Will H: a searchlight. If pitched up simply / directly, will turn directly toward light. If have a complicated system of cog wheels it will wobble more indirectly, but will come to the lighted spot in the end.

So + Loeb's tropism is no more mechanistic than Jennings', one is merely more complex & elaborate.

Allee tells how they applauded him as a youngster. J's & Loeb hated that it was their antics

Parker
Crozier
Loeb
Mast
Yerkes
Buckley
Allen
Darling
Spaulding

Hermann
Vernon
Carlgren
Cahn & Barratt.
Hirschfeld
McClendon
Mast
Hahnert
Loeb

Since begin of century, the interest in animal b'hr in zoo has declined & increased in psych.

Dr. Brown at N.U. & Dr. Parker on neuro-humeral theory. Interested in b'hr as indication of nerve syst. function. = descendant of Romanes.

Loebs f/s = Prof. Crozier & Prof. Hecht at Columbia. Developing the mechanistic side in restricted field. Looking for details of the tropisms of plants & lower animals = quite mathematical. Interested in theory of vision.

Mast at J. Hopkins is still active = descend. of Jennings. Wants to know to minutest detail about amoeba-paramecium etc. but intent on individuality & convinced of a vitalistic factor. Thinks future = a causal factor for the present action of animals.

Students of natural history. Allen - Cornell Darling of England & Russell of England = Watch birds. General biol. problems in back of their minds. B'hr on nesting ground is in part a result of no. of birds present. time of laying, no. of offspring, range, etc, all affected.

Along w. ecologists interested in migration, control, homing tendencies etc. Strecker-Kenn of Berlin Museum. Starlings made many back from England to Germany - Thinks they have a magnetic sense. ? = an "Oh my!" - observation.

Other psychol.s = Lashley = leader of behavioristic psychology was here & at Johns Hopkins. Now in advertising. Small localized of function, reborn w. large lesions. Influenced Dr. Klüver. increased work on primates for ancestry of human mind. Prof. Yerkes is leader in this field at Yale school of Primate biology. Yerkes has been gathering people trained in human psychol. Calvin Stone of Stanford on b'hr of white rat.

Queries of the animal ecologist modern

1) Do animals have defin. b'hr wh. enable them to find the habitat suitable to their ecol. physiol. powers

Ans. Same do, some don't. (Young spiders stick tail in air & let fly silk till wind takes 'em. Depends on where they drop as to whether they live or not.).

Mollusks on dogwood banks are just carried by currents, but many animals that do have special reactions for location

Is R/r adaptive? 20 yrs ago, yes. Now, "yes, in the long run." Certain parasites don't find host. Protective coloration. Dean Suby tried it out on birds – tied grasshoppers on various colored backgrounds. Concluded coloration is adaptive.

Are the Rns Constant or Variable? !

To what extent " . . . due to internal factors or environmental

Are animals conscious?

Is there a choice of Habitat? Do ani. prefer?

Group effects, social?

To what extent & environ. Cs factors affect ani. Obs?

Tropism vs. taxis (means more tomard trial & error)

" = inherent tendency of a living thing to R. Definitely to an external S.

" = a reflex action of an entire organism.

Allee in this century

Tendency to use tropism for attached forms. (tropistic Rs of)

" . . . takes " motile organisms. (" " ")

Most replaces w. geotropistic & geonegative etc.

Organization:

① Inherent Unlearned vs ② Conditioned Learned

simple ↓ complex

a. reflexes

b. tropisms

c. instincts

Weiss

1) Simple reflex
1-1 relat. p.
Sa → Ra etc.

2) Plastic behavior
cond'd or uncond'd.

3) Instinctive of chain reflex types unlearned.

Ken assumes that △s resulting from learning are ≐ to those built in and that this △ is not a major problem.

Problem of teacher interest — reorganize once in while.
Been start'g w. learned & tendency w. reflex. This year going to reverse the order.

Tropisms | Introduction ↑↑↑ | Body of course ↓↓↓

Galvanotaxis comes nearer to Loeb's idea than any other. P. in Jennings. Animals tend to orient w. relation to direction of current. All animals even up to vertebrate series, but not higher mammals.
Hermann 1886 14-day polywogs turn to anode (+). Like tiny galvanometers. ds dorsal roots cut off - even just tip of tail. Ant. ½ of tail will also cause ant. ½ has a part of cord. Seems to be due to effect on spinal cord rather than on ppl. (?)(?)(?)

Fish embryos react well head toward anode. If made to go toward cathode - make labored motions, swim easily toward anode. Look at the going up & down stream.

---

and stuff — etc.

refs
Hymad Science 48 - 1918
" & Bellamy Biol. Bull. 43 1922
Barth P.Z.Z. 1934

× × ×

Headless fish will react somewhat but not as well, vestibular apparatus that to be affected. R in begins bet about time of devel. of otolith. Vertebrates generally go toward anode.

General species of starfishes are elephants, 1st toward anode, then cathode(?). If nerve ring cut, they go toward anode(?) at once. Not to be action on nerve net.

Galvanotaxis not always effect on nerves tho — c.f. paramecium, amoeba. "Explanations" Verworn suggested anodal contrix. (= description) Carlgren 1905 that localized D_3 in water equiv. effect of current on localized streaming. Cohn & Barrel that 1905 # cataphoresis. (charged particles small, but not ions, move toward cathode.

Bacteria - "cataphoresis" refers to any drift - toward cathode or anode. as result of particle being charged.

Many large org's (plus unicellular) exhibit cataphoresis.

Verworn thot = reduction of surface tension on anodal area

McClendon " " increase " " " "

Mast 1931 - local decrease in strength of plasma jel on cathodal side.

Hahnert 1932 - solation at cathodal side = reaching (A) point of contact (B) point of H₂O.

Forward end of amoeba is relatively sol or plasmic.

Ri of p. to cathode depends on concent. of Ca ion. In entire absence, whole galvanotaxis Ri disappears. = anodal in very low concentrations & cathodal in higher. (good clue here - Ca physical = in rapid state of development at the present time) [Heilbrunn now prep.g article on Ri of protoplasm to Ca.]

Galvanotaxis common in ciliates & flagellates, but toward anode for those w. chlorophyll & colorless = cathodic Green Hydra go to anode, while brown Hydras head toward cathode.

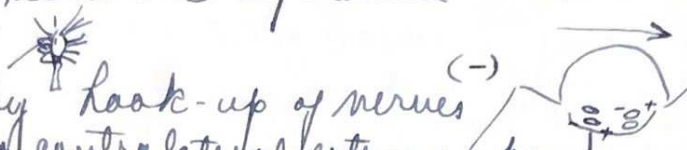
(Explanation of galvanotaxis = diffic. so stay off in lab work)

Two main theories: galvanotaxis

Loeb - characteristic postures assumed in elect. current by Balanonetes - goes toward anode either forward or backward. Current lengthwise thru nerve - irritability is decreased at anode, increased at cathode = anelectrotonus and catelectrotonus. ∴ nerves lengthwise in current will have three anodic & cathodic regions (-) ——— (+) extensors of tail work, crawls toward anode

When change current & get (+) ——— (-) appendages straight toward cathode - swims right back toward anode

of transverse to current legs & antennae bend on anodal side & extend on cathodal - sickles along towards anodal pole.



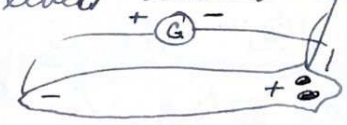
Explain all by Look-up of nerves central of ipsilateral flexors & contralateral extensors from one center of cord. (à la Loeb) if true then explain R ps cells on this side are more stimulated cause on cathode side of animal. all based on catelectro & anelectro-tonus.

Same applied to other two postures.

2nd theory Cabot & Barratt 1905 + Libby Hyman & Robertson.

Reference 1 only to lower forms that are cathodic, & also polar for tadpoles.

1. Ant. end has highest metabolic rate - w. gradient
2. Leads to a permanent diffce in potential. Wounded surfaces = electro-negative, unhurt. level = electro-negative = law of electro negativity.



This is what meant = elektro neg. in the galvanometer, but reversed internally.

3. Potential diffce of chemical origin - means anterior end acts as an anode which is pulled toward the cathode.

Annel. worms w. two high pts of positive potential should form U-shape & they do.

Take some of simple planarians w. one gradient & they shape toward cathode but our planarians here in lab have 2 poles of activity - in current forms U-shape.

A fission plane in some planarians w. 3 regions of high metab. activity. and you get a ~~doubling~~ pseudoplanarian W formed.

Form J when regents at tail.

≃ w. tadpoles. Head is ⊕ rapidly growing & tail also so animal bends toward ⊖

Barth from Chicago tested this theory. w. Tubularia if cut regen's readily & when stems put in elect. current, hydranth grows out toward cathode

If directed away will bend toward cathode (−) (+)

Should be able to Δ elect. potentials in a tubellaria worm by placing in weak elect. current. Elec. current Δ φ in protopl. by elect. current & animal Ri accdg to elect. current impinged upon it.

This unmodifiability in the pr. contraction patterns of the limb is more comparable to the conditions found in amphibia than ---

Hyman's theory makes no assumption about the actual mechanism involved. It so it must be regarded as incomplete, descrip. rather than explanatory.

Phenomenon is clear cut, but interpretation = incomplete

Barotaxis, barotropism = Ri to pressure (a less depri. Ri than galvanotax)

Lack of tropistic - geotaxis R to gravity = easy to demonstrate & hard to analyse. Gradients in axis of earth. light, air moist or turbulence, vapor. power of air, O_2 pressure, food, temperature. ← Current, equatic = as complex, O_2 gradient = steeper, pressure = steeper, temp = less universal. + CO_2 ...

Many Ri supposed due gravity can be found due to one above. Righting Ri occurs in entire absence of gravity — to surface film as well as bottom. = a contact Ri. Many = Ri by means of eyes in higher animals. many can walk erect in daytime but not in dark. Diptera probably. - halters or balancers in diptera used only to aid in balance.

Plants - show Ri to gravity w. auxostat, rotating wheel. by using it at an ∠ to earth can demonstrate a gravity component in these plants.

J's expt w. p. is good = Ri to light. Statolith theory for plants Ri to light

smaller anterior end of p. = the heavier. P. engulfed iron filings and oriented R. to magnetic ~~theory~~ field = basis of Loeb's theory. Vertebrates - semi circular canals

Dogfish

Cut ant. canal animal goes back
" part " " down (backward?)
" side " " rolls sideward.

From p. to mammals find a defin. R. to gravity.
animals (?) crawl up slope, if gets too steep it goes sideward
The ∠ taken = resultant of prep. Ri to gravity + muscular pull
Guinea pigs - use alternate action in slow slope.
" " hopping " on steep "

Crozier & others interested cause comes out in mathematics and animal after animal shows a ± Ri. sigmoid curve

Ri of fishes to gravity = in part mechanism that keeps em stratified + depths + Ri to pressure (this ~~is~~ in lakes)
Man to altitude + neg. Ri to high altit.s correlates w. amount of O_2. Supposed that all animal Ri to altitudes due to partial pressures of O_2. (A little evid. that birds can Ri to pressure per se.)

In most forms = a forced couple type of Ri, + rather than a forced movement.

Parker noticed org.s sink at day & come up at nite ~~several~~ hundred meters. Δ in viscosity of water as result of heat. Ris to light. Copeland off Prof. Parker Ri to light & Δs to the Fs.....

R. to water Current = Rheotaxis & rheotropism

Sessile - growth form & direct turning
Motile - ::/ widely distrib, myxetozoa creeps vs. current, p. orients vs. gentle current, spermatozoa orient vs.? a ciliary current.

3 Kinds of orientatn to fast currents

1. Passive R. by a force-couple may fly nymph attached at front end. Plumes on caudal end. caudal gill
darting fishes attached by pectoral fins.
Diff'l pressure

2. Active Response — also R. to diff'l pressure, mer = reflex. lateral line organs, & sensitive hairs, and muscles in platelorms.

3. Eye-reflex orientation - [Ryans - Am. J. Physiol. 1904] Carried in current w/out knowing it are fish etc unless they can see the bottom, bank, etc. Put fish in tin box & let it float w. current - no orientation, but when stop box, & let current go thru, then fish orient.

In lab - turntable with screens etc. fish swim just fast enough to keep an object still. But Palaemonetes react to pressure so it orients in the other way (Fish have been made to orient ~~downstream~~ vs. the usual pressure reflex) by eye reflex.

Birds also probably use eye-reflex as well as pressure. = anemotaxis R to air current.

Eye-reflex absent in darting fishes.

At night & in muddy water fishes use other reflexes.

Blind fish = very primitive to touch S.

Guppies in this tank move with the towel till guppie hits tank.

But in migrating fish should get opposite effect, but hasn't been tested, but someone tried.

Ryans worked on maintenance. accelerometer - inapplicable " " " migrate upstream. w. very meager equipment wh. is avidly quite commendable.

send upstream
- Increase O_2 tension
- Decrease CO_2 "
- Increase K ions or Na ions — send 'em upstream.
- " caffeine " " "

send downstream
- alcohols
- CO_2
- decrease O_2
- cyanides

(any material that depresses metabolic activity sends isopods downstream.

Antagonism between K & Ca.  K + Mg Na + Ca Na + Mg.
Rubidium & Caesium react like Ca.

In the Chicago region - [pond water: low Ca, high Co] vs. [stream H₂O: high Ca, low Co]

Acellus communis has a stream mores & a pond mores, pond mores always = neg. or indiff.'l to water current. Possible to turn pond into stream mores in lab. by putting them into other kind of water, but they gradually become acclimated. Pond indivs. never have quite as strong Rios as stream.

In a constant current they finally quit going upstream. Much more positive to intermittent current. But after a no. of hours 24 or so, they turn & go down. so can't migrate far.

But isopods facing upstream can face twice as much current as when facing downstream. Adaptive significance — and are we all?

Henderson's ideas on fitness of environment to animal life & Allee comes along in a way → such stuff!!

Just a collection of adaptations - a collection of behavior facts — no analysis, insight, or organization.

Nystagmus & eye reflex (as in train) eye tends to keep fixed on a point. // Nystagmus up & down also.

Look up past finals

Thigmotaxis — Barataxes (cont.)

stereotropism = part of Ri to space
proto. = + to weak touch
− " strong " "
turning axis = " thigmo to
photonegatives are usually strongly thigmotact.

= mid. of strength of this R.

Isopods & amphipods collect in corners. Sometimes crawl ½ inch above this and remain till die = non-adaptive forced movement.

Strong + thigmotactic Ri have been that to be initial S which releases a whole chain of next making reflexes.

Many photo-negative animals will go toward light or remain in it if thigmotaxis is built that way.

Weiss = ⊖ to light will R + to light if + to touch. come out in open spaces

Many animals disregard other S when R's to touch.

have a diff't rate of metabolism in contact than when "free" - have Comp. O_2 comparison

Weiss assumes O_2 accdg to preparation of O_2 in water, but in a glass tube its O_2 equivalent goes up as down. = in part thigmotaxis & in part something else?

Crozier & Moore (Oregon) found that is this drive is satisfied by crawling between 2 objects goes off straight but if along just one wall then turns toward side touched.

of turning depends on placement of

Klinotrophic reflex (Cr. & Moore) on Diplopod (a millipede) animal orients accdg to tensions on its body.

Another R to pressure = "Kattisimulation" or death-feigning.
Widespread arthropods & vertebrates.
A mechanical jar = good S.
Touch on back of snake's head (Hegner) neck or somewhere somewhat same to frog — expec. jumps back.
Body = not relaxed, but in state of tetany = shown in arthropods (using more O_2 than in normal activity).
shading of thigh-tarsi into shock reaction ✳ = a very a very gradual one & also get a transition to Ri to sound.

Ri to Sound in a previous position Ritz thinks that animals ability to make sound is much greater than ability to hear sound. Many sounds = 2nd day & of no importance.
Rattlesnakes = deaf don't hear other snake's rattle. Rhoades may feel its own rattle.
Bees are deaf McMeekan failed to get bees to R to sound.
(One case held a squealing bee & other bees ran over it smoothing its hair)
Trumpeter bumble bee who is supposed to make hive is ~~supposed to~~ just aerating the nest.
Whole prob. of insect R to sound is open to question.
Mosquitoes antennae vibrate to tuning fork vibrations but Ritz couldn't get 'em to vibrate to ♀ sound.
(Remove ♀ repro. glands & ♂ moths will gather around it instead of ♀ moth. so-adder.)

Many structures on insects that to be sound receptive - chordotonal organs in tibia of ◇ ~~grasshopper~~
if so! then most insects can hear.
Oecanthus & grasshoppers — good evidence they sing in unison the rhythm of each thicket is different. By clipping the tarsi off w. the organs broke the rhythm & clipping other legs didn't.
Humphrey & Adam Smith — record a C from so-called auditory organs of cricket & cockroach — used anal cirrus as receptor.
Found an elect. R from 500 - 11,000 cycles / sec 3,000 = best.

Weber's = 20 decibels above human. 1 decibel = a sound wh. a person can just hear & increase goes up logarithmic acc'd to Weber's law.

Cricket Circe - 'little R above 3-4,000 cycles - The circi need detect earthborn vibrations. (But cried in cockroach wind air)
Tuft hairs give R ≏ to sense organs.
[Types eye (reflex, in Whitman -]

Hearing in man - 32 - 32,000 vibrations/sec v/s
Dench " " - 1552 - 2000 v/sec = upper limit.

Humphrey & Radem Smith (cont.)
on cricket & grasshopper - Ri & 50 - 10,000 vib/sec.
but the curves were not similar to those of human
receptors of cricket have lower threshold at low freq.
but is high at freq.s best for human
tympanal organ fete. threshold of insects in general lower
than for human ear.
significe. of sound to insects cannot be judged by effective
loudness to human ear
2 factors here, loudness & v/sec. (such stuff!!)

Karnai Ris to sound.
They do R. " ". catapillar R to voice, bell, etc.
Vanessa butterfly larva threshold ranges whistle, cough,
32 - 1,000 v/sec
receptors = at base of hairs over body.

Summary:
A. Making of sounds does not mean they are of social significance.
grasshoppers pull femur over hind wings for no reason
nymphs without hind wings move femurs after hen about
B. Possession sound like receptors does not signify
functional.
C. R. of such receptors to sounds audible & given

suggest hearing in insect.

D. Many insects do R to aerial vibrations.

E. " others R. readily to substratal vibrations whether to aerial or not.

R. to Sound in Vertebrates.

1936

Do fishes actually hear? - Von Frisch Biol. Rev. v. 11. 210-246.

R. to sound in fish is rather widespread. Conditioned fish to R to sound signal. (Remarks on fish in winter ... bees ... summer.

Catfish & minnows can discriminate between freq.s can octave apart & it could be conditioned.

One fish learned to differ. a minor third.

Also 2 up to 5 tones can be remembered a separate Rs caused to each.

Minnow, catfish, & south am. fish the sensitivity to hearing is about of same order as human ear.

Minnow pops fly touch on skin if high + low vib. ppd by touch oddly.

Simple bladder linked to vaccules of ear in same fish & ... directs vib.s to it. = Ostariophysi other fish = less sensitive to sound.

Production of sound in fish is wide spread. [???]

croakers, glub-glub, croaking of catfish, stridulation of

Amphibia

Croaking & peeping of frogs & toads. Help migration? Tailed wrigglers perform extensive migration just as frogs do, but they make no cries.

Croak for peep only in spring. Some say all of frog's voice is useless. Others say = an aid to stimulating the sexes. Cummins penned off ponds to study migration.

Found that frogs do R. to croakings + splashings but don't R. to other sounds.

R. of toads & frogs = in essence like that of other vert.s.

W. devel. of social life get depend. of social intelligence sound.

Ri of bats & sound:

Bat makes a sound above upper threshold for human ears.

Fly in darkness thru canes, woods, etc. make remark. escaped from chambers w. very small holes so they have to bend wings & yet don't touch edges. They also fly thru maze of strung wires.

receptors for cognizance of space

Two hypotheses:

1) R. & touch, increased pressure.

2) Acute hearing - makes this own sounds which make shadows because of such short wavelength.

Ri & a S as a sign: repres. S.

Ri of ♀ deer & following ♂, much mating bibi w. sound signals.

Galaxies reacted & as warning.

Roads move toward shade & foes out when get in. = sign of shelter.

Ri & chemicals [Chemotropism] - ties back into horotactic field.

manure earthworm burrows into manure, but not into filter paper unless soaked in extract.

Same chem.s like this produce no effect unless in contact w. the body.

Ants have touch rec.s on antennae, but can't dissociate from chem. S on the antennae.

If antenn. removed they lick alien ants, but if intact get chem R. at distance, & touch also. If removed give queen Ri w. legs. Ants like in world of spatial smell rather in spatial color as man.

Hence smell shapes (w. antennae).

W. att

Aquatic animals affected by chemicals of medium, while many land animals have impervious coverings except for restricted specialized areas.

Marine anims need certain salts in fairly def. proportions & amounts. Gamarids = marine amphipods & need NaCl, KCl, MgCl, CaCl, & if any one ommitted dies in less than hour (Na, Ca, K).
Tubularia = colonial coelenterate.

Land animals affected particularly acids & chemicals in blood.

To what extent anims able to detect neces. chem.s in environ & react so as to maintain themselves. +, −, & orient. R's.

Gral. start's in sea w. its chem.s.
Surface of many marine org.s is sensitive chem's.
Fish skin to acids alkalis, salts, & quinine.
lower thresholds than for ".
Skin of the fish = less sensitive to chem's than mouth tongue & same kind. It's an irritating effects rather than of specific receptors.

R's of anims to chem's.
A) Chem. sense in general
B) Sense of smell (distance) in { general / feeding / reproduction
C) " " taste (contact)

M. L.

General R. to environ.

R. to O_2 & CO_2: Engelmann 1882 bacteria, infusoria gather around O_2. (Now used as test for O_2)
Jennis found p. collect around air bubble when O_2 excluded & in CO_2.
Amoeba (−) salts & dyes. P. (−) non acids, (+) wk. acids
O_2 & acid are connected items
Allee's gradient tank w. aceelus.
O/d aceli are ⊕ to higher end of O_2, don't orient directly
low O_2 " " less ⊕ " " " " .
Abramis Fishes = golden shiner became ⊕ to O_2 then lose sensitivity & start all over again.
adding CO_2 make R's stronger & acid still stronger — so it's the acid as well as O_2 that figure & particularly the acid. explains on CO_2 & center in medulla.

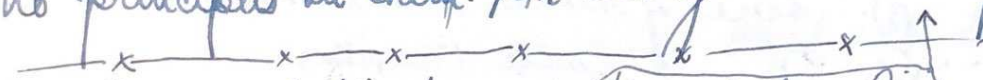
Diff't fishes R. diff't by.
Fishes became accustomed to one end rather than other. conditioned easily - could be Δ'd.
Allee - that they rubbed mucous on walls.

Gradients in O_2, Cl_2, etc. in water in eel grass, etc. What many animals would react to. Why fishes come to top and gulp air at surface film.

Allee found NH_3 caused fish to go into it & often stay till die. Coal gas waste products; gas come out of factories make fish rush into contaminated H₂O & give ⊖ fish & clean water. Fish never evolved an adaptive mechanism for this stuff. as d'd w. CO_2.

Mammals detect effect of rain & R & it the miles away. expec. in Sahara desert. We too can smell odor of rain on cement or on dust. Another case in they've been in contact w. for gener.s

No principles in chem. R accdg Allee nicely.



Chem. R's in relat'n food — General chem Rns

Mamart - leucocytes move into region affected by certain bacteria. will enter bacteriated tube under frog's skin, but won't enter sterile tube.
lymphocytes don't show this Rn.

Amoebae can move towards food. Et & Paramec. can "select" among foods. ~~Don't feed~~ That selected is food that is more digestible. Based on chem. elements

Hydra - will not accept ostracods that are cleaned unless the shells are soaked in ostracod juice. Same for filter paper.

Metridium.
Cilia on lips beat either direction. Tube on tentacles beat out, oh syphonglyphs beat in. Sawdust clean & soaked in meat juice R'd & in diff't ways.
Reversal in tentacles & reversal of cilia on the lips accdg to chem. S.

Basis of satiety in Nitrichium?
— expansion of mucous supply? no ⊤ used a half metrid. & it fed indefinitely. ⊥ It seems to be the internal pressure.

Probascis of prob. dilepsis anser (?) turns back around carmen — try cocyst on oral side mouth
of the probascis. Probascides cut off, will swim around & capture food just as if body were there. There's no mechanism for stopping feeding in the probascis.
When cut off would mouth then attacks Colpoda as usual & pops it down to where mouth used to be.
What stops probascis from feeding when attached to whole animal.

Basic probs of food qu & satiety covered here.
Pattern more elaborate in higher animals but no diffc except — presence of other feeding animals. fish / rats, chickens, children — after satiety a nearby hungry member may start the satisfied animal to feeding again.

Intensity gradient serves to orient law forms but in flat worms after fg intensity gradient till nose hits, it keeps going till mouth comes over the food. auricles of head are most sensitive to dem. S.

Dogfish - bottom feeder normally tracts fg normally = but plug on nostril & it makes circus movt. plug other, it circuses in opposite direction.
= forced movts Parker did it in deck pond at Woods Hole.

Feeding of vultures — eyes most imp. at distance, smell = imp. at close range. Pas covered carion & fly & stuffed carcass & to painted picture.

Strong - can birds smell? gulls? Hard to train smell discrimination but ck rain. Chapman finds nutters attracted to shacks by smell - more from leeward side.

Electrode technique to birds olfact. organs. Long-billed birds have long olfactory n's.

Trailing in hounds, wolves, etc.

Odor discrimin = very high in dogs

Can't be sure they can/dist. between 2 diff'l individ's of same sex & species.

Many dogs can pursue trails of related species bird dogs hunt, set for turtles.

How does he do it?

Motivation, hungry or not, trail of master etc.

Earth odor due compression - stranger vaporization

Plant odor from destroyed vegetation.

Odor traces from extraneous sources, shoe polish, etc.

body odor. Glands sorters of fur

Form of track. sight or smell

Greyhounds trail by sight.

Ground-trailers & sight-trailers

Effected by wind

Can tell direction of trail.

Intensity gradient accdg hunters.

Cobb's hypothesis.

Ground smell + animal smell.

diff'ce in shape accdg to direct.

Test back & forth of approach.

And so on - - -

Relation of sex recog. & sex R's to chem. sense

Plant sperm of many species R. to chem. emans. from ovum.
But ♂ & egg is purely chance among animals.
Lillie showed that Nereis has dif. Ri of sperm to egg as result of chem. R's. (?) to anim. & plant brought together.

Sense recognit. - not always chemical.
But present in most forms.
Moths = most spectacular demonst.
Fabre "oh my!" found nymph of species he hadn't seen in 20 years - put ♀ in cage & collected 60 ♂'s.
♂'s find ♀'s 1½ mi.'s away. (!) Not a R to physical nitrates cause R not given if ♀ kept in glass vessels.

Cell migration - touchy spot.
Chemotactic theory been prominent - neurogenesis 1st contacts when end-organ is close to approp. cord, drags N's after it.

3 theories still:
1. Chemotactic theory
2. Electrical "
3. Ground substance orientation, (Weiss)

No longer need great precision of outgrowth because of modulation. Not too great specificity.
Phis that to throw out ① & not ③.
Weiss 1934 - chem. agents don't influence outgrowth except indirectly by affecting substrate.
Hamburger to Weiss: favors tropism theory.
N's from opposite side of body cross over & innervate the eviscerated limb. Attracted tropistically.
Weiss thinks both art. & nerves patterned by (by muscle) factor. Specific attraction of diff. end organs and.....

Special type of tropism for all cell migration. Wallen calls it "rheotaxis", but it's compounded. Stereotropic, chemotr & other factors enter into cell migration.

The "Brauer body" of echinoderms along side of stone canal expec. in centrotus & sea urchins. Evid that germ cells orig. there & then migrate to gonads to grow.

All migrations are widespread. Cause = a matter of inquiry.

Apply principles here now to insects:

Wigglesworth's "Princ. of Insect Ecology"

Location of chem recep.s of insects:

Not in antennae but in wing bases, & other spots.

Ammon. Cl. may be pp'd in many places on body of insects - & S sensory expand wh. R also & other S. may have an irritating property. Legs of termites sens. to irrit. substances. Crickets "cerci" (2) are S.s by citron oils. on legs(?) Wing bases of beetle & basal segs of antennae R to irrit. pulvet.s. The Camponiform sensilli found on palters of dipt. & on "parapleurota" (= cockroach) & wings of lepidoptera have led some to think = true organs of smell.

Sense of taste (def. = ability to R to sour, sweet bitter, salt) Can insects detect same? Recep. located near mouth Rs to these S. Can condition for taste discrimination. Modern technique = candidate for this. Palps articulate mouth & some interior surfaces of mouth sensit. these chem. S. Hydrophilus further localization salt, sweet, bitter - on maxil. palps & salt by labial palps.

Ants, bees & wasps taste in part w. antennae - more sens. taste in tarsus & tibia. Fly's & honey bee tastes in feet as well as w. antennae.

Most subst. sweet to us are tasteless to honeybee, pentoses, sugar alcohols, & others.

Threshold conc. bees varies greatly. After starvation the threshold falls.

Gust organs on tarsi are extremely sensitive to sugar. Proboscis is extended when stands in sweet water.

"Painted Lady" butterfly 1/5 m. to 1/100 molecular goes down when starved. = 300 times sensitivity of human tongue.

M/20,000 = 24/25 times sensit. human tongue for Dextrans 17%.

More sensitive to sucrose than to other sugars

Maltose & lips but not tarsus of flesh fly.

Sense of Smell

Chiefly on antennae. Cockroaches extend ant & cheese will follow it around as it swings.

8 moths see. ♀ = on antennae.

Parasites sense host by smell.

Cricket cerci = part of repro. organ on poster. end of butt.

Interaction between diff. sense organs for complete R. Bee fly locates host by sight = a moving light/dark shadow. But after alighting the antennae are necessary to provoke lunging stab of proboscis.

Palps bear odor receptors as well as antennae. Cabbage butterfly's smell reduced only ½ when amput'd.

Von Frisch (Head of lab at Munich) (wh. Rockefeller built for him) worked w. foraging bees - trains to locate sugar w. visual or odor cues. Has used flower perfumes & essential oils. Can discern essence of orange from 4/5 other oils. Bee failed w. 4 essential oils related to essence of orange & = most pungent to man. Nose of bee resembles that of man.

Rhesus = about same, but bees can discriminate better. R & 32 substances of no biol. value. Can't locate sugar marked by foul-smelling odors. Many of flowers odorants to man appear to be w'out effect on man.

Bees lose R. to odor if antennae are cut off, & can't track. Some ind. differ sensitivity of sense organs accounted for by the thickness of chitin covering the receptor. But many other factors also.

2 kinds of insects in olf. sense

1) bees ≅ man ≠ man (taste also)
2) moths ≅ dogs

How sensit. man is to smell - rec's are at top of nose cavity in a recess where air usually reaches by, by sniffing pull air up into cavity. Smell vestigial in man / rec. occupy ¼ sq. inch. / It's about 1/10 times as large in dogs. (about 1 cc in volume.

Still extremely delicate in man. Dentist smells for decay (mercaptan can be smelled 1 mg / 20,000,000 liters of air) on his drill.

Such stuff!

Interaction between taste & smell:

Relative threshold for taste and smell. Few substances have both odor & taste - C_2H_5OH has it. 3 molecules caused taste it 5-10 molecular S's part of mouth in wh. no buds.

Olfact. organs of air-breathers wet S's by fluids, aqueous.

Taste ≠ 2 to 3 times higher than smell in man for C_2H_5OH

Hydrotaxis = R. to presence of H_2O

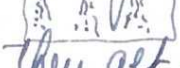
(simple reflex --- to --- complicated R.)

Plant roots grow toward water.

Many animals R. to moisture.

Earthworms, by test wavings, trial & error. } respiration rises
Isopods, trial & random sampling } in dry places.

Animals R. to humidity also.



R. of aquatic animals to air & how they get back into water. Fish flops down hill. Fiddler crab gets out of tide pools by making short migrations over sand & flopped toward sea by orienting after each jump.

They start out over the lowest land whether its seaward or not - also go out may they come in as far as possible.

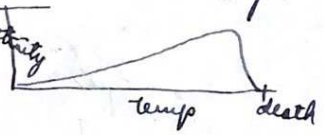
Rise of newly hatched loggerhead turtles - to find the sea from sand banks. Parker fixed up the scenery around hatching eggs. Found the youngsters made their way toward the largest amount of open sky whether it was inland or seaward.

Footnote: on halters & their function - find now that halters aided in maintaining balance by using organs. Halters as balancers = w. oblique rates of organs - vibrating fluid on ... shearing strain when animal falls laterally.

Lects Wed. Thurs. + Fri. | M W Th of this week

Rins of Animals & Temperature - wow ——!

6° - 35°-40° C death pt is closely associated w. upper limit of activity. Death point varies greatly.



Some phyllopods die at 18°C. = "fairy shrimps"

Extremes of exposure are diff from common.
"Bryocoles" like on moss have been revived after 150°C down to 1-270°C. (liq. He) They encyst at high temp & at low temp and are pretty well dehydrated. Include tardigrades, mites, and protozoa.

-20°C to about +65°C = usually extremes. Found 64°C heat out on dunes on sand = about desert temp.

Margin of safety at low end = high - & nice reserve.
Some lizards have normal temp. at 112° F and die at 116° F.

Primary effect of temp. is to affect the rate of metabolism.

Temperature values: Q 10 rule - for every 10°C rise in temp get a doubling of the metab. rate. The speed of metab. activity varies w/ a definite factor

Van Hoff or Q10 rule holds somewhat for chem. Arrhenius rule of metab. effects runs on an exponential scale.

Bli & this Rule

"Super-cooling" = solidification w/out formation of crystals or keep a liquid/liquid below usual freezing point.

Many organisms never freeze. ① Protoplasm contains less water in cold seasons ② Migrate to protected regions from meadows → forest, trees → ground, ③ Seek places where physical disturbance is reduced to a minimum. Metabolism quits.

So they can be cooled below freezing pt?.

Irreversible super-heating. great increase of activity may have adaptive significance.

Roy. Egad!: explains why animals avoid extremes of temp. Fresh H_2O mite trial & error business. came to rest by shuttle movt.s fast in hot, slow in cold, & so gradually settled in most temp. The effect of temp. on Bli

Other animals show dif. orientation in gradient. Rhodnius a hemipteran blood sucker can detect gradient of air w. its antennae. rather delicately w. antenn/= few mm. long = def. tropistic Bli

Cimex = Bli? not + to chem. emanations from blood mt., or washed skin, but fat glands' sebum do attract cimex the Bli is guided primarily by temp. w. antennae. & will try to pierce any warm, roughened, area. Also lice & beetles work Bli.

Many insects + to light also R to heat radiations grasshoppers orient diag. to light & heat, blind insects do it.

more freq. Rn to Heat = of trial & error type.
Diffic. to set up temp. gradient in water horizontally.
Didn't w. gradient tank & fish came to rest at about 25°C. (above normal, Bartol)
by a trial & error Rx.

Acclimatization figured in also. Past temp. affects pres. Rx of land isopods & same w. fishes.

Temps analyzed by Crozier & his bunch in terms of Arrhenius equations.

effect on locom. above 15°C coeffic 11-14,000
below 15°C 16-17,000

due to a fundamental △ in protoplasm — of same pacemaker / master chem. Rx or something. Been attacked w. vigor, but Crozier hasn't learned yet.

Rattlesnake can detect ossella's heated bodies. Rabbit pits of vipers are sensitive to heat.

Nest build'g of albino rat ~~about~~, amt of nest is indirectly prop. to temp. When hungry finish more of a nest (body temp = caller)

Solitary wasps digging: when t = high or low animal digs rapidly. Comes out to get warm by flying around in sun. Juggling of time, temp, & space. Temperature as a 5th dimension for wasps.

Light is another complex stimulus

a) Intensity
b) Ray direction
c) Wave length
   1) brightness (varies w. freq.)
   2) color
d) Heat must have a heat component
e) Polarized or not
f) Complete absence of light (= diff from negat. Ri to light)

R. to blackness = "skoto-taxis" to black.
Goldfish R. to larger black blobs on circular table
a cephalic beetle Anotiophilus +R to black & + to light.
Usually given by animals (−) to light.

R. to these factors of light depends on adaptation of sense organs.

Effect of light quite varied.
1) Photokinetic Ri = turns produced by light S. Same insects fall to floor if light is turned off speedily
May fly nymphs go into "light tetany".
2) Phototactic directive R.
photo taxes

Comment on some of the factors here.
R. to intensity & direction — if flashy lead back that animals R to the direction of the light waves.
intensity of light varies w. square of distance = a rather steep gradient.
Yerkes "light grader" which gave a gradient dark ... light
gets 2 intensity gradient inverse sq. law
+ the Δ lens gradient wh. was steeper than the other.

Also can set it up on horizontal source as well as vertical.
So direction of rays was differed from intensity gradient
Same animals R. to intensity gradient & other ⊥ to direction.
Daphnia R to intensity.
Cadis larvae are + to direction & indep. to intensity

Reversibility of these Rs

Daphnia's light Rs are easily reversed. At first = ⊕ but may gradually become ⊖ as become light adapted.
Picking up entomostraca in pipette caused reversal.
Same Δs give metabolic effects.
May fly nymph ⊕ may be made ⊖ by KCN a depressor.
" " ⊖ " " ⊕ " " " "
Of the weak solut. in KCN get stimul. at 1st from Kians
Can make When CN begins to work they change taxis at
last minute before they die.

Most complete system of Anim. Behav. yet worked out
Biol. Rev. v. 6, 1931 — Kühn's notions by Fraenkel

A. Tropisms - curvature mvt.s of fixed organisms
B. Taxes - direction mvt.s of motile organisms
1. Phototaxis - orientation in undirected path - R to discontinuous alternations in intensity of S. avoid R. to unfavorable S. [i.e. trial & error] works in both direct.s toward optimum.
topography 2. Topotaxis - mvts directed w. respect to source of S. (+ & −) transverse
a. Tropotaxis - orientat.n in excitation equil for symm. placed receptors & pairs equil for " " effectors.
each sense organ acts as the connected to a motor organ in 1 to 1 relationship - to mvt = straight toward or away from S.
a) remove sense organ → circus mvt.s
b) w. several S get a resultant orientation

b) Telotaxis = assumption of a position so that a definite portion of receptor is hit by S.

turning mant's always turning animal into position.

sense organ acts in more than one way, not 1 & 1, so mant may be in more in one direct.

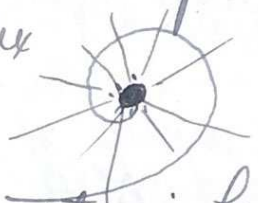
a) absence of circus mant's w/ extir of one sense organ.

b) w. sensual S don't get a resultant position, but orientat'n too one.

c) orientat'n not disturbed by unilateral injury to effectors.

c) Menotaxis | mant'g a def. angle in mat'n w. respect to S. | a def. pt in recept. rec's the S. Anim's Ri to keep same point in w sp

Lyon's eye reflex

light  polariz

Given by Hymenoptera in homing Ri's. — Ants & bees go out from nest in defin't direct'n. If carry 'em any hour they ff. ways back & so go to one side of nest.

d) Mnemo-taxis = memory taxis orientation from memory impressions. Rink interneurs.

= Rino to a sign. prob's of C-R, etc.

This system of Kuhn can be applied to all simple Ris of organism photo, geo, chemo, etc. -taxis & -tropisms

Want go thru phylum & classes

Rsn of insects to light is remarkably exact – sometimes approach precision Koch emphasized. Thus in contrast w. majority of rest of animals.

Kennedy of Ohio State! relative size of comp'd eyes in insects with optic centers that control vision.

dragon flies – practically whole ant. part of head = eyes. such pre-pupae likely to be dominated by light S.

Vertebrates have opposite type – relat. underdevel. of c n s in prop. to eyes.

In insects the sensory system has taken over bldr fns. vert.s

Rsn to λ of light: from x rays of radium to radio waves.

(10,000 A.U = 1,000 μμ.)

Paramecium = + to near ultra violet (indiff ordin. light.)

Earthworms see violet light.

Visual purple blackens most rapidly in green. man

Many animals R. to infra red as to darkness so can watch 'em.

(Diff animals to diff λ.)

Heat is greatest at red end. Impart. in photosynthesis enh. is maximum at red end.

Photochemical values = greatest at violet for many chemicals.

+ animals tend to collect at violet end.

– " " red "

Brightness varies as measured by human eye.

greatest in high int. at orange.

" " low " " green.

How much do other animals sense color?

R. to diff λ doesn't mean Rg to color as we know it – can never know. [Braddock is red-green blind – shows what we're up against in trying to tell what insects see.]

Von Frisch - trained bees to come to yellow, failed w. red. indicate bees can be trained to locate food in orange, yellow, green, — to blue green, ultraviolet, food green?

Fish take food from red forceps & avoid all others.
Fish see range of spectral colors.
Birds, also, parakeets R & colors men can see.
Native color preferences in many lower animals.
blue = one of favorites.

Hecht of Columbia an man 1932
specific props of color vision:
color mixture
spectra luminosity
hue discrimination
complementary colors
spectrum saturation
all interrelated mathematically
can all be gotten from assumption of 3 receptor processes.

Rays & two ends of spectrum.

1) Infra red end.
Can photograph infra-red now.
pipis by eyes in some animals. eyes of certain owls = susceptible to infra red.
frogs, mice will photograph & so owl should detect. & dead ones could it be found, like ones called.

Photokinesis (?)
some modern lamps approach cold light. can also do it w. a cm. of distilled water wh. absorbs 89% of the heat.
Solitary bees are less active on cloudy days other things being equal. Recovered from cold faster quickly in cold light than in darkness / photokinesis or light transformed to heat.

Ultra Violet End:

Lutz of Am. Mus. Natur. History. Suspicions of mimicry & Kris & Beglar. bees didn't go to same colored flowers. Used a pinhole camera & plate sensit. to ultraviolet — showed many flowers have ultra viol. pattern much diff't from our sight. Yellow spiders on yellow backgrounds show up clearly in ultraviolet light.

Luna moth has sex diffes in ultraviolet emanation.

Men wandered how much insects R to ultra violet.
Trigona stingless bee on Barro colorado island. Used 2 pairs of same color but w. diff't ultra violet content

Bee's recog'd the pattern & locate nest by.
So they saw ultra violet.
We must know sensitivities of other animals.
moths smell
birds (?) etc. other exam.s
bees sight

Bunsen-Roscoe Law.
Grotthus Law
Lambert's Law
Inverse square law
Cosine law of Illumination

General principles applicable to phototropism - regularities in animals. Abt despite the Harvard Law.

"presentation time" = length of time a S must act to cause R.
reaction time = time of continuous exposure to a S before R is given
presentation time can't be longer than R'n time
latent period = diff'ce in "pres. & react." times

(Endendrium Hydroids may R. seven hours after presentation of S)

summation of S = a series of weak S may give as strong a R as
threshold of S = if the orig. S has combined
weakest S that may cause a R.

R & optimum conds: = conds that give maximal R for maximal length of time.

Bunsen-Roscoe Law - strength of S x duration if constant will give constant effects. K·I·t con. intensity · time.

Blaauw - .000,17 CaM for 43 hr = 26.3 CaM secs. } same effect
26,500 CaM. " .001 sec = 26.5 " " " . } on oat sprouts.

≈ for endeavrium hydranths - Loeb.

Grotthus Law - only absorbed energy brings about photo-R. absorption spectrum of receptors & structures between, skin, cornea, etc. etc. Absorption effect higher in amoeba than in photon law.

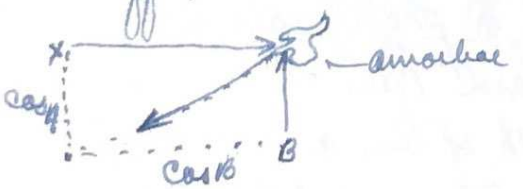
Lambert's law - fraction of light absorbed by any medium is independent of the of source of light.

Inverse square Law. - intensity varies inversely w. distance.

Cosine Law of Illumination: - $\cos x = \frac{b}{h}$

orientation effect varies w. cos. of ∠ of incidence of light

effect $E = K i t \cdot \cos \angle a$



= extension of Bunsen Roscoe law.

Limulus tied by tail & heard — moves away from light - they use 2 lights & he followed the resultant of the two

Spatial R of animal & light is affected by his own anatomical topography !! When 2 lights hit ommi it orients so both eyes get same illumination

Forced maze inside the circle.

R's trial & error outside the circle.

Whether trapotactic or phototactic depends in part on the spatial structure of the organism.

The Tan ∠ of orientation = cot ∠ h · $\frac{I_1 - I_2}{I_1 + I_2}$

so applied B-B+ as law to the animal itself.

more diffic. to show on neg. animals.

(This junk is done by Crozier).

B-R law fails w. very low intensities — even w. photographic plates.

Intermittent light ++ up = constant sum

as shown on Daphnia rotates w. light on one eye

one eye intermittent & one eye constant gave same result as constant on both

↖ Talbot's law — shown on Mya, Limulus, etc.

Hecht of Columbia derives law theoretically from his theory of vision.

for human eye, Talbot's law holds w/in wide range.

exptl error = ± 1/19 -

2 lights, 1 const. & 1 intermittent, the intermittent one gave a higher brightness.

Weber-Fechner Law - 1846. ie mean Δ in S. necessary to produce a Δ in sensat. = fractional increment of acting S.

Fechner extended it to include carriere ΔS in sensat. caused by any fraction = same thing.

This law doesn't hold at extremes.

Humans to fungi included in the law.

due to concentration of S-g ions.

Patten found exceptions of highly technical sort.

on blowflies w/ hips and dipped in ink. showed that Weber's law holds for them for light intensities.

If 2 S. active together, their R depends on relative intensity as formula.

Doc Pan on earthworms in this lab
"The earthworm was introduced from a glass tube" & was supposed to choose between relative wetness of tissue papers. He substantiated Weber's Law!!

Fechner's Law - brightness of stars originally set up in scale according to just detectable difference & they found now by physical measurement that the diffs are relative.

Ri of chromatophores: whole matter of color Δ.

Δ's in shade, color, color pattern.

shrimps clear until S'd by play of colors passes over body when S'd.

octopus = translucent when at rest & dark brown when S'd. mottled phases come in by eye-reflexes. swimming reflexes & burning laugh attitudes controlled by eye-reflexes.

three lizards (called as chameleons) of South east - Δ color when two come together & fight. Beaten = yellow, win = green & when at rest = grey.

Survival value in it as demonstrated by Lemmer w. predating birds.

Ri of flounders & their background.

Δ's in shade, color, color pattern.

light shade over light bottom
dark " " dark " (take up pattern & color also)

Rate of adaptation varies w. individ. & time, & length of time that animal has been in previous color.

4 days from max. black & white after 2 weeks but after transferring back & forth for two weeks if made the Δ in 2 min. Alice doesn't see but that it is a learning process.

Two theories about effector mechanism involved. i.e. the chromatophores { A = modified smooth m. cells mid. is indirect
B = " amoeboid "

25 yrs ago A. Spaeth - effect of salts on chromatophores & smooth m. cells
chlorides - basic ions Rb, Ca, NH$_4$, K, Na.

B. General outlines of chromatophore = constant, but has channels thru which pigment expands or contracts w'in the cell – so not a straight amoeboid action.

No state of rest shown by these cells as in smooth m. cells.

some of cells contain guanin & are pure white in reflected light. They may cover the pigment cells.

Regulation is thru eyes. Ant. end on black → black all over. One eye on white, other on black → grey all over. Either eye influences whole body.

Removal of both eyes removes the capacity to Δ.

Animals adjusted to one color tend to return to that color background – Allee expands – fish like here in Cl. tend to come to rest on background they've been resting.

Braun of N.U. Johns crayfish tends to do same thing for dark-light contrasts. Δ is controlled by the pigmented eyestalks that receive light from below, the lower " in the eye.

Problem of Rapid Δ to their background.
Focus of intensity alone Flounders etc.

2 hypotheses:
bottom water & illumination overhead
① that it's the ratio between 3 & nearby surfaces
② Δ in between its own surface & surroundings.

Lumber stained skin of fish & found ② was not supported.

① Fish from dark grey background moving to white, intensity greater should become pale like other combinations
from light grey to stronger ill. shades became dark

① was supported by Lumber.

When a bud Pearson, took it up in this course.
used black bullheads. Found black had more effect than merely relative. Also got poor results using
mirrors below. But got stat. sign. results supp'g
the ratio theory when used grey paper.

Physiol. of control of chromatophores
espec. in invert.s
1870 - blinded frogs lose control of chromat.s

à la Parker
Proc. Am. Acad. Arts & Sci's
v 69

1895 - adrenalin causes contrn of chromatophores.
1914 - hypophysectomy caused tadpoles → light
1919 - pituitary Hypophysis in caused → dark.
1930 - ~~pseudo-Addison~~ nerves act on endocrine glands
& so affect cells. Also humoral secretions
from neurons themselves.
1935 - White light shrimp eats yellow then it gets yellow
blood of dark & injected into light shrimp,
caused darkness
extracts of eye stalk cause color Δ.
an expanding substance in nature of one

Crustacea - no kind of direct nerv. system
control of visib. chromat.s
a small sinus gland in the eye stalk

N. system control demonstr'd for fishes & lizards
A. eye to blood to chrom.
B. eye to nerves " "

Eyes are not only receptors involved in pituitary
& bullhead.

Uncond. R due to chromat. cells rather than n. S.
If chromat. released from control of eyes go into expanded state.
When long exposed to darkness pigment degenerates. Surface forms found black in caves get pale.

No final exam. until Ph.D. — concentrate on reports present more completely make out skeleton outline w. title labeling, conclusions & make 15 cap.s per class. Like short notes don't have to summarize method.
Schedule 3 reports a day from 11 till 12 — can have 40 min.s or 50 min. We get thru at 1:00 P.M. Give report on Mon. 18th. along w. Wheeler & Banks on Rats — probably the last.
Motion pict. this afternoon at 4 in Chem.

Instincts

2 general types - learned & unlearned

Unlearned

a. Unorganized - sans n. syst. (sponges

b. Reflexare type - are to one relationship bet. S. & R.
some are reflexologists in psychology.
some say no such thing as a reflex (some
if you block one pathway then R goes other path
certain S brings def. R.

c. Tropisms - forced movements.

d. Instincts

Instincts defined in many different ways. from idea it's only a word to clear out analytical portion of it.

2 types of definition:
1. objective (this is part of view)
2. subjective

Allee - Instinctive R's are a reality (inspite of sociologists)
many things that to be instincts are now known to be early conditioned.

Behaviorist regards breathing, swallowing, gland secretion etc. = innate (b/f) merging on instinctive.

Allee's def. instinct = modify Wheeler def = more or less complicated activity of an organism acting as a whole, typical of species, w/out previous experience or modify. caused by object, w/a purpose of which organism is not aware.

Watson's example - boomerang

Hard to draw line between instinctive R's & other b/h of cells - metamorphosis. where draw line between spinning & pupating

Tropisms = building stones of instincts

Instinctive b/h centers around propagation and food getting.

Relative strength of instinctive drives. Warner - white rats - w. electric grill.
4 days = best time for starving, 8 days weakens the hunger drive.
drink > food > sex.

Instinctive life best shown in social insects.

bees, ants, wasps, foraging, nest-building, care of young perverted & care for commensals & parasites.

in colonial life the closer they are concerned w. brood & reproduction, the more definite & unmodifiable they are.

♀ ant - fixed compound type of life

nuptual flight & ♂ ♀ — settles, detaches wings, starts off

1. excavates small cell
2. enters cell
3. lays eggs
4. feeds young w. an secretion
5. hunts 'em
6. unearths them
8. helps 'em hatch

like a machine

can make gaps in the series w'out disintegration

finds hole & doesn't dig one.

" food ... secrete it.

time lap. delayed too long and secretion dries up, eats rotten eggs & feeds others. All activities tend towards production of mature brood.

These instincts not as fixed as supposed.

Solitary wasps - Tachy. no chance of social training

Diff species attack diff kinds of food.

Prey stung & manipulated diff. it becomes quiet & limp.

Phil Rau of St. Louis: - Wasp studies Ajield & Peckham's stuff.

Queens transmit instincts which they themselves do not show — therefore not acquired.

Instincts may or may not appear perfectly for 1st time & never be repeated.

Stone — perfection of copulatory bhr sans practise.

some show no improvement - others do.

Many instincts in vertebrates are subject to improvement by learning.

Reflexes instincts that don't appear till late.

What, no peck-order !!

Incidental Rin may aid in perfecting an instinctive Rin.
On other hand - tadpoles in chloretone.

Rats copulate at about 50th day — Kline's colony.
" " " " 50th. — Chicago " . New York

Deferred & transitory instincts.

Remains of wing m's etc. act as S to nest-building in ants.
Ant collows nurse young up & slight.

Instincts modified by evolution
Vestigial & decadent instincts

Ants feed from tongues of slaves ordinarily, but learn to feed themselves after a while.

Instinctive bibi is not plastic — in a way, but it can be modified just like limb motor patterns. spider & web.

Locusts lay eggs in earth & deposit froth over hole wh. hardens.
" " on floor & cancels 'em w. froth just same.

Hens will manipulate eggs that aren't there.

Yet they may be plastic.

Pigeons white × blue → blue ♂'s, blue ♀, white ♂, white ♀
spring → winter

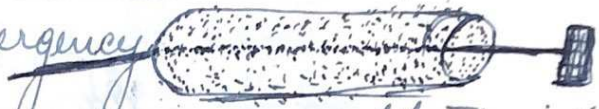
a gynandromorph pigeon shows both male & female bibi.
♀ birds injected w. testosterone attempt to copulate w. ♀'s.

Pathological instinct – Rep + care for other organisms as young + become defective because inhibitions are not helpful

Method of evaluation of instincts = same as for structural evaluation. No evidence for inheritance of acquired function.

Animals notoriously stupid when required to perform instinctive f'ct'n. Diff's between learned & unlearned.

Human b'hr based on fundamental drives. Instinctive b'hr may break out in emergency



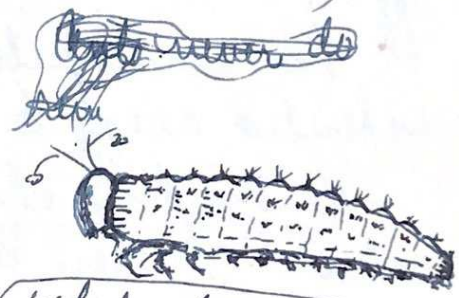
K K Kansas — a lib of instincts in all of our b'hr. } diff's
" " "learning" " " " } important

Michigan Michigan

Conscious = learned
Unconscious = instinctive } lay vocabulary

Allee's formula Act = function of acquired x innate

Allee would not go in w. those who deny existence of consciousness because we can't handle it.



Wheeler's book on ants for every zool. student

Instinct & Human B'hr.

Wheeler's search for fundamental instinctive tendencies involves in scientific research. Oh Inherited b'hr drives

1. Curiosity in cows, apes, children wow! & stuff! Oh my!
2. Hunting instinct - nutrition preintrudy.
3. Acquisitive " " " "
4. Contrivance " mud pies

More human instincts! (cont.)

5. Emulation competition for this + that % of world's work due to it.
6. Communication origin in social animals
7. Craving for sympathy + appreciation
8. Coöperation instinct

Why?

In the Univ. of Chicago.

Finkel, Thomas, Bank; a woman psychologist + son on far into the night.

Types of webs spun by spiders are inherited.

Tilla (genus) spins  web w'out one sector.

Use this factor as well as a structural " to key out the animal.

Accdg to genetics it's the structure as whole that's inherited but Lorgnons, catalysts, etc. Allee calls it behavior that affects structure.

The ear infection or same defect of mice ear is inherited accdg to Mendelian ratio.

Huntington's chorea + color blindness ∴ Mendelian ratios. ∴ Maze-learning ability in rats inherited.

Wild, hooded, + albino rats have diff + bldr complexes.

Lush x Hindoo & European cattle found bldr inherited.
wilder, Bellamore, more germans.

There are inherited bldr patterns.

Racial differ that stand out — structural & biol
acc'dg to some anthropologist.

Instinct precedes intellig. biol ont- & phylo-genetically.
Prof. Whitman had a bit of particidate in his early.

Development of Unlearned Behavior.

Lee Maier & Schneirla
Coghill - J. Genet. Psych. 1936
whole before parts split into reflexes.
result of further maturation of n-syst.
Amblystamid = correct
Amblystoma = prior in literature.

1) non-motile stage = ideomuscular R. stage.
2) early flexure (" sensory & motor present but not bridge
neck region 1st central. to S. turns head away
later whole trunk floor plate cells bridge gap
ant. end 1st.
3) coil stage
4) S stage rever

coil starts then central starts before complete of 1st. reversal = due proprioceptive S.
Manthorpe's eels grew down.

Things we knew at the "turn of the century."

½ hr. delay after removal of animals from Chloretone is due to wash out of anes. shown by Carmichael who put 'em back into Chloretone after swim found took ½ hour to learn

Kuo's stuff on chick embryo - w. windows in shells.

3 days heart beat bobs heads up & down

4 " head bends actively.

6 " leg & neck flexion

7 beak opens & closes rapidly as head nods

9 " swallowing of fluid by mouth.

12 " head movt reduced & bill activity

m's strengthened.

17 " heads lifts & thrusts forward w. opening & clapping of bill.

21 " shell chipped by bill.

---

1) anatomical Δ's
2) position of embryo in egg
3) S's from growth Δ's
4) pattern of S. from medium.

Newly Hatched Chick

Turning of head
Opening closing of bill } partially combined into one pattern.
Swallowing.

Visual S set off pecking
certain amt of trapping involved
1st 30 hrs pecking retarded by m. weakness
1st peck at bright objects - sometimes get food conditions to discriminate bwn food & bright objects

Activity = Inherited x Acquired

Controversy between whole & part devel. of NS.

Coghill & Angulo vs. Windle (W.C.) Carmichael

Windle in Physiological Zoology

D. Hooker - early fetal act. in mammals — Yale J. Biol Med v. 8 1936
review.

Rat by Angulo

slight bend of head on snout S. so head turned away
spread caudad in next 2-3 days
later limbs come in ant. first, post. later.

Windle Cat & rat

cats reflexes occur in front limb before in neck.
w. pressure phenomena, occur once.
only soon after uterus opened.

Carmich fetal guinea pig
specific before general

Coghill Ang — due ~~proprioc~~ tactile.
W-Carm — " proprioceptive.

Human embryos — Hooker
nose & upper lip sensitive early.
fairly stereotyped coörd. & mod't. = normform.
typical cephalic sequence.

Conditioned B'hi – not C-reflexes (= Cond'd automatism)
Learning = facilitation w. repetition.

Mimosa – fail to R. if you S. 'em too frequently.
fatigue or learning.

Rhythmic mvmt.s in diurnal cycle – Can be Δ'd by Δ's in illumination periods – have a certain inertia from one st. to another.

Lashley – uses such illus.s ↑

Protozoa

Amoeba's learning curves micro beams of light so moved away. Increase in speed of R'n after repetition. Retention of this for 50 hrs.

Stentor – did same leave out phases of the pattern @ $\xrightarrow{BC}$ D

Pseudo-learning of p. time to turn around in cap. tube – decrease in size as result of straining – squeeze out H_2O

Food selection not random contact take one species more freq. than another – imp. orange in.

Lack true n. syst

increased excitability

may be no associative learning as in forms w. n. syst.

Coelenterates w. n. syst. n. net.
attached hydroids nothing better in protozoa.
nerve net has not increased learning much
Sea anemones do show simple habits – of bending to right or left – due to persistence of m. tonus.
Can △ this contract in pattern by S.
Disagreement as to whether learning or not.

Echinoderms nerve-net also
Republics of reflexes.
Evid. they can learn. Righting Ri Jennings.
Have tendency to use trivium arms rather than trivium usually.
Is got original to refrain from using arm it ordinarily used. Brace of lashed for a week.
Longer the training – longer the retention.

Vertebrates fishes
Learning = well established
-Pike learned to go thru hole in glass rather than strike at minnows directly.
Perch learn not to take minnows thru glass.
Fish trained to audit. S.
" " red & green lights.
" " " simplest mazes.
learn better when many there
" " " see other fish perform.

Amphibia: not much better in fish – same evid that they are inferior.

Tadpoles can be trained & lose memory when metamorphose.

Can train 'em not to snap at food.

Toads trained to reject ants, insects & spiders

Urodeles in maze – 1 out of 6 learned.

Toads go around glass partition to get food.

Reptiles:

Transfer to diff't kinds of food. Reynolds taught 'em to eat liver. Killed quickly.

Garter snakes trained to eat hamburger.

Turtles trained to escape from confinement.

4 cul-de-sacs 40 trials 35 min. to ½ mins. About as good as rats.

Individ. variat.s

Retention for 21 weeks

Green water snake trained to get from dry cold chamber to moist warm chamber.

Birds: used a lot

learn simple maze about as readily as white rat.

Canaries learned to reduce time w/out reducing errors.

Birds trained to mimic sound & retention for years.

Mammals:

Rat as fast as man.

Learning by repetition as.
" " ifferation, insight.

sense organs may
" " find synthesis

Miss Ranch rest of days 40 min.s | 30 min's & 10 min. sleeps

C'd Invertebrates:

Worms & Arthropods

Flatworms been trained so doesn't show
contrary phototaxis.

Animal exposed to light repeat 5 mins place
in dark 25 mins for 24 hrs.

Average no. of touches to keep worms quiet fell
from 110 to 4 or so

Learned to stay still for period of 5 min.

Same evidence of retention after lapse of
10 hours.

When brain removed all c&g lost.

Not known whether synaptic system or not -
usually synapses placed anterior worms on ant
ganglia on other side

Ctenophores don't have synapses.

Evidence of polarised transmission in
coelenterates. # of synapses (?)

Annelid worms have been trained - Warren
Handle triangle by acute ∠. Worm can merely
hold the △'s / better. Not much good.

Worm will cease trying to pull a leaf into its
burrow after so many trials + learning

Yerkes trained a worm to turn to right 
came sandpaper, elect. shock, etc. after
1000 trials but so over 6 months.

Retained after cutting out cerebral ganglia.

Copeland Polychaetes

Trained Nereis to come out of tube to feed if
he turned a light on. One worm unknown
others when light off.
the light was changed.

Salve easily trained others = morons

Leeches - Whitman

No. 6 wks. leeches came to Whitman's shadow
& assumed feeding position.

Earthworm = best repres. of animal kingdom.
even for learning.

Arthropods approach lower vert's in ability
to learn.

Crayfish trained to ff man about lab.

Spiders did not to drop to ground

Cockroach on  maze to get out of light & water.

⅓ never learned
⅓ " imperfect.

forgot everything overnite
no carry-over
other workers have got carry-over.

Bees have been much trained. Pattern vision diff't odors.

Ants trained

Wasps - Berlaine solitary & dist. △ from □

Can't train rats - Lashley did it but by maze technique but by jumping technique.

Wasps are easily trained. Conclude wasps = superior to rats, monkeys, & △ habits.

Nervous Syst.

Nerve net did introd. advance in learn.

△ from unpolarized & polarized is accompied by increased.

Doesn't matter whether nervous syst. is above or below gut.

Increase in cephalization ff'd by increase in learning.

Inheritance of Acquired Habits

Pavlov's mice / assistants' bungling.

McDougall's work on

Crew, Agar, Wistar Rats inbred, uniform.

trained escape from water tank

elect. shock punishment, strong,

Improvement over generations. (What about selection?)

Nobody can repeat. Had to select — couldn't breed 'em all. Wright - tends to be drift w. such small popul.s & probably it was an evolutionary period.

Migration of Birds (Dunkel probably be good expt'l animal.)

Food supply (population effect)

Temperature

Inherent physiol. periodicity (~~abominable~~ rare)

Light

S gonads & so S migration.

(Birds gonads swell in summer / shrink in winter)

or exercise of longer day S gonads.

endocrines don't seem involved (?)

Bissonette = big worker on analysis of migratory factors in birds.

Pituit. regulates gonads & they S migration.

Red light is more effective on gonads than others.

2 brood birds? periodic cycle.

~~Hormone~~

hormone supposed to affect the n. syst.

Nerve centers etc. excitable by hormones?

There seem to be such.