3 Lerntheorien

Literatur:

A. Holzinger: Basiswissen Multimedia Band 2, p. 106-170

B.R. Hergenhahn, M. H. Olson: An Introduction to Theories of Learning, 6th edition, Prentice-Hall 2001

Was ist Lernen?

- Holzinger:
  - „Lernen ist ein *Prozess*. Mit „Lernen" bezeichnen wir jede Veränderung unseres Verhaltens (behavior) oder unseres Wissens (knowledge) – unabhängig davon, ob es beabsichtigt oder unbeabsichtigt (inzidentiell) erfolgt."
  - Wie erkennen wir Veränderung des Wissens? Durch Verhalten?
- G. A. Kimble (1961):
  - „Learning is a relatively permanent change in behavioral potentiality that occurs as a result of reinforced practice."
  - Must learning always result in a behavioral change? How do we recognize a change in „potential behavior"?
  - How permanent is „relatively permanent"? („neither transitory nor persistent") Is there learning in short-term memory?
  - Incidental learning through experience?
    - » Sensitization, habituation?

Imprinting

- Konrad Lorenz (1952):
  - Gänseküken gehen eine Bindung zu dem ersten bewegten Objekt ein, das sie in ihrem Leben sehen
  - Spezies-typische Verhaltensänderung (Instinkt)
- Ist das „Lernen"?
  - Oder „unlearned behavior"?
  - nicht durch „reinforced practice"
  - aber durch Erfahrung/experience
- Mischformen
  - Learned/unlearned
  - Z.B. Fliegen lernen bei Vögeln

Definition of „Learning"

Hergenhahn/Olson p. 7:

„Learning is a relatively permanent change in behavior of behavioral potentiality that results from experience and cannot be attributed to temporary body states such as those induced by illness, fatigue, or drugs."

Computergestütztes Lernen und Lerntheorien

- Computer können das „Lernen" grundsätzlich **nicht** verbessern.
  - Lernen ist eine Leistung des Individuums.
- Chancen von multimedialem computergestütztem Lernen:
  - Didaktische Aufbereitung
  - Verbesserung von Motivation, Aufmerksamkeit und Aktivation *(arousal)*
  - Computer ist ein geduldiger „Lernpartner"
- Begleitung durch menschlichen Lehrer fehlt
  - Intuitive Steuerung der Materialauswahl, Lehrmethode, Trainingsstärke etc.
- Lernsoftware
  - Soll sich optimal an Lernprozess anpassen
  - ***Jede Lernsoftware basiert auf einer Lerntheorie.***

Experimentelle Wissenschaft Psychologie

- Lerntheorien sind Modelle zur Erklärung von Experimenten
- Experiment:
  - Basiert of *operationaler Definition* (messbarer Definition) der Begriffe der Theorie
  - Rahmenbedingungen: Labor, natürliche Beobachtung?
  - Idiographischer oder nomothetischer Ansatz? (Ein Subjekt unter vielen Bedingungen oder viele Subjekte und deren Durchschnittsverhalten)
  - Menschliche oder tierische Subjekte?
  - Abhängige und unabhängige Variablen?
    - » Beispiele unabhängiger (bei Experimentdefinition bestimmbarer) Variablen: Alter und Geschlecht der Subjekte, Art und Qualität von präsentiertem Material, ...
    - » Beispiele abhängiger Variablen: Punktzahlen, Fehlerzahlen, Antworttrate, Häufigkeit von Antworten, Stärke von Reaktionen, ...

Lerntheorien: Überblick

	Behaviorismus	Kognitivismus	Konstruktivismus
Ca. entstanden	1913	1920	1945
Lern-Paradigma	Reiz–Reaktion	Problemlösen	Konstruieren
Beurteilung nach	Leistung (Faktenwissen)	Wissen (Konzeptwissen)	Kompetenz (Gesamtproblem)
Signalfluss-Modell	Lerner / Input / Output	Feedback / Lerner / Input / Output	Feedback / Lerner / Input / Output
Softwaretypus	Computer-Aided Instruction (CAI)	Computer/Web-Based Training (CBT/WBT)	Simulation Mikrowelt

3 Lerntheorien

3.1   Lernen

3.2   Behaviorismus

3.3   Kognitivismus

3.4   Konstruktivismus

3.5   Lernen als sozialer Prozess

Literatur:

A. Holzinger: Basiswissen Multimedia Band 2, p. 112-132

B.R. Hergenhahn, M. H. Olson: An Introduction to Theories of Learning, 6th edition, Prentice-Hall 2001

Classical Conditioning: Ivan Petrovich Pavlov
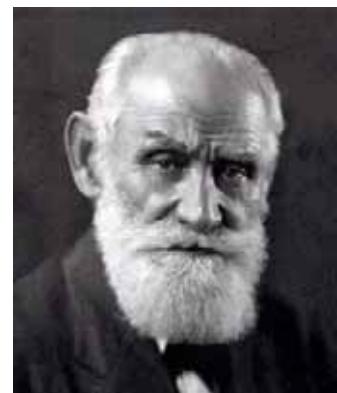
Ivan Pavlov (1849 – 1936)
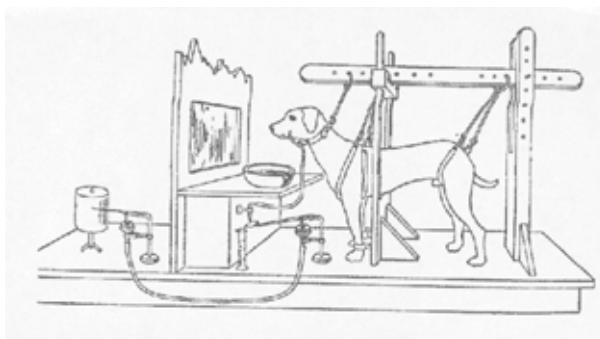
Conditioning

- Unconditioned behavior:
  US → UR
- Training:
  US + CS → UR
- Conditioned behavior:
  CS → CR

- Unconditioned stimulus (US)
  – e.g. meat
- Conditioned stimulus (CS)
  – e.g. sound
- Unconditioned reaction (UR)
  – e.g. saliva
- Conditioned reaction (CR)
  – e.g. saliva
- CR and UR
  – same quality
  – CR lower magnitude than UR

Paradigm of Behaviorism

- Behavior
    - is a pattern of *stimuli* and *responses*.
    - can be observed like observations on the environment.
- Goal of behavioralism:
Elaborate the laws of the relationship between stimulus and response
- *Learning* in behavioralism:
    - How to condition the responses of the learning subjects to certain stimuli
    - Human being seen as a „black box"
- Learning environment in behavioralism:
   - Provides stimulus-response pairs

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Edward Lee Thorndike: Connectionism

- Connection = neural connection between stimulus and response
- Assumption: All mammals learn in the same manner
    - Trial-and-error experiments with animals (e.g. cats and monkeys)
    - There is no reasoning involved in learning
- Learning is incremental, not insightful


Edward Thorndike
(1874 – 1949)
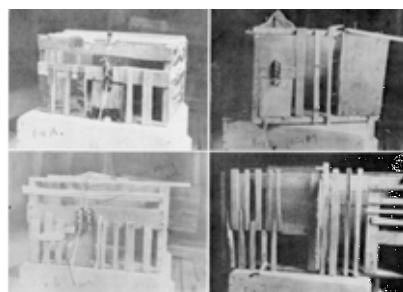
Before the main behavioristic movement!

Thorndike puzzle boxes for cats

Law of Readiness

- Dependency of reaction on internal state of organism:
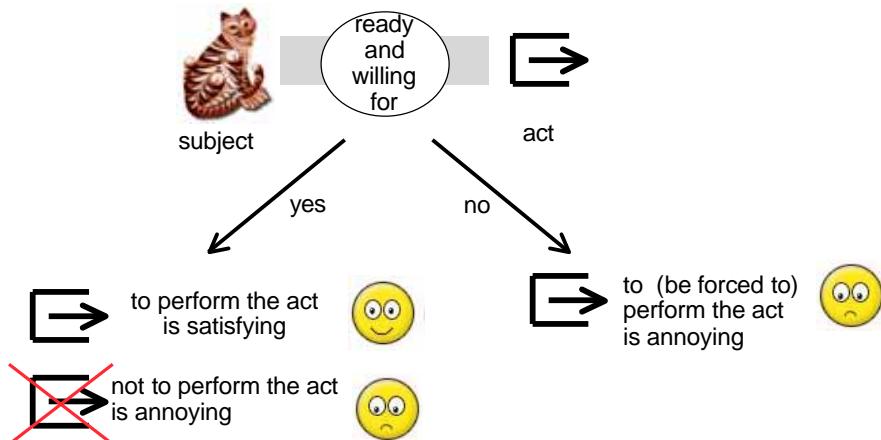
Law of Exercise

- Law of use:
  - Connections between a stimulus and a response are strengthened as they are used
- Law of disuse:
  - Connections between a stimulus and a response is weakened when the connection is not used
- Strong emphasis on practice
  - Basis for „drill-and-practice" software
- Thorndike 1929, Congress of psychology
  - „I was wrong."
  - Revocation of the law of exercise!
  - Only minor effects provable in extensive experiments

Law of Effect

- Response followed by a satisfying state of affairs
  → strength of connection is increased
  - Rewards
- Response followed by an annyoing state of affairs
  → strength of connection is decreased.
  - Punishment
- Revised law of effect (1930)
  - reinforcement pf connections works
  - punishment does nothing to the strength of a
    connection
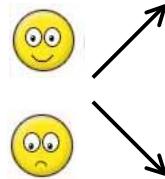
Clark Leonard Hull:
Mathematical Learning Theory

- Mathematical explanation of adaptive behavior
  - Stimuli = input variables (S)
  - Responses = output variables (R)
  - Intervening (non-observable) variables
- Strength of connection:
  - *Habit strength* H between S and R: $_SH_R$
  - $_SH_R = 1 - 10^{-cN}$
  - N = number of reinforcements
- Influence of *drive* (D):
  - $_SE_R = {_SH_R} \cdot D$
  - *Excitatory potential* E between S and R: $_SE_R$

Clark Leonard Hull
(1884 – 1952)
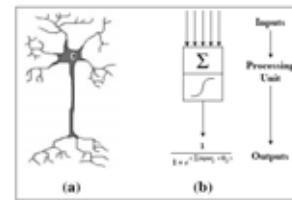
Burrhus Frederic Skinner: Operant Conditioning

- Radical behaviorism
  - Rejects to use terms like „drive", „motivation"
- Behavior
 - Respondent behavior
    - » Elicited by known stimulus
    - » Controlled by its causes
    - » „type S" conditioning (Pavlov-like)
  - Operant behavior
    - » Not elicited by known stimulus but emitted by organism
    - » Seems to appear spontaneously
    - » Controlled by its consequences
    - » „type R" conditioning (operant conditioning)
    - » Probability of certain behavior is modified according to consequences
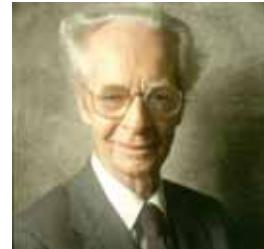
B.F. Skinner
(1904 – 1990)

Principles of Operant Conditioning

- A response followed by a reinforcing stimulus tends to be repeated.
- A reinforcing stimulus is anything that increases the rate at which an operant response occurs.
  - „The only defining characteristic of a reinforcing stimulus is that it reinforces."

response

reinforcer

leads to

response

response

response

. . .
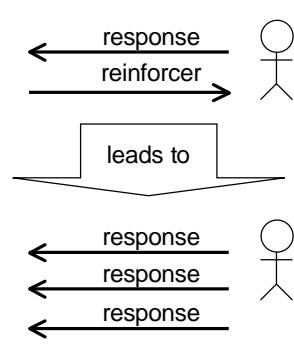
To modify behavior:
- Find something that is reinforcing
- Wait until desired behavior appears
- Immediately reinforce!

The Skinner Box

- Grid floor (can be used for electric shocks)
- Light
- Lever
- Food cup (reinforcement)
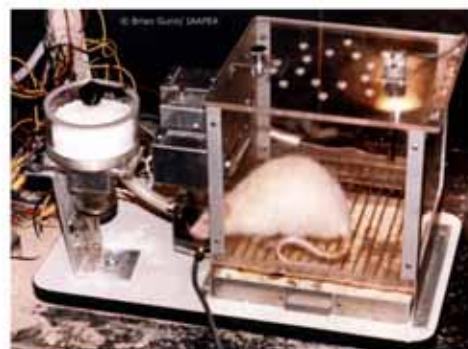
Purely Observational Approach

- Reproducable experimental conditions like in experimental physics
    - „A pigeon is brought to a stable state of hunger by reducing it to 75 percent of its weight when well fed. It is put into an experimental cage for a few minutes each day. A food hopper attached to the cage may be swung into place so that the pigeon can eat from it. A solenoid and a timing relay hold the hopper in place for five sec. at each reinforcement." (B.F. Skinner)
- Automated collection of data:
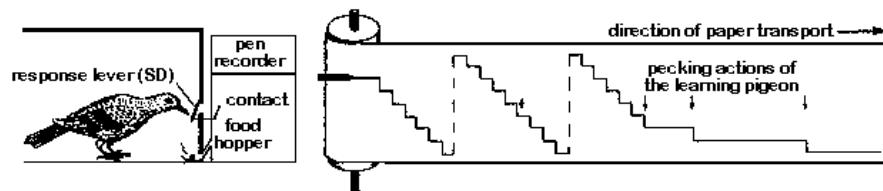
Shaping, Extinction, Recovery

- Over time, step-wise reinforcement of behaviors *shapes* behavior.
- Example: Learning pigeons to turn clockwise
  - First: Any clockwise movement is reinforced
    - » Differential Reinforcement
  - Further on: Behavior increasingly similar to target behavior is reinforced
    - » Successive approximation
- Extinction: Removal of reinforcement
  - Gradual process
- Spontaneous Recovery
  - Learned behavior reappears if animal is brought back to experimental situation

cumulative response

t
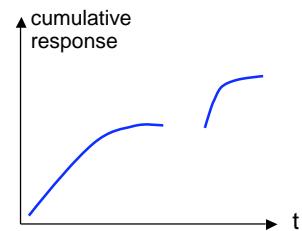
Superstitious Behavior

- What happens if the reinforcement appears randomly, *independent of what the subject animal is doing?*
- Animal tends to repeat the (random) behavior just before reinforcement
  - Bob its head, turn in a circle, stand up on back legs, …
  - „Rituals" to influence good luck?
- Human superstitious behavior:
  - Baseball player adjusting his hat
  - Bowler twisting and turning his arm after having released the ball
  - …

Discriminative Operant, Chaining

- Combination of cause- and effect-based conditioning
- Example:

  Light switched on → animal presses lever → food is dispensed

  discriminative   →   *operant response*   →   *reinforcing stimulus*
  stimulus

     (S^D)   →   (R)   →   (S^R)

            Association of interest
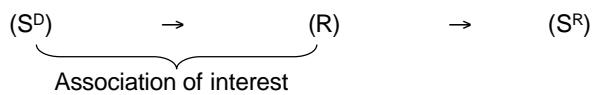
- Chaining:
  Reinforcing stimulus of one reponse acts as discriminative stimulus for another reponse
- Example:

  in test chamber → orient toward lever → sight of lever → approach lever → …
     (S^D)   →   (R)   →   (S^R)
                                        (S^D)   →   (R)   → …
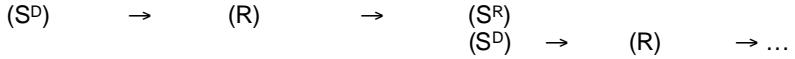
Punishment

- Punishment:
  - Response removes something positive or adds something negative
- Estes (1944)
  - Comparison how to remove a learned response (in rats)
    » by „extinction" (no further reinforcement)
    » by punishment (electric shock)
  - Punishment turned out as effective only in a very short time range, in the long run no more effective than „extinction"
- Other arguments against punishment:
  - Transfers only negative advice
  - Causes unfortunate byproducts
  - Justifies inflicting pain
  - Elicits aggression
  - Replaces one undesirable reponse with another undesirable reponse

Criticism of Behaviorism

- No consideration of the quality of mind states
  - Same approach to human beings and animals
  - Stimulus-response as the main paradigm
- Memory seen as a passive storage unit
  - Just reproduction
  - No active processing
- Use of animal experiments
- Simplistic teaching concepts
  - Learning software concentrating on factual knowledge
  - No development of problem-solving skills

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3   Lerntheorien

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A. Holzinger: Basiswissen Multimedia Band 2, p. 133 – 145

B.R. Hergenhahn, M. H. Olson: An Introduction to Theories of Learning, 6th edition, Prentice-Hall 2001

Cognitivism: History

- „The behavioristic attack on the introspective method of Wundt and Titchener […] At about the same time the behaviorists were attacking introspection in America, a group of psychologists began attacking it use in Germany. This small group of German psychologists called themselves Gestalt psychologists." (Hergenhahn/Olson p 249)
- „The Gestaltists"
- Kurt Lewin (1890 – 1947):
  - Field theory of human motivation
  - All psychological facts a human experiences make up a person's *life space.*
  - The totality of these events determines behavior at any given time.
  - A person exists in a continually changing field of influences, and a change in one of them affects all the others.
- Katona experiment (1940):
  - Remember the following digits
    » 1 4 9 1 6 2 5 3 6 4 9 6 4 8 1

Gestaltpsychologie

- *Gestalt:*   (Edgar Rubin 1886 – 1951)
  - Bestehend aus *Form* (äusserer Begrenzung) und *Figur* (erkanntes Objekt)
  - Figur hebt sich ab vom *Grund*
  - „Das Ganze ist mehr als die Summe seiner Teile." (Aristoteles)

- *Gestaltgesetze:*   (Max Wertheimer 1880 – 1943)
  - Zentrales Gesetz: *Prägnanzgesetz*
    („Gesetz der guten Gestalt", „Gesetz der Einfachheit")
  - Jedes Reizmuster wird so gesehen, dass die resultierende Struktur so einfach wie möglich ist.
  - Eine Figur ist „gut", wenn sie aus Teilelementen heraus erkennbar ist.

  - Viele Versionen von Gestaltgesetzen, hier nur sehr kleine Auswahl!

Prägnanzgesetz

- Die von den Sinnesorganen aufgenommene Information:
  - Komplex geformte schwarze Fläche
- Die wahrgenommene Information:
  - Überlagerung zweier einfacher Formen (Kreis und Linie)
- Die Wahrnehmung bildet Hypothesen über eine *einfache* Figur
  - Erfahrungshintergund

Gesetz der Geschlossenheit
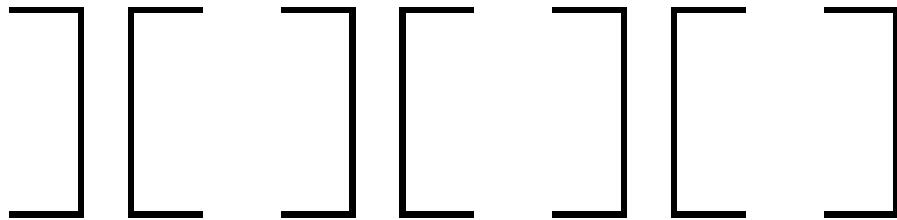
- Fehlende Informationen werden aus dem Erfahrungshintergrund ergänzt
  - Ermöglicht Erkennen auch verfälschter Darstellungen (z.B. Verdeckungen)
  - Kann zu Fehlinterpretationen führen

Gesetz der Vertrautheit

- Es sind mehrere inkonsistente Interpretationen gleichzeitig möglich
- Wie viele Gesichter sind im folgenden Bild enthalten?
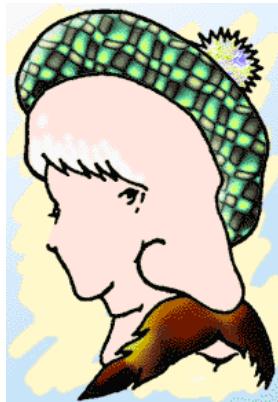
Wolfgang Köhler: Problemlösen bei Affen

- Experimente mit Schimpansen
  - Verwendung von Werkzeugen, Kombinationen, Umwegen
- Hühner können vergleichbare Probleme kaum lösen!

Wolfgang Köhler
(1887 – 1967)

Grundparadigma des Kognitivismus

- Mit Kognition *(cognition)* bezeichnet man jeden mentalen Prozess, der mit den zentralen Elementen *Erkennen* und *Wissen* zu tun hat.
- Beispiele:
  - Begriffsbildung *(conception)*
  - Wahrnehmung *(perception)*
  - Wiedererkennen *(recognition)*
  - Schlussfolgern *(reasoning)*
- Im Mittelpunkt des Kognitivismus stehen individuelle Denk- und Verarbeitungsprozesse.
- Lernen ist eine *Wechselwirkung* zwischen externem Informationsangebot und einer intern vorhandenen Wissensstruktur.
- Lernen ist *Verarbeitung von Information zu Wissen.*

Jean Piaget: Development of Intelligence

- Intelligence:
  - Approximation to conditions optimal for survival of the organism
  - Changes dynamically with maturity
- Schemata:
  - *Schema* = potential to act in a certain way
  - *Content* = particular manifestations of a schema
    - » Overt manifestations (e.g. reflexes, physical reactions)
    - » Covert manifestations (thinking)
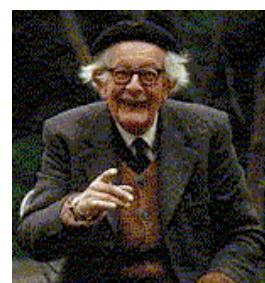
Jean Piaget
(1896 – 1980)

Assimilation, Accommodation, Equilibration

- Cognitive structure of an organism:
  - Number of available schemata
- Assimilation:
  - New experiences are integrated into existing schemata
- Accommodation:
  - Developing new ways to deal with previously unknown events
- Example:
  - 4 months baby dealing with its first experience of a rattle
  - Assimilation: A thing which can be grasped
  - Accommodation: After many attempts, developing the new concept of „something which makes noise when shaked"
- Equilibration:
  - Organisms have a tendency to create an harmonious relationship between themselves and their environment.

Jerome Seymour Bruner: Narrative Psychology

- „The teaching and learning of structure, rather than simply the mastery of facts and techniques, is at the center of the classic problem of transfer... If earlier learning is to render later learning easier, it must do so by providing a general picture in terms of which the relations between things encountered earlier and later are made as clear as possible."

Jerome Seymour Bruner (1915 –)

- Very much on the border to constructivist theory (see next section) and social learning
- Cognitive development of children:
  - Enactive: Sensation = objects
  - Iconic (2 years): Mental images
  - Symbolic (7 years): Language, mathematical notation

Robert Gagné: Behaviorism & Cognitivism

- Eight phases of learning:
  - Signal learning (similar to Pavlov's theory)
  - Stimulus response (similar to Thorndike's Instrumental Conditioning)
  - Chaining (as described by Skinner)
  - Verbal association
  - Discrimination learning
    » Different/identical responses to different stimuli
  - Concept learning
    » Generalization, classes, categories
  - Rule learning
    » Being able to demonstrate some defined behavior (e.g. calculating)
  - Problem solving

Robert M. Gagné
(1916 – 2002)