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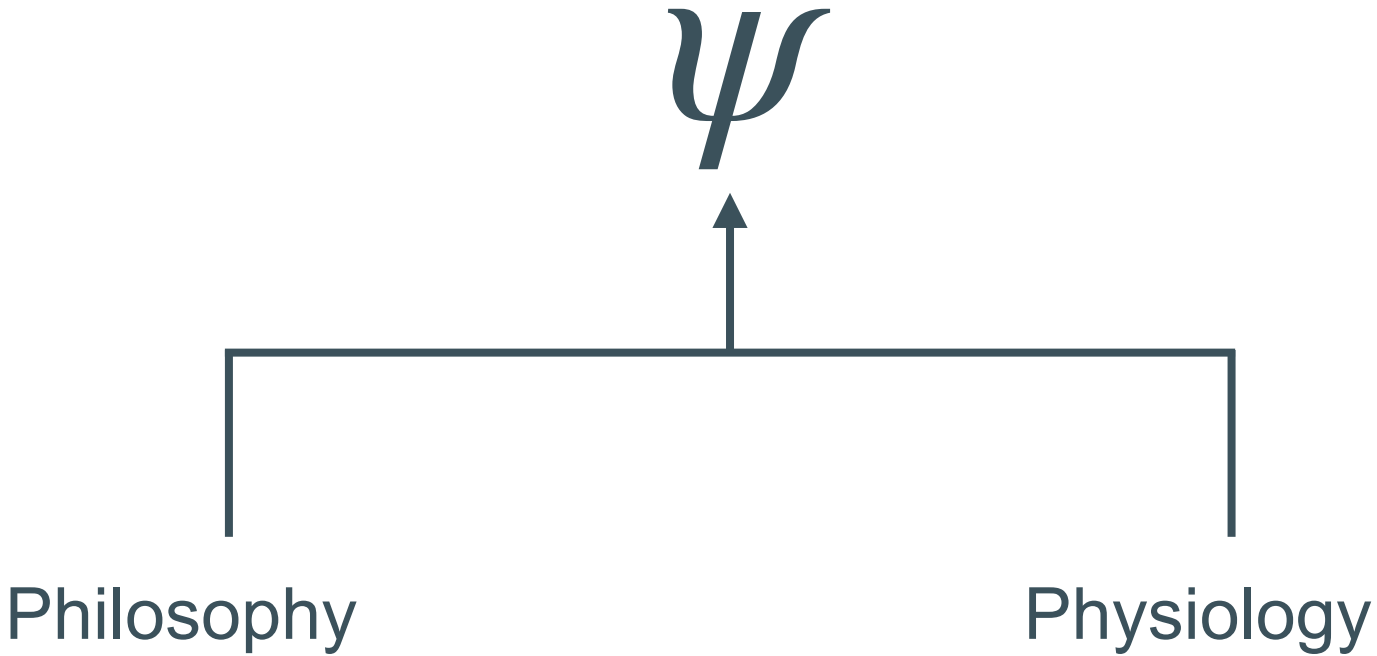
Wissenschaftstheorie & Einführung in das wissenschaftliche Arbeiten

Kurze Geschichte der Psychologie I: Grundlagen der experimentalen und differentiellen Psychologie

Dr. Blazej Baczkowski (Błażej Bączkowski)

Roots…

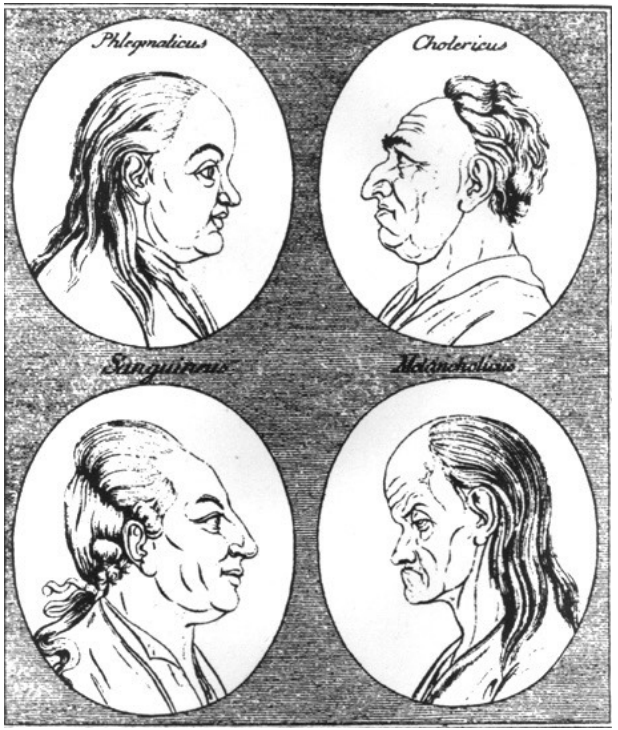


The questions asked by ancient philosophers…

- Are body and mind one or two different entities?
- Do we have (immortal) souls? Where is it located?
- How are body and spirit connected? Is the spirit part of the soul?
- How does perception work?
- How do we obtain true knowledge? Pure logic or observations of our surroundings?
- Do thoughts determine emotions or the other way around?

Die Temperamentenlehre — erstes Persönlichkeitsmodell

- Begründer der Medizin als eigene Wissenschaft
- (Psychische) Krankheiten entstammen nicht Dämonen oder Gottes Strafe, sondern sind natürlichen Ursprungs
- Vier-Säfte-Lehre (Übernahm Elemenentlehre von Empedokles): alles Krankheiten entstehen aus Ungleichgewicht von Blut (=Feuer), Schleim / Phlegma (=Wasser), gelber Galle (=Luft), und schwarzer Galle (=Erde)
- vier Persönlichkeitsstrukturen bzw. Temperamente „Sanguiniker“, „Phlegmatiker“, „Melancholiker“ und „Choleriker“ aus den griechischen Wörtern für diese vier Körperflüssigkeiten



Where do our beliefs come from?
— origin of the nature vs nurture debate

Plato (c. 428 - 348 v. Chr.)

universal Forms descends to knowledge of particular imitations (anamnesis; dualism)

Aristotle (384 - 322 v. Chr.)

things that exist or happen in the world, give rise to knowledge of the universal (monism)

Raffael (1510). Die Schule von Athen

Where do our beliefs come from? — ideae innatae

- we are born with some (not all) beliefs and ideas; we know that they are true but we do not learn about them from experience; they are considered true for all human beings (for example, Plato and Descartes considered the knowledge of God as innate)
- “innate” usually means “disposition” (innate structure) to develop certain ideas or beliefs (consider today’s “universal grammar” by Noam Chomsky)
- nativism is a modern view that some dispositions are genetically inherited (e.g., innate fears)

René Descartes (1596 - 1650)

Where do our beliefs come from? — tabula rasa

- we develop ideas and beliefs through experience
  - sense perception (external)
  - introspection (internal)
- Locke: the ability to reason is innate but the content (material) has its source in experience
- Hume: perceptions are divided into:
  - impressions (based in experience)
  - ideas (built through associations from impressions)

John Locke (1632 - 1704)

David Hume (1711 - 1776)

Psychology — a young science

die Psychologie habe “eine lange Vergangenheit, aber nur eine kurze Geschichte” (Ebbinghaus, 1908)

Vorgeschichte

als Wissenschaft

1. Experimentalpsychologisches Labor (1879) Universität Leipzig

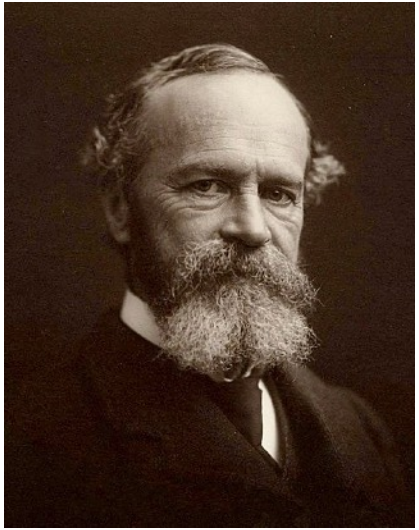
Die ersten Psychologen
— Wilhelm Wundt (structuralism, mental causality, psychophysical parallelism)

- Vater der experimentellen Psychologie als eigenständige Wissenschaft (“Principles of Physiological Psychology” / “Grundzüge der physiologischen Psychologie” in 1874)
- Gründung des ersten Labors für Psychologie an der Philosophischen Fakultät in Leipzig (gab damals keine eigenen Lehrstühle für „Psychologie“)
- Bildete selbst einige der wichtigsten Psychologen der nächsten Jahrzehnte in Deutschland und den USA aus
- repräsentiert den Umbruch zu einer methodisch sauberen Herangehensweise in der Psychologie
    - Seelenleben besteht aus simplen „Elementen“
    - Systematische Introspektion einfacher Wahrnehmungen
    - Aufzeichnung der sichtbaren Reaktion der Versuchsperson und deren subjektiven Berichten

Wilhelm Wundt (1832 - 1920)

Die ersten Psychologen
— William James (functionalism, pragmatism, neutral monism)

- Vater der amerikanischen Psychologie (“The Principles of Psychology” in 1890)
- Begründer der funktionellen Psychologie
- begründete die philosophische Schule des Pragmatismus
- entwickelte die philosophische Perspektive, die als radikaler Empirismus bekannt ist.
- Emotionen lösen nicht körperliche Reaktionen aus, sondern die Wahrnehmung der körperlichen Veränderung führt zum Emotionserleben (James-Lange-Theorie)



William James (1842 - 1910)

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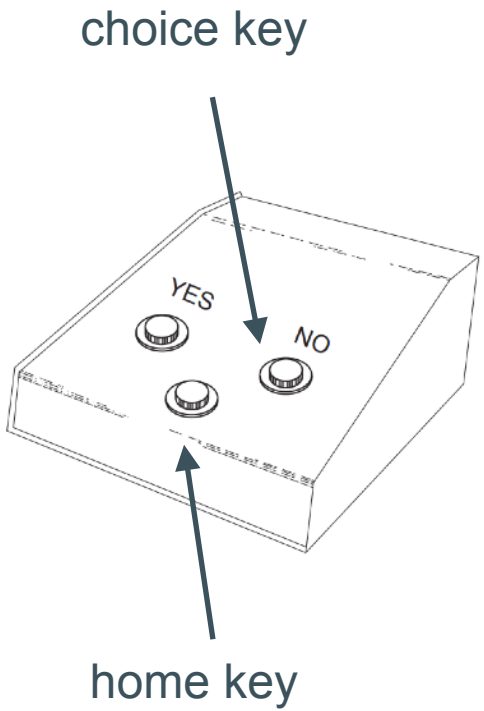
Grundlagen der experimentalen Psychologie

Basic terminology (I)

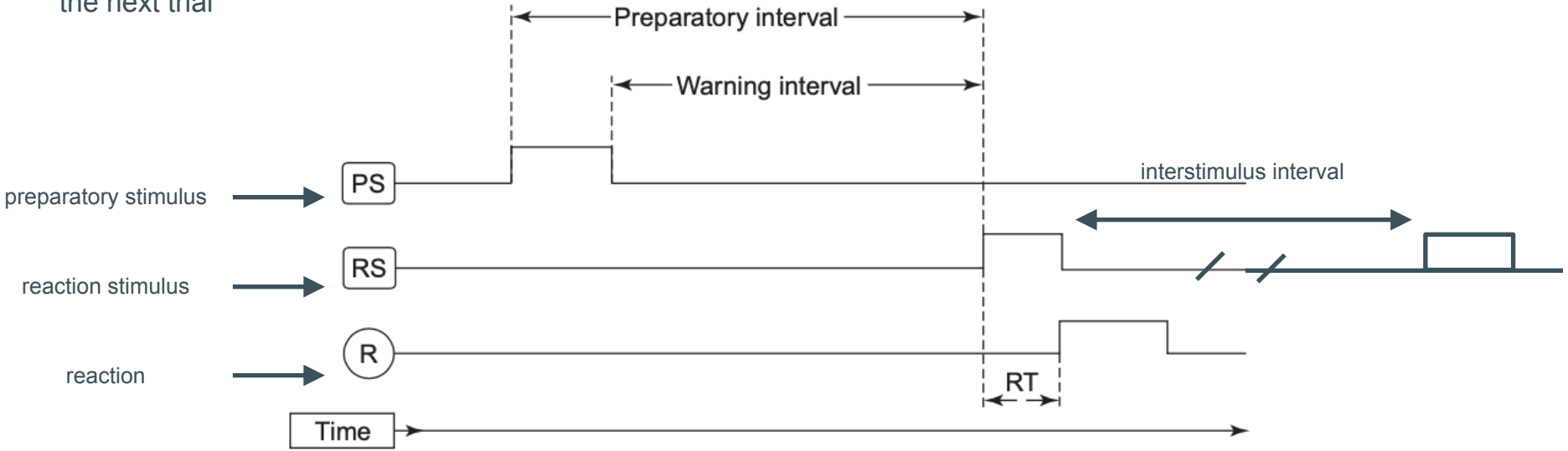
- Person (P) / Subject — the individual being tested
- Experimenter — the individual who administers the test
- Elementary Cognitive Task (ECT) — any task where there is a specified ‘successful’ (‘correct’) outcome which are to be attained through a relatively small number of mental processes
- Stimulus (S) / Signal — a change (on / off) in some stimulus condition (light, sound, etc) detectable by a sensory receptor
- Reaction Stimulus (RS) — a designed S to which P is instructed to react in some specified way (e.g., a light going on)
- Preparatory Stimulus (PS) — S occurring prior to RS intended as a ready signal / cue to alert P of the impending RS
- Reaction — a detectable movement, physical change, or action by P (e.g., pressing a key) occasioned by the occurrence of RS
- Trial — basic unit of ECT; a single sequence of RS and PS followed by R
- Paradigm — in experimental psychology, the particular arrangement of the S and R elements of the test, the procedural requirements for performing the task, the particular time intervals



Jensen, A. (2006). Clocking the mind: Mental chronometry and individual differences. Elsevier, the Netherlands

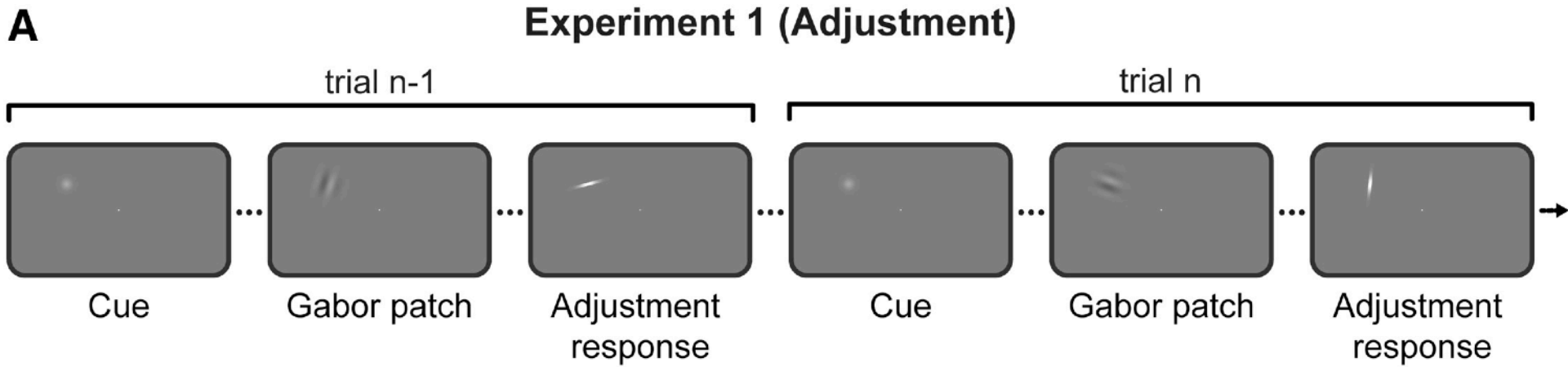
Basic terminology (II)

- Preparatory interval (PI) — the interval occurring between the onsets of the PS and the RS
- Warning interval (WI) — the interval between the termination of PI and the onset of RS
- Reaction Time (RT) — the elapsed time between RS and R when P has been made aware that this is a timed response, which should be made quickly but accurately
- Interstimulus interval (ISI) — the time interval between the onset of the RS on a given trial and the onset of the RS on the next trial



Jensen, A. (2006). Clocking the mind: Mental chronometry and individual differences. Elsevier, the Netherlands

Example



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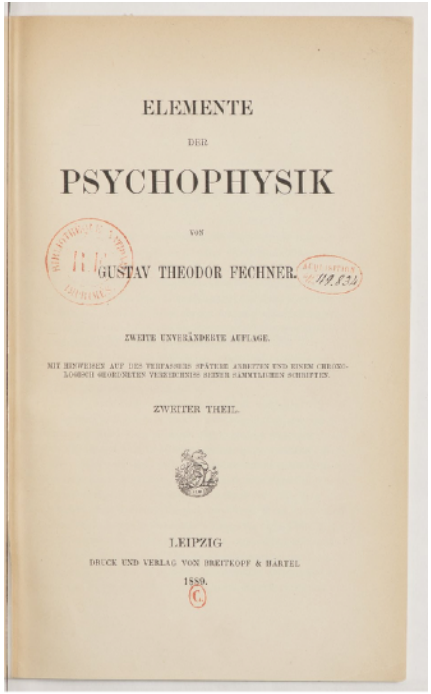
Psychophysik

Psychophysics
— how matter translates into mind (1860)

“Unter Psychophysik soll hier eine exakte Lehre von den funktionellen oder Abhängigkeitsbeziehungen zwischen Körper und Seele, allgemeiner zwischen körperlicher und geistiger, physischer und psychischer, Welt verstanden werden.”


ELEMENTE

DER

PSYCHOPHYSIK

VON

GUSTAV THEODOR FECHNER.

ZWEITE UNVERÄNDERTE AUFLAGE.

ZWEITER THEIL.

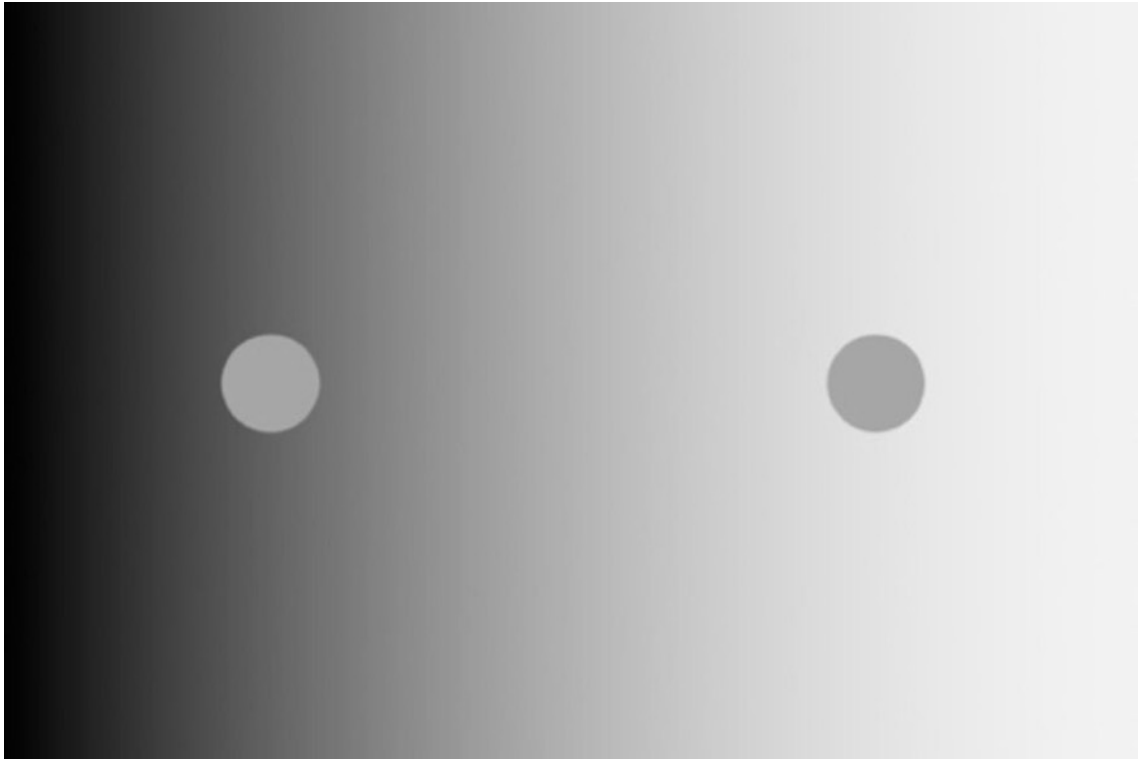
LEIPZIG

DRUCK UND VERLAG VON BREITKOPF & HÄRTEL

1889.

Gustav Fechner (1801 — 1887)

Psychophysics
— functional relationship between the physical stimulus and its sensation



Trichromatic theory (Young-Helmholtz) — all colours can be synthesised from three primary colours

Die drei Grundfarben

einen schwach die anderen stark. Denken wir uns in *Fig. 119* in horizontaler Richtung die Spectralfarben in ihrer natürlichen Reihenfolge aufgetragen, anfangend von Roth *R* bis zum Violett *V*, so können die drei Curven etwa die Erregungsstärke der drei Arten von Fasern darstellen, No. 1 die der rothempfindenden, No. 2 der grünempfindenden, No. 3 der violettempfindenden.

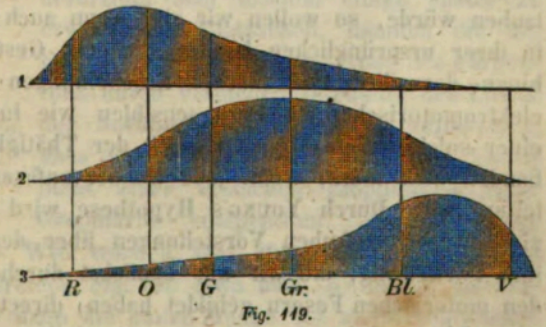


Fig. 119.

Helmholtz (1867). Handbuch der Physiologischen Optik

VISUAL PIGMENTS OF RODS AND CONES IN A HUMAN RETINA

By J. K. BOWMAKER* and H. J. A. DARTNALL†
From the M.R.C. Vision Unit, University of Sussex, Falmer, Brighton, BN1 9QG, Sussex

(*Received 9 March 1979*)

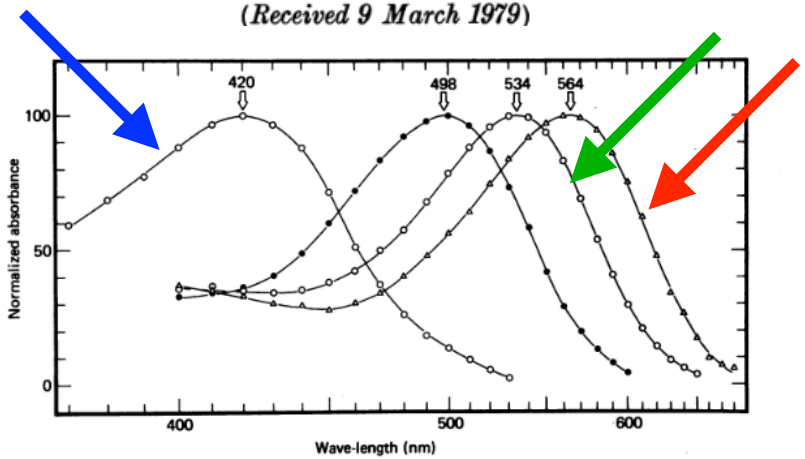


Fig. 2. The mean absorbance spectra of outer segments of the four classes of human photoreceptors. Curves labelled as follows: '498', mean of eleven rods; '420', mean of three blue-sensitive cones; '534', mean of eleven green-sensitive cones; '564', mean of nineteen red-sensitive cones.

Just-noticeable difference (JND)
— kleinste bemerkbare Unterschiede in allen Sinnesmodalitäten

Weber’s Gesetz

$$\frac{\Delta R}{R} = k$$

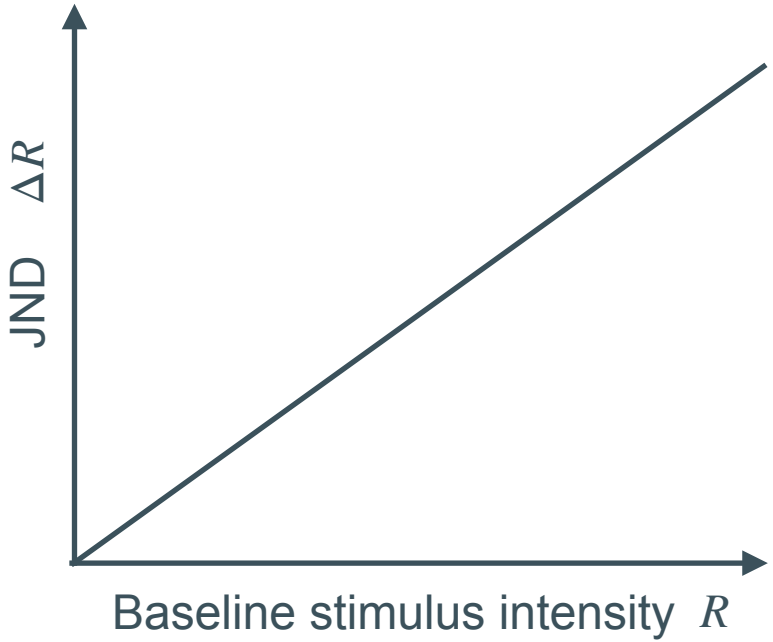
R Starke eines Reizes
ΔR Differenz
k konstante eines Sinnessystems

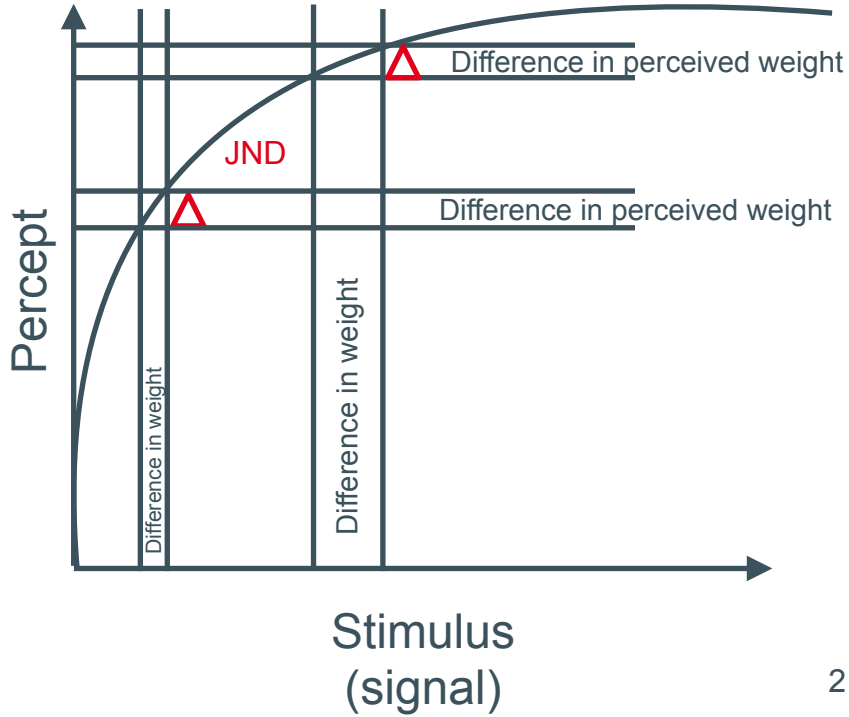
$$\frac{\Delta R}{R + a} = k$$

zB.
2% für Gewichtwahrnehmung auf Haut
1-2% für Helligkeitsunterschiede
10-20% für Geschmacksunterschiede

Ernst Weber (1795 — 1878)

Weber-Fechner Gesetz — logarithmic encoding





What is the minimum detectable amount of light?

ENERGY, QUANTA, AND VISION*

BY SELIG HECHT, SIMON SHLAER, AND MAURICE HENRI PIRENNE‡

(*From the Laboratory of Biophysics, Columbia University, New York*)

(Received for publication, March 30, 1942)

"(…) in order for us to see, it is necessary for only 1 quantum of light to be absorbed by each of 5 to 14 retinal rods."

Two-interval-forced-choice (2IFC) detection paradigm

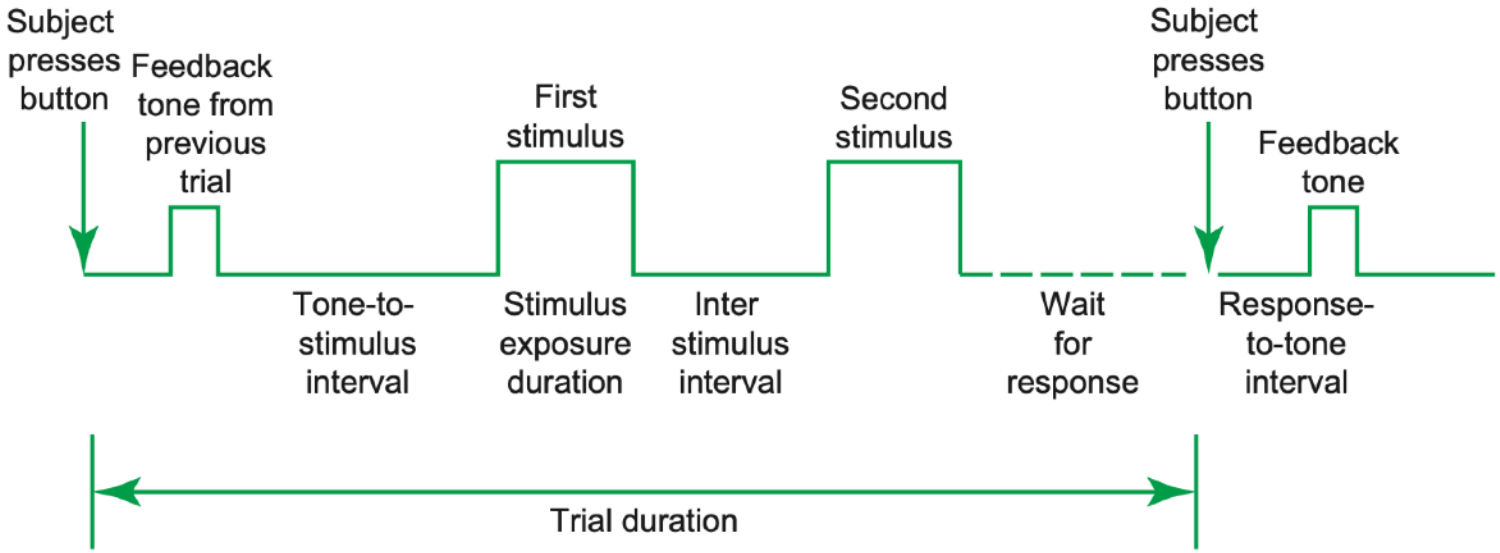
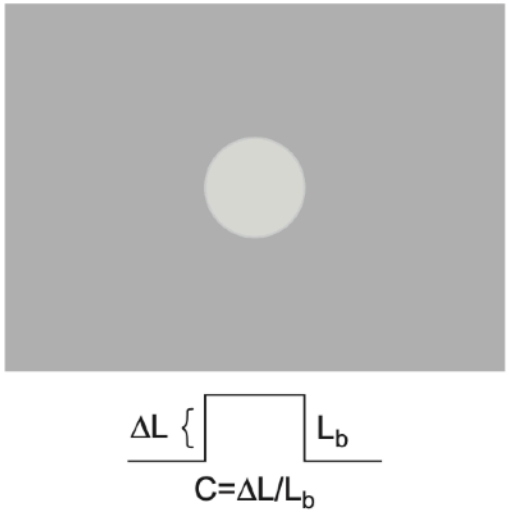
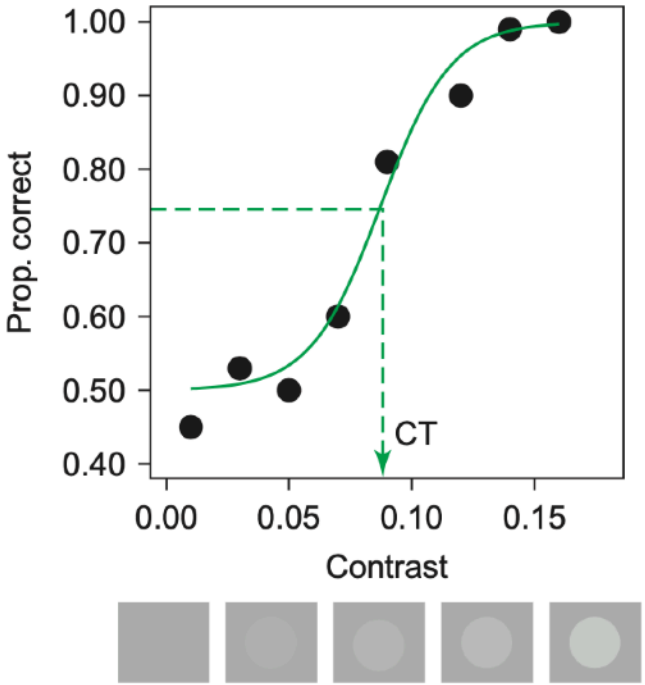


FIGURE 3.5 Example timing of stimulus presentation during a typical 2IFC trial.

Psychometric function





Kingdom & Prins (2010). Psychophysics. A practical introduction. Elsevier.

Psycho-physiology as a precursor of psychology…

The achievements of psycho-physiology had made an enormous impression and had shown that psychological phenomena:

- can be empirically investigated and
- can be formulated mathematically.

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Mentale Chronometrie

Mentale Chronometrie
— the speed of mental processes (1868)

OVER DE SNELHEID VAN PSYCHISCHE PROCESSEN,

DOOR

F. C. DONDERS.

Terwijl de wijsbegeerte zich in het afgetrokkene bezig houdt met de beschouwing der psychische verschijnselen, heeft de physiologie, beschikkende over de resultaten der wijsbegeerte, het verband tusschen die verschijnselen en de werking der hersenen te onderzoeken. Op morphologisch gebied springt dat verband terstond in het oog. Tegenover de bekende feiten van vergelijkende anatomie en anthropologie, is elke twijfel omtrent het bestaan van zoodanig verband onhoudbaar. Maar de physiologie kan zich met dat algemeene resultaat niet tevreden stellen. In combinatie met de stoornissen, bij ziekelijke veranderingen waargenomen, tracht zij door het experiment de onderscheidene psychische faculteiten zoo veel mogelijk te localiseeren, en vooral den aard der werking, die de psychische verschijnselen vergezelt, op het spoor te komen. Met het onderzoek van den fijneren bouw der hersenen verbindt zij daarom dat van de scheikundige samenstelling en van de omzetting harer bestanddeelen. Zij constateert, dat bij bloedverlies of onderdrukte hartswerking het bewustzijn verloren gaat, zij leert daaruit, dat regelmatige toevoer van bloed een voorwaarde is voor

Frans Cornelis Donders (1818 - 1889)

Breakthrough in nerve physiology

- mind is beyond the reach of empirical science
- even if the expression of mind is mediated by physical structures,
  its properties could never be measured because nerve conduction has infinite velocity

Immanuel Kant (1724 — 1804)

- nerve conduction velocity was measured first in bullfrogs
- leg's muscle and its attached nerve were isolated
- the nerve is stimulated by an electrode at various distances from its attachment to the muscle
- the resulting muscle twitch is recorded
- the velocity was between 25.0 and 42.9 m /s

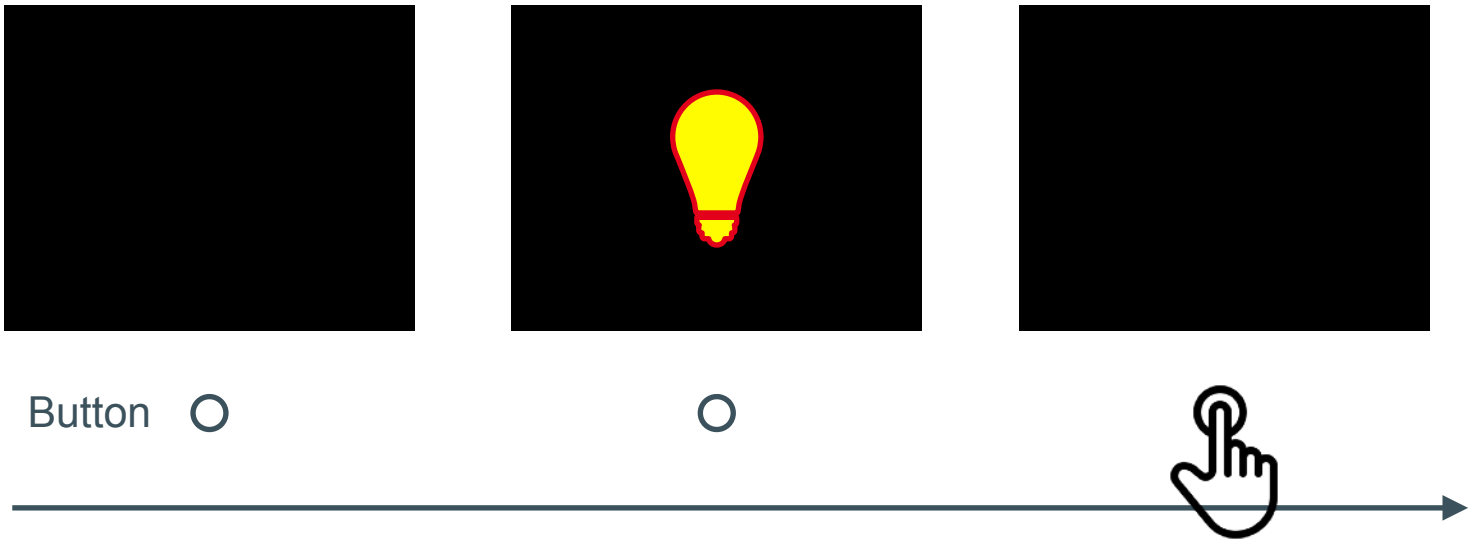
Hermann von Helmholtz (1821 — 1894)

The revolutionary idea — insertion and subtraction method

“The idea occurred to me to interpose into the process of the physiological time some new components of mental action. If I investigated how much this would lengthen the physiological time, this would, I judged, reveal the time required for the interposed term.” (Donders, 1868/1969, p. 418)

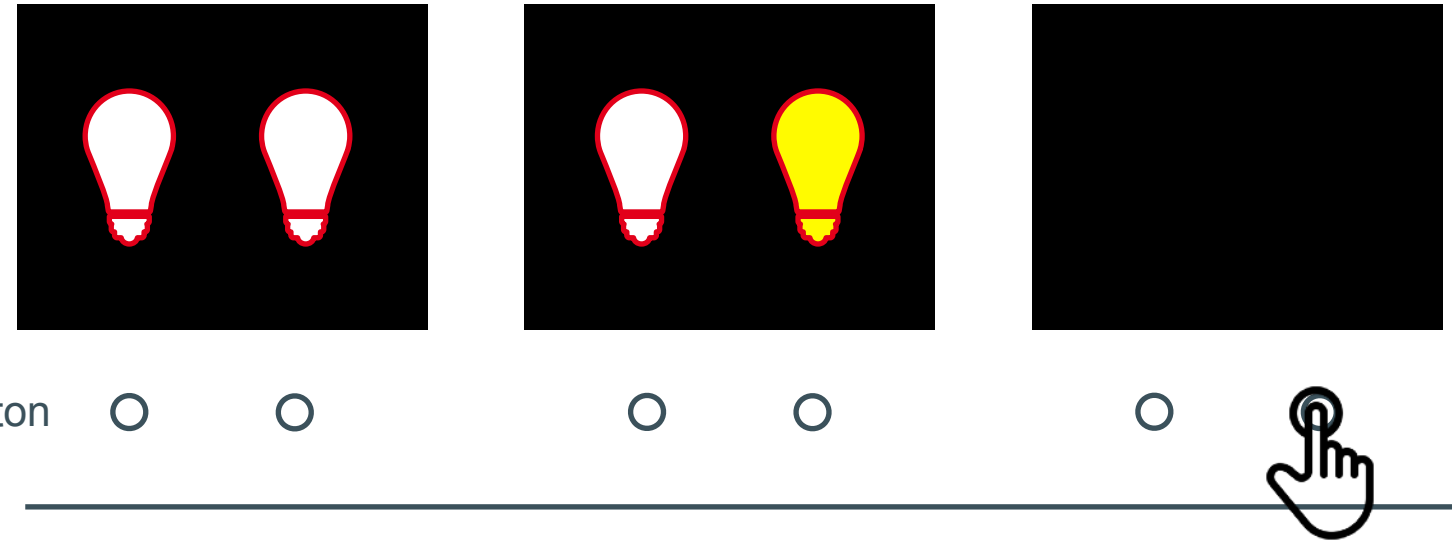
Donders' RT paradigms
— simple RT task (stimulus detection)

Press the button as soon as possible when the lamp is on



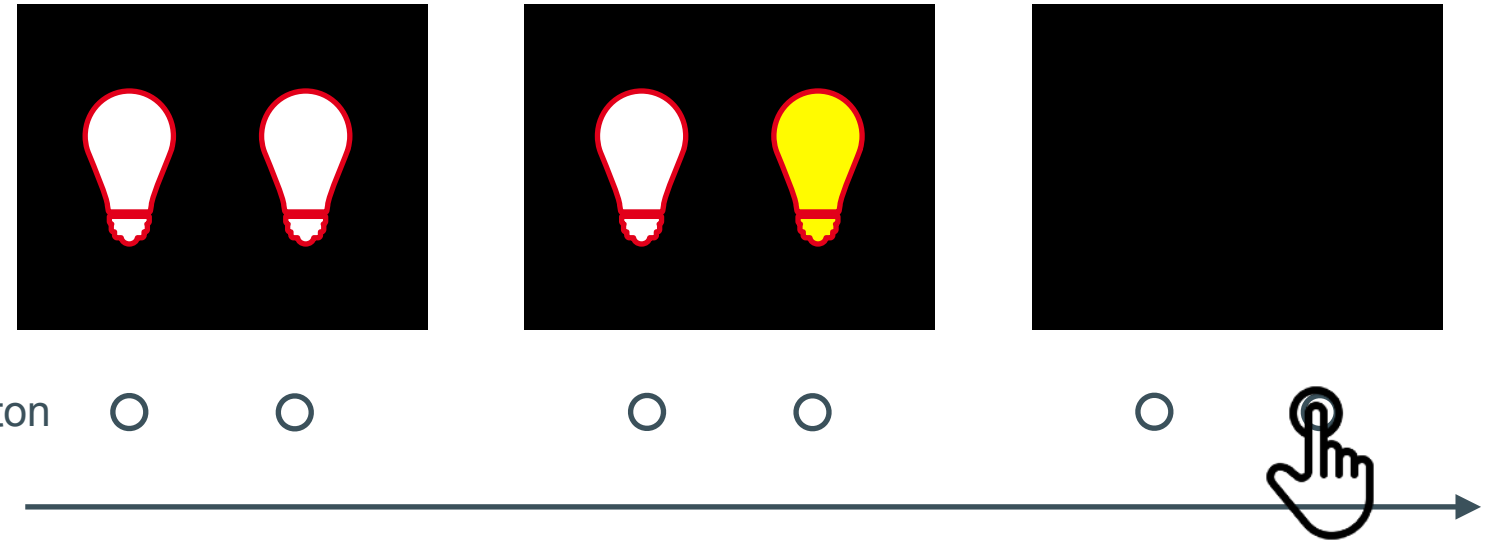
Donders' RT paradigms — choice RT task

Press the left button when the left lamp is on;
press the right button when the right lamp is on



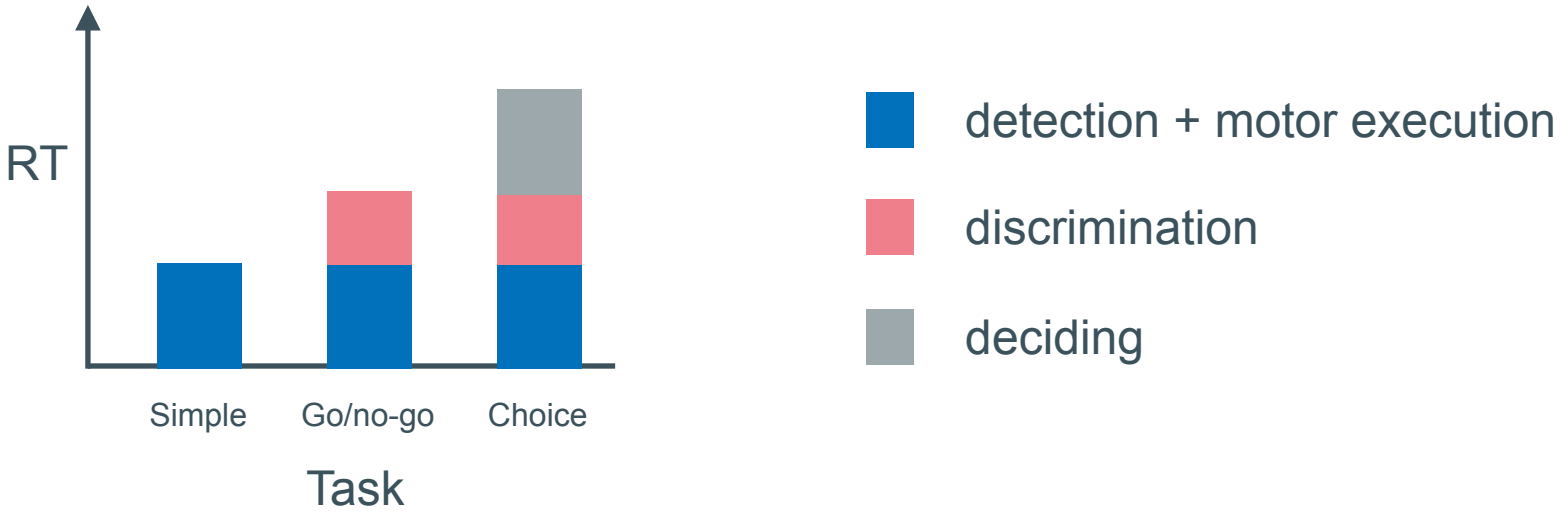
Donders' RT paradigms — go / no-go RT task

Press the right button when the right lamp is on;
Do not respond when the left lamp is on

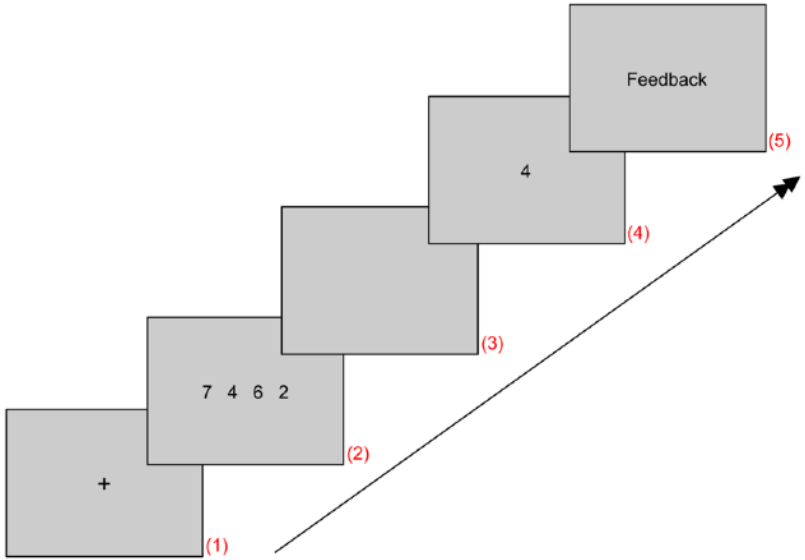


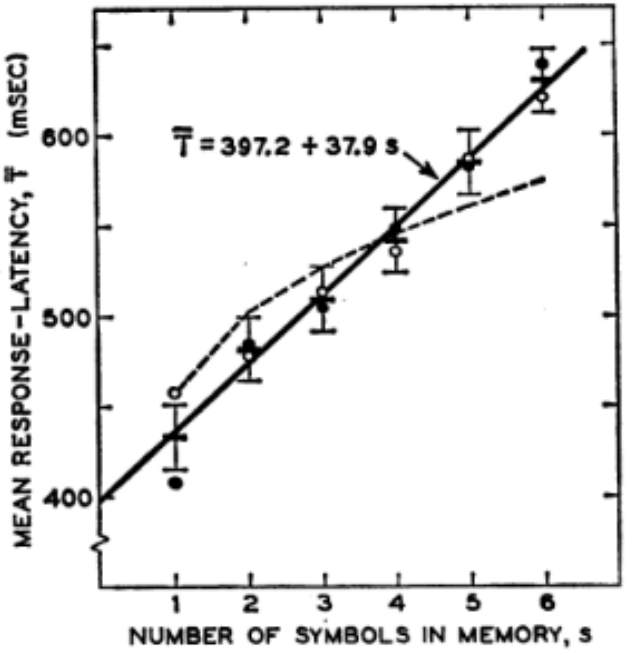
The insertion and subtraction method

Simple task: detection + motor execution
Go/no-go task: detection + discrimination + motor execution
Choice task: detection + discrimination + deciding + motor execution



The Sternberg Short-Term Memory Scanning Paradigm





Sternberg, S. (1966). High-speed scanning in human memory. *Science*, *153*, 652-654. doi: 10.1126/science.153.3736.652

Objections
— the fallacy of pure insertion

- assumption: insertion does not affect the other components, and therefore it is additive
- additional components may interact

Mental chronometry as a precursor of cognitive psychology…

The three types of reaction time tasks by Donders could be seen as the birth of cognitive psychology — inferring mental functions from behaviour.

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Psychometrie

“The two disciplines of scientific psychology” — Lee Cronabach’s presidential address to the APA (1957)

Response (R)
Stimulus (S)
Organism (O)

Experimental
— variation among treatments

$R = f(S)$

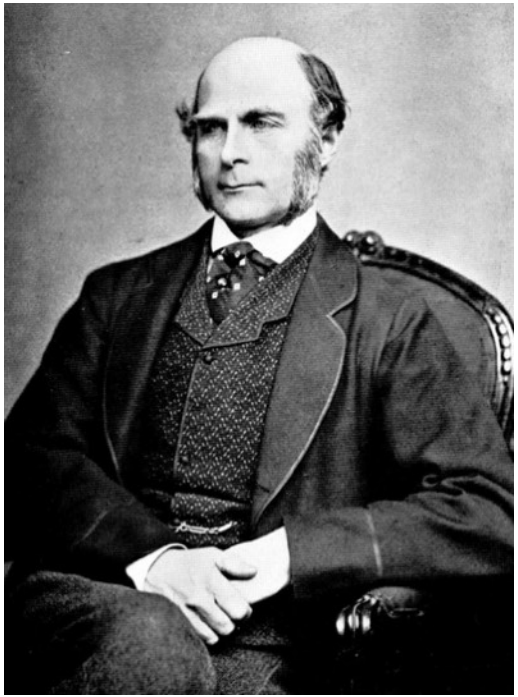
Differential (correlational)
— variation among organisms

$R = f(S \& O)$

functional relationship applicable in a lawful manner to all human beings

Intelligenzmessung (RT)

- Cousin von Charles Darwin
- Pionier der Erforschung individueller Differenzen (v.a. Intelligenz)
- Intelligenz als Ergebnis natürlicher Selektion
  - sensory discrimination
  - quickness of response
- individuelle Unterschiede in einem Merkmal unterliegen der natürlichen Selektion



Francis Galton (1822 - 1911)

Intelligenzmessung (IQ test)

- Von der franz. Regierung beauftragt, standardisierte Schuleignungstests an Kindern durchzuführen
- Entwickelte einen Test zur Intelligenzmessung bei Kindern auf Grundlage von geistigen Fähigkeiten (Gedächtnis, Assoziationstests etc.)
- Vergleich der Ergebnisse in verschiedenen Gruppen von Kindern
  - William Stern's ratio (Intelligenzquotient)

$$IQ = \frac{Intelligenzalter}{Lebensalter}$$

Alfred Binet (1857 - 1911)

From unobservable phenomena to observable data

Schlüsselwörter

- Die Temperamentenlehre (Hippokrates, Galen)
- “nature vs nurture”
- Rationalismus (rationalism), Empirismus (empiricism), Nativismus (nativism), “tabula rasa”, “ideae innantae”
- Strukturalismus (structuralism, Wundt), psychische Kausalität (mental causality, Wundt), Psychophysischer Parallelismus (psychophysical parallelism, Wundt), Introspektion (introspection, Wundt)
- Funktionalismus (functionalism, James), Pragmatismus (pragmatism, James), Neutraler Monismus (neutral monism, James)
- Psychophysik (psychophysics), Weber-Fechner-Gesetz (Fechner-Weber’s law), die differentielle Wahrnehmbarkeitsschwelle (just-noticeable difference)
- Two-interval-forced-choice (2IFC) detection paradigm (psychophysics), psychometrische Funktion (psychometric function)
- mentale Chronometrie (mental chronometry), Reaktionszeit (reaction time), Insertion / Subtraktion (insertion / subtraction method, Donders), Donders’ tasks: simple task, choice task, go / no-go task
- differentielle und experimentelle Psychologie (differential and experimental psychology)
- Psychometrie (psychometrics), Intelligence quotient (IQ score)

Ergänzende Literatur / Quellenmaterial

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