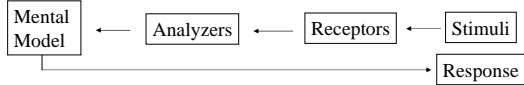


7a. Interactivity

Knock and a door will open

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Perceptual processing recap



```

    graph LR
      Stimuli --> Receptors
      Receptors --> Analyzers
      Analyzers --> MentalModel[Mental Model]
      MentalModel --> Response
  
```

- Perception increases information abstraction
- A one-way, “*stimulus causes response*” process
- What is *wrong* with this picture?
 - It is *passive we are active*
 - What if response changes stimulus? (this lesson)
 - How to know what to abstract? (Learning - next lesson)

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Interactivity

- Stimuli cause responses but responses also cause stimuli! e.g.
 - direction body faces
 - how head is turned
 - where eye is directed
 - focal length of the lens
- In interactivity, two entities both “cause” each other
 - e.g. a conversation
 - We change the world, the world changes us

All determine what stimuli appear on the retina

Both are causes and both are effects

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The web and interactivity

- We view a web page because we clicked a link by *choice*
- We stay at a web page *by choice*, as browsers have a BACK button
- Hypertext links give web movement choices in a document context (better than a menu!)
- The web has interactivity between people and programs
- In human-computer interaction, *control is shared*

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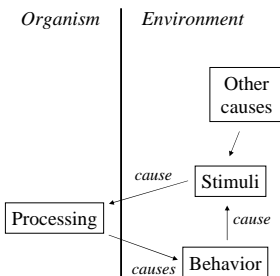
Application

- Interactivity questions
 - What can the user *do*?
 - What user *choices* are offered?
 - How does the program *respond* to user choices?
 - Is the user “in control” or dominated?
 - Are they patronized like a child?
 - How long does a program “talk” before letting users do something?
- In HCI, what counts is not what the program does but what the user does

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Feedback loops

- Stimulus-behavior, a *causal feedback loop*
- An *open loop* (other causes can affect it)
- Such loops are the base of biological *learning*



```

    graph TD
      subgraph Organism
        Processing
      end
      subgraph Environment
        OtherCauses[Other causes]
        Stimuli
        Behavior
      end
      OtherCauses --> Stimuli
      Stimuli -- cause --> Processing
      Processing -- causes --> Behavior
      Behavior -- cause --> Stimuli
  
```

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Feedback loops & learning

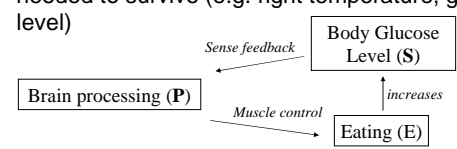
- Mental models simulate *causal relations* between sensations
 - Bump a glass and see it fall and break
- See a behavior (cause) a sensation (result)
- We learn to connect sensory information, as A “causes” B
- The FB loop *rate* affects this learning (next lesson)

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Link: [Homeostasis](#)

Homeostasis

- **Homeostasis**, the *maintenance of an equilibrium state*. is a basic necessity of life systems
- *Feedback loops* allow homeostasis - stable states needed to survive (e.g. right temperature, glucose level)



```

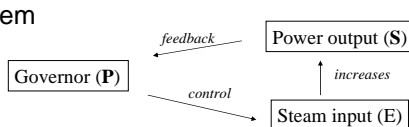
    graph TD
      P[Brain processing (P)] -- "Muscle control" --> E[Eating (E)]
      E -- "increases" --> S[Body Glucose Level (S)]
      S -- "Sense feedback" --> P
    
```

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Link: [Cybernetics](#)

Example - Watt's governor

- *Problem*: Modern machines can generate so much power they destroy themselves
- *Solution*: Let output power level negatively control (govern) the input causing the power
- *Result*: This feedback loop gives a stable system



```

    graph TD
      P[Governor (P)] -- "control" --> E[Steam input (E)]
      E -- "increases" --> S[Power output (S)]
      S -- "feedback" --> P
    
```

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Link: [Cybernetics](#)

Cybernetics

- “A method of controlling the system by reinserting into it the results of its past performance” (Wiener)
- Allows *self-regulating systems* - systems that steer (navigate) themselves (eg web “agents”)
- Examples:
 - Hungry rats search for food until satisfied
 - Machines search for a power point to recharge
 - Web bots search for information until satisfied

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What causes what?

- If output causes input and input causes output, what causes what?
- One-way causality can't handle feedback loops
- A new *dynamic system* explanation is needed
 - The FB loop performs according to its desired end state

This “goal” defines the system and “causes” its activity.
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Link: [Purpose](#)

Teleology

- Once, explaining human behavior via goals was called reverse causality:
 - People go to restaurants because they want to eat
 - The heating system runs because “it wants” to get the temperature to 70°
- Such *teleological* explanations were rejected as using a *future state* (goal) to explain *present* one
- In *cybernetics*, such explanations are meaningful, as goals built into the system at *the beginning*
 - e.g. set a desired temperature before a central heating system starts

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Feedback loop components

- A closed feedback loop has three components:
 - *Sensor(s)* - report state (e.g. thermometer)
 - *Effector(s)* - change state (e.g. heating unit)
 - *Processing* – stores the system’s knowledge, relating sensor readings and effector actions
- Heating systems are *closed*, as they only respond to internal state changes
- cf animals have *internal* and *external* sensors

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Feedback loops

- A FB loop has:
 - *Sensors*: measure state changes (temperature)
 - *Processing*: Has *parameters* of desired temperature state and *knowledge* that heat raises temperature
 - *Effectors*: Mechanism to create heat
- A *control process* matches *sensed state* (room temperature) to *desired state* (desired temperature) to operate an *effector* (heater) according to inbuilt *knowledge*

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Biological vs mechanical loops

<p>Mechanical:</p> <ul style="list-style-type: none"> – One input (temperature) – One output (to heat) – One desired state (temperature level) – One central controller – Closed loop (affected by itself) – Knowledge <i>hard-wired</i> or <i>pre-programmed</i> 	<p>Biological:</p> <ul style="list-style-type: none"> – Many inputs (senses) – Many outputs (muscles) – Many desired states (warm, fed, no pain ..) – Many control processes – Open loops (affected by outside itself) – Knowledge <i>genetic</i> and <i>acquired (learned)</i>
--	--

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Biological feedback loops

- A biological feedback loop has :
 - **External senses** register the environment, e.g. see food or prey
 - **Internal states** have built in parameters, e.g. blood glucose level causes the need/drive hunger
 - **Effectors**: Muscle actions change environment, e.g. to attack prey
 - **Processing**: Brain must know what acts change the environment to improve internal states

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Operation requirements

- As a feedback loop cycles:
 - *The environment* changes, e.g. a tornado
 - *Effectors* change, e. g. we get stronger
 - *Desired states* change, e.g. what we want
 - *Control processes* change
 - *What sense input* predicts environment change?
 - *What internal states* can the environment satisfy?
 - *What effector acts* change the environment?
- All control process changes are *knowledge* due to *learning*

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Web searches as FB loops

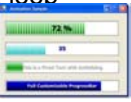
- *Environment*: Selection display list
- *Effector*: Type search text
- *Desired state*: Helps mental model
- *Control process*: Was it useful?



- Search systems help feedback loops if they:
 - *Are visible*: In a common or obvious place
 - *Complete user typing*: Suggest common previous phrases
 - *Give end state choices*: e.g. advanced search tools, or offer common alternatives, like “Beatle” as an insect or a song group
 - *Searches of searches*: To refine a search of many results

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Feedback rate

- *Strongly* affects if a user aborts a loop
- For a FB delay:
 - Give a progress bar - but not a fake 
 - Occupy the user (e.g. informative message of useful knowledge for the next step)
 - Run the action in background and “bell” the user when done
 - Give partial results and ask for more guidance
 - A Mozart web search after 10 minutes gives 1,000,000 hits
 - It comes back after 1 second with 1,000 hits to ask if more are needed

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Initiation - where do loops start?

Link: Anokhin

- A FB loop cycle can be:
 - *Stimulus driven* - driven by environment changes
 - *Action driven* - driven by random actions
 - *Process driven* - driven by purposes, goals or expectations
- Animals are not *passive* to stimuli, they *actively* seek to generate stimuli
- A feedback loop where pre-set processes initiate acts to generate stimuli is *process driven*.

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Application- locus of control

- People like to be the *locus of control* in a feedback loop (e.g. gambling)
- Web site *choices* can be:
 - *Directed* - system requires user responses: use in a clear case with non-expert users, e.g. a bank transaction
 - *Guided* - system suggests responses and warns against others: a complex case if users are sometimes expert, e.g. travel
 - *Free* - system does what the user wants without comment: if a user knows what they want, e.g. web

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Human desires, purposes

- Some goals are genetically “hard-wired” e.g. hunger, sex
- People also *set their own goals* - the human system can change its own operation parameters
- Whether pre-set (genetically) or set at run-time (learning), goals define human behavior
- *We are goal seeking systems in a feedback loop*
- Hence “You are your goals”

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Human goals

- Goals explain behaviors e.g. “to entertain” can be offering food, singing, a joke - all with nothing in common but their purpose
- People can:
 - have goals that conflict
 - change goals over time
 - have goals they have never done (go to moon)
 - have goals that are impossible (find a unicorn)
 - have goals to get other goals (get educated to get a job to get money to get a woman)

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Application - why people visit sites

- Some common web site goals:
 - To get information (wikipedia)
 - To be entertained (music site)
 - To be informed (news)
 - To be sexually aroused (pornography)
 - To talk (chat room)
 - To travel (map site)
 - To belong and follow trends (twitter)
 - To learn or teach (discussion group)
 - To connect to friends (Facebook) etc, etc

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Knowledge

- Some human knowledge is hard-wired (genetic)
 - Sensory knowledge - e.g. redness, boundary, octave
 - Motor knowledge - e.g. babies suck reflex
 - Goal knowledge - e.g. to keep warm
- But all knowledge can't be hardwired *because environments change*
- So feedback systems *learn (develop knowledge)*
 - Of sense input (cognitions)
 - Of motor output (skills)
 - Of needs and desires (emotions)

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Knowledge specialization

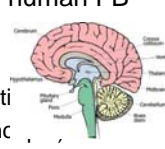
- To *interact* we use:
 - Sensors (senses)
 - Parameters (needs/desires)
 - Effectors (muscles)
 - Processing to link the above
- We “succeed” if we:
 - Have desired vs current state knowledge
 - Register environmental knowledge
 - Know what acts cause what environment effects
 - Choose acts to get our desired state
- The movie “*What women want*” illustrates this

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Three sub-systems

- Three sub-systems *manage* the human FB loop:
 - Motor control** (actions/skills)
 - State management** (needs/emoti
 - Sensory analysis** (perceptio
- The neural systems are:
 - Spine
 - Psychomotor (cerebellum) – Heart
 - Affective (limbic) – Head
 - Cognitive (cortex)
- These sub-systems are *human interaction*



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How our brains share control

- A feedback loop can controlled in three ways:
 - *Intellectual control* – knows *how* things work, by theory knowledge, but not what we want or how to get it
 - *Motor control* - knows *what* works, by tacit knowledge, but not what we want or why it works
 - *Emotional control* - knows *what* we want, by experiential knowledge, but not how to get it or why we want it
- Specialist:
 - *intellectuals* theorize but can't practice or feel
 - *artists* feel but can't effect or understand
 - *leaders* effect but can't understand or feel
- A *balanced* approach evolves all three knowledge types

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Homework – To Read

- Homeostasis
 - <http://www.answers.com/topic/homeostasis>
- Cybernetics
 - <http://www.answers.com/topic/cybernetics>
 - <http://en.wikipedia.org/wiki/Cybernetics>
- Purpose
 - <http://www.answers.com/topic/purpose>
 - <http://en.wikipedia.org/wiki/Purpose>
- Anokhin
 - <http://en.wikipedia.org/wiki/Anokhin>

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Next:

- The motor and emotional sub-systems

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