COMP140: Creative Computing Hacking

Psychology of Game Interactions

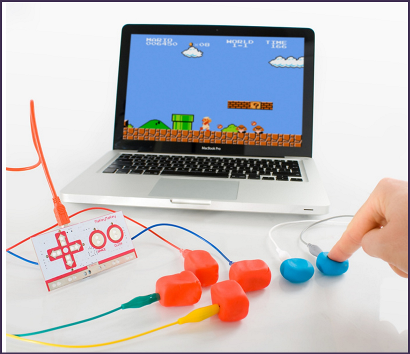
Lecture Objectives

Today's lecture will build upon HCI as both a discipline of study and a discipline of design to address:

- A well-known **theory** about cognition from the area of human-computer interaction.
- **How to apply** the theory to the design of user interfaces for games.

This will be followed up by a sprint review in which you will demonstrate your work-in-progress to your tutor.

Important Notice



Remember to bring your *Makey Makey* kit and associated materials to these lectures for practical support toward the end of each of these sessions.

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Cognition and Information Processing

Learning Outcomes

In this section you will learn how to...

- **Explain** what is meant by `cognition'
- **Show** the importance of information processing models to HCI
- **Explain** the shortcomings of cognitive and information processing models
- **Discuss** the role of cognitive models in games, and HCI more broadly

Further Reading

- Eysenck, M.W. and Keane, M.T. (2000) *Cognitive Psychology: A Student's Handbook*. 4th Edition. Erlbaum Associatates.
- Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S., and Carey, T. (1994) *Human-Computer Interaction*. Addison-Wesley.

What is Cognition?

- The cognitive approach is currently the dominant framework (or paradigm) for HCI (Perry, 2006).
- Players are characterised as ‘information processors’, in which information undergoes a series of ordered processes in the player’s mind.
- This worldview draws a comparison between the human brain and a computer; we can therefore model player activity in the same way that we model computer processing.

Socrative `JBYPC3BBY`

- In pairs.
- Quietly discuss what you think is meant by the term ‘cognition’ for 2-minutes.
- **Explain** cognition in your own words.

What is Cognition?

- Cognition itself refers to the `processes by which we gain knowledge' (Perry, 2006, p. 8).
- This includes understanding, remembering, reasoning, attending to, awareness and acquiring skills.

What is Cognition?

In a simple model of cognition, such as that proposed by Barber (1988), the process of cognition can be described as composing four sequential stages:

- Information entering the system as **input** is first encoded and turned from a physical environment event (i.e., pixels on the screen) into a **mental representation** held electrochemically in the brain.
- This encoded information is then compared to existing repesentations stored in memory.

What is Cognition?

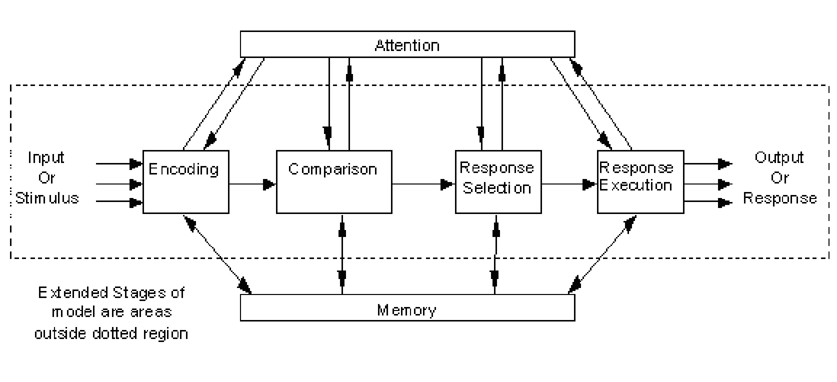
In a simple model of cognition, such as that proposed by Barber (1988), the process of cognition can be described as composing four sequential stages:

- Having compared the representation to the information represented in the memory, the information processor can select an appropriate response.

- The final stage involves the execution of the selected response.

What is Cognition?

In a simple model of cognition, such as that proposed by Barber (1988), the process of cognition can be described as composing four sequential stages:



Socrative `JBYPC3BBY`

- In pairs.
- Quietly revisit what is meant by the term `cognition' for 2-minutes.
- **Explain** cognition in your own words.

Cognitve Models in HCI

- It is important to note that cognitive activity is often conceptualised as being 'goal orientated'
- This means there is an intended and planned result for the processing.
- Or, in other words, 'means end analysis' — determining the difference between the current-state and the goal-state (e.g. interpret current position and move towards a power-up, in order to collect it)

Cognitive Models in HCI

Newman and Lamming (1995) somewhat controversially called moelling human behaviour in this manner `human virtual machines', drawing from the term `virtual machine', which is a description of an abstract system.

Cognitive Models in HCI

However, as previously illustrated, they have much utility:

- Understand information requirements needed to identify and progress toward a goal
- Optimise representations that are easy for people to encode and compare (e.g. health bar vs absolute number);
- Make predictions which can be used to test the efficacy of a design
- and so on...

Cognitive Models in HCI

Or more generally:

- Understand what is going on when users use systems
- Predict in advance how users will behave
- Identify and explain the nature of problems that users encounter
- Provide knowledge about what users can and can't be expected to do
- Design systems to take advantage of partucular aspects of user skills and abilities

Cognitive Models in HCI

There are, however, several drawbacks:

- An idealised information processing unit is assumed — people are not so ideal
- Individual and ephemeral factors such as motivation and mood play an important role in behaviour;
- Considerable variation in characterisitcs and abilities
- The system boundary may ignore real-world tools and contexts (e.g. using a DPS calculator instead of performing mental arithmetic manually).

Socrative JBYPC3BBY

- In pairs.
- Quietly discuss how cognitive models could inform the design of a game interface.
- **List** the possible uses.

Perception and Attention

Learning Outcomes

In this section you will learn how to...

- **Discuss** different explanations of `perception' and their characteristics
- **Discuss** the importance of perception to HCI and explain how we can exploit our understanding of perception in designing game interfaces
- **Discuss** the role of attention in our cognitive processes and explain how human attention can be exploited in HCI design

Further Reading

- Eysenck, M.W. and Keane, M.T. (2000) *Cognitive Psychology: A Student's Handbook*. 4th Edition. Erlbaum Associatates.
- Newman, W.M. and Lamming, M.G. (1995) *Interactive System Design*. Addison-Wesley.
- Norman, D. (1988) *The Psychology of Everyday Things*. MIT Press.

Further Reading

- Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S., and Carey, T. (1994) *Human-Computer Interaction*. Addison-Wesley.
- Gibson, J.J. (1979) *The Ecological Approach to Visual Perception*. Houghton Mifflin.
- Gregory, R.L. (1978) *Eye and Brain: The Psychology of Seeing*. 5th Edition. Weidenfeld and Nicolson.

Perception and Representation

- Perception covered the sequence of events from the presentation of physical stimulus to the concious (or, indeed, unconcious) experience of it.
- Two approaches to explain visual perception include:
  - Gregory's (1978) **construcitivist** approach;
  - and the **direct perception** approach advanced by Gibson (1979).

Perception and Representation

- The constructivist approach claims `(person person seeing) constructs a model of the world by transforming, enhancing, distoring, and discarding information' (from Preece *et al*, 1994).
- In essence, humans construct a world of objects from information in the environment and our own knowledge.
- In other words, the images we `see' are not copies of the world, but are `mentally constructed' from our own knowledge and skills in comination with sensory information.

Perception and Representation

- In contrast, the direct perception approach claims `perception is picking up information from the environment and does not require any further processing' (from Perry, 2006, p. 12).
- In essence, perception is a direct copy of the environment with information being added or removed for the purpose of meaning making.
- In other words, the images we `see' are indeed copies of the world, without any further need for processing, but we may process our perception in order to interpret things and make meaning.

Perception and Representation

- Central to the ecology of the, latter, direct perception approach is the notion of an **affordance** (Norman, 1988)
- What we 'see' as the permissable actions or behaviours of a systems, objects, or events is permitted—or *afforded* by that thing—is obvious; there is no need for further information processing.

Perception and Representation

"...the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. (...) Affordances provide strong clues to the operations of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing. When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction needed."

(Norman, 1988, p.9)

Perception and Representation

Perception and Representation

Perception and Representation

- Affordances are usually viewed an important aspect of the design of game interfaces. It is important to appreciate that affordances are detected—not interpreted.
- **Disambiguation:** A backpack icon for an inventory is a metaphor, not an affordance. This is because it is not obvious how to use it, it has to be interpreted in light of the users’ existing knowledge.

Perception and Representation

- **Disambiguation:** The escape key to access a menu is a convention, not an affordance. This is because the functionality is premised upon user expectation and therefore requires prior knowledge.
- **Disambiguation:** Solid Snake's wavy bandana illustrating freedom is a semiotic, not an affordance. This is because its a non-verbal sign that communicates something and has nothing to do with functionality.

Socrative `JBYPC3BBY`

- In pairs.
- Quietly discuss what affordances exist in game interfaces.
- **List** them.

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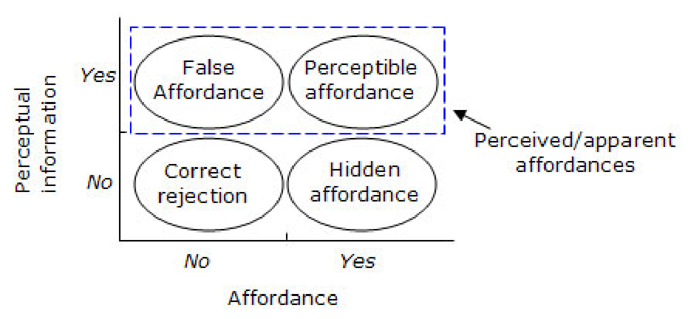
Socrative JBYPC3BBY

- In pairs.
- Quietly discuss whether this is an affordance, metaphore, semiotic, or convention.
- **Select** your answer.

Perception and Representation

- In games, affordances are represented through the interface—often through the pixels.
- As such, they are often illusions. They are not `real' affordances because they have no physical form.
- HCI professionals often refer to such affordances as `perceived affordances' due to their virtual nature. They exist only as an artefact of perception.

Perception and Representation



Caution should be exercised when using perceived affordances due to the risk of creating a false affordance in an interface (Adapted from Norman, 1988).

Perception and Representation

We can exploit these artefacts in the design of game interfaces (from Perry, 2006):

- **Size:** For two similar objects, differing only in size, close together, the larger object will appear much closer than the smaller object.

Perception and Representation

We can exploit these artefacts in the design of game interfaces (from Perry, 2006):

- **Size:** For two similar objects, differing only in size, close together, the larger object will appear much closer than the smaller object.
- **Interposition:** If an object is placed `over' another, such that it is obscured, the unobscured object will appear to sit on top of the other.

Perception and Representation

We can exploit these artefacts in the design of game interfaces (from Perry, 2006):

- **Contrast:** Objects that are further away, gradually dissapring into the distance, appear to lose their contrast, clarity, and brightness; this can be simulated in the interface to illustrate relative distances between objects.

Perception and Representation

We can exploit these artefacts in the design of game interfaces (from Perry, 2006):

- **Contrast:** Objects that are further away, gradually dissapring into the distance, appear to lose their contrast, clarity, and brightness; this can be simulated in the interface to illustrate relative distances between objects.
- **Texture:** Level of detail of objects appears to grow larger as they come closer. As such, objects with more detail appear closer than those with less clearly defined features.

Perception and Representation

We can exploit these artefacts in the design of game interfaces (from Perry, 2006):

- **Shadow:** Placing a shadow behind an object makes it appear to sit above the screen; with changes to shadow size making the `space' behind it appear deeper or shallower.

Perception and Representation

- It is not possible to show all information as directly perceivable physical objects.
- Designers have to consider moving beyond represent**ed** objects to represent**ing** abstract forms.
- That is, to create symbols: something standing in for something else.
- There are two ways this is done in games—direct mappings and arbitrary mappings (from Perry, 2006).

Perception and Representation

- **Direct Mapping:** A direct correspondence exists between the objects represented and the form of respresentation. Examples include the use of metaphors (e.g. a backpack icon for an inventory) and (some) semiotics (e.g. red to highlight a hostile entity).

Perception and Representation

- **Arbitrary Mapping:** No direct link between the object represented and the form of presentation. Examples include the use of abstract codes (e.g. 50 for a creeper when using the /summon command), abstract shapes (e.g. + for health), and team colors in multiplayer games. However, these abritrary codes need to be learned before they can be used effectively.

Socrative `JBYPC3BBY`

- In pairs.
- Quietly discuss what other **direct mappings** exist in game interfaces.
- **List** them.

Socrative `JBYPC3BBY`

- In pairs.
- Quietly discuss what other **arbitrary mappings** exist in game interfaces.
- **List** them.

Colour Perception and Colour Blindness

- When designing user interfaces, it is important that we do not arbitrarily exclude users with impairment.
- A common form of visual impairment that affects players is deuteranomaly (8% of men and 0.5% of women).

Colour Perception and Colour Blindness

- Colour coding of interface design elements must take this into account
- Examples of common issues can be found at `gameaccessibilityguidelines.com`.

Socrative `JBYPC3BBY`

- In pairs.
- Review the guidelines at: `gameaccessibilityguidelines.com`.
- **Identify ONE** example of a flaw in a game interface and how to overcome it.

Attention and Memory Constraints

- At a biological level, humans have capacity constraints that limit the information that they can perceive and process.
- To manage this, we tend to converge on two forms of attention:
  - **foused attention**: attending to one event only.
  - **divided attention**: multi-tasking

Socrative `JBYPC3BBY`

- **Give** ONE example of a game interface that requires **focused attention**.
- **Give** ONE example of a game interface that requires **divided attention**.

Attention and Memory Constraints

Several techniques can be used to focus attention in a game interface (adapted from Preece *et al*, 1994):

- **colour**: colour schemes differentiate areas on the screen, such as the grey side-bar in C&C games
- **structure**: information is positioned to faciliate ease of access, such as resources positioned on the HUD
- **alerting**: noise and flashing to direct attention, such as the shields down alert in the Halo series

Attention and Memory Constraints

Several techniques can be used to focus attention in a game interface (adapted from Preece *et al*, 1994):

- **highlighting**: information is highlighted at relevant location, such as the grenade off-screen arrow in Fallout
- **windowing**: information pops up in a window, such as a confirmation dialogue when trading in Guild Wars

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Mental Representation & Conceptual Models

Learning Outcomes

In this section you will learn how to...

- **Define** what is meant by the term `mental model'
- **Explain** the place of mental models in HCI
- **Explain** what a metaphor is
- **Describe** the use of metaphor in HCI
- **Describe** the use of mental models in HCI

Further Reading

- Lackoff, G. and Johnson, M. (1980) *Metaphors We Live By*. UCP.
- Norman, D. and Draper, S. (1986) *User-Centred Systems Design: New Perspectives on Human-Computer Interaction*. LEA.
- Norman, D. (1983) `Some Observations on Mental Models' in Gentner and Stevens (eds) *User-Centred Systems Design: New Perspectives on Human-Computer Interaction*. Erlbaum.
- Kempton, W. (1986) *Two Theories of Home Heat Control*, Cognitive Science 10, pp. 75 - 90.

Mental Representation & Conceptual Models

- The ways in which information we see, hear, and feel is represented in our brains can have implications for design.
- Psychologists believe information is stored so it can be recalled readily.
- Topics on knowledge representation include semantic networks, scripts, mental models, and so on—a vast field.
- We can leverage these representations through the application of metaphors and conceptual models in designs.

Human Memory Storage

- Attention and memory are linked — you remember what you pay attention to (Perry, 2006).
- There are three forms of memory store to consider:
  - **very short term sensory store**: iconic; echoic; haptic.
  - **mid-term working memory**: commonly referred to as short-term memory.
  - **long-term memory**: persistant storage of throughts and ideas.

Human Memory Storage

- Information moves through sensory to working memory through our attending to it.
- Information moves through working memory through rehersal.

Socrative JBYPC3BBY

- In pairs.
- An example of long-term memory use in an RTS is remember unit capabilities, while echoic memory might be a confirmation beep when issuing a command.
- Quietly discuss other ways we may use memory in an RTS game.
- **Explain ONE** key design decision.

Human Memory Storage

There are two sorts of memory usage which we can consider:

- **recognition**: cues in the environment remind us of things
- **recall**: drawing things from memory without a prompt

Human Memory Storage

People find recall more challenging than recognition. Normall (1888) calls these two uses of memory `knowledge in the head' and `knowledge in the world', with implications for the ways we use such knowledge:

- as internal representatons (human memory)
- from the world through external presentations (memos, events)
- embodied in constraints from the world (the limits imposed on our behaviours from the environment

Socrative `JBYPC3BBY`

- In pairs.
- An example of 'knowledge in the world' are greyed-out menu items — users recognise they are not available and do not need to recall this.
- Quietly discuss other examples of 'knowledge in the world' expressed in a game interface.
- **State ONE** example.

Human Memory Storage

Good game interfaces emphasise recognition and knowledge in the world over recall and knowledge in the head.

A Cognitive Economy

Nonetheless, there are ways we can improve recall where it is neccessary. Knowledge is organised by people to promote a cognitive economy (Collins & Quillan, 1969); we do not conduct exhaustive searches of our memory every time we wish to recall something. It is organised in some way.

A Cognitive Economy

Two such examples include:

- **semantic networks**: knowledge is organised by association.
- **scripts**: an encoding of knowledge about a particular context, such that it can guide behaviour.

Socrative `JBYPC3BBY`

- In pairs.
- An example of a semantic network in action is knowing the capabilities of a character based on its class (e.g. a cleric and monk are healers).
- An example of a script is knowing what to do to recruit a pick-up group in an MMORPG.
- Quietly discuss how semantics and scripts may influence game interaction.
- **Explain ONE** example, **briefly stating** which concept you are referring to.

Mental Models in Psychology

- Norman (1983) describes mental models as `mental simulations'; models that people have of themselves, others,the environment, things they interact with, etc.
- Remember the fridge example from last week? You may well have developed an incorect mental model while trying to decipher the controls.

Mental Models in Psychology

(see Kempton, 1986)

Socrative `JBYPC3BBY`

- Briefly, is the statement correct?

Mental Models in Psychology

- We build mental models to predict external events before we take action.
- Play an important role in human reasoning, and consequently player behaviour in games.
- Are players developing an accurate mental model?

Mental Models in Psychology

(Thomson, 2007)

http://archive.wired.com/gaming/virtualworlds/magazine/15-09/ff_halo?currentPage=all

Conceptual Models in the Interface

- Players need to understand their actions in order to make meaningful choices.
- As such, designers need to design an interface in a way that shapes the players' mental model construction.
- Normal (1988) suggests how the design and the player's mental model are linked through the 'system image' (i.e. the visible part of the interactive system).

Conceptual Models in the Interface

"In many ways the primary task of designer is to construct an appropriate system image, realising that everything the user interacts with helps us to inform that image: the physical knobs, dials, keyboards, and displays (...) text, input, output, and error messages"

(Normal, 1986, p. 44)

Conceptual Models in the Interface

Newman and Lamming (1995) provide design guidelines along these lines:

- Identify the mental model you intend the player to adopt, preferably before designing the game interface;
- Link the mental model to the intended means of interaction;
- Hide aspects of the system image that conflict with player performance on an action/activity;
- Explout the system image to convey the intended mental model;
- and show the state of the game as it is *now*—not as it was some time ago.

Practical Activity

Sprint Review

- **Load** the game you are working with.
- **Connect** your novel game controller.
- **Demonstrate** the prototype to your tutor.
- While you are waiting, self-organise into pairs to discuss your work-in-progress. Focus on the psychology of the game interface and how psychological concepts could inform the design. Remember, you are assessing the interactivity; not just the controller itself. Be broard and all-encompassing in your discussions.