

# Cognitive, Social, and Emotional Interaction

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Dr Charles Martin

## Announcements

- Assignment 2 Due today!
- Next week lecture is on Friday (???)
- Course now shifts to support final project.

## Plan for the class

1. Final Project Details
2. Cognitive Aspects of Interaction
3. Social Interaction
4. Emotional Interaction

# Final Project Details

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# Final Project Details

- a complete design and evaluation process for a prototype interactive system.
- design a prototype in response to a real-world problem
- evaluate this system using HCI research methods
- report on the results

**primary submission document: a  
5-minute recorded presentation**



**Figure 1:** Two users evaluating an interface in an office foyer.

## Final Project Research Challenge

***Sustainable living through technology:*** You woke up this morning, checked your email, and found that you have a new job—ANU Student Lead for Sustainable Living!

*Your challenge is to help university students adopt sustainable behaviours in their everyday lives guided by the UN Sustainable Development Goals (SDG) which call for urgent action on climate change, responsible consumption, and sustainable communities.*

*You will need to choose a focus (e.g., energy use, waste reduction, transportation, consumption), prototype and evaluate an interface to make sustainable living more accessible, engaging or effective. Your system should involve a level of non-standard interaction, either through unusual use of standard computer IO hardware, or a novel interface.*

# Final Project Specification

- include documentation of a testable prototype, research question, evaluation plan, data collection, data analysis, and articulation of findings
- include a **video recording** of a presentation which follows the provided headings: `project-presentation.mp4`
- include documentation in `project-documentation.md` which follows the provided headings (**N.B.:** this text may be a transcript of your spoken presentation with references and images, it may also be a slightly different text.)

# Final Project Sections

Your presentation and documentation will have the following sections:

1. **Research Question, Plan, and Conclusions**
2. **Prototype Design and Features**
3. **Research Data, Analysis and Findings:** N.B. you can choose to collect either qualitative, quantitative, or both
4. **COMP6390 Only—Positionality Statement:** critically reflect on your presence and influence within the technology design process in a statement of positionality.

## Video Presentation

- clear and concise covering the section headings above
- understandable audio **spoken by you**
- must include **video of your face** while presenting in the presentation
- must include at least 5 but no more than 10 slides
- title slides, personal introductions, tables of contents, reference slides are **not required** (waste of time!)

Suggested recording method:  
Microsoft Powerpoint's built-in recording tool

**no genAI or text-to-speech allowed for the video presentation!**

## Questions on the Final Project

Who has a question about the final project? (Or anything else?)

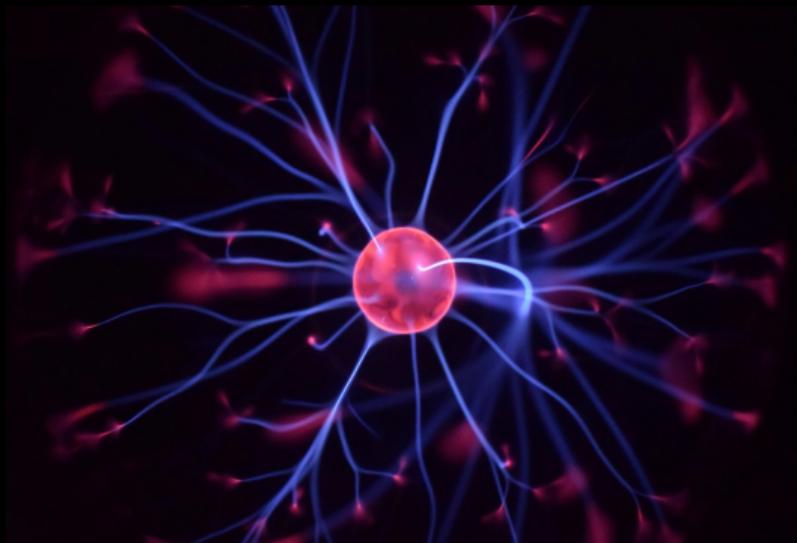
# Cognitive Aspects

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## Cognitive Aspects

The way we think affects how we act and interact in our life.

We can design systems to cope well with human cognition to fit well with our capacity for remembering, deciding, perceiving, and attending.



**Figure 2:** COGNITION (Photo by Stefano Bucciarelli on Unsplash)

# Cognition

A definition from Oxford English

Dictionary:

*The action or faculty of knowing taken in its widest sense, including sensation, perception, conception, etc., as distinguished from feeling and volition...*



**Figure 3:** (Photo by Mathilda Khoo on Unsplash)

# Cognitive processes

Cognitive processes can change depending on the problem:

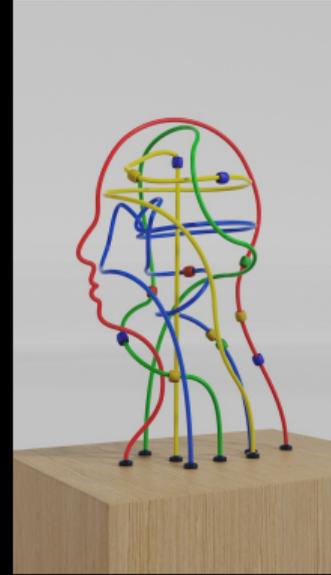
- **Experiential Cognition:**  $2 + 2 =$
- **Reflective Cognition:**  $312 \times 56 =$

A famous frame for this difference is “fast and slow thinking” (Kahneman, 2011).

# What are cognitive processes?

1. Attention
2. Perception
3. Memory
4. Learning
5. Reading, speaking, listening
6. Problem solving, planning, reasoning, decision making

(Eysenck & Brysbaert, 2023)



**Figure 4:** (Photo by Luke Jones on Unsplash)

# Attention

Selecting things to focus on, relevant to our needs, from possibilities.

- clear goals (directed searching vs browsing)
- information presentation (structure and layout in the interface)
- multitasking and attention
  - depends on individuals and context
  - relevance of distractions
  - effort to task switch
  - designing to support effective multitasking

(a)

City	Motel/Hotel	Area code	Phone	Single	Double
Charleston	East Western	843	747-0961	\$126	\$130
Charleston	Dups Inn	843	861-1000	\$118	\$124
Charleston	Holiday Inn R.	843	744-1621	\$136	\$140
Charleston	Holiday Inn SW	843	556-7939	\$124	\$147
Charleston	Howard Johnsons	843	534-4148	\$131	\$136
Charleston	Romana Inn	843	774-8281	\$123	\$140
Charleston	Shelton Inn	843	744-2401	\$124	\$142
Columbia	East Western	803	796-5403	\$129	\$134
Columbia	Casina Inn	803	756-4200	\$142	\$148
Columbia	Dups Inn	803	756-9099	\$123	\$127
Columbia	Holiday Inn RW	803	768-4444	\$122	\$126
Columbia	Howard Johnsons	803	772-7200	\$125	\$127
Columbia	Quality Inn	803	772-2670	\$134	\$141
Columbia	Rutland Inn	803	756-2700	\$126	\$144
Columbia	Vagabond Inn	803	756-6243	\$127	\$130

(b)

Pennsylvania  
Berks Motel/Hotel, Crisline Courts  
(610) 625-8511 S: \$118 D: \$120  
Berks Motel/Hotel, Holiday Inn  
(610) 625-9096 S: \$129 D: \$136  
Berks Motel/Hotel, Midway  
(610) 625-8127 S: \$124 D: \$125  
Berks Motel/Hotel, Penn Manor  
(610) 625-8177 S: \$122 D: \$125  
Berks Motel/Hotel, Quality Inn  
(610) 625-5188 S: \$123 D: \$128  
Berks Motel/Hotel, Terrace  
(610) 625-5111 S: \$122 D: \$124  
Berks Motel/Hotel, The Club  
(610) 362-3527 S: \$120 D: \$124  
Berks Motel/Hotel, Holiday House  
(610) 362-4511 S: \$122 D: \$125  
Berks Motel/Hotel, Holiday Inn  
(610) 362-4531 S: \$122 D: \$146  
Brimacombe Motel/Hotel, East Western Plaza  
(610) 725-4332 S: \$120 D: \$127  
Brimacombe Motel/Hotel, Motel 70  
(610) 725-4323 S: \$116 D: \$118

**Figure 5:** Structured and Unstructured information text (Rogers et al., 2023)

## Design Implications for Attention

- consider context to make information salient when required
- techniques: animation, colour, ordering, spacing
- avoid cluttered visual interfaces
- support switching and returning (but how?)



**Figure 6:** Some interfaces need to be very careful about attention...  
(Photo by milan degraeve on Unsplash)

# Perception

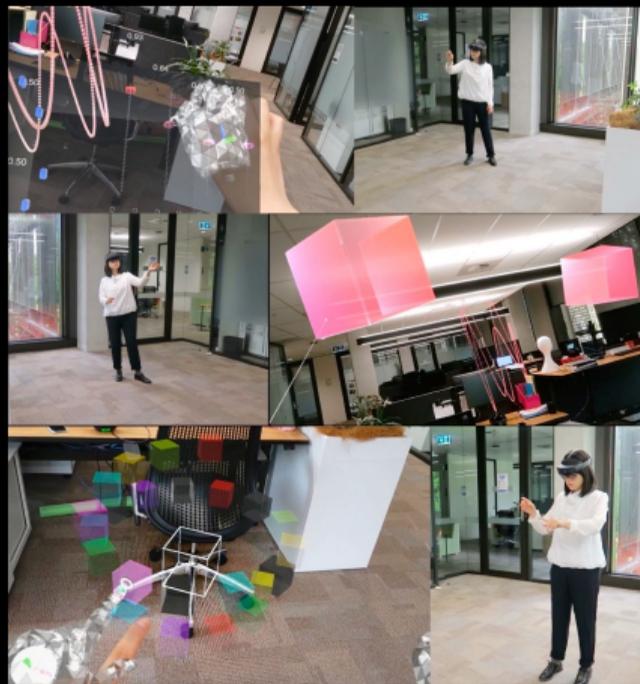
- how we sense information and transform it into experience
- proprioception: Awareness of position and movement of body through muscles and joints
- vision dominant for sighted folks
- followed by hearing and touch
- important to present information so that it can be readily perceived



**Figure 7:** How does our perception influence design?

## Design Implications for Perception

- design icons and graphics to be distinguished
- white space and separators to group information
- sounds (earcons!) can help distinguish information
- colour contrast is important for perception (and accessibility)
- haptic feedback: use carefully, perhaps in response to user initiated actions



**Figure 8:** The layout of music controls in AR affects perception (Wang & Martin, 2022)

# Memory

- brain filters what to remember and what to forget to avoid overload – but not always in the way we want to!
- filtering into memory – depends on encoding process (e.g., active vs passive learning) and context (e.g., seeing someone in a different context)
- people are better at **recognition** than recall
- relying on technology rather than memory (e.g., car navigation system, “let’s ask Claude..”)
- personal information management
- remembering passwords and multifactor authentication



**Figure 9:** Photo by Piotr Miazga on Unsplash

## Design Implications for Memory

- avoid long and complex procedures for carrying out tasks
- design interfaces for **recognition** rather than recall (familiar patterns and consistency)
- provide ways to label digital information for identification



**Figure 10:** This is a bad pun, but memory cards are hard to recognise! File management systems help us to use recognition rather than recall to sort stored data. (Image: Denise Jans on Unsplash)

# Learning

accumulation of skills and knowledge through memory (Rogers et al., 2023, p. 119)

- incidental learning vs intentional learning
- learning by reading vs learning by doing
- learning through collaboration
- micro-learning
- multimodal learning through new and emerging technologies e.g., augmented reality and virtual reality



**Figure 11:** (Hooper et al., 2012)



**Figure 12:** (Cheng et al., 2017)

## Design Implications for Learning

- design to encourage exploration
- design constraints and guide users to appropriate actions

Learning theory concept: “zone of proximal development”—we should get users into that state!



**Figure 13:** How do we encourage exploration and embed guidance into systems! Games are awesome at this. (Image: Philippe Bout on Unsplash)

## Reading, Speaking, Listening

- communication skills
- meaning the same across modes
- writing is permanent, speaking is transient
- reading quicker than listening
- listening less cognitive effort than reading
- some more grammatical than others
- interactive books, speech technologies, natural language processing, tactile interfaces, assistive technologies



**Figure 14:** Our experience of the same information changes depending on the context, reading a book, chatting with a friend, listening to a meeting (Image: Chris Montgomery on Unsplash) 22

## Design Implications for Communication

- keep length of speech menus to minimum (less than 3-4 options)
- extra intonation on artificial speech
- provide options for making text large



**Figure 15:** Source: Design Boom



**Figure 16:** Photo by Nicolas J Leclercq

## Problem Solving, Planning, Reasoning, Decision Making

- Involve “reflective cognition” in relation to actions, choices, consequences
- How do you make purchasing decisions?  
What role does technology play?

### **Design Implications**

- Provide information and help for users to improve their performance.
- Use simple and memorable functions for rapid decision making.
- Let users set their own configuration and options.

# Cognitive Frameworks

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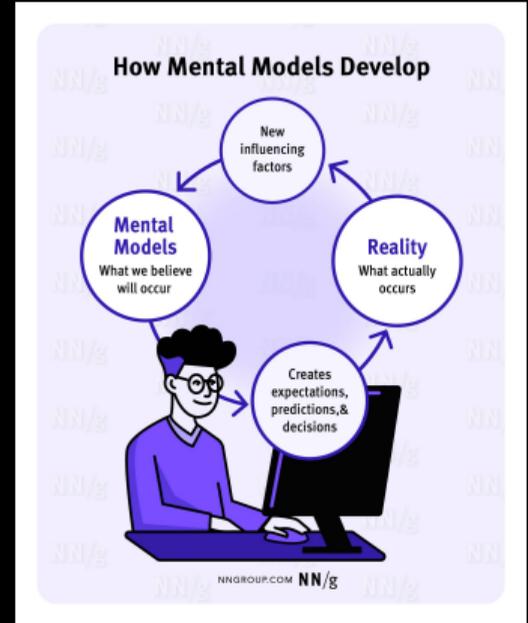
# Cognitive Frameworks

- **Mental models**
- **Gulfs of Execution and Evaluation**
- **Information Processing**
- **Distributed Cognition**
- **External Cognition**
- **Embodied Interaction**

# Mental Models

A mental model is our internal understanding of how a system works.

- used to reason about unfamiliar technology or troubleshoot problems
- develop through experience; often incomplete or incorrect
- common errors from misapplying logic of a system: thermostat/oven vs. water tap
- poor mental models lead to difficulty identifying problems and explaining system behavior
- interfaces can help through clear instructions, contextual help, and appropriate metaphors

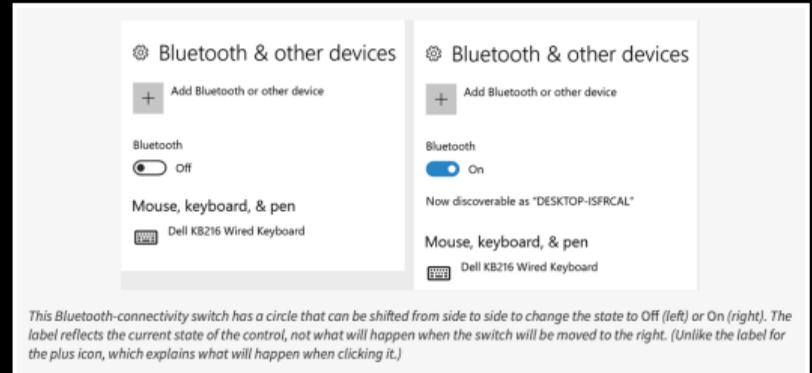


**Figure 17:** Mental Models (nngroup)

# Gulfs of Execution and Evaluation

influential early HCI framework  
describing gaps between user and  
interface (D. A. Norman, 1986)

- gulf of evaluation: understanding state
- gulf of execution: understanding controls
- design challenge is bridging these gulfs to reduce cognitive effort
- framework explores mappings between system design and user understanding
- provides discourse for identifying mismatches in user-system



**Figure 18:** Problem with switches: how do you know what happens when you switch it!

## Information Processing

- **Mind as information processor:** (1980s metaphor) mind processes information through ordered stages (input, processing, output) involving mental representations like images, models, and rules
- **Human processor model:** conceptualized cognition as series of perceptual, cognitive, and motor processors to predict user interaction times with computers (Card et al., 1983)
- **Reaction time predictions:** The information processing approach enabled hypotheses about user response times and cognitive bottlenecks when overloaded with information
- **Shift to external cognition:** Modern HCI focuses on understanding cognitive activities in context, analyzing how environmental structures support cognition and reduce cognitive load
- **Cognitive load measurement:** Mental effort required for learning is assessed through methods like NASA-TLX survey, which measures mental

# Distributed Cognition

- interactions between multiple people and artefacts
- event-driven, systems as the unit of analysis, collective behaviours
- information flows and transformations through the system
- different levels of granularity
- analysis addresses problem solving, communication (verbal and non-verbal), coordination mechanisms, accessing and sharing knowledge
- analysis can inform design implications and decision-making in designing to support distributed cognition

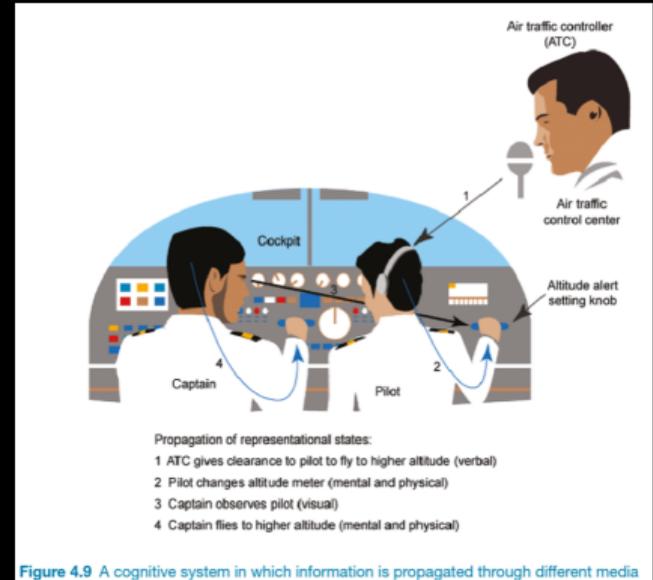


Figure 4.9 A cognitive system in which information is propagated through different media

**Figure 19:** Image: Rogers et al. (2023) p.128

# External Cognition

- internal representations (in the head) and external representations (artefacts in the world) and how they interact
- combined with tools (e.g., pens, calculators, spreadsheets) to support cognitive activities
- the cognitive processes involved when we interact with different external representations
- cognitive offloading, computational offloading, annotating and cognitive tracing



**Figure 20:** Cognitive Offloading



**Figure 21:** Computational Offloading



**Figure 22:** Cognitive Tracing

## Embodied Interaction

our bodies and experiences shape how we perceive, feel, and think (Hornecker, 2005)

- artifacts indicate usage through coupling to the world (e.g., open book as task reminder)
- sensorimotor experiences enable abstract thinking (inside-outside, up-down concepts)
- body mediates interactions with technology and shapes emotional responses
- movement instrumental in thought evolution and spatial thinking development
- abbreviated actions more effective than full simulation for learning skills

# **Social Interaction**

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## Activity: Social human computer interactions

Let's consider one angle on social computer use.

*What are the kinds of situations in which you would phone someone (rather than text)?*

**Write** for 2-3 minutes, **vote** for 1 minute, then let's discuss.



**Figure 23:** PollEverywhere link:  
https://pollev.com/charlesmarti205

fundamental part of everyday life; how does technology mediate this?

- social media transformed how people connect across time and space
- COVID-19 accelerated videoconferencing adoption (and highlighted limitations)
- excessive phone use raises wellbeing concerns
- digital etiquette (muting, virtual hand-raising, emoji reactions)
- social coordination shifted to texting; added complexity!

## Face-to-Face Conversations

conversation may seem effortless but is a skilled collaborative achievement. how do these unfold?

- turn-taking rules: speaker chooses next, someone else starts, or current speaker continues (Sacks et al., 1978)
- adjacency pairs: first utterance sets expectation for response
- repair mechanisms: repetition, gestures, and clarifications
- nonverbal cues coordinate conversation flow
- interfaces that emulate human



**Figure 24:** Conversation is a key human capability that can be used in HCI (Photo by Aarón Blanco Tejedor on Unsplash)

## Remote Conversations

- **video conferencing:** early research (1980s-90s) showed people spoke louder, took longer turns, interrupted less
- mainstream adoption via Skype, FaceTime, then Zoom/Teams
- virtual 2D spaces (e.g., Gather.Town) aim to recreate social presence and community
- **telepresence** creates perception of being present in a physical location while actually elsewhere
- **telepresence** through robots, rooms, virtual reality, games
- **social presence:** the feeling of *being there* in a virtual space



**Figure 25:** Telepresence in music at NIME2025 with a live pianist and two remote musicians (Photo by Charles)

## Co-Presence

supporting people in activities when they are interacting in the same physical space

- supporting effective collaboration
- hand gestures, body language, use of objects
- awareness: knowing what is going on around you, functioning as “close-knit teams”
- shareable interfaces: whiteboards, touch screens
- social translucence: enabling participants and activities to be visible



**Figure 26:** The Reflect Table: Pierre Dillenbourg in Rogers et al. (2023) p.55



**Figure 27:** musical instrument holograms to aid collaboration (Wang et al., 2025)

## Social Games

games designed to facilitate social interaction between two or more players who are aware of each other's presence and actions

- can be cooperative or competitive, played with or without technology (board games, video games, online platforms)
- three heuristics: synchronous vs asynchronous interaction, symmetrical vs asymmetrical relationships, strong vs weak social ties (Ricchetti, 2022)
- unconventional approaches, e.g. Journey (shared exploration)
- communities through live streaming (Twitch) foster social bonds



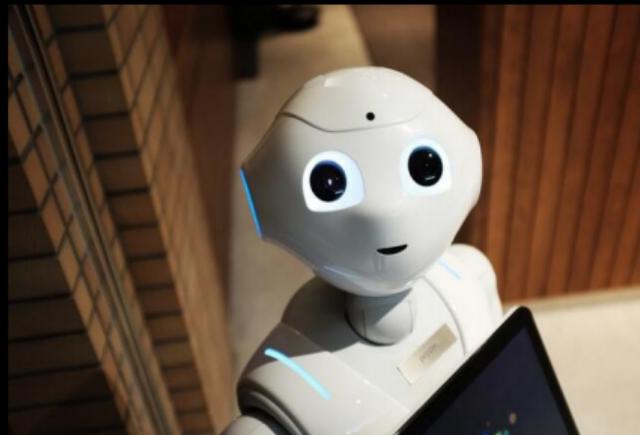
**Figure 28:** Journey (2011) had an unconventional coop mode with almost no communication possible and little gameplay gain except the feeling of shared experience.

# Emotional Interaction

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## Emotional Interaction

How do our emotions manifest in interaction?  
Can designing for emotions help us in our  
tasks, or help us manage them?



**Figure 29:** Pepper Robot (Photo  
by Alex Knight)

## Emotions and Behaviour

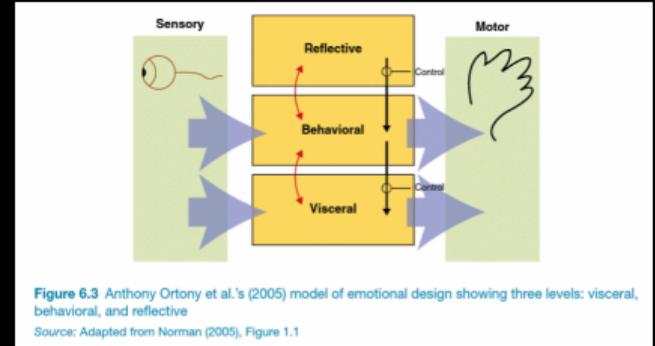
- emotions affect behavior but relationship is complex and context-dependent
- emotional interaction design considers what makes users feel happy, sad, anxious or motivated
- users express emotions through facial expressions, body language and tone of voice
- automatic emotions happen rapidly while conscious emotions develop slowly
- interfaces can detect emotional states but decisions needed on appropriate responses

# A Model of Emotional Design

Understanding emotions assists with design. Positive and negative emotional states have different effects on creativity and tolerance (D. Norman, 2005)

Ortony et al. (2012) model of emotional design:

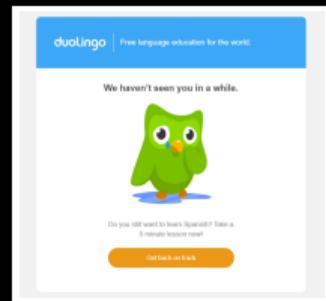
- visceral: look, feel, sound
- behavioural: use (usability)
- reflective: meaning, personal value, culture



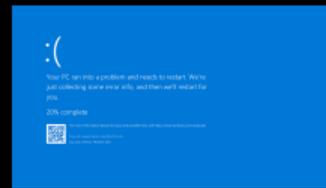
**Figure 30:** (Ortony et al., 2012)

# Expressive Interfaces and Emotional Design

- design features that seek to create an emotional connection with users or elicit emotional responses in users
- expressivity through animation, sonification, vibrotactile feedback (e.g., mobile phone or watch buzzing)
- aesthetics affects perceptions of usability and pleasure of use
- annoying interfaces elicit negative responses



**Figure 31:** Duolingo Reminders



**Figure 32:** Windows Blue Screen of Death

# Affective Computing and Emotional AI

- computers recognising and expressing emotions (Rosalind Picard: Affective Computing, Engineering Emotion)
- measuring of feelings using facial expressions, voice, and physiological data
- sensing technologies: cameras, biosensors, speech analysis, motion capture, accelerometer sensors
- typical ML task classify emotions (anger, joy, sadness) as percentages from facial markers
- mood tracking apps: help manage emotions, moods, and mental health



Figure 6.10 Facial coding using Affectiva software  
Source: Affectiva, Inc.

**Figure 33:** Analysing emotion from a camera image.

# Persuasive Technologies

persuasive design uses interface techniques to change user behavior and thinking

- pop-ups, recommendations, prompts, and one-click purchasing
- playful interventions (piano stairs, echoing bins)
- fitness trackers use dashboards, leaderboards, and social comparison for motivation
- social norms influence consumption - households adjust behavior based on neighborhood comparisons
- effective persuasion balances being noticeable without being intrusive or



**Figure 34:** The world's deepest bin (2009) a playful bin that sounds like dropping an rubbish in a deep hole.

# Anthropomorphism

anthropomorphism is the human tendency to attribute human qualities to animals and objects, widely applied in technology design

- applied in software designs, as well as hardware such as robots
- e.g., *"ChatGPT" vs "Claude"*.
- personalized first-person interaction ("Hi Charles!") proves more engaging than impersonal third-person commands
- robot dolls incorporate sensors, speech recognition, and servos
- should robots be hard (Sony AIBO) or soft designs that enhance emotional connection through touch? (e.g., haptic



**Figure 35:** The haptic creature (Yohanan & MacLean, 2011)

# Questions: Who has a question?

## Who has a question?

- I can take *cathchbox* question up until 2:55
- For after class questions: meet me outside the classroom at the bar (for 30 minutes)
- Feel free to ask about **any aspect of the course**
- Also feel free to ask about **any aspect of computing at ANU!** I may not be able to help, but I can listen.



**Figure 36:** Meet you *at the bar* for questions. 🍸 🥤 🍵 ☕  
Unfortunately no drinks served!



# References

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## References i

- Cheng, A., Yang, L., & Andersen, E. (2017). Teaching language and culture with a virtual reality game. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 541–549.  
<https://doi.org/10.1145/3025453.3025857>
- Eysenck, M. W., & Brysbaert, M. (2023). *Fundamentals of cognition (4th ed.)*. Routledge. <https://doi.org/10.4324/9781003384694>

## References ii

- Hooper, C. J., Preston, A., Balaam, M., Seedhouse, P., Jackson, D., Pham, C., Ladha, C., Ladha, K., Plötz, T., & Olivier, P. (2012). The french kitchen: Task-based learning in an instrumented kitchen. *Proceedings of the 2012 ACM Conference on Ubiquitous Computing*, 193–202.  
<https://doi.org/10.1145/2370216.2370246>
- Hornecker, E. (2005). A design theme for tangible interaction: Embodied facilitation. *ECSCW 2005: Proceedings of the Ninth European Conference on Computer-Supported Cooperative Work, 18–22 September 2005, Paris, France*, 23–43. [https://doi.org/10.1007/1-4020-4023-7\\_2](https://doi.org/10.1007/1-4020-4023-7_2)
- Kahneman, D. (2011). *Fast and slow thinking*. Allen Lane and Penguin Books, New York.

## References iii

- Norman, D. (2005). *Emotional design: Why we love (or hate) everyday things*. Basic books.
- Norman, D. A. (1986). Cognitive engineering. In *User centered system design* (pp. 31–62). CRC Press.
- Ortony, A., Norman, D. A., & Revelle, W. (2012). Affect and proto-affect in effective functioning. In *Who needs emotions?: The brain meets the robot*. Oxford University Press.
- Ricchetti, M. (2022). *What really makes social games social?* Conference Talk. <https://www.gdcvault.com/play/1015724/What-Really-Makes-Social-Games>

## References iv

Rogers, Y., Sharp, H., & Preece, J. (2023). *Interaction design: Beyond human-computer interaction, 6th edition*. John Wiley & Sons, Inc.  
<https://quicklink.anu.edu.au/kv9b>

Sacks, H., Schegloff, E. A., & Jefferson, G. (1978). A simplest systematics for the organization of turn-taking for conversation. *Language*, 50, 696–735.

Wang, Y., & Martin, C. P. (2022). Cubing Sound: Designing a NIME for Head-mounted Augmented Reality. *International Conference on New Interfaces for Musical Expression*.

## References v

- Wang, Y., Xi, M., Adcock, M., & Patrick Martin, C. (2025). Seeing the sound: Supporting musical collaboration with augmented reality. *Proceedings of the 2025 Conference on Creativity and Cognition*, 99–112.  
<https://doi.org/10.1145/3698061.3726905>
- Yohanan, S., & MacLean, K. E. (2008). The haptic creature project: Social human-robot interaction through affective touch. *Proceedings of the AISB 2008 Symposium on the Reign of Cats & Dogs: The Second AISB Symposium on the Role of Virtual Creatures in a Computerised Society*, 1, 7–11.

Yohanan, S., & MacLean, K. E. (2011). Design and assessment of the haptic creature's affect display. *Proceedings of the 6th International Conference on Human-Robot Interaction*, 473–480.  
<https://doi.org/10.1145/1957656.1957820>