LESSON 5

Cognition & Design

Memory

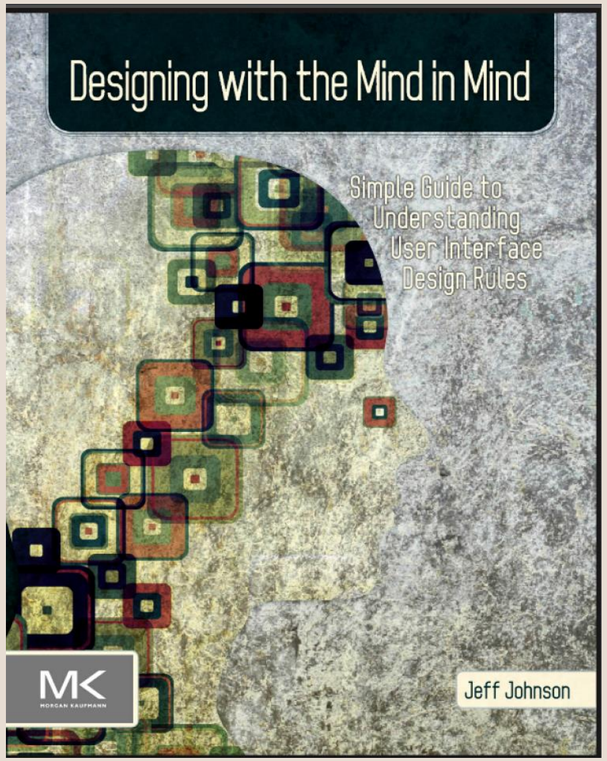
Memory

Objectives

- Understand how long term and short-term memory work
- To understand how memory affects user interface design
- To know the limitations of attention
- Understand the characteristics of long-term and short-term memory
- To be aware of the user interface design implications of memory.
- To know about the information scent
- To be familiar with recognition and recall

Source

This lesson's material and images are from the following book:



Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules
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Memory

1

Memory

Short-term and Long-term memory

We can distinguish between two types of memory.
Previously it was not understood if these were part of the same system or separate.
Recent research indicates they are functions of the same system.

Designing interactive systems should augment, not burden, memory.

Long-term Memory

Perceptions enter the brain through the sensory systems

- Visual, auditory, olfactory (smell), gustatory or tactile

These trigger a response in the brain

Each sensory system has a corresponding area in the brain

- e.g. visual cortex, auditory cortex

These pass the signals to another part of the brain

Long-term Memory

Specific areas detect only simple features

e.g. sour taste, dark edge, diagonal line, high-pitch sound, motion

The new area combines these lower level features to form high level features such as

Animal, threat, duck, Uncle Kevin

Long-term Memory

The set of neurons that are affected by perception depends on it's features and context

- dog barking – you are in front of the dog
- dog barking – you are inside a car

Similar perceptual stimuli results in more overlap of neurons

Long-term Memory

Memory formation consists of long-lasting and even permanent changes in the neurons in a neural activity pattern

It is easier to reactivate the pattern in the future

Activating a memory consists of reactivating the same pattern that occurred when the memory was formed.

Long-term Memory

Recognition

New perceptions similar to the original ones reactivate the same patterns of neurons.

Recall

If no similar perception exists, stimulation from activity in other parts of the brain can also reactivate a pattern. This awareness results in recall.

The more a pattern is reactivated the stronger it becomes resulting in it being easier to reactivate

Corresponding perception becomes easier to recognize and recall.

Long-term Memory

A particular memory is not located in a particular part of the brain.

- Network of neurons
- Span over a wide area
- Damage does not mean deletion
- Damage can effectively eliminate a memory

Short-term Memory

Short-term memory is not a store.

It is a combination of phenomena arising from perception and attention – awareness.

Short-term Memory

Perceptual senses have their own, very short, memory.
When stimuli ceases residual neural activity still exists
    like a bell ringing after it has been struck
There are several components of short-term memory including
    residual perceptions
    long-term memory
A subset of the information from our perceptual systems, and long-term memories that are conscious of *right now*, equal the main part of our short-term memory.

Short-term Memory

Characteristics

- Focus of our attention
- What we are conscious of at any given moment
- Two important characteristics of short-term memory
  1. Low capacity
  2. Volatile

Short-term Memory

Low Capacity

Most famous HCI guideline 7 +/- 2 from George Miller in 1956
Research in the 1960 & 70s say this maybe too high
If experiments disallow unintentional chunking the figure is more like 4 +/- 1
Other research used similar items and people had to remember shared features
It is suggested it is better to measure features of items rather than items or chunks.

Short-term Memory

Volatile

Old thought - new information comes into short-term memory the old information leaves
Now - more the current focus of our attention
Volatile – we lose items or goals from our short-term memory (e.g. forget what we are doing)
  Why did I come into this room?
  What was I just about to do?
  What was I just about to say?
  I have lost count now

Short-term Memory

Volatile

We pay attention to some features
If we compare two pictures to notice differences
Then we are given different goals
We will notice different features and differences in features
This is called *change blindness*

Short-term Memory

Change Blindness

- A person pretends to be a tourist and asks for directions
- A person tries to help
- Whilst looking at a map they are distracted
- The experimenter changes hat, hair colour, even gender,
- but the helper does not notice – their focus is on the map

Test your short-term memory

A SHORT-TERM MEMORY TEST

To test your short-term memory, get a pen or pencil and two blank sheets of paper and follow these instructions:

1. Place one blank sheet of paper after this page in the book and use it to cover the next page.
2. Flip to the next page for 3 seconds, pull the paper cover down and read the **black numbers** at the top, and flip back to this page. Don't peek at other numbers on that page unless you want to ruin the test.
3. Say your phone number backward, out loud.
4. Now write down the black numbers from memory. … Did you get all of them?
5. Flip back to the next page for 3 seconds, read the **red numbers** (under the black ones), and flip back.
6. Write down the numbers from memory. These would be easier to recall than the first ones if you noticed that they are the first seven digits of *pi* (3.141592), because then they would be only one number, not seven.
7. Flip back to the next page for 3 seconds, read the **green numbers**, and flip back.
8. Write down the numbers from memory. If you noticed that they are odd numbers from 1 to 13, they would be easier to recall, because they would be three chunks ("odd, 1, 13" or "odd, seven, from 1"), not seven.

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9. Flip back to the next page for 3 seconds, read the **orange words**, and flip back.
10. Write down the words from memory. … Could you recall them all?
11. Flip back to the next page for 3 seconds, read the **blue words**, and flip back.
12. Write down the words from memory. … It was certainly a lot easier recall them all because they form a sentence, so they could be memorized as one sentence rather than seven words.

3 8 4 7 5 3 9

3 1 4 1 5 9 2

1 3 5 7 9 11 13

town river corn string car shovel

what is the meaning of life

Design Implications

MEMORY

User interfaces (UI) should help people remember essential information from one moment to the next

UI should let users focus on their primary goal

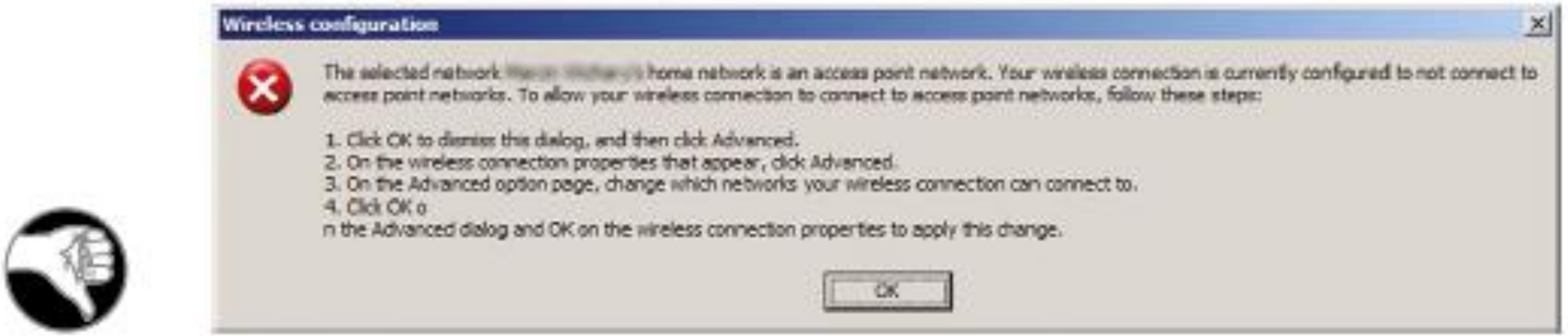

FIGURE 7.4

Instructions for Windows XP wireless setup start by telling users to close the instructions.

Design Implications

Modes

Some user actions have different effects depending on the mode the system is in

Example: a camera may have different picture modes and a video mode

Adv. More functions

Disadv. People can make modal errors

Especially with poor feedback

Design Implications

Search results

- People often forget search terms even though they have just entered them
- Systems now show search terms with the search results

Instructions

- Given a list of instructions, e.g. a recipe or directions, people tend to write them down
- Systems that involve several steps should allow users to read instructions until all the necessary steps are completed

Long-term Memory

Characteristics

Long-term memory has weaknesses
- Error prone
- Weighted by emotions
- Retroactively alterable

Error prone
- we don't know the capacity of memory in the human brain
- It is a combination of abstract features that are compressed
- In HCI a user may remember there is a command to insert a page but not remember where

Long-term Memory

Characteristics

- Retroactively alterable
  - You may disagree with your sister, brother or friend about a shared experience
  - Example: Ronald Reagan
    - Reagan spoke about helping Jews in Europe during World War II
    - But he was never in Europe during WWII
    - He was in a film about WWII

Test your long-term memory

A LONG-TERM MEMORY TEST

Test your long-term memory by answering the following questions:

1. Was there a roll of tape in the toolbox in Chapter 1?
2. What was your *previous* phone number?
3. Which of these words were *not* in the list presented in the short-term memory test earlier in this chapter?
   city stream corn auto twine spade
4. What was your first grade teacher's name? Second grade? Third grade? …
5. What Web site was presented earlier that does not show search terms when it displays search results?

Regarding question 3: When words are memorized, often what is retained is the *concept*, rather than the exact word that was presented. For example, one could hear the word "town" and later recall it as "city."

Design Implications

People need assistance to help remember
- Augment memory
- Don't burden memory

Examples:
- PIN / passwords – complex or too long
- rememberable date – what date?

Results in:
- passwords written on post-its & stuck to the PC
- Simple passwords – easy to crack
- Customer support recovering passwords

Design Implications

MEMORY

Consistency

more consistency = less memory burden

Design A is easiest to learn

Design B will take more time to learn

Design C will result in more errors over a long period of time

Table 7.1 Which UI Design will be Easiest to Learn and Remember? Which One will be Hardest?

Object	Document Editor Keyboard Shortcuts: Alternative Designs					
	Design A		Design B		Design C	
	Cut	Paste	Cut	Paste	Cut	Paste
Text	CNTRL-X	CNTRL-V	CNTRL-X	CNTRL-V	CNTRL-X	CNTRL-V
Sketch	CNTRL-X	CNTRL-V	CNTRL-C	CNTRL-P	CNTRL-X	CNTRL-V
Table	CNTRL-X	CNTRL-V	CNTRL-Z	CNTRL-Y	CNTRL-X	CNTRL-V
Image	CNTRL-X	CNTRL-V	CNTRL-M	CNTRL-N	CNTRL-X	CNTRL-V
Video	CNTRL-X	CNTRL-V	CNTRL-Q	CNTRL-R	CNTRL-E	CNTRL-R

Attention

2

Attention

Predictable patterns

Aspects of human behavior follow predictable patterns, some due to memory limitations

Interactive systems are designed to recognize these patterns.

There are some important patterns to note

Attention

Important patterns include:

1. We focus on our goals not our tools
2. We use external aids to keep track of what we are doing
3. We follow an information ‘scent’ towards our goal
4. We prefer familiar paths
5. Goal, execute, evaluate
6. We forget to cleanup

Attention

We focus on our goals not our tools
- our attention has very limited capacity
- So we focus on our goal
- We can focus on our tools (e.g. application)
- But if we have to refocus on our tools we can lose track of our goal – what we were doing.
- Example: having to re-read something when distracted
- UI design: applications & web sites should allow the user to focus on their goal

Attention

We use external aids to keep track of what we are doing

We use aids or markers to help us remember

- Counting objects – move the objects or use our fingers
- Reading books – bookmarks
- Arithmetic – use a pen & paper or a calculator
- Checklists – to remember all we need to, check off items in the list
- Editing documents – keep in separate folders

Attention

We follow an information ‘scent’ towards our goal

- our attention does not focus on instructions, option labels, icons or other aspects of the UI in computer-based tools
- We are attracted to keywords associated with our goal
    - buy, ticket, flight, reservation
- Match words we can see with our goal
- This has been called “following the scent towards the goal”

Attention

Look at the ATM screen for each of these tasks:

Pay a bill
Transfer money to your savings account
Pay your dentist by funds transfer
Change your PIN
Open a new account
Purchase traveler's cheques

Attention

We follow an information ‘scent’ towards our goal

Did you go to the wrong option?
Did ‘open an account’ takes you to open-end fund? It is under other services.
Did ‘purchase traveler’s cheques’ take you to ‘request cheque book’?

Attention

We follow an information ‘scent’ towards our goal

- The goal-seeking strategy is strong across many systems
- Suggesting systems should lead users to their goals
- But how do you know the user’s goals?
- Options should be clear for each goal
- Misleading messages can be difficult at decision points in the scent to a goal

Attention

Yes or no is better than OK and cancel

confused?

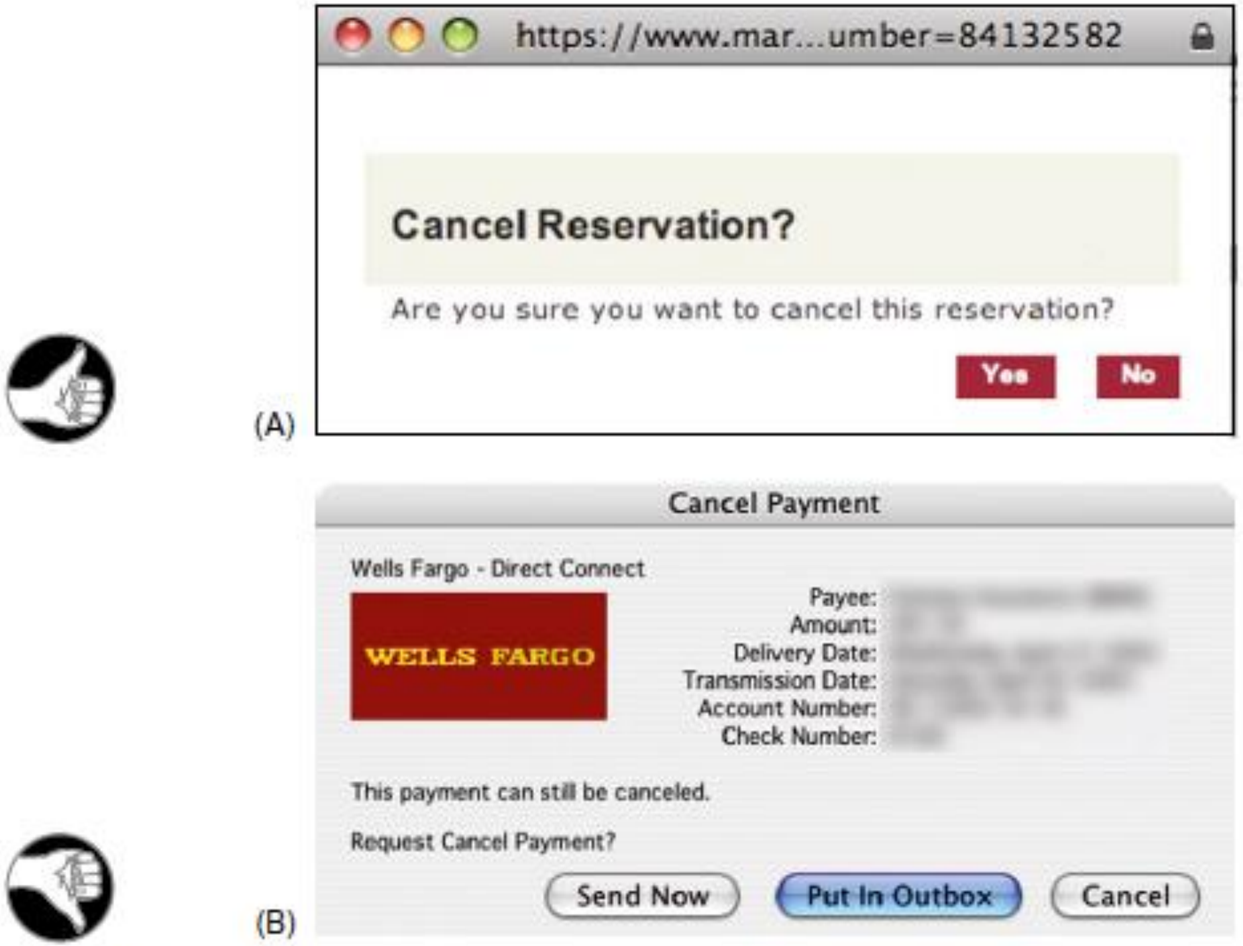

FIGURE 8.4

Marriott's cancellation confirmation (A) provides clearer scent than Quicken's (B).

Attention

We prefer familiar paths

- Especially when working under deadlines
- Exploring new paths is problem solving
- Following known paths can be done automatically
- Users will continue to use a path they know even if they are aware that an easier, quicker and better way is available.
- People are willing to do more in order to think less.

Attention

Design implications

- Guide – software should show users to their goals, provide a clear information scent
- Make it easy for users to switch to a faster path after they have gained experience.
- Keystrokes are not always important
  - Infrequently used software, e.g. ATM machines, does not need to be concerned with the number of keystrokes but more with ease of use.

Attention

Goal, execute, evaluate

Over several decades scientists have discovered we follow a thought cycle:

- Form a goal
- Choose and execute actions
- Evaluate have the actions worked
- Repeat until the goal is reached

FIGURE 8.6

ITN's flight reservation system clearly shows users' progress toward making a reservation.

Attention

- ***Goal:*** Buy airline ticket to Berlin, using your favorite travel Web site.
- ***Step 1:*** Go to travel Web site. You are still far from the goal.
- ***Step 2:*** Search for suitable flights. This is a very normal, predictable step at travel Web sites.
- ***Step 3:*** Look at search results. Choose a flight from those listed. If no flights on the results list are suitable, return to Step 2 with new search criteria. You are not at the goal yet, but you feel confident of getting there.
- ***Step 4:*** Go to checkout. Now you are getting so close to your goal that you can almost smell it.
- ***Step 5:*** Confirm flight details. Check it—all correct? If no, back up; otherwise proceed. Almost done.
- ***Step 6:*** Purchase ticket with credit card. Check credit card information. Everything look OK?
- ***Step 7:*** Print e-ticket. Goal achieved.

Design Implications

ATTENTION

goal

Provide clear paths for the goals the software is intended for, including the initial steps.

execute

Design objects and actions on the task. Provide a scent to guide the user without taking them away from their goal.

evaluate

Provide feedback and allow users to go back to achieve their goal.

Attention

We forget to cleanup

- Short-term memory is what is the focus of our attention
- This is partly our current goal
- Our attention resources are directed toward obtaining information to complete our goal
- Our focus switched from higher level goals to lower level goals and back again when tasks are completed.
- When we complete a task we release it from our focus i.e. we forget about it

Attention

We often forget to:

- Switch off car headlights
- Remove documents from copiers and scanners
- Turn off cookers or ovens
- Turn off indicators if not reminded
- Leave books or magazines on seats when leaving
- Set devices back into the normal mode after using a different mode

Attention

We can design systems to aid cleaning up

- Cars turn off indicators or use aural reminders
- Cars switch off car headlights automatically when the car is no longer in use
- Copiers and scanners indicate the task is incomplete
- Devices revert back into the normal mode after a set period of time.

Recognition & Recall

3

Recognition & Recall

RECOGNITION
& RECALL

Recognition

- New perceptions similar to the original ones reactivate the same patterns of neurons.

Recall

- If no similar perception exists, stimulation from activity in other parts of the brain can also reactivate a pattern. This awareness results in recall.

Recognition & Recall

RECOGNITION
& RECALL

Recognition is easy

- We need to be able to recognize things quickly for survival
- Recalling memories is not so important
- Similar perceptions in similar contexts cause similar patterns in neural activity
- Repeated activation makes it easier to reactivate the pattern
- Recognition is essentially perception & long-term memory working together

Recognition & Recall

RECOGNITION
& RECALL

Recognition is easy

- Patterns of neural activity (memories) can be activated in 2 different ways:

1. Perceptions
2. Other brain activity

- If a perception is similar to an earlier one,
  - and the context is close enough,
  - it stimulates a similar pattern,
  - resulting in a sense of recognition

Recognition & Recall

RECOGNITION
& RECALL

Recognition is easy

- We assess situations quickly
- Ancestors needed to know if an animal was potential food or a threat immediately
- We recognize faces very quickly
- We don't recognize faces quickly
- The same face perceived again reactivates the same pattern , only easier than before
- This is *recognition*

Recognition & Recall

RECOGNITION
& RECALL

Recall is hard

- Recall is when old patterns are reactivated without perceptual input
- We have developed without the immediate necessity for recall but the ability of recall
- We use aids to help us with recall such as
  - Notes for speeches
  - Diaries for dates
  - Address books
  - Calendars for appointments

Implications for UI design

RECOGNITION & RECALL

Graphical User Interfaces (GUI)

- The ease of recognition verses the difficulty in recall is seen in GUI design
- The GUI is based on two well-known UI design rules:

1. See & choose is easier than recall & type
2. Use pictures where possible to convey function

Recognition & Recall

RECOGNITION
& RECALL

See and choose

- Show users their options
- Allow them to choose
- Not require the user to recall what they want
- Recognition rather than recall is one of the widely used heuristics for UI evaluation
- Recall and type can be used such as search boxes

Recognition & Recall

RECOGNITION
& RECALL

Use pictures

- Users recognize pictures very quickly
- Also stimulates related information recall
- Only good if the familiar meaning matches the intended meaning
- GUIs originated in the 1970's & were widely used throughout the 1980's and 1990's
- Additional design rules based on human perception have been added.

Recognition & Recall

RECOGNITION
& RECALL

Additional UI design rules

- Use thumbnail images
  - the features are important – even if they are smaller
- Popular functions should be more visible
  - Users can recognize rather than recall options
- Use visual clues to let users know where they are
  - Visual recognition is fast and reliable
  - Web site pages have a shared distinctive style
- Make authentication information easy to recall
  - Use password hints, don't restrict password choices excessively

Conclusion

Designing interactive systems should augment, not burden, memory

There are several components of short-term memory including residual perceptions and long-term memory

Volatile and low capacity are characteristics of short-term memory

Attention is limited

We focus on our goals not our tools

Recognition is easier than recall

References

Johnson J. (2010) *Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules*. Morgan Kaufmann, San Francisco

Thank You!

any questions?