

Human Factors

Chaklam Silpasuwanchai

Asian Institute of Technology

chaklam@ait.asia

Overview

① Perception

- Biases
- Structure
- Limitations
- HCI and vision
- Design implications

② Memory

- Design implications

③ Cognition

- Attention
- Learning
- Reasoning
- Design implications

Sources

- Jeff, **Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Guidelines**, 2nd ed. (2014).
- Mackenzie, Chapter 2, **Human Factors**, Human Computer Interaction: An Empirical Research Perspective, 1st ed. (2013)

HCI challenge

- **Human variability** is the biggest challenge of HCI
- Obviously, understanding humans increase our success
- Here, we discuss human **perception, memory and cognition**

① Perception

Biases

Structure

Limitations

HCI and vision

Design implications

② Memory

Design implications

③ Cognition

Attention

Learning

Reasoning

Design implications

Perception

- **First stage of processing** in the brain, occurs when sensory signals are received as input. It is at this stage human makes meanings
- Perception has been studied in a area of experimental psychology known as **psychophysics** - examines the relationship between perception and physical phenomena

Facts about Perception

- ① Our perception is biased by
 - our goals
 - our belief
 - our experience
 - the context
- ② Our vision is optimized to see structure
- ③ Our color vision is limited
- ④ Our peripheral vision is poor
- ⑤ Visual search is linear unless target "pops"
- ⑥ Reading is unnatural

Our perception is biased...



Our perception is biased...

Page 3

Back

Next

Back

Page 4

Next

Our perception is biased...

Exactly same character



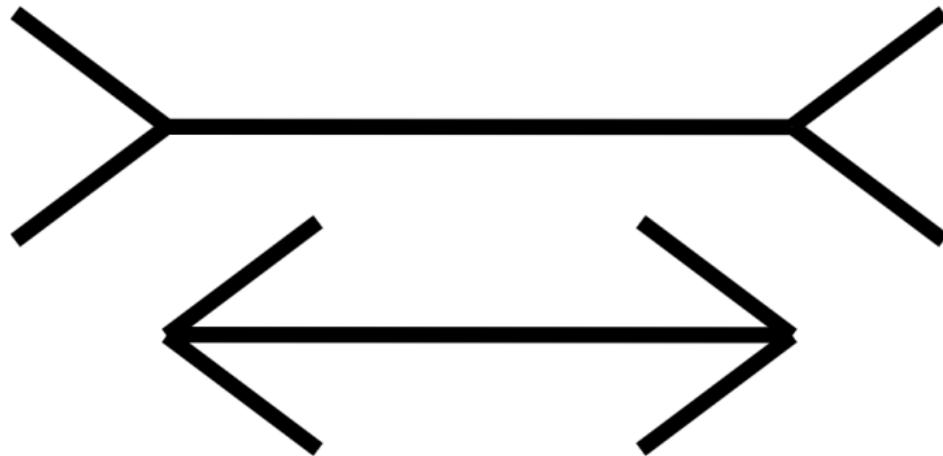
Our perception is biased...

But our perception can be changed based on the **context**

THE CHT

Our perception is biased...

Muller-Lyer illusion



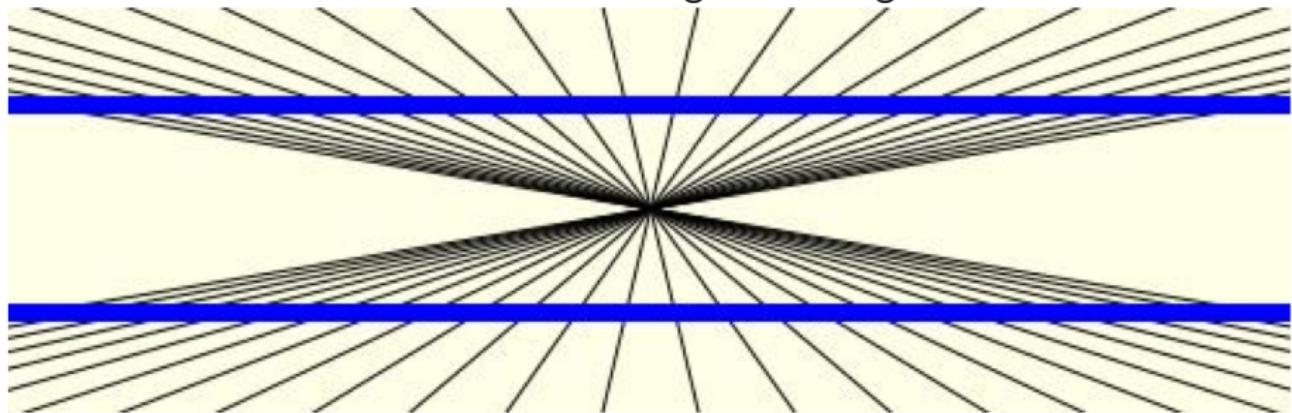
Our perception is biased...

Muller-Lyer illusion



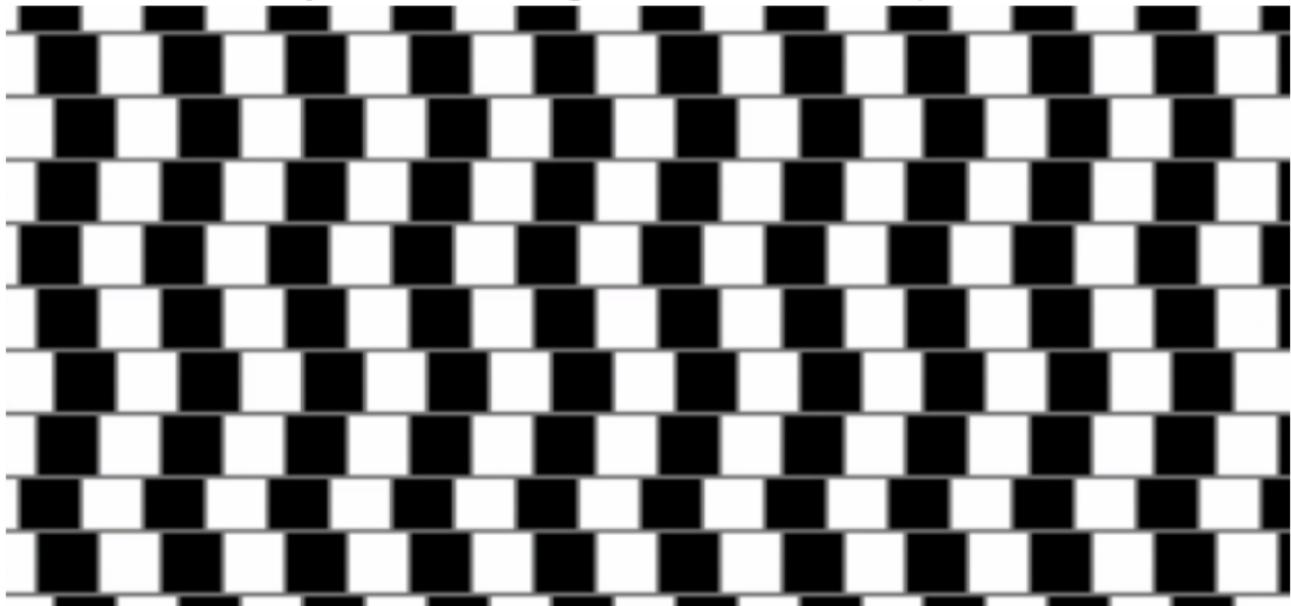
Our perception is biased...

All lines in this image are straight!



Our perception is biased...

Gray lines are straight, horizontal, and parallel!



Our perception is biased by goals

- Our perception is biased toward our **goals**
- Tend not to notice things unrelated to goals

Our perception is biased by goals

The homepage of the University of Canterbury's website features a navigation bar with links to Study, Courses, Departments, Students, Research, Teaching, Contact, a Search bar, and a magnifying glass icon. The main content area is divided into several sections: 'Courses' (with a video thumbnail of a student), 'International' (with a video thumbnail of a landscape), 'Liaison' (with a video thumbnail of two people), 'More Engineering' (with a video thumbnail of two people), 'Scholarships' (with a 'more' button), 'Postgraduate' (with a video thumbnail of a computer screen displaying 'ONE UNIVERSITY OF CANTERBURY'), and 'Nau mai, haere mai ki te Whare Wānanga o Waitaha' (with a video thumbnail of a landscape). Below this, there are sections for 'Information for' (Prospective Students, International Students, Postgraduate Students, Current Students, Visitors and Community, Business and Industry, Alumni and Friends, Prospective Staff) and 'Quick Links'.

Information for	Quick Links
Prospective Students	>
International Students	>
Postgraduate Students	>
Current Students	>
Visitors and Community	>
Business and Industry	>
Alumni and Friends	>
Prospective Staff	>

NEWS

News Feature


Expert to talk about captive elephants

6 May 2013 | Erin Ivory, one of the world's leading

WHAT'S HAPPENING

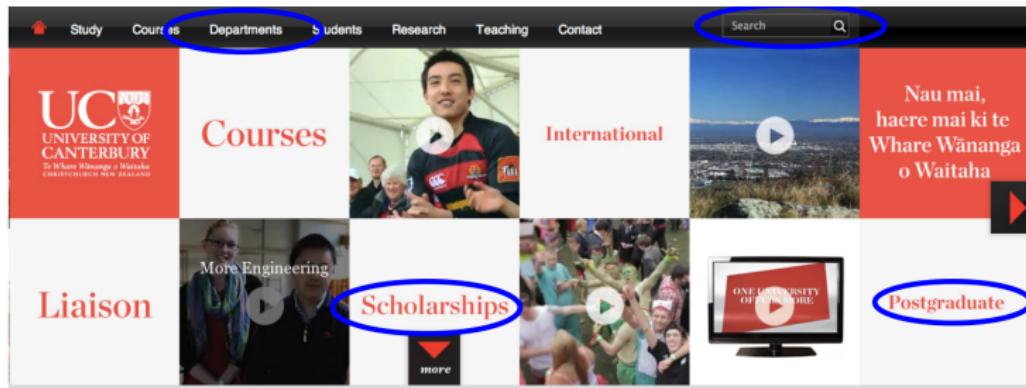
Events


Introducing the UC Careers Kit

Explore over 70 major subjects and discover where a UC degree can take you.

Congratulations!
You have been randomly selected to win \$100!
Claim at Bursars' Office,
with Reward Code 03D4X

Our perception is biased by goals



Information for

Quick Links

- Prospective Students
- International Students
- Postgraduate Students** (circled in blue)
- Current Students
- Visitors and Community
- Business and Industry
- Alumni and Friends
- Prospective Staff

NEWS

News Feature



Expert to talk about captive elephants
6 May 2013 | Erin Ivory, one of the world's leading

WHAT'S HAPPENING

Events



What can I do with a degree from UC?

Introducing the UC Careers Kit

Explore over 70 major subjects and discover where a UC degree can take you.

Congratulations!
You have been randomly selected to win \$100!
Claim at Bursars' Office
with Reward Code 03D4X

Our vision is optimized to see structures

Gestalt Principles of Visual Perception

- Proximity
- Similarity
- Continuity
- Closure
- Symmetry
- Figure/ground
- Common fate

Proximity

Items that are closer appear grouped

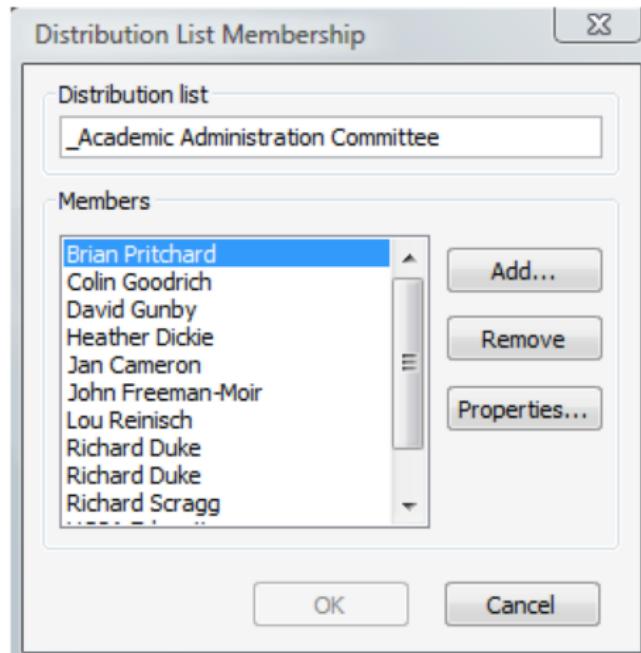


Left: rows



Right: columns

Proximity



Proximity

Orchidaceae - Wikipedia, the free encyclopedia

en.wikipedia.org/wiki/Orchidaceae ▾

Orchids are easily distinguished from other plants, as they share some very evident apomorphies. Among these are: bilateral symmetry (zygomorphism), many ...

[Etymology](#) - [Distribution](#) - [Taxonomy](#) - [Characteristics](#)

orchids, gift orchids, hobby growing

www.orchids.com/ ▾

Orchids.com Logo, Login | Home | My Account | Customer Service · Sign In or Register | Shopping Cart. 1-888-4ORCHID (1-888-467-2443) - 9 am-5 pm (Pacific) ...

Pacific Orchid Exposition - San Francisco Orchid Society

www.orchidsanfrancisco.org/poe.html ▾

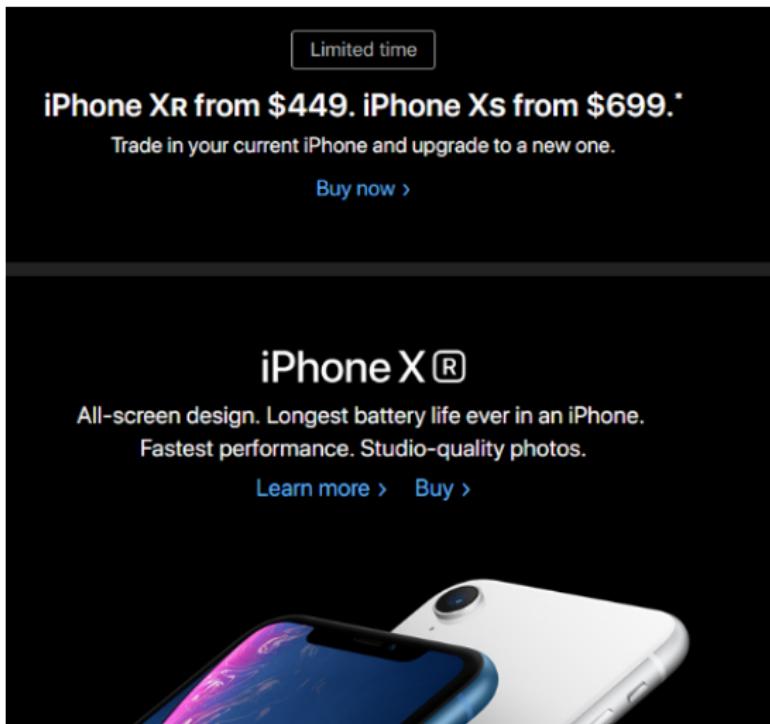
The San Francisco **Orchid** Society would like to express its thanks to the Taiwan Tourist Bureau CBS and KCBS for their continued support in production and ...

Orchids in the Park - San Francisco Orchid Society

www.orchidsanfrancisco.org/orchidsinthepark.html ▾

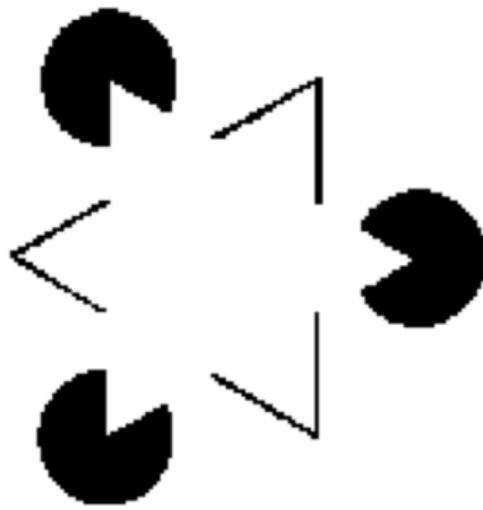
Thanks to all volunteers and attendees for a successful "Orchids In The Park" event. --
Images by Jeff Harris. --Images by Jeff Harris. <back to top> ...

Proximity



Closure

We tend to see whole, closed objects, not collections of fragments



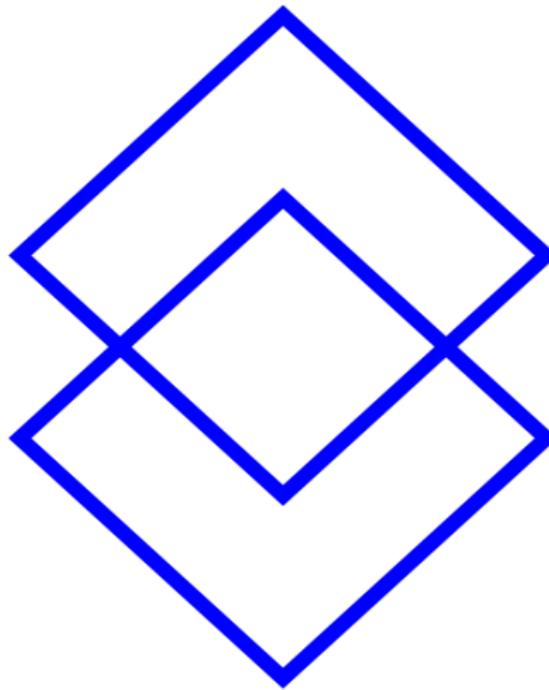
Closure

We tend to see whole, closed objects, not collections of fragments



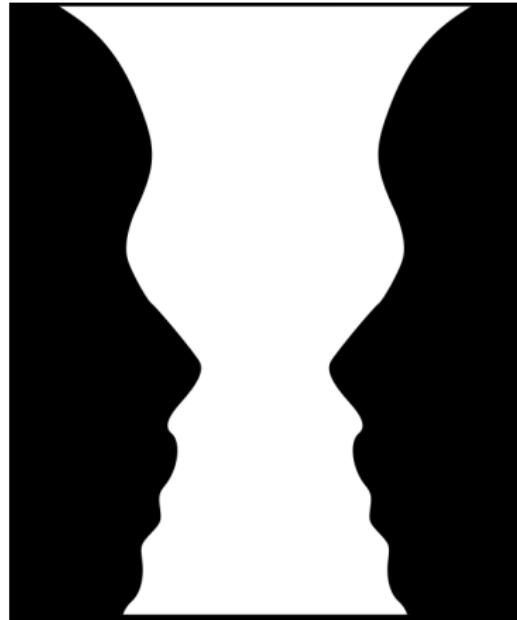
Simplicity

We tend to see simple figures rather than complex ones



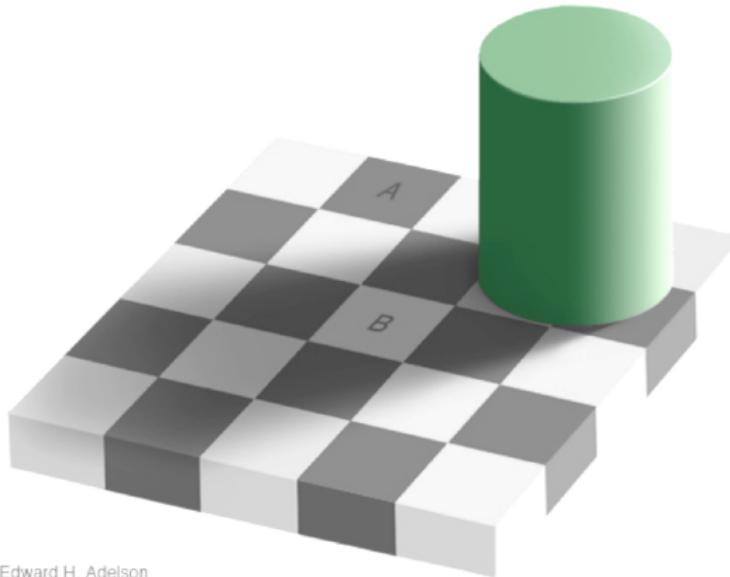
Figure/Ground

The tendency to simplify based on the figures and the grounds



Our color vision is limited...

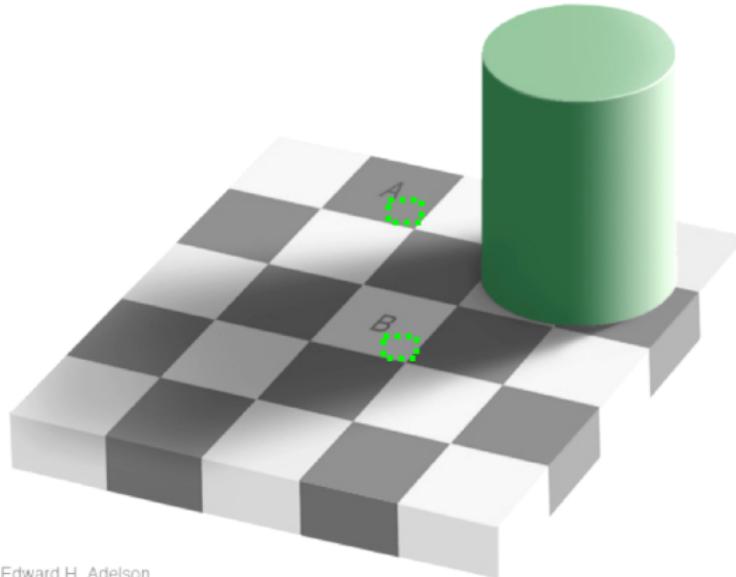
Optimized to see contrasts, edges, and changes, not absolute levels



Edward H. Adelson

Our color vision is limited...

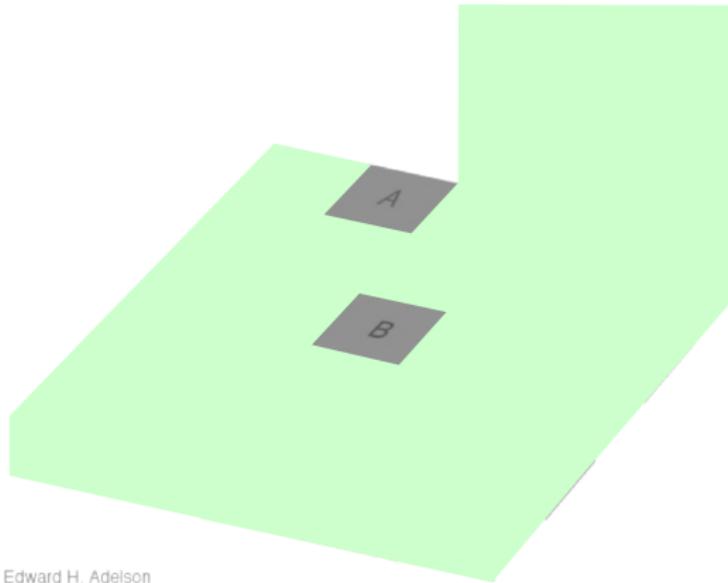
Optimized to see contrasts, edges, and changes, not absolute levels



Edward H. Adelson

Our color vision is limited...

Optimized to see contrasts, edges, and changes, not absolute levels



Our color vision is limited...

We have trouble discriminating - pale colors, small color patches, separated patches...



Our color vision is limited...

We have trouble discriminating - pale colors, small color patches, separated patches...



Our color vision is limited...

We have trouble discriminating - pale colors, small color patches, separated patches...

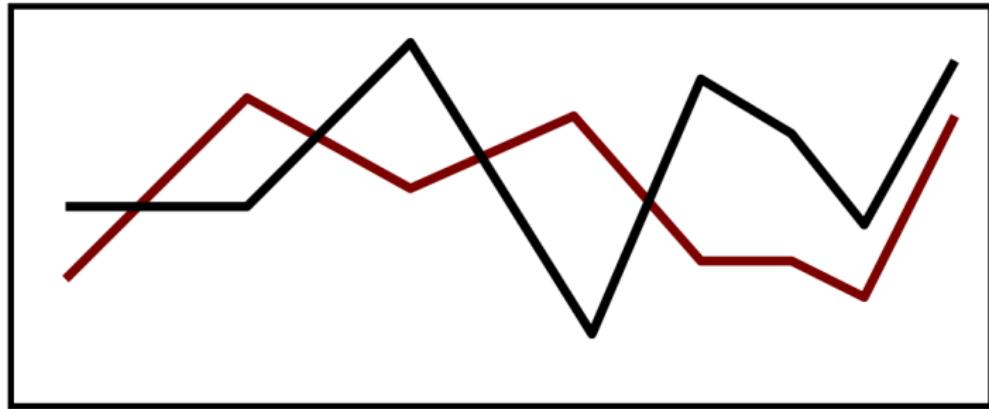


Our color vision is limited...

Some people have color blindness

- 8% of males
- 0.5% of females

colors that would be hard for red-green colorblind people to distinguish



Our color vision is limited...

Most common forms of color blindness - red-green called deutanopia

Google: normal



Google: deutanopia



Our color vision is limited...

Don't use colors only! Also rely on other things like shapes or cues

E.g., Let's improve ITN.net

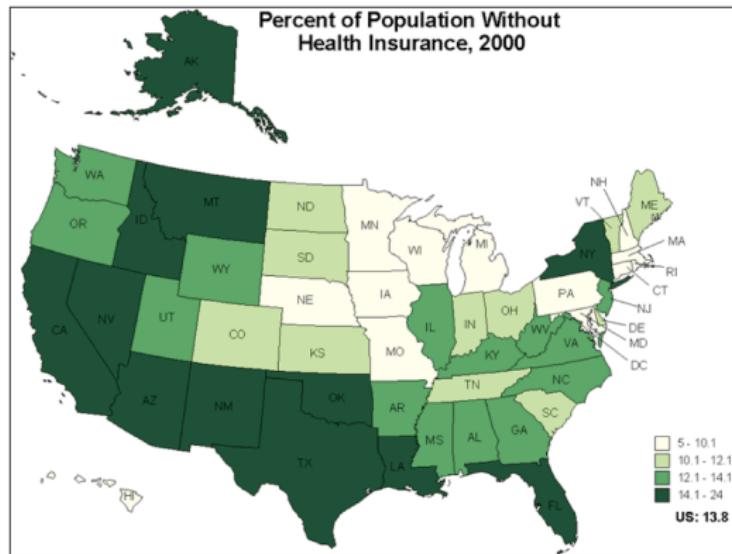


How *they* improved it:



Our color vision is limited...

Don't use subtle color differences. Should still look different in gray scales.
Bad examples below....



Our peripheral vision is poor...

Our view of vision is actually narrow...

Invalid Pin No. Please try again.

Login

For best results, Netscape Navigator 3.x or higher is recommended.

ID

Pin No

[Change your PIN](#)

Our peripheral vision is poor...

Bad design...

RETURNING CUSTOMER LOGIN

Login ID not found.

Login ID:

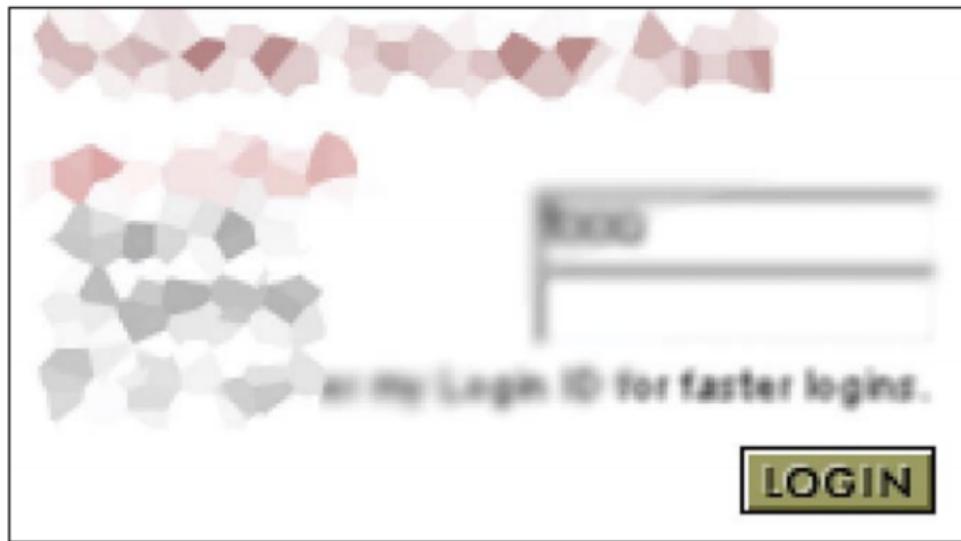
Password:

Remember my Login ID for faster logins.

LOGIN

Our peripheral vision is poor...

Simulating the fovea...



Our peripheral vision is poor...

Better design...

The screenshot shows a web browser displaying the **informaworld** homepage. The top navigation bar includes links for **eBooks**, **Journals**, **Reference Works**, and **Abstract Databases**. Below this, there's a search bar with the placeholder "Search entire site" and a "GO" button. Another search bar below it says "Explore informaworld" with its own "GO" button. To the right of these are links to "Browse Publications A-Z", "Browse Subjects A-Z", and "Advanced Search". The main content area is titled "My Account" and features a "Register" button. Below the register button, there are two sections: "Personal Registration" and "Institutional Registration". Under "Personal Registration", it says: "Creating a personal account will allow you to create marked lists, request email alerts, set up personal subscription access and buy personal subscriptions online." There is also a note about institutional registration: "Register your institution to purchase an online subscription for your organisation." A note states: "Note that accounts already exist for subscriptions purchased off-line. Please contact us for more information." Below this, a link says "Already registered? - Please sign in to access an existing account." At the bottom of the registration form, there is a "Sign in" button and a link "[forgotten password?]". To the right of the "Sign in" button, a red warning message is displayed: "⚠ Username/password combination was not recognised." The URL in the browser's address bar is <http://www.informaworld.com/auth/register>.

Our peripheral vision is poor...

Better design...

Create a Free Email Address

[Already a Member? Click here](#)

* First Name: 

* Last Name: 

* Desired Email Address: @aol.com
3-16 letters or numbers. It must start with a letter.

* Password: Password Strength 
Please enter a Password that is 6-16 characters using only letters and numbers.
6-16 letters or numbers.
[Help for creating a secure password.](#)

HCI and vision

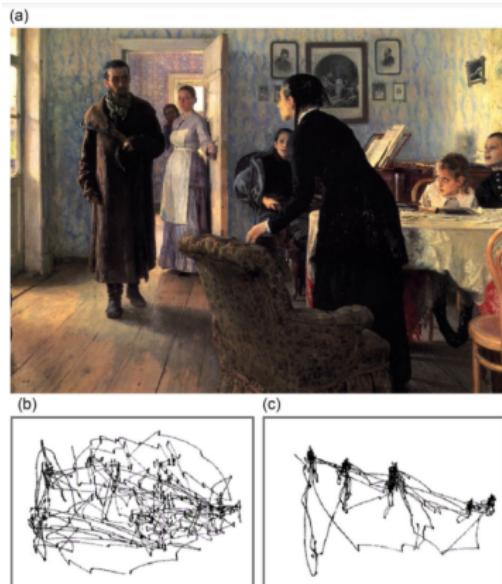


FIGURE 2.6

Yarbus' research on eye movements and vision (Tatler et al., 2010). (a) Scene. (b) Task: Remember the position of the people and objects in the room. (c) Task: Estimate the ages of the people.

Figure: Source: Fg 2.6 (Mackenzie)

HCI and vision

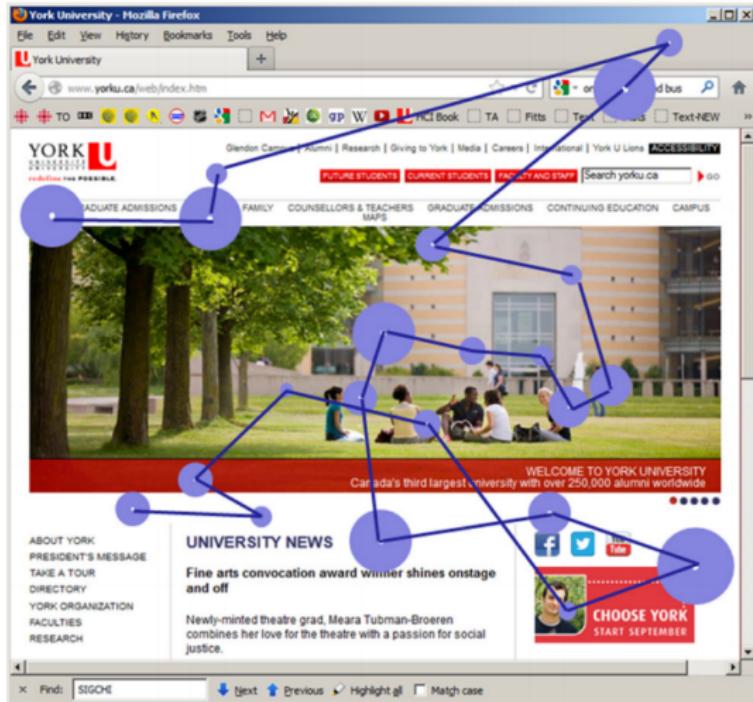
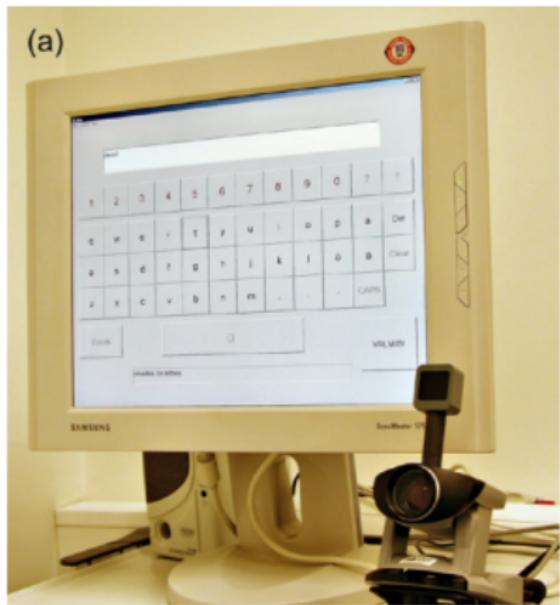


FIGURE 2.7

Scanpath for a user locating content on a web page.

HCI and vision



(b)

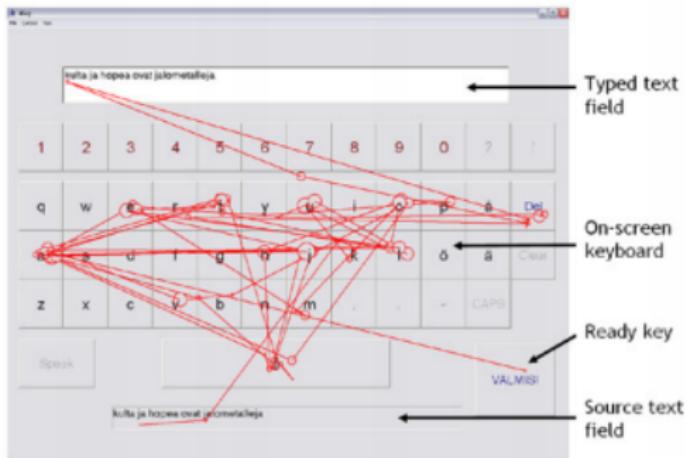


Figure: Source: Fg 2.13 (Mackenzie)

Design implications

- **Don't believe what users say;** instead understand their goals and knowledge (and what they don't know)
- Always exploit **structure** rules
- Use **color** very carefully
- Humans can focus only at **very tiny spot**. Thus put where users are **looking**
- Use **affordance, convention, constraints, mapping** can increase visual search speed

① Perception

- Biases
- Structure
- Limitations
- HCI and vision
- Design implications

② Memory

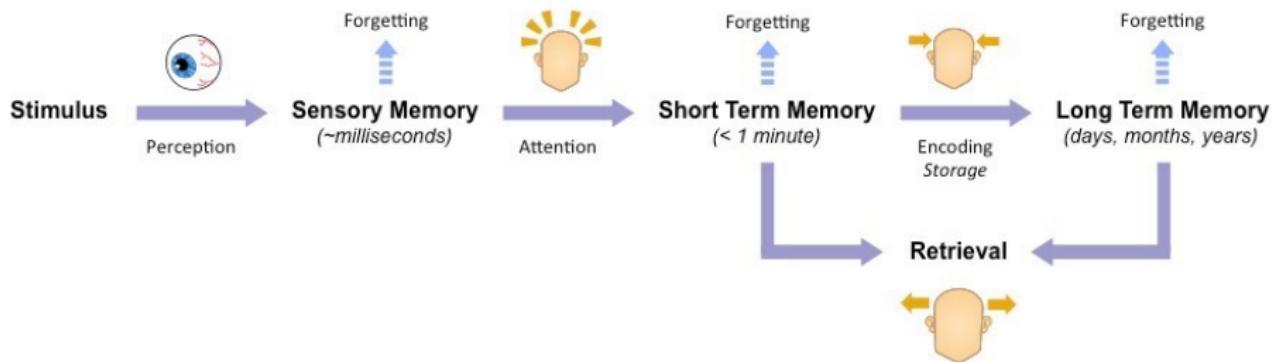
- Design implications

③ Cognition

- Attention
- Learning
- Reasoning
- Design implications

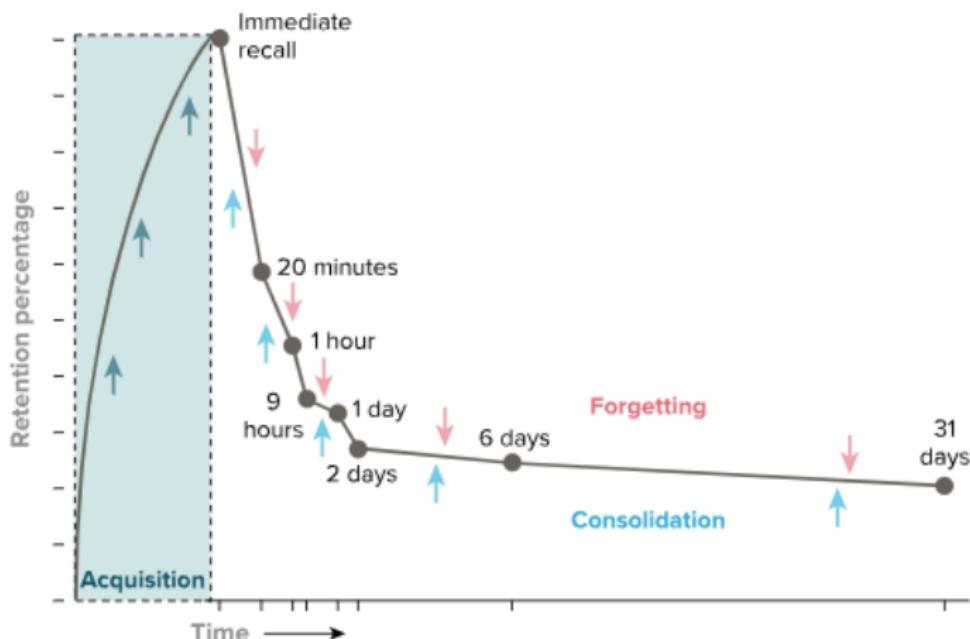
Our memory is imperfect

- Short Term Memory (STM or WM)
- Long Term Memory (LTM)



Our memory is imperfect

Memory strength over time



SOURCE: R.L. DAVIS & Y. ZHONG / NEURON 2017

KNOWABLE MAGAZINE

Short-term memory

- Also known as working memory
- Can remember around 7 (± 2) unrelated items (3-5 are better estimates, according to Jeff)
- Can stay for around < 1 minute
- **Chunking** improves our short-term memory

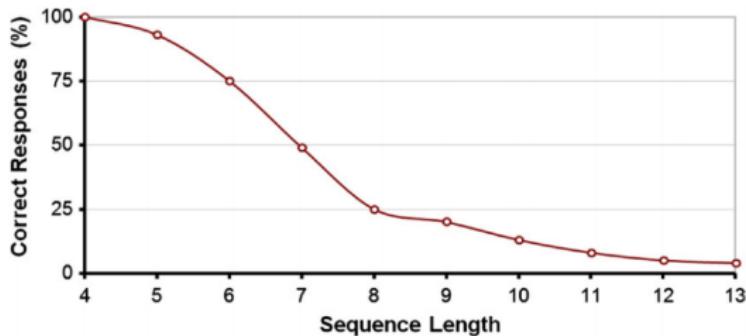


Figure: Source: Figure 2.18 (Mackenzie): Digital lengths and memory

Chunking

Deploy and scale seamlessly

Our optimized configuration process saves your team time when running and scaling distributed applications, AI & machine learning workloads, hosted services, client websites, or CI/CD environments.

Deploy

Manage

Secure

Scale

Monitor



Cluster deployments

Provision multiple Droplets (virtual machines) in seconds with our control panel, CLI, or directly against our API.



Optimized compute types

Get the compute resources you need with Standard or Optimized Droplets.



One-click apps

Skip the install and configuration process with pre-built open source images supporting Rails, Cassandra, Docker, and more.



Global availability

Deploy to any of our data center regions around the world.

Long-term memory

- Stores life time experience but prone to error and biases
- Similar experience trigger same patterns > **recognition**
- Internal neural activity triggers pattern > **recall**
- Why we forget?
 - **Decay theory:** proposes that memory fades due to mere passage of time - active rehearsing information is believed to counter this temporal decline
 - **Interference theory:** proposes that similar information can make memories less accessible

Provide external memory aids

$$5+6*7/3 =$$

19

Provide external memory aids

The use of flagging helps...

Mailboxes

	Inbox	7
	Flagged	185
	Red	7
	Yellow	92
	Drafts	92
	Sent	
	Junk	692
	Trash	
	All Mail	408

Smart Mailboxes

	Recovered Me...	
--	-----------------	--

Google

	Important	13
	Boomerang-O...	
	CHI-list	2
	CSCW	
	Interaction De...	

Sort by Unread

- **Slideshare** 11:25
More content like "[ID] Week 02. Un...
SlideShare is now on Android. Get the app We found something with that mi...
- **Kyoko Hatakenaka** 11:10
[renlab 02543] Fwd: [kut 06647] (...
Dear all, University will do power outage work from 8:30 to 16:30 on A...
- **Patiphan Pholmat** 11:03
✉ Accepted: Open House Meeting
Attachment: Mail Attachment.ics
- **CHI-JOBS automatic digest...** 11:02
CHI-JOBS Digest - 3 Aug 2017 to 7...
There are 2 messages totaling 83 lines in this issue. Topics of the day: 1...
- **CHI-ANNOUNCEMENTS auto...** 11:01
CHI-ANNOUNCEMENTS Digest - 6...
There are 11 messages totaling 1538 lines in this issue. Topics of the day: 1...
- **Apiporn Simapornchai** 11:00
✉ Accepted: Open House Meeting
Attachment: Mail Attachment.ics
- **Quora Digest** 07:34
What laptop do I buy for deep learni...

Apiporn Simapornchai

Declined: Open House Meeting

To: Chaklam Silpasuwanchai



Mail Attachment

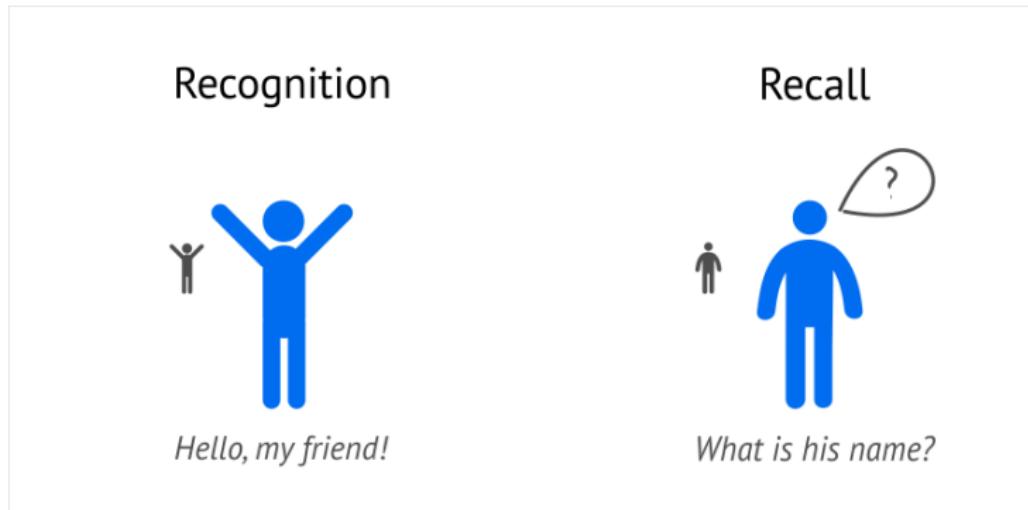
Provide external memory aids

```
STIU-M-00101:~ csilpasuwanchai$ history
1 ipconfig
2 ifconfig
3 ping 10.10.101.62
4 ping Server returned error: "334
5 Server returned error: "334
6 ping smtp.office365.com
7 java -version
8 cd /System/Library/Java/
9 ls
10 ls
11 cd ..
12 ls
13 cd ..
14 ls
15 cd /Library/
16 ls
```

History of commands helps...

Recognition much faster than recall

- Use menus and metaphors
- Use auto-completion if recall is really needed



Design Implications

- Use **convention** and **consistency**
- Use **recognition** instead of recall when possible (but do not forget ways for novice to transition to experts)
- Use **chunking** when possible; 3-5 rule
- **Put the knowledge in of the world** (Norman, 1988), e.g., bookmarks, history of commands, tagging, time stamping, reminders, marked emails, pwd etc.

① Perception

- Biases
- Structure
- Limitations
- HCI and vision
- Design implications

② Memory

- Design implications

③ Cognition

- Attention
- Learning
- Reasoning
- Design implications

Attention

- Our attention is limited
- Goldfish has an attention span of 9s, guess how much is of humans? 8s! (In 2000, our attention span is 12s)
- Do you remember what I discuss in the previous slide? What did you eat yesterday morning?



Our attention is on the goal, not the tools/person

<https://www.youtube.com/watch?v=FWSxSQsspiQ>



Loose ends

- When we finish our goal, we often forget the "loose ends" of tasks
 - Turning headlights of car off
 - Forgetting to take your ATM card after withdrawing money



End with action

DigitalOcean Products Customers Community Pricing Docs Support Login Sign Up

Do more with Droplets

Discover your infrastructure's potential with the help of over a thousand easy-to-follow development and system operation tutorials.

TUTORIALS

How To Automate the Scaling of Your Web Application on DigitalOcean Ubuntu Droplets

PRODUCT DOCS

How to use Block Storage on DigitalOcean

PRODUCT DOCS

An Introduction to DigitalOcean Monitoring

[Check out more tutorials](#)

Ready to get started?

[Create your account](#)

© 2019 DigitalOcean, LLC. All rights reserved.

Company
About
Careers

Products
Droplets
Spaces

Community
Tutorials
Meetups

Support
Contact Support
FAQ

NEWCHAPTER Home Products Health Needs Ingredients Our Difference Shop My Account

New chapter. You subscribe today! Get this off your monthly automatic bill.

The New Chapter tradition.

New Chapter® was founded over 15 years ago to bring natural wellness to others. We believe in the healing power of nature, and that's why we're committed to using whole food and quality ingredients to make our supplements.

[EXPLORE OUR STORY](#)

Stay in touch

Sign up for our newsletter today for wellness tips and special offers.

Email Address

[SIGN UP](#)

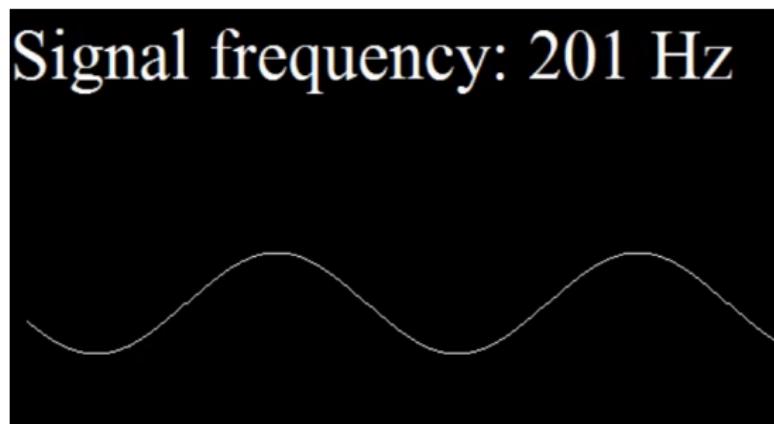
Don't worry, you can unsubscribe at any time.

[Facebook](#) [Instagram](#) [Twitter](#) [Pinterest](#) [YouTube](#)

Hearing capabilities

- Human hearing begins with sounds of 0-10dB. Conversational speech is about 50-70 dB. Painful sound is about 120-140 dB
- Pitch is the frequency and human can perceive sounds in the range of 20Hz to 20,000Hz (mine was 200Hz! How about yours?)

<https://www.youtube.com/watch?v=qNf9nzvnd1k>



Multitasking

- Humans cannot really multi-task, we can only quickly switch between multiple tasks in ms

<https://www.youtube.com/watch?v=vJG698U2Mvo>



Learning

- **Convention** helps learning
- **Feedback** helps learning
- **Risk** is low
- **Reward** is high

Convention helps learning

Always preach...follows convention!

Products	About	Legal	Resources
Vitamins	Our Science	Terms & Conditions	My Account
Herbals	Our Tradition	Retailer Policy	Blog: Unlocking Wellness
Fish Oil	Ingredients	Privacy Policy	Newsletter
Booster Powders	New Chapter Rewards	Our Guarantee	Recipes
Mushrooms	Contact Us	Accessibility Notice	Digital Resources
Probiotics	Careers		
Calcium	FAQ		

* These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.

* Limited time introductory offer.

© Copyright 2019 P&G

Convention helps learning

Always preach...follows convention!

The screenshot shows the homepage of NewChapter.com. At the top, there's a purple header bar with the text "Always preach...follows convention!" in white. Below it is a sub-header with the text "Use our store locator to find products at a shop near you." In the main navigation area, there's a logo for "NEWCHAPTER.", followed by a horizontal menu with links: Home, Products, Health Needs, Ingredients, Our Difference, and Shop. To the right of the menu is a "My Account" section with icons for search, user profile, and shopping cart. A red banner below the menu encourages users to subscribe with the text "Save when you subscribe today! Get 15% off your monthly subscription."

Bring wellness home.

Our products are made with your well-being in mind.

You'll feel good about choosing New Chapter[®] – our multivitamins are all Non-GMO Project Verified and we strive to create products made with certified organic vegetables and herbs. We use only the highest quality ingredients, just for you.

Convention helps learning

Convention is about "stealing" but make it better

The screenshot shows a product search results page for 'convention' on the Nike website. At the top, there are filters for 'BRAND', 'COLLECTIONS', 'FIT', and 'COLOR'. The main content area displays a grid of five items per row, with two rows visible. Each item includes a small image, the product name, and a price.

Category	Product Name	Color	Price
BRAND	Nike Men's 2-in-1 Running Shorts	2 Colors	\$100
	Nike Therma Sphere Men's Running Pants	2 Colors	\$120
COLLECTIONS	Nike Sportswear Men's Hoodie Jacket	4 Colors	\$100
	Nike Sportswear Windrunner Men's Hooded Jacket	4 Colors	\$110
FIT	Nike Sportswear Club Fleece Men's Jogger	7 Colors	\$45
	Nike Sportswear Tech Fleece Men's Slim Fit Cargo Pants	4 Colors	\$100
COLOR	Nike Sportswear Tech Pack Men's Fleece Joggers	8 Colors	\$40-\$110
	Nike Sportswear Tech Fleece Icon Men's Stretch Joggers	3 Colors	\$120

Feedback helps learning

Feedback informs us how to become better



Risk is low

- **Cheap failures** - no ways to make errors; easy to recover



Rewards

- If you decide to break the cycle and reinvent something new
 - make sure its **reward exceeds learning effort**
 - make sure it's **learnable** and able to master over time!
 - even better, **expert can still learn** something, i.e., novice vs. expert mode
- **Games** are fun, because everytime we play, **we get better, to no limits.** (Self Determination Theory, 1985)



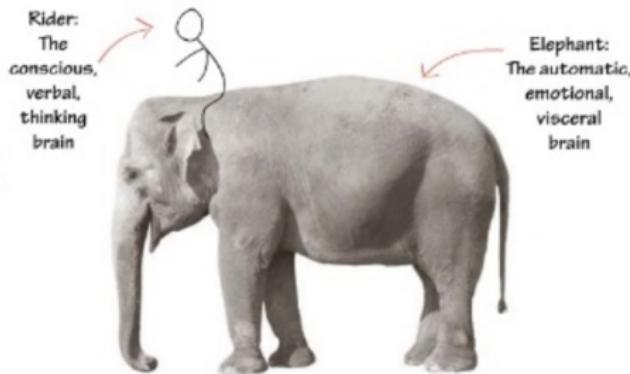
System 1 and System 2

- Our brain has two systems: system 1 and system 2
- **System 1** is the *irrational* brain - fast, automatic, unconscious, yet govern most of our behavior
- **System 2** is the *rational* brain - slow, precise, conscious, "believes" it governs our behaviors

System 1 and 2

One brain, two minds

- Elephant = impulsive mind
- Rider = Rational mind
- Path = the environment



Willpower is the strength of the rider

System 1 and System 2

- A baseball and a bat together cost 110. The bat costs 100 more than the ball. How much does the ball cost?
- System 1 instant answer: 10 (wrong)
- System 2 may reject that answer. Or not.
- System 2 can calculate correct answer; System 1 cannot.

Human decisions are rarely rational

System 1 usually controls decisions but is very biased.

- **Losses** mean more than **gains**
- **Recent** history and strong memories "feel" more
- **Experience** and **intuition** means more than mountains of statistics and data
- People **avoid risks** for potential gains, but **take risks** for potential losses
- Influence by **word** (75% survival rate vs. 25% mortality rate)

Human decisions are rarely rational

Kahneman and Tversky: Fourfold Pattern

	Gains	Losses
High Probability Certainty effect	95% chance to win \$10k Fear of loss Risk Averse	95% chance to lose \$10k Hopeto avoid loss Risk Seeking
Low Probability Possibility effect	5% chance to win \$10k Hopeto gain Risk Seeking	5% chance to lose \$10k Fear of loss Risk Averse

- TL - eye surgery with 95% success but afraid of eye loss
- TR - desperate investment with 95% failure but still do it
- BL - only 5% chance to win **lottery** but still do it
- BR - only 5% chance to lose, but get **insurance**

Human decisions are rarely rational



Human decisions are rarely rational



Design Implications

- **Prioritize** your information. People only have around a window of **5-8s**.
- Remind **loose ends** - e.g., return to default mode, disconnect after inactivity, end with action, etc.
- **Convention** and **feedback** helps learning.
- If it is something **new**, make sure learning is fun with **low risk** and **high rewards**.
- Don't assume people **will think or read or learn**. We are irrational.
- Test regularly and quantitatively. Don't only take **average** performance but take note of the **special** cases.

Activities

Classwork

- Download latest PEBL from <http://pebl.sourceforge.net/download.html>
- Perform the Muller-Lyer experiment 2 times. Combine the two csv files into one and perform analysis using any tool, e.g., Excel.
- Attempt to think of **three** research questions, **three** corresponding hypotheses, and perform **analysis**. Finally make a **50** words conclusion for **each** question.

The challenge is to think what are good scientific questions, and do proper analysis. Make sure all graphs have standard bar errors.

What's next

In following week, read my slide on **Test** and these complimentary resources:

- Mackenzie, Chapter 6, **Hypothesis Testing**, Human Computer Interaction: An Empirical Research Perspective, 1st ed. (2013)
- Yatani, Advanced Topics in Human-Computer Interaction,
<http://yatani.jp/teaching/doku.php?id=2016hci:start>

Please also download **JASP** for our next next week workshop.

Questions