Pitfalls in the Human Visual System

Slide 1 of 42

Pitfalls in the Human Visual System   *Can we trust our eyes?*

Radiologists are Experts in Perception

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
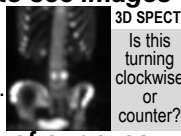Motion that's not there
Smooth Motion
Perspective
Colors ①
Length

Eyes are tools we use to see images
➤ It's not sufficient just to see the image with our eyes…
➤ We need our brains to interpret what our eyes see.

3D SPECT
Is this turning clockwise or counter?

Like any tool, we need to know the limitations of our eyes
➤ What are the "pitfalls" between the way our eyes see and our brain interprets?
Can we trust our eyes?

1 of 42

Slide 2 of 42

Pitfalls in the Human Visual System   *Can we trust our eyes?*

Parallel Lines

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ①
Length

Seeing parallel articular surfaces is an important concept in joint imaging

Parallelism = Anatomic
Parallel Lines ACJ
Parallel Arcs Glenohumeral Joint

Lack of Parallelism = Dislocation
Posterior Shoulder Dislocation

A,T 30yoM   T,C 35yoM

2 of 42

Slide 3 of 42

Pitfalls in the Human Visual System   *Can we trust our eyes?*

Parallel Lines

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ①
Length

It's easy to see these 2 lines are parallel

But if we add diagonal lines, they no longer appear parallel

3 of 42

Slide 4 of 42

Pitfalls in the Human Visual System   *Can we trust our eyes?*

Café Wall Illusion

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ①
Length

Straight rows of black/white bricks that don't appear straight

4 of 42

Slide 5 of 42

Pitfalls in the Human Visual System   *Can we trust our eyes?*

Café Wall Illusion

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ①
Length

Perception, 1979, vol 8, p 365-380   eyetricks.com
Café at the bottom of St Michael's Hill, Bristol, England
5 of 42

Slide 6 of 42

Pitfalls in the Human Visual System   *Can we trust our eyes?*

Café Wall Illusion

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ①
Length

opticalillusioncollection.com
Port 1010 building, Docklands region, Melbourne, Australia
6 of 42

©Ken L Schreibman, PhD/MD   1/25/15   www.schreibman.info

Pitfalls in the Human Visual System

Pitfalls in the Human Visual System *Can we trust our eyes?*

Café Wall Illusion

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
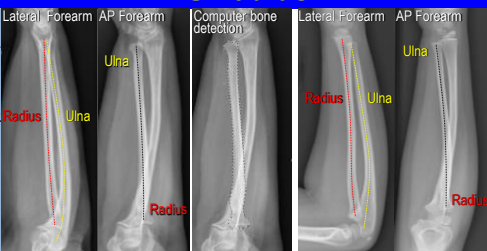Length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

youtube.com
"10 optical illusions in 2 minutes"

7 of 42

Pitfalls in the Human Visual System

Café Wall Illusion

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

2007 ARRS, Universal Studios, Orlando…
…Men In Black bathroom floor

Pitfalls in the Human Visual System *Can we trust our eyes?*

"Ulnadius"

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

Lateral Forearm | AP Forearm | Computer bone detection | Lateral Forearm | AP Forearm

Ulna, Radius, Radius, Ulna

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

Courtesy of Dr. Martin Crowe, Consultant Radiologist
The Queen Elizabeth Hospital, Norfolk, UK.

9 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Orientation is Important

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

I was taught a trained observer could read a chest radiograph upside down…

Perhaps I can convince you otherwise…

Basically normal

www.schreibman.info
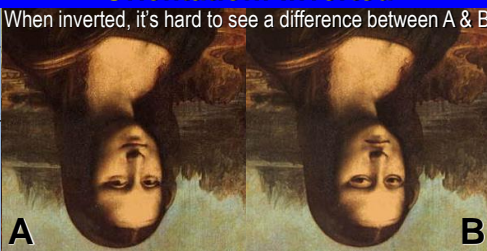© 2015 Ken L Schreibman, PhD/MD

10 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Orientation: Inverted

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

When inverted, it's hard to see a difference between A & B

A   B

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

exploratorium.edu

11 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Orientation: Side-by-Side

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

To me this means our eyes are sensitive to how we orient our images side-by-side. On our PACS I always use the same side-by-side arrangement:
➢ PA vs Lat Views
➢ T1 vs T2 series

A   B

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

Forbidden City, Beijing, China

12 of 42

Pitfalls in the Human Visual System

Pitfalls in the Human Visual System *Can we trust our eyes?*

Shapes that aren't there

Human brain is hardwired to see shapes
➤ **Pareidolia**: random images perceived as significant*
➤ Faces

Man in Moon

Face in Mars

Old Man of the Mountain

nasa.gov

Viking1 orbiter 1976

White Mountains New Hampshire *pre 2003*

*wikipedia.org

13 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Shapes that aren't there

Cow in the Milk Bottle

Wisconsin Dells

14 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

There are no white circles here

Rows of black crosses

15 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

There is no triangle here

Once we see the triangle, it's hard to *not* see the triangle!

We start with 3 circles (pizzas)
Take a slice out of each…
Rotate them…
We now see a triangle…
…that's not really there
Even if we pull the circles away from each other…
We still see the triangle that's not there!

16 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

There are no spirals here

ritsumei.ac.jp

wikipedia.org

17 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

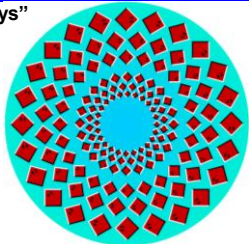## Motion that's not there…

ritsumei.ac.jp

18 of 42

Pitfalls in the Human Visual System

Pitfalls in the Human Visual System *Can we trust our eyes?*

Motion that's not there…

"Rotating rays"

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
ritsumei.ac.jp
19 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Motion that's not there…

"Rotating Snakes"

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
ritsumei.ac.jp
20 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Motion that's not there…

"Rollers"

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

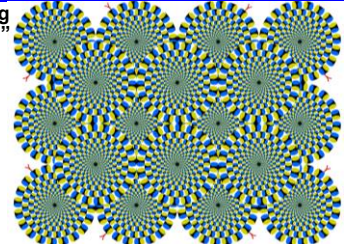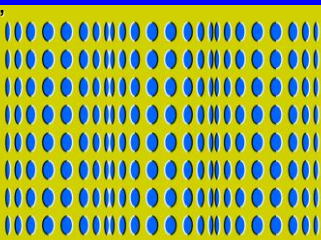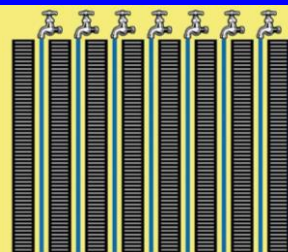www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
ritsumei.ac.jp
21 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Motion that's not there…

"Pouring Water"

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
moillusions.com
22 of 42

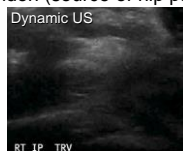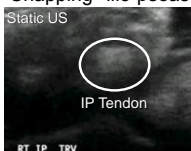**Pitfalls in the Human Visual System** *Can we trust our eyes?*

Smooth Motion

Traditionally, radiologists looked at static pictures
Ultrasound allows for dynamic examinations
➤ US is being used increasingly in MSK
　✓ "Snapping" Ilio-psoas tendon (source of hip pain)

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

Static US
Dynamic US
IP Tendon
RT IP TRV
RT IP TRV

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
23 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Smooth Motion: Linear

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

Black&White squares moving same speed
in smooth linear motion back&forth

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
24 of 42

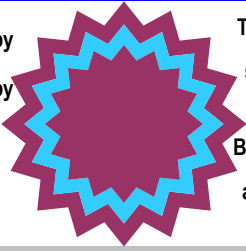©Ken L Schreibman, PhD/MD 1/25/15 www.schreibman.info

Pitfalls in the Human Visual System

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Smooth Motion: Rotational

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
○ Smooth Motion
Perspective
Colors ⓘ
Length

Purple star… surrounded by a blue star… surrounded by a purple star

Rotate the blue star…

The blue star is rotating smoothly…

But it appears to rotate in a cog-wheel fashion!

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

25 of 42

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Motion Induced Blindness

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
○ Smooth Motion
Perspective
Colors ⓘ
Length

Focus your attention on the blinking green dot

We add in 3 yellow dots in the periphery

Even when we add in many blue crosses, you can still easily see all 3 yellow dots while focusing on the green dot

But if we make the crosses move…

and you stay focused on the green dot…

Soon, 1, 2, or even all 3 yellow dots will briefly disappear!

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

26 of 42

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Importance of Multiple Views

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
○ Perspective
Colors ⓘ
Length

We need to put the two views together in our own brains to understand what's in front and what's behind.

This is a made up example…

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

27 of 42

Pitfalls in the Human Visual System — *Can we trust our eyes?*
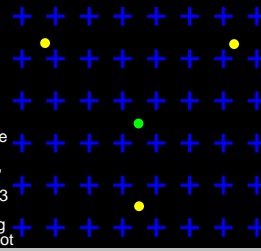
For joints need three views

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
○ Perspective
Colors ⓘ
Length

PA view thumb   Oblique view   Lateral view

…negative   …negative   DISLOCATED!

This is a real example

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

28 of 42

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Forced Perspective

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
○ Perspective
Colors ⓘ
Length

Marty is *not* taller than the Sears Tower

Marty age 8

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

29 of 42

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Forced Perspective: Deception

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
○ Perspective
Colors ⓘ
Length

Picture on real estate site
➢ HUGE pool!

epicfail.com

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

30 of 42

Pitfalls in the Human Visual System

Pitfalls in the Human Visual System *Can we trust our eyes?*

Forced Perspective: Static

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
○ Perspective
Colors ⓘ
Length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
games.yahoo.com
31 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Forced Perspective: Dynamic

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
○ Perspective
Colors ⓘ
Length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
illusioncontest.neuralcorrelate.com
2010 Best Illusion of the Year Winner
32 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Colors that aren't there

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
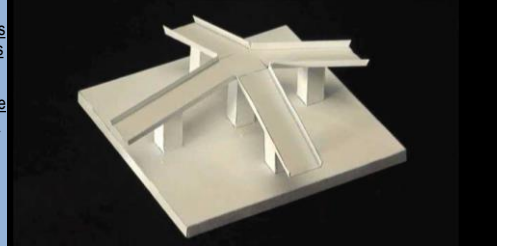Motion that's not there
Smooth Motion
Perspective
○ Colors ⓘ
Length

I'll add in some pink circles…

but keep focus on the +

See what happens when we take away circles…

It looks like the pink circles get replaced by green circles!
or
it looks like there is a green circle moving around a clock face

But there is NO green circle!
(There's nothing green on this slide)

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
Focus your attention of the +
33 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Light vs Dark: Blue

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
○ Colors ⓘ
Length

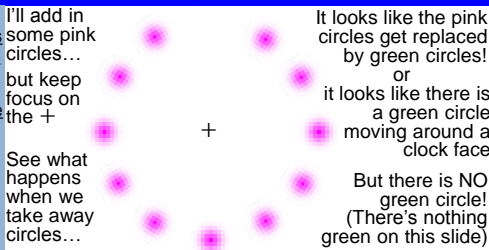We add in some light blue bars...

Light blue & Dark blue right?

and some dark blue bars...

No, they are the same exact shade of blue!

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
We start with black&white bars
34 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Light vs Dark: Gray

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
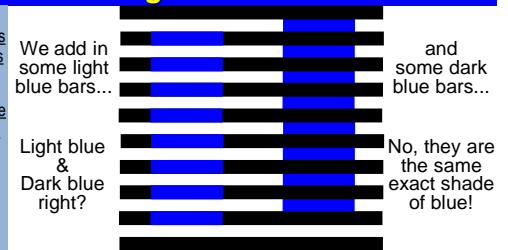Motion that's not there
Smooth Motion
Perspective
○ Colors ⓘ
Length

This is a gradient. It contains all shades of gray. Human eye cannot assess *absolute* values of gray, only lighter or darker than background

White

Black

So if we change the background…
It looks like the gradient changes!

If we change only ½ the background
It looks like ½ the gradient changes!

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
35 of 42

Pitfalls in the Human Visual System *Can we trust our eyes?*

Shadows: Gray

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
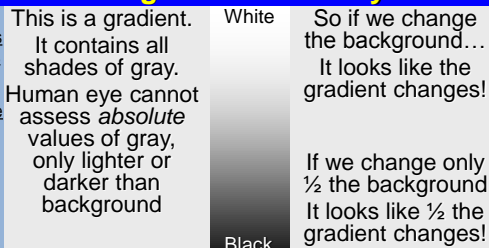Motion that's not there
Smooth Motion
Perspective
○ Colors ⓘ
Length

Can you believe squares A & B are the same color?

Edward H. Adelson

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD
persci.mit.edu
36 of 42

© Ken L Schreibman, PhD/MD   1/25/15   www.schreibman.info

Slide 37

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Shadows: Color

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
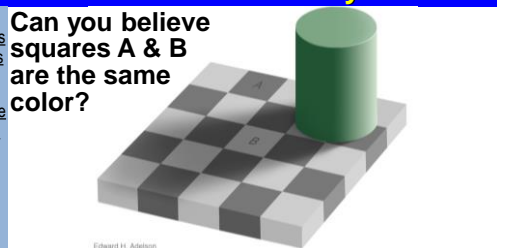Motion that's not there
Smooth Motion
Perspective
○ Colors ⓘ
Length

What color is this tile? →

What color is this tile? →

R. Beau Lotto
www.spiegel.de

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

37 of 42

Slide 38

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Colors: #TheDress

If you see BLACK & BLUE Wave Left Hand

If you see GOLD & WHITE Wave Right Hand

Kim Kardashian West @KimKardashian "What color is that dress? I see white & gold. Kanye sees black & blue, who is color blind?"

Perspective
○ Colors ⓘ
Length

Brightness: -40%
Contrast: +40%

Original JPEG

Brightness: +40%
Contrast: +40%

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

tumblr(2/25/15) buzzfeed(2/26 5pm) Twitter(2/26 6pm)
NYTimes(2/27) WSJ(2/27) NPR(2/27) SNL x3(2/28)

38 of 42

Slide 39

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Our Eyes are Poor at Judging Length

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
○ Length

We've all seen questions like this:

Which horizontal line is longer?

Same length

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

39 of 42

Slide 40

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Our Eyes are Poor at Judging Length

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
○ Length

Length

Width

Width

Length

R. Beau Lotto

Two tables of very different shape
Green: Rectangular Red: Square

40 of 42

Slide 41

Pitfalls in the Human Visual System — *Can we trust our eyes?*

What have we learned?

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors ⓘ
Length

We are not good at judging length
➤ Need to make actual measurements

We are not good at judging gray levels
➤ Need to measure Hounsfield Units

How we orient images matters
➤ Need to hang things the same way every time

Complex backgrounds can fool you
➤ All radiology images have complex backgrounds…

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

41 of 42

Slide 42

Pitfalls in the Human Visual System — *Can we trust our eyes?*

Thank you!

Introduction
Parallel Lines
Orientation is Important
Shapes that aren't there
Motion that's not there
Smooth Motion
Perspective
Colors
Length

Thank you!

www.schreibman.info
© 2015 Ken L Schreibman, PhD/MD

media.photobucket.com

42 of 42