

**Ramachandran and Hirstein's  
"The Neurological Basis of Aesthetic"  
for Computer Graphics**

*Bruce Gooch  
University of Utah*

**Why does art work?**



**Why does art work?**



**Why Does Art Work?**

- Do Rules exist, What are the Rules?
- How did these Rules come about?
- What Brain mechanisms are involved?

**"The Neurological Basis of Aesthetic" by  
Ramachandran and Hirstein**

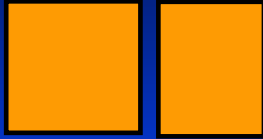
- Studies of the Human Visual System
- Artistic Technique & Art History
- Organize Results and Advocate Testing  
Ongoing fMRI, Galvanic Skin Response,  
BP & Heart Rate, Eye Tracking, Etc, ...

**Ramachandran and Hirstein's Eight "Laws" of Art**

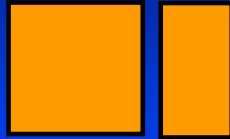
- The Peak Shift Principle
- Perceptual Grouping and Binding
- Isolation of a Single Visual Cue
- Problem Solving
- Contrast Extraction
- Symmetry
- Generic Viewpoint
- Use of Metaphor

## The Peak Shift Principle

- Exaggerated elements are attractive.



Training Set



Testing Set

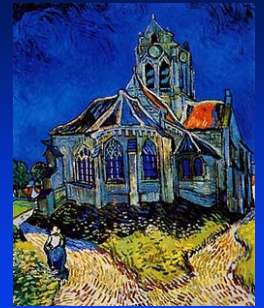
## Photograph



## Peak Shifted Photograph



## Peak Shifted Color



## Peak Shifted Color



## Peak Shift in Form



TheMcNay  
THE MUSEUM OF MODERN AND CONTEMPORARY ART

## The Peak Shift Principle

- **Exists Across Visual Modalities**

Outline, Color, Form, Motion, Highlight, Depth are all susceptible to Peak Shift.

- **Reward and Non-Reward Stimulus Must be Close**

## Learning Speedup Via Peak Shift



10 Training Passes



1-2 Training Passes per Condition

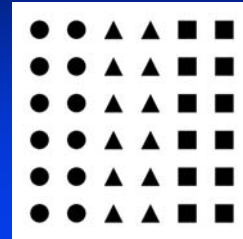
## Applying the Peak Shift Principle to CG

- **Contact Cues in Animation**
- **Distance Perception in VR**
- **Perceptually based Anti-Aliasing**
- **Limit Geometric Complexity**
- **Temporal Anti-Aliasing**

## Perceptual Grouping

- **Similarity**

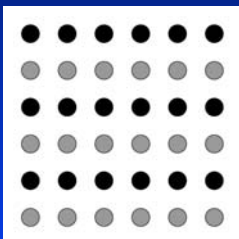
Items that are the same are grouped. (Shape)



## Perceptual Grouping

- **Similarity**

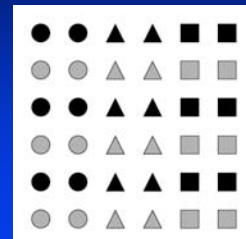
Group by intensity.



## Perceptual Grouping

- **Similarity**

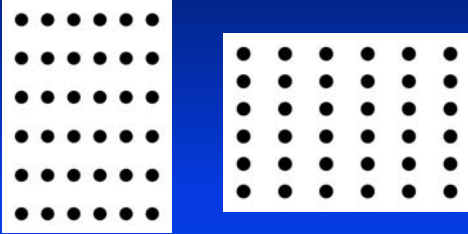
intensity overcomes shape.



## Perceptual Grouping

- **Proximity**

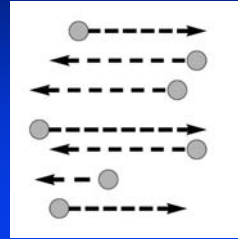
Items that are physically close are grouped.



## Perceptual Grouping

- **Common Fate**

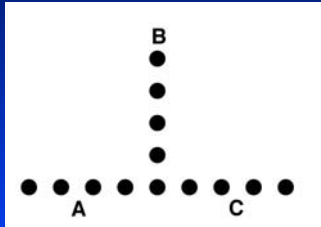
Items that move together are grouped.



## Perceptual Grouping

- **Continuity**

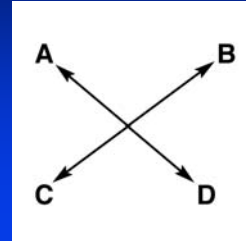
Items that form or are joined by a line are grouped.



## Perceptual Grouping

- **Continuity**

Items that form or are joined by a line are grouped.



## Perceptual Grouping

- **Closure**

Items that form closed regions are grouped.



## Perceptual Grouping

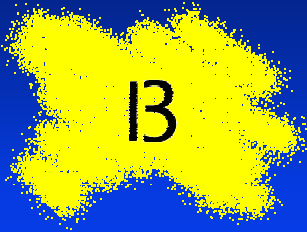
- **Past Experience**

Items are interpreted based on surrounding items.



## Perceptual Grouping

- Center item appears as the Letter B.



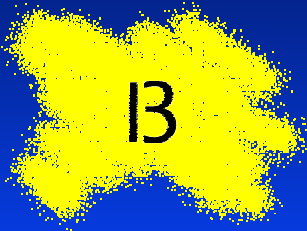
## Perceptual Grouping

- Change the Surround



## Perceptual Grouping

- Center item appears as the number 13.



Images courtesy of Professor Charles Schmidt, Rutgers University

## Applying Gestalt Grouping to CG



Anthony A. Apodaca, Larry Gritz

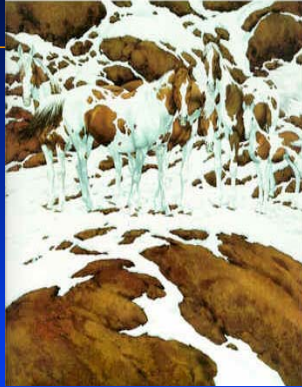
## Perceptual Binding



## Perceptual Binding



## Perceptual Binding



Bev Dolittle

## Perceptual Binding



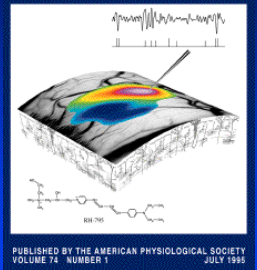
## Perceptual Binding



## Isolation of a Single Visual Cue

- Helps focus a viewers attention.

Based on the observation that differentiated brain cells exist for the perception of, color, depth, form, etc.



Grinvald et al.

## Photograph



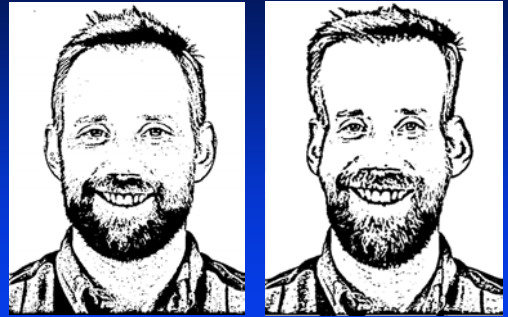
## Single Visual Module



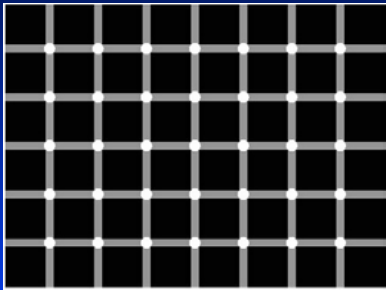
**Peak Shift applied on Single Visual Module**



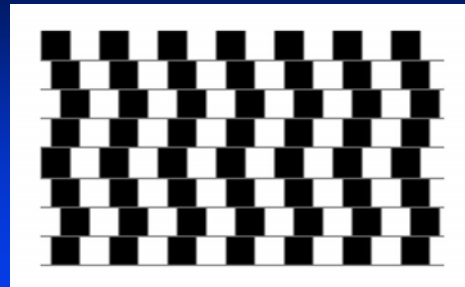
**Peak Shifted Line Art Faces**



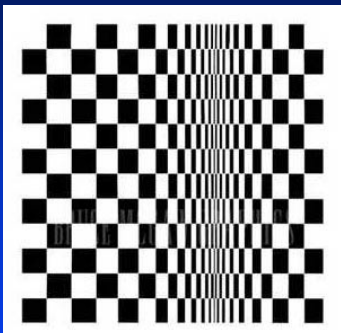
**Herman Grid, Count Black Spots at Intersections**



**Apparent Movement**



**Op Art**



**Bridget Riley**

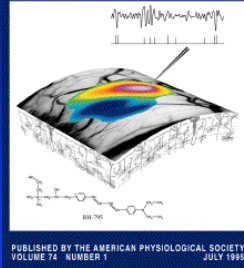
**Idea of Movement**



**Duchamp**

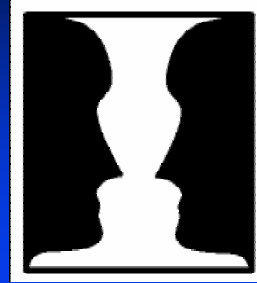
## Applying Visual Cue Research to CG

- Take advantage of new computational models of Human Vision
- Tone Mapping
- Motion planning
- Anti-Aliasing



## Problem Solving

- Perceptual “problem solving” is reinforcing.



## In Scene Elements



Arcimboldo

## Problem Solving in the Subject Matter



Wyeth

## Sometimes the Problem is Obvious



## Contrast Extraction

- Contrast is reinforcing.

- Color



- Size



- Position





### Contrast (Intensity)



### Contrast (Size and Number)



### Contrast (position)

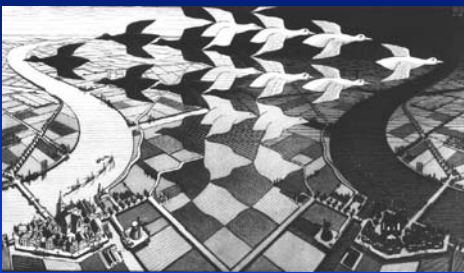


### Symmetry

- Symmetry is attractive.



### Symmetry



### Generic Viewpoint

- Unique Vantage Points are Suspect.



## Generic Viewpoint



## Generic Viewpoint in CG

- **Choosing a Viewing Angle.**  
Blantz et al., Perception 99
- **Avoiding confusing self occlusion.**  
Gooch et al., EGRW 01

## Use of Metaphor

- **Visual puns and metaphors enhance art.**

Metaphor: an implied comparison between two things of unlike nature that still have something in common.



## This is Not a Pipe



Magritte

## This is a Pipe Knot



Gooch

## Conclusion

- This is just a Frame Work
- Not Everything is Included
- Look for more & better results in the future

## Thanks

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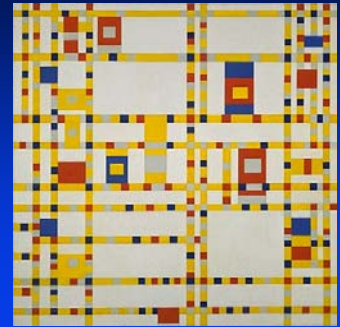
- NPR BOF, Tuesday 7:00, Menger Hotel

[www.cs.utah.edu/~bgooch](http://www.cs.utah.edu/~bgooch)



## Broadway Boogie-Woogie

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Mondrian

## Three Hotels on Broadway Boogie-Woogie

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Caywood

## Format

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- One
- Two
- Three