**Foveal Vision**

- thumbnail at arm’s length
- small high resolution area on retina

**Equal Legibility**

- if fixated on center point

**Foveal Touch**

- star-nosed mole

**Ears**

- perceived as temporal stream
- but also samples over time
- hard to filter out when not important
- visual vs auditory attention
- implications
- harder to create overview?
- hard to use as separable dimension?
- 'sonification' still very niche area
- alternative: supporting sound enhances immersion

**Other Modalities**

- barrier: lack of record/display technology
- haptics maturing
- "haptic visualization" very new
- smell, taste
- out-there SIGGRAPH ETech demos
- characterization possible after technology barriers fall

**Psychophysical Measurement**

- JND: just noticeable difference
- increment where human detects change
- average to create "subjective" scale
- low-level perception more uniform than high-level cognition across subjects

**Nonlinear Perception of Magnitudes**

- sensory modalities not equally discriminable

**Dimensional Dynamic Range**

- linewidth: limited discriminability

**Dimensional Ranking: Accuracy**

- spatial position best for all types

**Cleveland vs. Mackinlay: Quantitative**

<table>
<thead>
<tr>
<th>Mackinlay</th>
<th>Cleveland</th>
</tr>
</thead>
<tbody>
<tr>
<td>position</td>
<td>position along common scale</td>
</tr>
<tr>
<td>length, angle, slope</td>
<td>position along nonaligned scales</td>
</tr>
<tr>
<td>area, volume</td>
<td>length, direction, angle</td>
</tr>
<tr>
<td>density, saturation</td>
<td>area</td>
</tr>
<tr>
<td>hue, texture, connection</td>
<td>volume, curvature</td>
</tr>
<tr>
<td>containment, shape</td>
<td>shading, color saturation</td>
</tr>
</tbody>
</table>

**Webber's Law**

- ratio of increment threshold to background intensity is constant
- relative judgements within modality

\[
\frac{\Delta I}{I} = K
\]

**Cleveland example:** frame increases accuracy


**Readings Covered**

- Ware, Chapter 5: Visual Attention and Information That Pops Out
- Ware, Chapter 6: Static and Moving Patterns

**Human Perception**

- sensors/transducers
  - psychophysics: determine characteristics
- relative judgements: strong
- absolute judgements: weak
- continuing theme
- different optimizations than most machines
  - eyes are not cameras
  - perceptual dimensions not nD array
  - (brains are not hard disks)

**Foveal Vision**

- thumbnail at arm’s length
Preattentive Visual Dimensions
- color alone: preattentive
- shape alone: preattentive
- combined hue and shape (demo)

Separable vs. Integral Dimensions
- not all dimensions separable
- color color color size x-size red-green
- location motion shape orientation y-size yellow-blue

Glyphs
- composite graphical mark
- encoding using multiple dimensions
- large-scale individual glyphs vs. small-scale texture fields
- grouping into large-scale patterns
- integral vs. separable analysis
- when do they help?

Gestalt Principles
- proximity, similarity, continuity/connectedness/good continuation
- closure, symmetry
- common fate (things moving together)
- figure/ground, relative sizes

Proximity

Similarity

Continuity

Gestalt Laws
- principles of pattern perception
- "gestalt"; German for "pattern"
- original proposed mechanisms wrong
- rules themselves still useful
- Pragnatz
- simplest possibility wins
Connectedness
- can overrule size, shape

Closure
- overrules proximity

Symmetry
- emphasizes relationships

Common Fate
- demo
tepserver.ucsd.edu/~jlevin/gp/time-example-common-fate

Relative Size
- smaller components perceived as objects

Figure/Ground
- determined by combination of previous laws

Graph Drawing Tension
- node placement
- close
- far
- visual popout of long edge
- either
- connectedness
- tradeoffs abound in infovis!
- grammars
- node-link graphs
- maps

Motion
- works for preattentive/grouping
- less studied than static dimensions

More Perception
- Rensink grad course taught every few years
  http://www.cs.ubc.ca/~rensink/courses/cpsc532E/
  http://www.psych.ubc.ca/~rensink/courses/psyc579/

Presentation Topic Choices