Crossmodal Attention & Multisensory Integration: Implications for Multimodal Interface Design

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In the Realm of the Senses
Majority of information presented visually


Are there any costs of monitoring more than one sensory channel?

Performance Costs Associated with Attending to Multiple Modalities

<table>
<thead>
<tr>
<th>Possible</th>
<th>Presented</th>
<th>Cost in ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audition → Vision</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Touch → Vision</td>
<td>104</td>
<td>Touch is</td>
</tr>
<tr>
<td>Touch → Audition</td>
<td>98</td>
<td>Sticky</td>
</tr>
<tr>
<td>Vision → Audition</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Audition → Touch</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Vision → Touch</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>
1) Lip-reading facilitates shadowing
2) Better performance when auditory & visual information from same position
‘...there is no animal in which there is known to be a complete segregation of sensory processing’ (Stein et al., 1996)

You simply cannot predict multisensory perception by studying senses in isolation.
Multisensory Motion Perception

Displays presented every 2 s until response

Task: Report direction of auditory motion

Crossmodal Dynamic Capture

Auditory motion perception compromised by synchronous presentation of visual motion

Rules of Multisensory Integration

- **Superadditivity**: Weak stimuli interact synergistically when presented from same location at about same time
- **Subadditivity**: When these conditions are not met
- **Sensory Dominance**: Vision for space, hearing for time, olfaction for appetitive, touch & olfaction for affective

Virtual Body Effect

- Virtual body effect (shadows)
- Tool-use (computer mice/laser pointers)

Incorporation & Embodiment

Changing perception of touch with sound

Dry  Hydrated
Multisensory Synchronization
When should you present multisensory stimuli?

Perception of Simultaneity

- Wide temporal window of multisensory integration
- Perception of simultaneity enhanced when stimuli from same location

Biophysics: Transduction Latencies

Speed of neural processing

Physics

Light travels faster than sound, so distant events seen first

‘Horizon of Simultaneity’

Physics cancels out biophysics at 10m

Multisensory Synchronization

- Most interfaces closer than 10 m
- Simultaneous presentation of multisensory signals doesn’t assure perception of simultaneity
- Desynchronizing inputs might enhance multisensory integration & perception (warning signals)
Multisensory Entertainment

‘Most designers have gotten to the point in production where the decision is made to hit the viewer with everything they’ve got. The big sounds, the dramatic slam of music from the dead silence, the sudden appearance of the beast. And the kids sit there saying ‘been there...done that...ho hum...’’ (Ralph Thomas, ‘Nothing to sniff at?’, 2002)

Olfactory Interfaces?

• Reducing symptoms of road rage
• Alerting drowsy drivers
• Burnt rubber smell for bad drivers
• Olfactory console so drivers can choose smell to suit mood/ surroundings
• Technology available to introduce PC smell (Digiscents failed; Arvel, Japan)

Conclusions

• Attention & multisensory integration critically determine perception & behavior
• Spatial constraints on focused & divided attention between hearing, sight & touch
• Multisensory temporal synchrony
• Understanding multisensory interactions will lead to better interface design
• From intuition to understanding via cognitive neuroscience

Aging & Multisensory Perception

• By 2025, more than a billion people over 60 (US Senate Special Committee on Aging, 1985-1986)

5th Annual Meeting

International Multisensory Research Forum

Barcelona, June 2-5 2004

www.multisense.info/2004

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