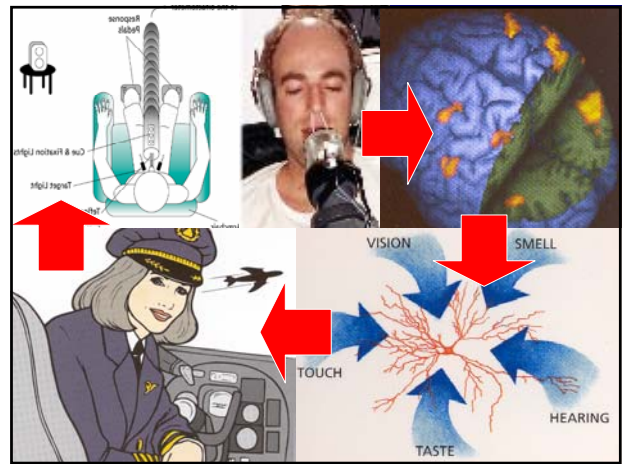


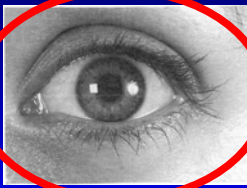
Crossmodal Attention & Multisensory Integration: Implications for Multimodal Interface Design

Charles Spence

Department of Experimental Psychology,
Oxford University



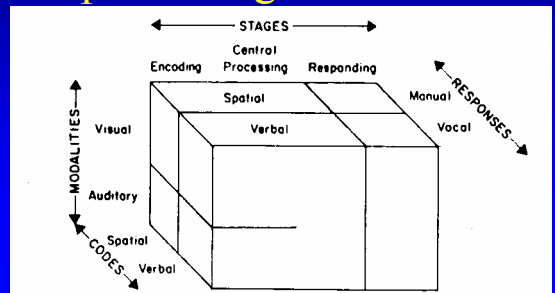
In the Realm of the Senses



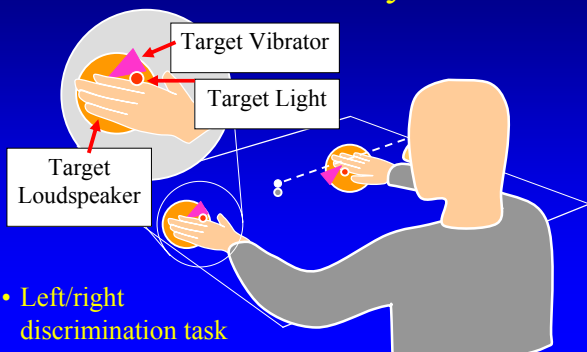
Majority of information
presented visually



Wickens (1980, 1984, 1988, 1992...) Structure of human processing resources



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



Performance Costs Associated with Attending to Multiple Modalities

Possible	Presented	Cost in ms	
Audition	→ Vision	= 55	
Touch	→ Vision	= 104	Touch is
Touch	→ Audition	= 98	Sticky
Vision	→ Audition	= 68	
Audition	→ Touch	= 67	
Vision	→ Touch	= 66	

Same Position

Relevant Visual



Relevant Auditory

Irrelevant Visual



Irrelevant Auditory

Different Position

Relevant Visual



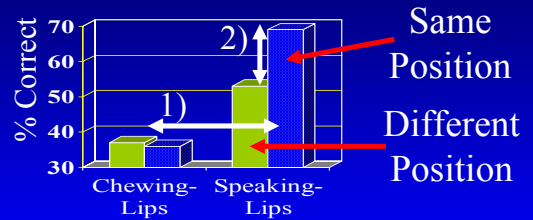
Irrelevant Auditory

Irrelevant Visual



Relevant Auditory

Shadowing Performance



- 1) Lip-reading facilitates shadowing
- 2) Better performance when auditory & visual information from same position

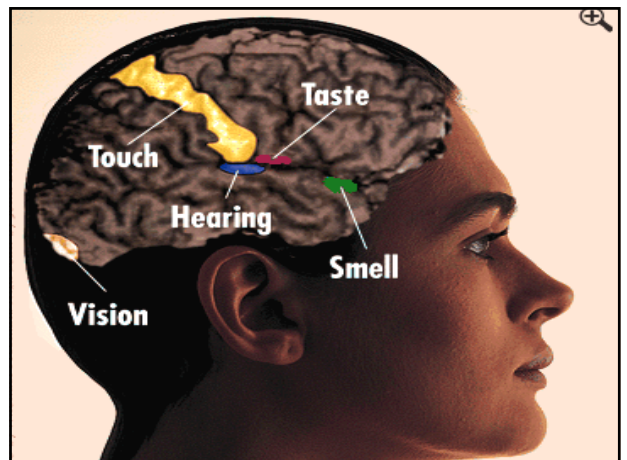
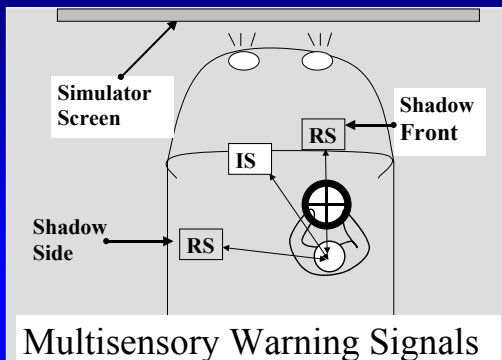
Don't Dial & Drive?

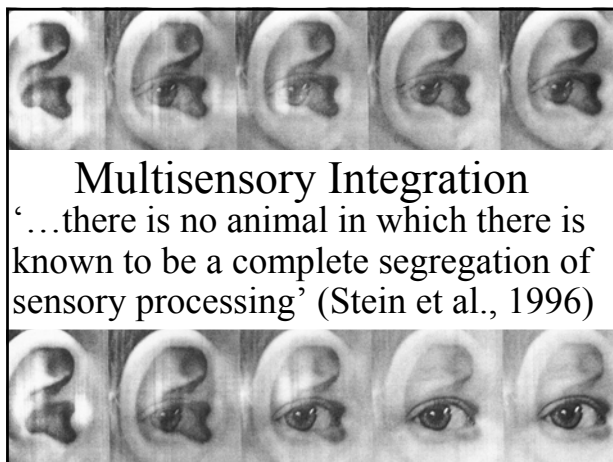
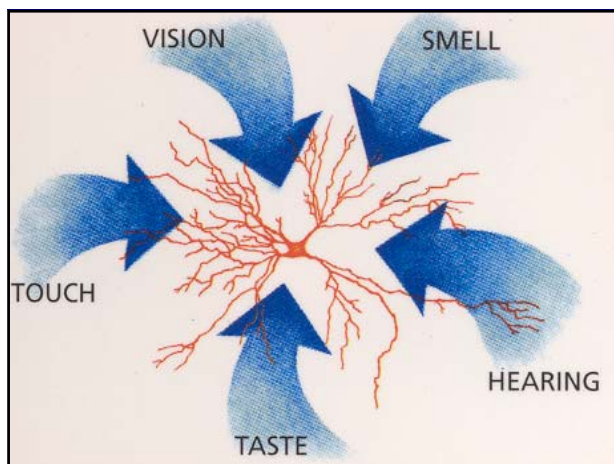


Leeds Advanced Driving Simulator

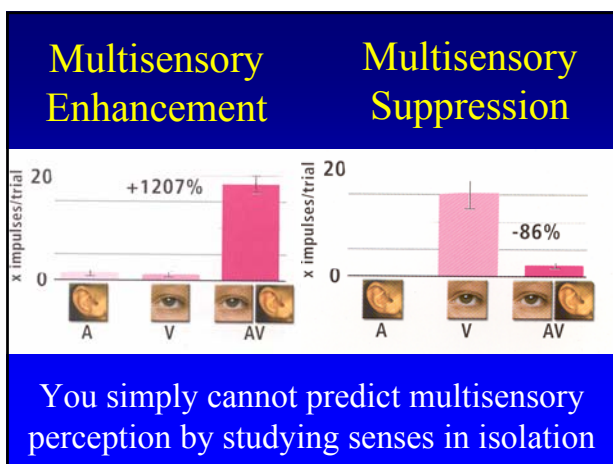
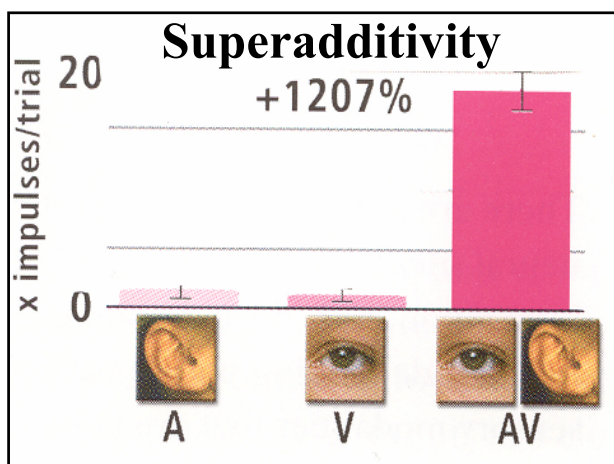


Spence & Read (2003)

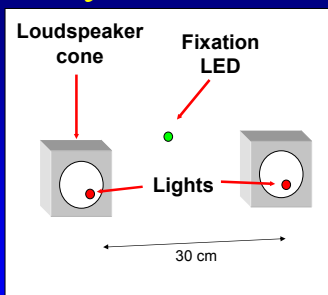




Multisensory Integration
 ‘...there is no animal in which there is known to be a complete segregation of sensory processing’ (Stein et al., 1996)



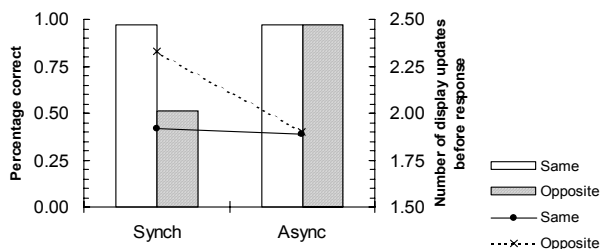
Multisensory Motion Perception



Displays presented every 2 s until response

Task: Report direction of auditory motion

Crossmodal Dynamic Capture

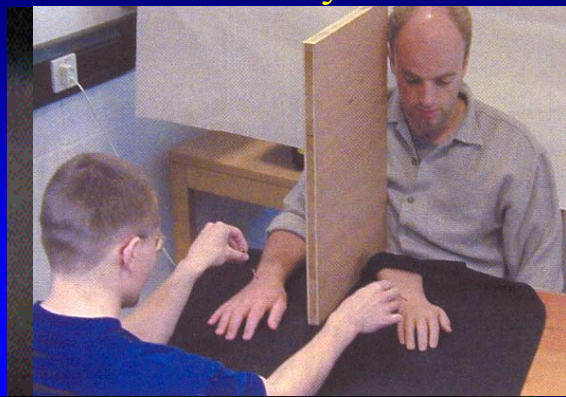


Auditory motion perception
compromised by synchronous
presentation of visual motion

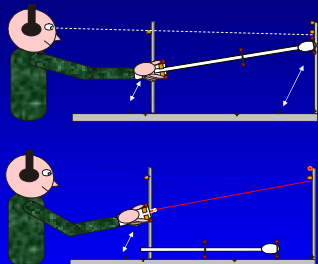
Rules of Multisensory Integration

- **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



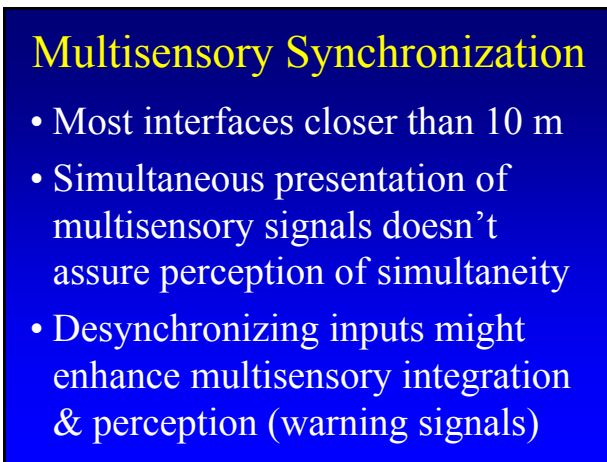
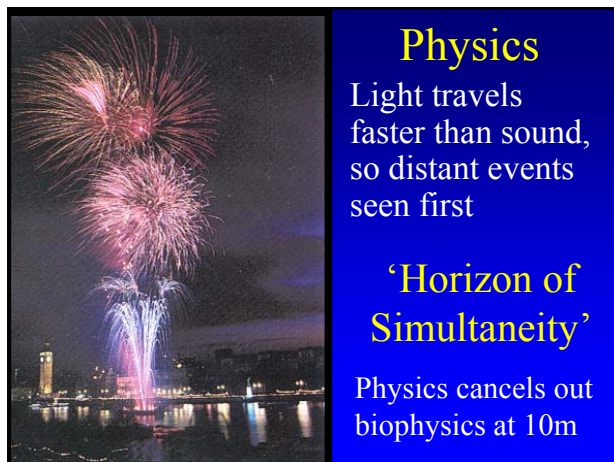
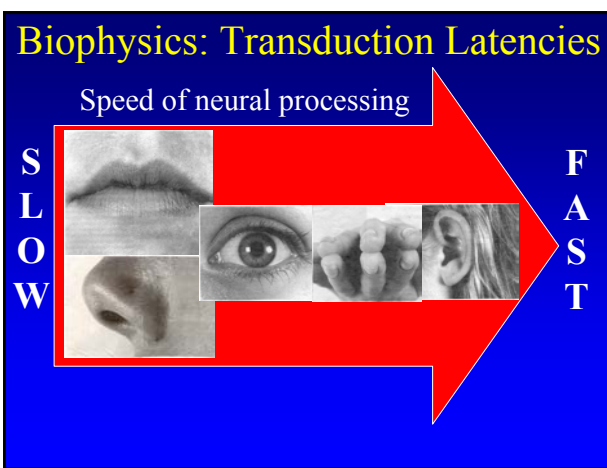
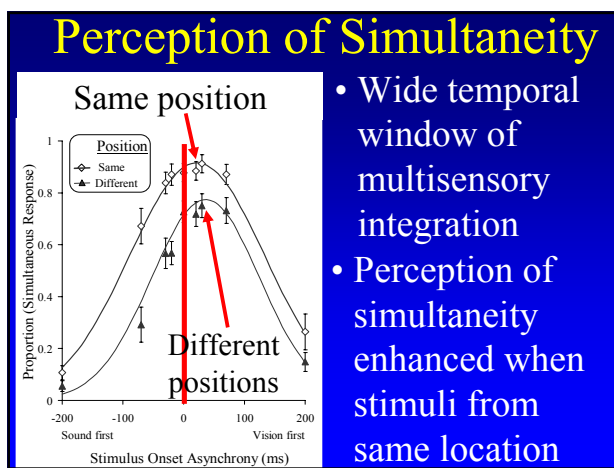
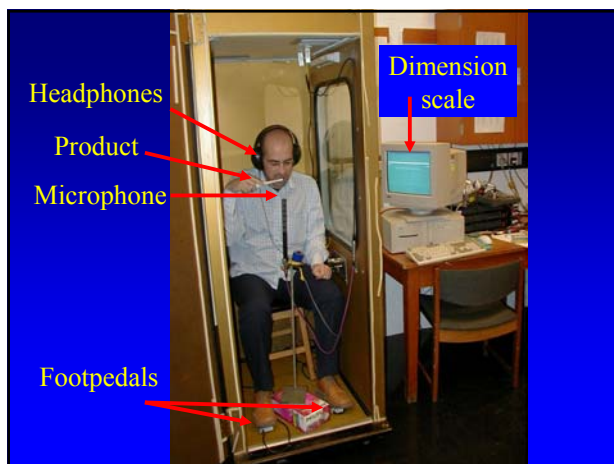
Incorporation & Embodiment



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

Changing perception of touch with sound





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



Barcelona, June 2-5 2004

www.multisense.info/2004

Contact: imrf2004@psi.ub.es