Ch 10. Multisensory Integration and Calibration in Adults and Children
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• Describe on the ventriloquist effects in spatial and temporal domains
The Ventriloquist effect

- Would a modal stimulus ‘capture’ another?

- An observer is presented with light blob with a click sound in a same position as the probe

- and the conflict stimulus, blob appears $\Delta^\circ$ rightward and click displaced $\Delta^\circ$ leftward to the probe

- The observer is to report whether conflict stimulus is on the right of probe or not
The Ventriloquist effect

- Orange: clear blob
  visual dominance

- Dark Red (or brown): intermediate
  32 degree blurred blob
  Equal dominance between auditory and visual signals

- Pink: severe 64 degree blurred blob
  auditorial dominance

- Blue arrow: PSE or point of subject equality (the location where average observer perceiving the given stimuli at)
The Ventriloquist effect

- Fig B. Predicted PSEs by the ideal integration model (see Ch1.)

- Prediction fits with measured result (different figure shape means each subject and different colour means different blur levels)
The Ventriloquist effect

• Fig C. Lower threshold in bimodal performance.

• This means improved precision (consistent, reliable performances or lower variance), and implies two modalities are successfully integrated.

• And lowered threshold also corresponds to MLE prediction.
The Ventriloquist effect in more natural condition

- Saccade: rapid eye movement
- Before an eye movement, some oculomotor signals are sent to visual areas to suppress the perception of huge visual changes (We don’t feel the world is moving but feel we are seeing different areas)
- This signal actually *interferes* and results in mislocalization in some condition.
The Ventriloquist effect in more natural condition

- Fig A. in fixed eye, accurate and precise perception is achieved

- But in performances 25ms before saccade, precision is lost and some bias (maybe compensating eye movement) occurs.
The Ventriloquist effect in more natural condition

- Fig B. Auditory discrimination seems unaffected by saccade. PSEs unchanged.
The Ventriloquist effect in more natural condition

- Fig C. Bimodal integration is achieved and bimodal PSE is between the cases of Visual and Auditory perception.
The Ventriloquist effect in more natural condition

- X-axis: Time from saccadic onset
- Left: average from all subject, Right: from one subject
- We can see that closer to the onset of saccade, severer visual perception distorted. By integrating Audiovisual stimuli, Bias could be reduced.
The Ventriloquist effect in more natural condition

- Y-axis: threshold = inverse precision
- Visual precision is altered by saccade but auditory.
- Bimodal integration is much more precise than monomodality.
- and MLE modeling achieves quite good fitting.
The Ventriloquist effect in more natural condition

• **IMPORTANT!** Integrating weights changed in dynamical way. (dynamic coordinate shift)

• When Visual perception is distorted in the most, its integrating weights gets down (treated less importantly)
The Ventriloquist effect in more natural condition

- "Perisaccadic visual signals are already distorted when they are integrated with other sensory cues"
- "Visual signals... reweighted dynamically"
- This result suggest that and instantaneous estimate of visual precision is required, dynamic coordinate shift occurs.
Ventriloquism in Temporal domain

- Two markers consist of a simultaneous flash and noise, which are given in the beginning and the end of the session.
- Test stimulus (w or w/o saccade) are consist of asynchronous flash and noise but not perceived as distinct, because the gap is not that long. The exact half point between two stimulus is considered as the moment test stimulus occurred.
- The temporal delay between the sound and the noise is $2\Delta ms$, that is, if sound was advanced by $\Delta ms$, noise comes $\Delta ms$ delayed.
- Observer is to be reporting whether test stimulus is close to the marker I or marker II.
Ventriloquism in Temporal domain

- Fig A. without saccade, B. with saccade
- x-axis: ∆ms noise delayed and flash advanced
- PSB: point of subject bisection (the moment stimuli observer perceived)
- if PSB > 0, then observer reported the stimuli is closer to marker II
Ventriloquism in Temporal domain

- If visual and auditory inputs had contributed the same amounts, then the curve would have been flat. (because PBS would not been changed wherever \( \Delta \) is)
- If visual input dominantly contributed, the plot would be fitted to Negative slope (because increased \( \Delta \) would mean advanced light. (forget the figure. text said in this way) and advanced light would be percieved as advanced test stimuli so decreasing PSB
Ventriloquism in Temporal domain

- The plot fits to positive slope so audition dominate in fixed case (weight^2 = 0.83+-0.04), so Sound captured perceived timing of bimodal audiovisual stimuli.

- in saccade condition, it is less accurate but auditorial stimulus' weight^2 is even bigger (=0.95+-0.06).

- This result is opposite to spatio-ventriloquist effect.
Another question

- We just checked that Saccade, the visual distorting signal surely affected temporal perception.
- Hence, authors assumed auditorial inputs could affect spatial perception also.
Another question

- Experimenter showed green flash bar while subjects producing saccade (eye movement 20° rightward)
- Noise burst were given before or after the flash came
- If noise affected spatial perception, advanced noise will make subject to perceive flash earlier, so to be at different location.
Question Busted

- Nope
- Unaffected
- Maybe because the noise lacked spatial indication
Development of Multimodal calibration

- Sensory systems should be recalibrated as maturing, at least because growing limbs, eye length, interocular distance, etc.
- So experimenters tested sensory conflict tasks on children of varying ages
• Visuo-haptic conflict task is used.

• Experimentor gave subject a standard, in which visual and haptic stimuli were in conflict. (visual block is 55mm +\(\Delta\)mm, haptic block is 55-\(\Delta\)mm)

• in adult, (and hence, in MLE prediction) visual cue is dominant. so, when \(\Delta=\text{-3mm (orange)}\), Standard is smaller, subjects would tend to report probe is taller than standard even if it actually is smaller than standard (left-shifted)
• This prediction were correct for 10 years old child (upper)

• when X-axis(relative) probe size is around -2mm, Child still reported it is taller than standard
• But 5 years old child (lower) reported different!

• When $\Delta=-3$ mm, for haptic standard were bigger than probe, s/he reported the probe is smaller than the standard
It is clear that this inverse dominancy changes over ages.
Loser takes all

- Haptic threshold is always larger than vision threshold (=low precision)
- Bimodal sensory input did not lower the threshold in younger children (=no integration compared to Fig. 1C)
Concluding Remarks

• Precision could be improved (=lowering threshold) coordinating multimodal senses (Fig. 1)

• This coordination processes works in dynamical way (Fig 3)

• Spatial and Temporal ventriloquism captures different modalities (Fig 1-3 vs 4)

• Multimodal coordination changes (or refined) over maturing (Fig 5-7)