Hearing voices then seeing lips: disunity of subjective timing

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Introduction

Due to physical and neural delays, the sight and sound of speech causes a cacophony of asynchronous events in the brain. How can we still perceive voice and lipmovements as simultaneous?

Our converging evidence suggests that actually, we do not: 1) Case study: dissociation between subjective timing for two different concurrent tasks: Temporal order judgement and McGurk effect

2) Individual differences in neurotypical participants: anti-correlation of subjective timings for the above concurrent tasks

1) Case study

- Patient PH: male, retired pilot, 67 at time of testing. midbrain and auditory brainstem lesions. In 2008 began to experience voices leading lip-movements. Otherwise high-functioning, by neuropsychological assessment.

- High-resolution MRI: two small lesions – anterior-medial tip of the left sub-thalamic nucleus – Right dorso-medial pontine nucleus – Both regions may play a role in timing, audition or crossmodal interactions

Method

- Stimuli: typical McGurk stimuli
  - Convergent and incongruent combinations: movie of lipmovements [ba], [ga] paired with audio [fa], [da].
- Variable auditory lag: – 9 levels, range ±500ms, randomised.
- Dual task: – Timing judgement and phoneme identification
- Timing judgements, two types: – Temporal Order Judgement (TOJ) or Simultaneity Judgement (SJ).
- Blocked, counterbalanced.
- Dependent measures: – TOJ or SJ – Point of Subjective Simultaneity (PSS) – Phoneme judgements – Optimal timing for McGurk effect (McG)

Comparison of PH with controls

- a) Timing Judgment:
  - TOJ: audiometry lag required for subjective synchrony – Healthy: – Verbal
  - Simultaneity Judgments (SJ):
  - PH: 44ms auditory lag – Healthy: slight auditory lead

- b) McGurk:
  - PH requires opposite visual lag for maximal McGurk, consistent with pathological auditory slowing.
  - PH outside all healthy 95% CIs

Timing discrepancy (PSS) & (McG):

- PH vs. healthy controls (Crawford t(5)=2.24, p<0.05, one-tailed)

- Specific to speech (TOJ veridical
  - Timing discrepancy (PSS – tMcG):
  - Healthy: slight auditory lead
  - PH: ~200ms auditory lead (auditory
  - McGurk, consistent with pathological auditory slowing.
  - PH requires opposite visual lag for maximal McGurk, consistent with pathological auditory slowing.
  - Healthy: ~Veridical
  - PH: ~200ms auditory lead (auditory

Summary:

Lesion reveals dissociation: auditory slowing (consistent with pathology) in McGurk, versus opposite auditory speeding for TOJ

2) Individual differences

- Black symbols: healthy (young and older); White: PH

a) TOJ sessions: Negative correlation. TOJ probes distinct mechanisms

b) SJ sessions: Positive correlation. Perceived simultaneity may depend on quality of integration

A challenge for existing theories

- Different tasks subject to different delays – e.g. McG and TOJ tasks
- Modalities synchronised to their unimodal norms – Norm represents best guess at “when was now”
- Apparent repulsion of timings for different tasks: – If one signal is delayed, others will seem to be speeded, relative to the norm

Proposed Temporal Renormalisation theory

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Conclusions

- Subjective timing depends on discrete mechanisms subject to their own neural delays
- There is no apparent unity of subjective timing: We can concurrently experience the same external events as happening at different times.
- We cannot correct delays, though we can compensate for them
- Via renormalisation, senses are synchronised on average

References