Commentary

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Sound Symbolism Conference
Emory University
March 2010
Evidence that correlations exist between sound and meaning

• when sound and meaning are compatible:
  • processing is faster than when they're incompatible (Howard)

• when certain sound-meaning relations are present in words:
  • people can predict the meanings of the words above chance (Laura, Lynne)
  • children and adults learn these words relatively quickly (Lynne, Mitsumi)
  • parents use these relations to teach children words (Mitsumi, Laura)
  • the words prime other words that share the same sound-meaning correspondence (Ben)
  • people and machines use these relations to draw inferences about other people’s mental states (Sandy)

• other relevant relations
  • synesthesia (Daphne)
  • cross-modal mappings (Krish)
  • phonemic cues for grammatical class (Morten)
What mechanisms produce these effects?

• simulation-based accounts of concepts and meaning
  • a simple-minded insufficient account
    • direct feature overlap

• possible mechanisms that link meaning to sound (etc.)
  • direct neural connections between features
  • multi-sensory (supra-modal) areas
  • cross-modal learning
  • general magnitude
Simulation-based accounts of concepts and meaning

• relevant modalities process the instances of concepts
  • modalities in perception, action, introspection

• the profile of modalities relevant for a concept varies (Cree & McRae, 2006)
  • birds, tools, food, musical instruments, etc.

• concepts become captured in the circuits that process a concept’s instances
  • feature areas integrated by association areas
  • a concept is a distributed multimodal circuit that captures the information processed for its instances

• these circuits later produce simulations of instances
  • sampling of circuit information that is:
    • dynamic, context-sensitive, frequency-based
  • conceptualization uses the same circuits as perception, action, and introspection
Martin’s (2001, 2007) circuits for object concepts

- **FORM**
  - lateral fusiform
  - medial fusiform

- **MOTION**
  - ventral premotor
  - intraparietal sulcus

- **STS**
  - Faces, animals, people

- **middle temporal gyrus**
  - Tools

- **intraparietal sulcus**
  - Tools

- **ventral premotor**
  - Tools

- **Faces, animals, people**

- **Tools**
Simmons et al.’s (2010) person processing circuit
Wilson-Mendenhall et al.’s (2010) circuit for CONVINCE
Feldman Barrett et al.’s (2007) circuit for EMOTIONS

Neural Reference Space for Emotion
Linking sound and meaning
Simple-minded account

• a speaker’s conceptualization implemented as a simulation

  WALK (me, lecture hall, quickly)

    • activates relevant modality-specific areas for self, body, walking, lecture hall, path in space, etc.
    • motor areas associated with speed become active

• the speaker produces an utterance spoken at a fast rate

  “I’m going to walk to the lecture hall quickly.”

    • the speed of action in the simulation of walking affects the speed of speaking
    • assume that a common population of neurons underlies the speed of:
      • simulated walking
      • speaking
Linking sound and meaning
Simple-minded account

• a listener’s processing of the utterance
  “I’m going to walk to the lecture hall quickly.”
  • the spoken utterance activates motor areas via mirroring
  • activates neurons associated with fast speed

• the listener represents the utterance’s meaning as a simulation
  WALK (speaker, lecture hall, quickly)
  • activates relevant modality-specific areas for self, body, walking, lecture hall, path in space, etc.
  • neurons associated with fast speed are already active, thereby facilitating constructing the appropriate simulation
**Linking problems**

• *does a common population of neurons really represent speed?*
  • for the spoken rate of the utterance
  • for the speed of walking in the simulation

• *identifying the ends of two dimensions involves different features*
  • fast speaking
  • fast walking

• *dimension-specific reference points must be involved*
  • fast speaking relative to average speaking rate
  • fast walking relative to average walking rate

• *how are these different dimensional categorizations computed and linked?*
More distant mappings

Conceptualization : Speech
- vertical position : speaking pitch
- object speed : speaking speed and pitch
- urgency : speaking speed
- affective valence : speaking pitch and speed
- size : loudness

Conceptualization : Non-Speech
- object speed : music speed
- subjective states : honest signs

Synesthesia
- sound : shape
- shape : color

Cross-modal mappings
- vision : touch
Possible linking mechanisms

• **direct neural connections between features**
  • initial brain organization (Daphne)
  • activating one feature activates the other via a direct connection

• **multi-sensory (supra-modal) areas**
  • perhaps another form of initial brain organization (Krish)
  • activating one feature activates the other via the shared area

• **cross-modal learning**
  • correlations across modalities in experience
  • large things tend to be loud, slow, and to produce low pitches
  • small things tend to be soft, fast, and to produce high pitches
  • activating one feature in a pattern activates others in it, via pattern completion
“It’s all general magnitude”
Stella muttering to herself all day yesterday

• extensive evidence for cross-modal mapping
  • Dahaene’s SNARC effect
    • mapping number to handedness
  • Stella’s recent developmental work
    • size maps to number, duration

• suggests the presence of a general magnitude scale (Walsh, 2003)
  • maps dimensions into one another
  • automatically, rapidly, ubiquitously
  • implemented by the IPS?

• potential implication
  • as entities and events are processed, salient values on dimensions are mapped onto the general magnitude scale
  • values on the general magnitude scale are mapped back into other dimensions that become relevant
  • thus, speed of simulated walking can be mapped onto speed of speaking
Simultaneous linking mechanisms

• in many cases, simultaneous mechanisms may operate together
  • structure in initial brain organization
  • empirical cross-modal patterns
  • general magnitude
  • others???

• learning and expertise
  • how much learning is necessary to establish a mapping?
  • how does practice at a mapping affect subsequent performance?
Phonaesthemes

• for non-arbitrary relations, this account may work
  • e.g., roundedness ➔ round

• for arbitrary relations, another account may be necessary
  • e.g., gl-
    • language-specific cues for nouns vs. verbs (different across languages)
  • perhaps network discrimination learning dynamics are sufficient
    • i.e., linking mechanisms aren’t necessary
The relevance problem

• a given sound cue could potentially prime multiple dimensions
  • speaking pitch → height, valence, rate, etc.

• contextual constraint
  • fly ball: speaking pitch → height
  • emotional event: speaking pitch → valence
  • walking somewhere: speaking pitch → rate