Lexical entry: the connection between sound and meaning

Question:
- What’s the nature of the connection? Is it something you could lose?
- I.e., is it possible to have both your sound representations and meaning representations intact but just not be able to connect them?
  - Aphasia evidence suggests yes.
- Selective loss in linking sound to meaning in comprehension:
  TRANSCORTICAL SENSORY APHASIA

- Selective loss in linking meaning to sound in production:
  ANOMIA
Transcortical sensory aphasia

- Auditory comprehension deficit in the absence of evidence of phonological impairment or semantic impairment.
- Word repetition is intact.
  - Requires accessing phonological representations but can be performed without access to semantic representations.
- Naming is intact (although this is debated).
  - Therefore:
    - Phonological representations are intact (as they can be used in production).
    - The route from meaning to sound is intact (but not vice versa).
- The sparing of repetition the main difference to Wernicke’s aphasia (where repetition is impaired).
Transcortical sensory aphasia

- Extremely rare form of aphasia; thus hard to study.
- However, has been successfully studied with so-called electrical interference
Inducing TSA with electrical interference
(Boatman et al. 2000)

- Stroke lesions typically involve multiple areas
- Focal, transient, lesions can be via induced electrical interference:
  - A low-level (10–15 mA) electrical current is generated for 5–10 s at a time, between pairs of electrodes located on the lateral surface of the cortex.
  - The current disrupts processing associated with the underlying brain tissue, causing a “functional” lesion for about 5 seconds.
- Downsides:
  - Invasive
  - Subject population limited to patients undergoing electrocortical mapping.
    - Electrical interference testing is routinely used to map speech and language functions in epilepsy patients implanted with subdural electrode arrays to assess their candidacy for focal resection surgery.
Inducing TSA with electrical interference
(Boatman et al. 2000, Transcortical sensory aphasia: revisited and revised, Brain)

All electrode locations (81 electrode pairs, range: 6-18 pairs per patient)

- Patients tested on:
  - Repetition
  - Picture naming
  - Auditory comprehension (‘move the green square’)
  - Word and paragraph reading
  - Spontaneous speech
  - Syllable discrimination
Inducing TSA with electrical interference
(Boatman et al. 2000, Transcortical sensory aphasia: revisited and revised, Brain)

Location of electrode sites where TSA was induced (auditory comprehension is impaired).

Intact: Repetition, syllable discrimination, speech.

Naming is impaired in 19/29 sites.
Inducing TSA with electrical interference
(Boatman et al. 2000, Transcortical sensory aphasia: revisited and revised, Brain)

Location of electrode sites where TSA was induced (auditory comprehension is impaired).

Intact: Repetition, syllable discrimination, speech, naming and word reading.
Inducing TSA with electrical interference
(Boatman et al. 2000, Transcortical sensory aphasia: revisited and revised, Brain)

Location of electrode sites where Wernicke’s aphasia was induced.

Impaired auditory comprehension, repetition and naming. Fluent speech.
Sound-meaning interface in the Hickok & Poeppel (TiCS, 2004) model

Main argument: Transcortical sensory aphasia
Loss of naming: ANOMIA
Loss of naming: ANOMIA
Loss of naming: ANOMIA

- Comprehension:
  - In anomia, activation of meaning on the basis of sound is intact.
Loss of naming: ANOMIA

- **Comprehension:**
  - In anomia, activation of meaning on the basis of sound is intact.

- **Production:**
  - But activation of sound on the basis of meaning is impaired.
Lesion site most commonly left anterior temporal lobe (including the Ashcraft case report), although this is not a very strong generalization.

The impairment is often limited to specific semantic domains (e.g., fruits and vegetables).

**Loss of naming: ANOMIA**
Making sense of category specific naming deficits

- Category specific naming deficits suggest that different types of meanings are stored in different parts of the brain such that it is possible to lose the connection to sound from certain types of meanings but not others.

- This actually makes some sense given when we know about lexical access from psycholinguistics.
Lexical Decision Task

- Most common task in studies of lexical access
- Present string; is it a word or a nonword?
- Nonword foils must be plausible
  - Use “pseudowords”
  - Pronounceable
  - Conform to English orthographic rules (blicket)
Lexical Decision Task

- Encoding
- Lexical Access
- Decision
- Response
Semantic priming

Time

+  +  +  +

+  doctor  +  +

+  +  +

“yes”  “yes”  nurse
Semantic priming

Response Time

Related: doctor-nurse
Neutral: xxxx-nurse
Unrelated: table-nurse
Spreading Activation Model

cradle

baby

bed

hospital

nurse

dentist

doctor

fever

rain

heat

canary

sun

green

yellow

grass

animal

mammal

bird

ostrich
Spreading Activation Model

cradle

baby
bed
hospital
nurse
dentist
doctor
delirium
fever

grass
green

rain
heat
sun

yellow
canary

bird

animal

mammal

ostrich
Semantic priming is highly automatic and occurs even in a mediated form:

LION primes STRIPES (mediate by TIGER)

Evidence that the mental lexicon is organized into semantic fields.
Phonological neighborhoods

- So, each word activates not only its own representation, but also the representations of semantically related words.
- The same holds for sound: each word activates a family of similar-sounding words.
Lexical access

Stimulus: TURN
So one might imagine that TSA also might come in category-specific versions. Like an inability to access the meanings of words starting with a /p/. But this does not seem to occur.

So no evidence for different sound representations occupying clearly distinct patches of cortex.