MacKay, D.G. (2011). The semantics-phonology interface. In P. C. Hogan (Ed.). *The Cambridge Encyclopedia of the Language Sciences* (pp 757-758). Cambridge, England: Cambridge University Press.

SEMANTICS-PHONOLOGY INTERFACE

Systems theories in widespread use within the cognitive and neurosciences (see HIPPOCAMPUS) face two major challenges: determining when systems differ and determining where and how different systems interact. Both problems have been solved for the **PHONOLOGICAL** and sentential-semantic systems. The **SEMANTICS**-phonology interface has been established via three complementary criteria – independent activity, connectivity, and error frequence – that may help resolve other system-boundary disputes. Under these theoretical and empirical criteria, the sentential-semantic versus phonological systems are *language-memory* and *comprehension-production* systems. That is, the sentential-semantic system contains units for comprehending, storing, retrieving, and producing **MORPHEMES**, **WORDS**, phrases, and **PROPOSITIONS**, and the phonological system contains units for comprehending, storing, retrieving, and producing **SYLLABLES**, phonological compounds, and segments. These are the three criteria for viewing the semantic-sentential versus phonological systems in this way.

The Independent Activation Criterion

Independent activation is a system-differentiation criterion. Current theory (e.g., MacKay et al. 2007) has used K. S. Lashley's (1951) distinction between activation versus **PRIMING** to distinguish between systems (see also SPREADING ACTIVATION). Activated units automatically prime, or prepare, for activation all units to which they are connected, regardless of the system that houses the units. However, primed units don't necessarily become activated: Application of a *system-specific* activating mechanism is necessary to activate a primed unit. For example, when a speaker familiar with the noun *desk* sees a desk, units in visual systems prime or ready for activation the lexical unit representing the noun *desk* in the sentential-semantic system. However, the speaker seeing a desk doesn't necessarily activate the primed unit representing *desk*: We don't go through life naming whatever we see. To produce the noun *desk*, an activating mechanism specific to the sentential-semantic system must activate the primed content unit representing *desk* (see MacKay 1987, 1992).

Because functionally independent activating mechanisms activate the representational or content units in different systems, content units in one system can be activated independently from content units in another system, and content units that are independently activatable are part of different systems under the independent activation criterion. The phonological versus muscle movement systems clearly satisfy this independent activation criterion because we can produce internal speech without overt muscle movement: Internal speech occurs when we activate phonological units without activating corresponding muscle movement units, indicating that phonological and muscle movement units occupy separate systems under the independent activation criterion. Similarly, we can produce sequentially organized thought internally without becoming aware of inner speech sounds and without overt movement, indicating a third independently activatable system under the independent activation criterion: the sentential-semantic system. Of course, only units within the phonological and muscle movement systems

become activated when we learn and produce experimentally constructed nonsense syllables, whereas units in all three systems become activated in concert during full-blown sentence articulation (see MacKay 1992).

The Connectivity Criterion

Connectivity is a systems-interaction criterion. Content units for perceiving and producing sentences are functionally (but not structurally) hierarchic (see MacKay 1987, 23; also Jackendoff 2003, 5–34), and differing patterns of connectivity for units at the highest versus lowest levels in a system indicate how systems interface under the connectivity criterion. In general, the highest-level units in a system only receive bottom-up connections from *within the same system*, whereas the lowest-level units in a system receive bottom-up and lateral connections *from outside the system*. For example, syllable units only receive bottom-up connections originating within the phonological system, whereas lexical units receive bottom-up *and* lateral connections from outside the sentential-semantic system. The bottom-up "extrasystemic" connections come from orthographic and phonological systems and enable speakers to produce a word such as *apple* on the basis of hearing or seeing the word *apple*. The lateral extrasystemic connections come from visual and other sensory systems and enable speakers to produce *apple* solely on the basis of seeing, smelling, or tasting an apple (see MacKay 1987, 14–38). The dividing line between phonological versus sentential-semantic systems, therefore, falls between syllables and lexical/morphemic units under the connectivity criterion, with syllable units as the highest level in the phonological system and lexical/morphemic units as the lowest level in the sentential-semantic system.

The Error Frequency Criterion

Error frequencies provide converging evidence for both system differentiation and boundary determination. Evidence based on error frequencies has established hundreds of subsystems known as sequential domains, which are functionally distinct sets of content units that share the same activating mechanism, for example, proper nouns (see MacKay 1987, 44–5). Error frequencies also reinforce the syllable-word/morpheme interface as the dividing line between the phonological versus sentential-semantic systems. For reasons related to the speed–accuracy trade-off (see MacKay 1987, 61), speech errors are relatively more common for units at low rather than high levels within a system. This means that error frequencies can indicate where one system ends and another begins. Consider substitution errors involving words versus syllables. Word substitutions greatly outnumber syllable substitutions in everyday speech, a quantum jump in error frequency that provides converging evidence for establishing syllables versus words/morphemes as the boundary between the phonological versus sentential-semantic systems.

The pressing problem for future research is to resolve boundary disputes afflicting other putative cognitive systems using principles similar to the independent activation, connectivity, and error frequency criteria for establishing the phonology versus sentential-semantic interface (see MacKay et al. 2007).

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