What's in a rule
The acquisition of the English past tense

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What is linguistic productivity

Grammar (i.e. competence) is the ability to produce a potentially infinite number of grammatical sentences with finite means.
(Chomsky 1965)

Language is the infinite use of finite means.
(Wilhelm von Humboldt)

What are the (finite) means that enable us to produce an infinite number of sentences?
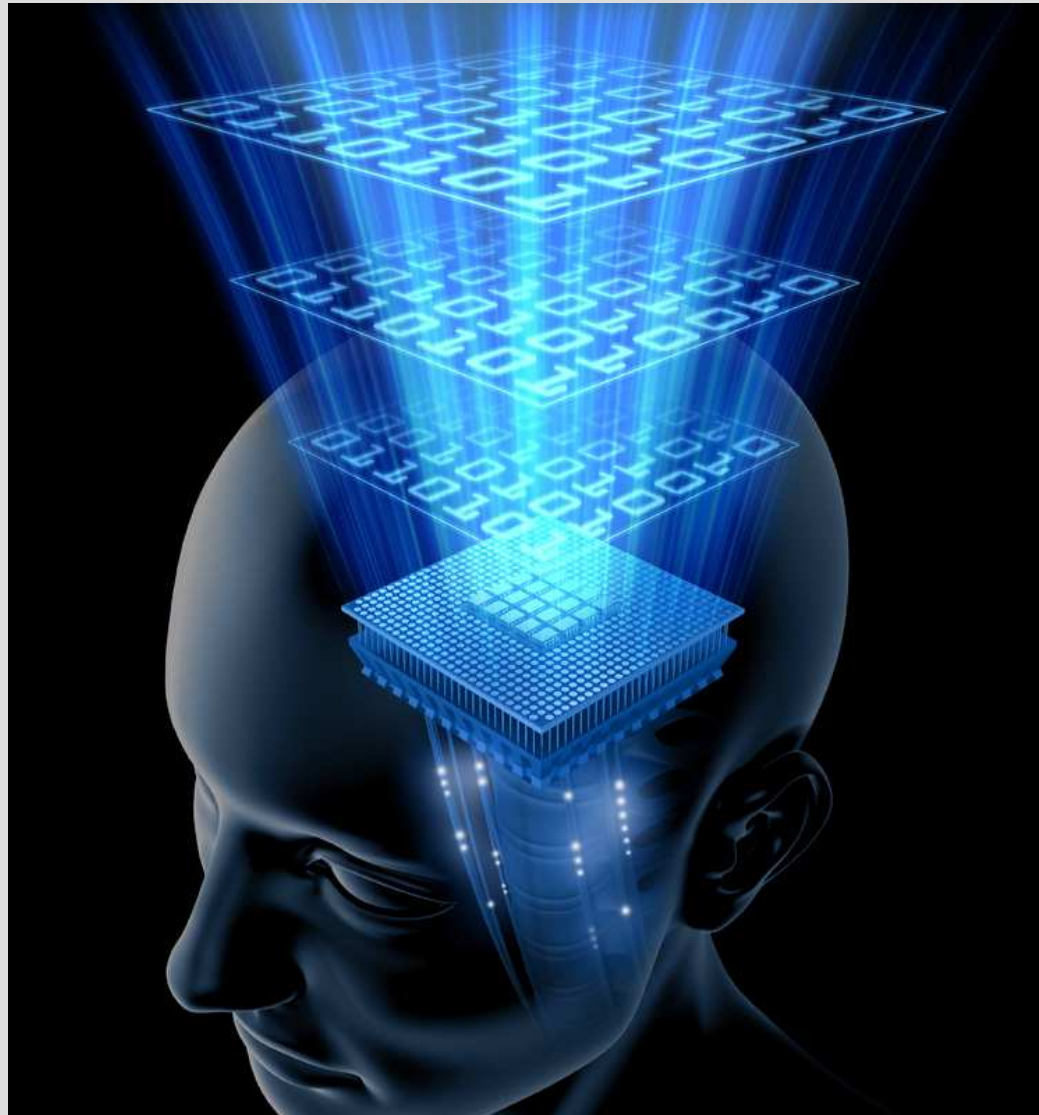
Grammatical rules

What's a rule?

What is a grammatical / linguistic rule?

Plural Noun	→	N-[s]	morphological rule
NP	→	DET (ADJ) N	phrase structure rule
Quantifier	→	$\forall$x [student(x) talks(x)]	semantic rule

(4 x 3) + 5 = 17

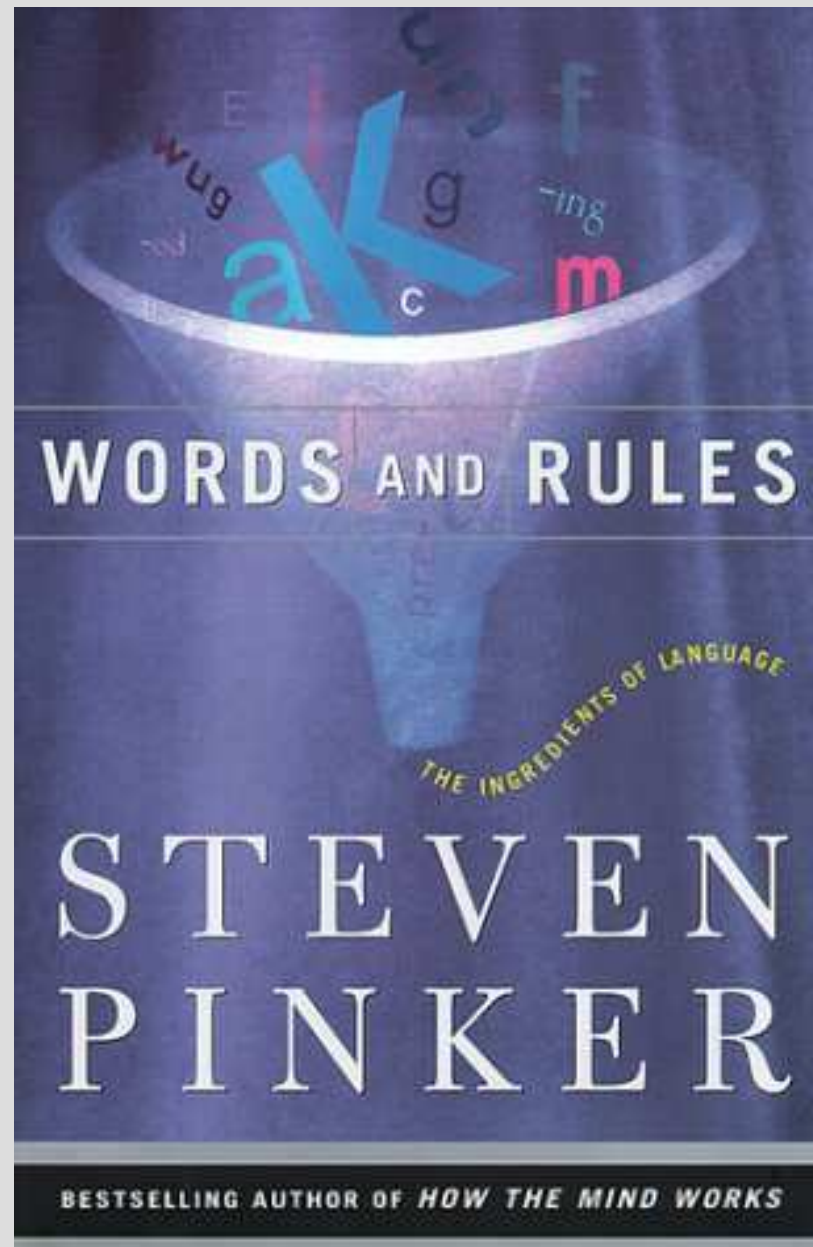<table border="0" cellspacing=5 cellpadding=5>

The digital computer is the most influential metaphor of human cognition and (mental) grammar in cognitive science. (Bates and Elman 2002)

Does the mind really work like a computer?

Does linguistic productivity involve combinatorial rules that are similar to programming commands in a computer language?

WORDS AND RULES

THE INGREDIENTS OF LANGUAGE

STEVEN PINKER

BESTSELLING AUTHOR OF *HOW THE MIND WORKS*

The acquisition of the English past tense

Regular verbs

walk → walked
kiss → kissed
like → liked
hate → hated

Irregular verbs

sing → sang
swim → swam
buy → bought
hit → hit

Children's errors

buy → buyed
buy → buyed
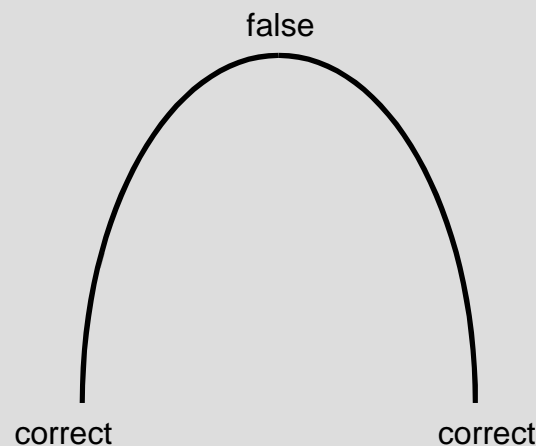sing → singed
hit → hitted
go → goed

Blends

go → wented
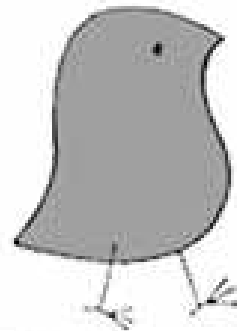see → sawed

The development of the past tense

Three developmental stages:

1. Children produce the correct inflected forms: *went, kissed*

2. Children overgeneralize the regular past tense form: *ringed, sayed*. But only a proportion of all irregular verbs are regularized (estimated 4.5% - 40%).

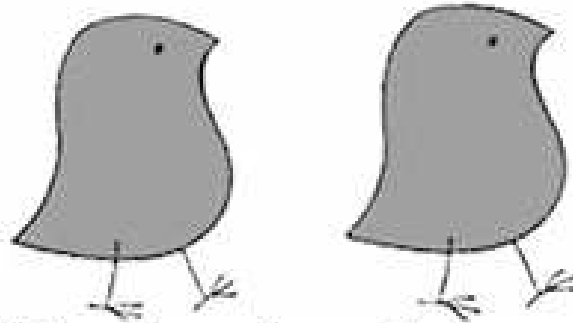3. Children eliminate overextension errors.

false

correct   correct

U-shaped development

The wug test

Berko 1956

The wug test

This is a man who knows how to rick.

He is ricking.

He did the same thing yesterday.

What did he do yesterday?

Yesterday he ___

Berko 1956

The acquisition of the past tense

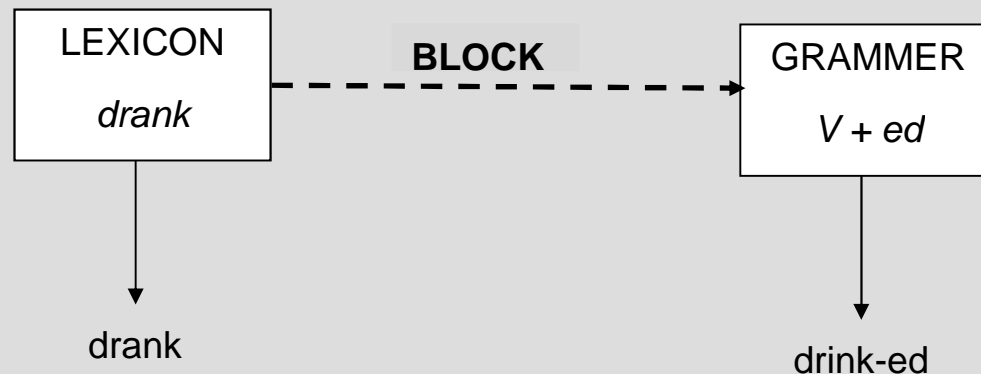Conclusion: Children use rules to produce inflected word forms.

But ...

- children vary in their use of the past tense,
- and children do not only produce novel regular forms but also novel irregular forms (e.g. *fring -> frung*).

How do we account for this?

The dual mechanism account

Pinker: The formation and acquisition of the past tense involves (i) combinatorial rules, and (ii) a blocking device.

```
┌─────────────┐                          ┌─────────────┐
│   LEXICON   │ ─ ─ ─ BLOCK ─ ─ ─ ─ ▶   │  GRAMMER    │
│    drank    │                          │   V + ed    │
└─────────────┘                          └─────────────┘
       │                                        │
       ▼                                        ▼
     drank                                  drink-ed
```

Open questions:

- ❑ Why are children inconsistent?
- ❑ Why do children go through an overgeneralization phase?
- ❑ Why do they produce blends (e.g. *wented*), which they never encounter in the ambient language?

Bybee and Slobin 1982

The occurrence of children's mistakes with the past tense is not random.

Their errors correlate with two factors:

- ❑ The frequency of individual verbs
- ❑ The phonetic similarity between verbs

Since frequent verbs are deeply entrenched in memory, they cannot be so easily changed.

Old English		Modern English	
climb	clomb	climb	climbed
step	stope	step	stepped
laugh	low	laugh	laughed

Bybee and Slobin 1982

Why does similarity affect the formation of the past tense?

Irregular verbs—such as *hit*, *eat*, or *find*—that end with an alveolar plosive, are less frequently used with the *-ed* suffix in the past than verbs that end in different speech sounds.

	-ed suffix added	*-ed* suffix not added
Verbs ending in t/d	42	157
Verbs not ending in t/d	203	34

Children are reluctant to add the *-ed* suffix to a verb stem ending in an alveolar plosive because these verbs look already a bit like past tense forms. (Bybee and Slobin 1982)
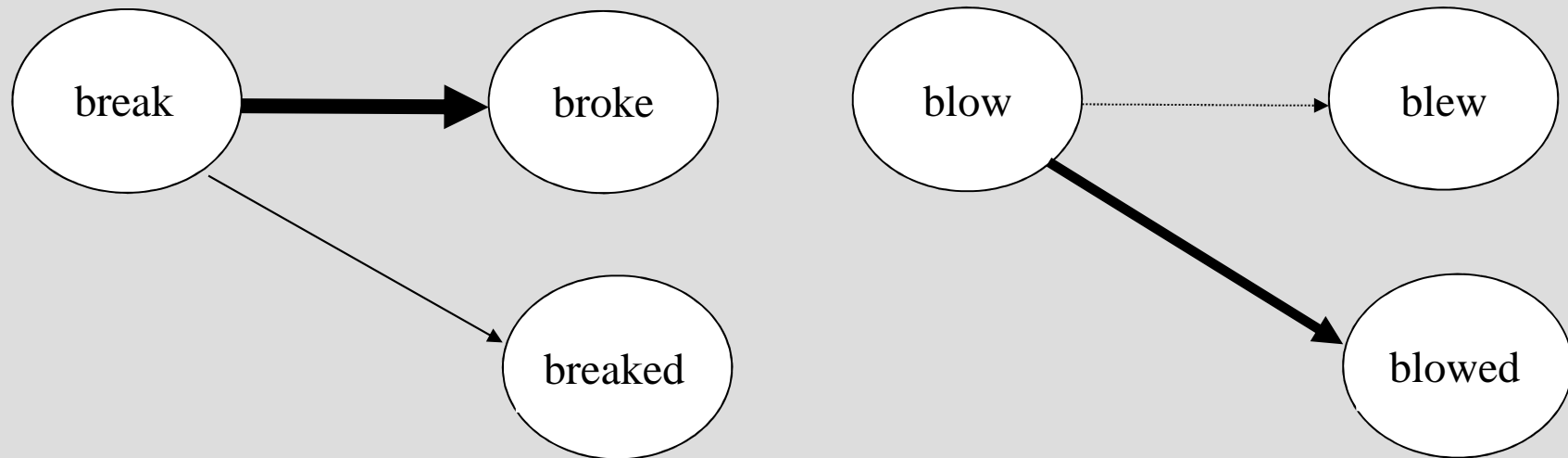
Bybee and Slobin 1982

Children tend to regularize irregular verbs:

- If these verbs do not already look like past tense forms
- If there is little phonological overlap between present and past tense forms

Shared consonants in onset	
see - **s**aw **fl**y - **fl**ew	

Bybee and Slobin 1982

Children tend to regularize irregular verbs:

- If these verbs do not already look like past tense forms
- If there is little phonological overlap between present and past tense forms

Shared consonants in onset	Shared consonants in onset and coda
see - saw	**breake - broke**
fly - flew	**drink - drank**

Bybee and Slobin 1982

Bybee and Modor 1983

/ɪm/	swim	swam	swum
	come	came	come
/ɪn/	begin	began	begun
	run	ran	run
/ɪŋ/	ring	rang	rung*
	sing	sang	sung
	spring	sprang	sprung
/ɪŋk/	drink	drank	drunk
	shrink	shrank	shrunk
	sink	sank	sunk

Both children and adults produced novel past tense forms such as 'bing -> bung', 'klim -> klum'.

Bybee and Modor 1983

Three factors influenced the subject's performance:

- ❑ The stem vowel
- ❑ The initial consonant cluster
- ❑ The final consonant cluster

Bybee and Modor 1983

Initial consonant cluster	Responses with vowel change
sCC	44%
sC	37%
CC	27%
C	22%

Final consonant cluster	Responses with vowel change
ŋ, ŋk	44%
k, g	25%
n, m	21%
C	4%

Bybee and Modor 1983

The irregular past tense forms constitute a schema.

Past tense
(s) CC [ɪ] ŋ k

These schemas are in competition with each other.

Bybee and Modor 1983

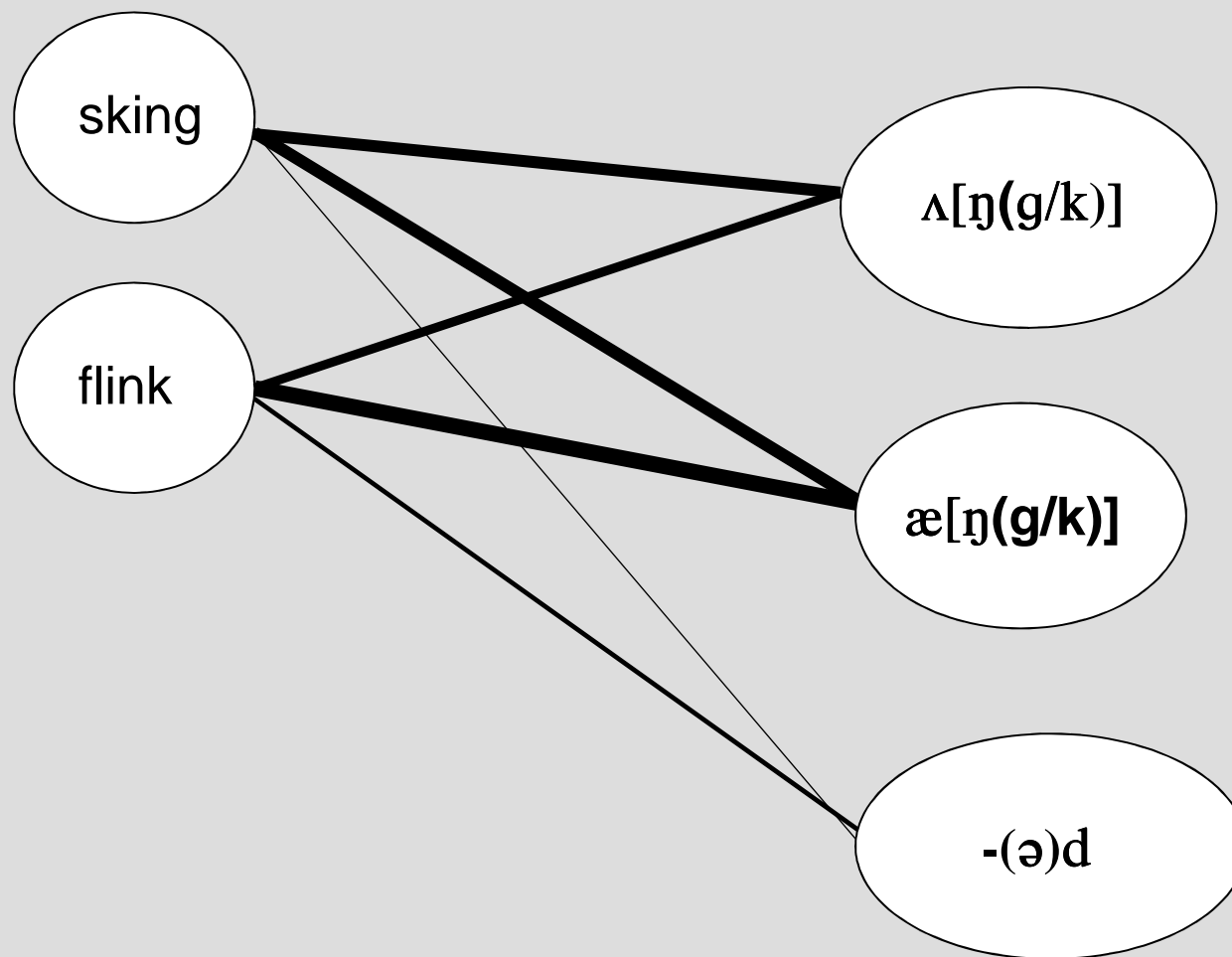Children treat the formation of the past tense as a "matching problem".

The productivity of the past tense is based on associative links between present and past tense forms that are determined by frequency and similarity.
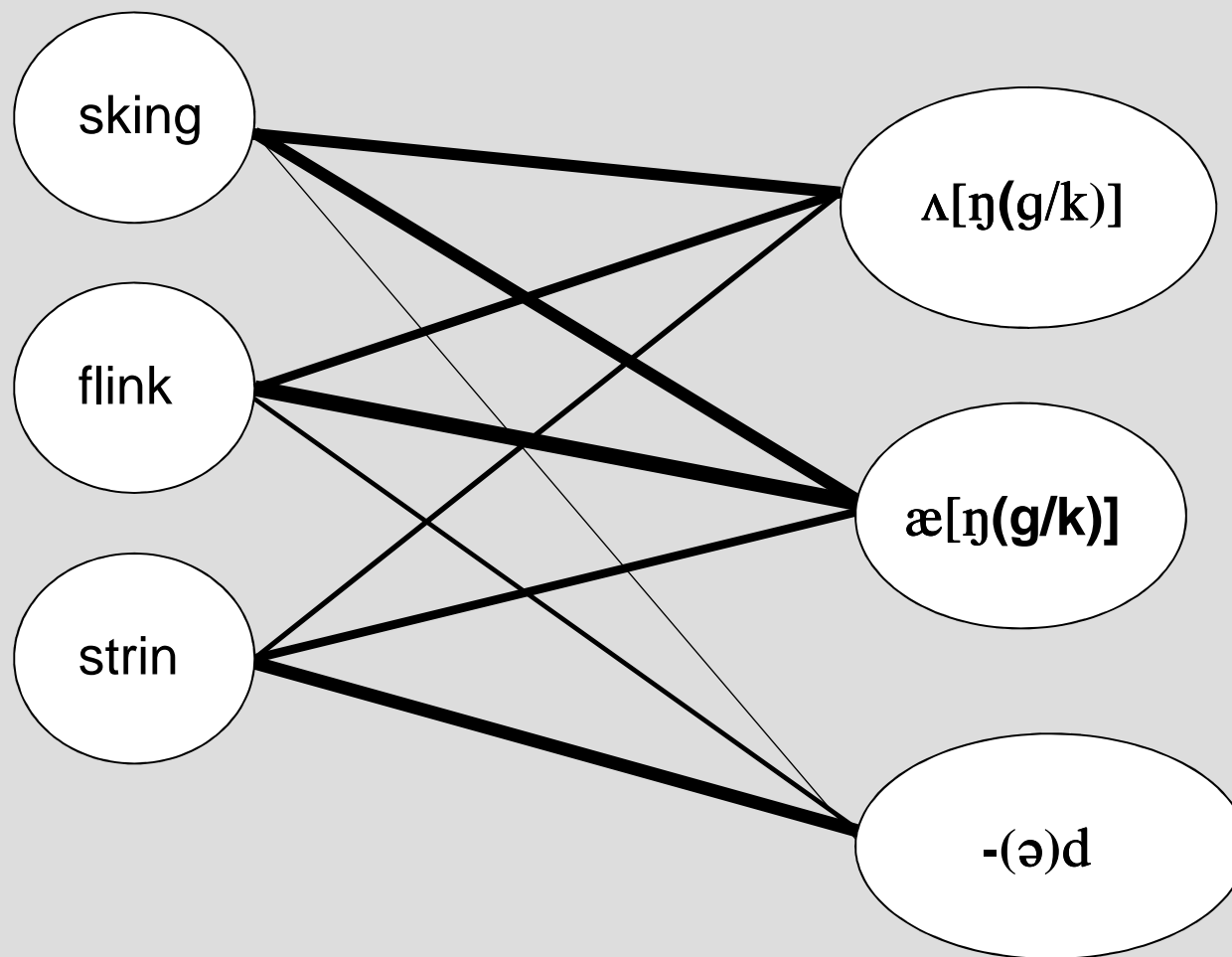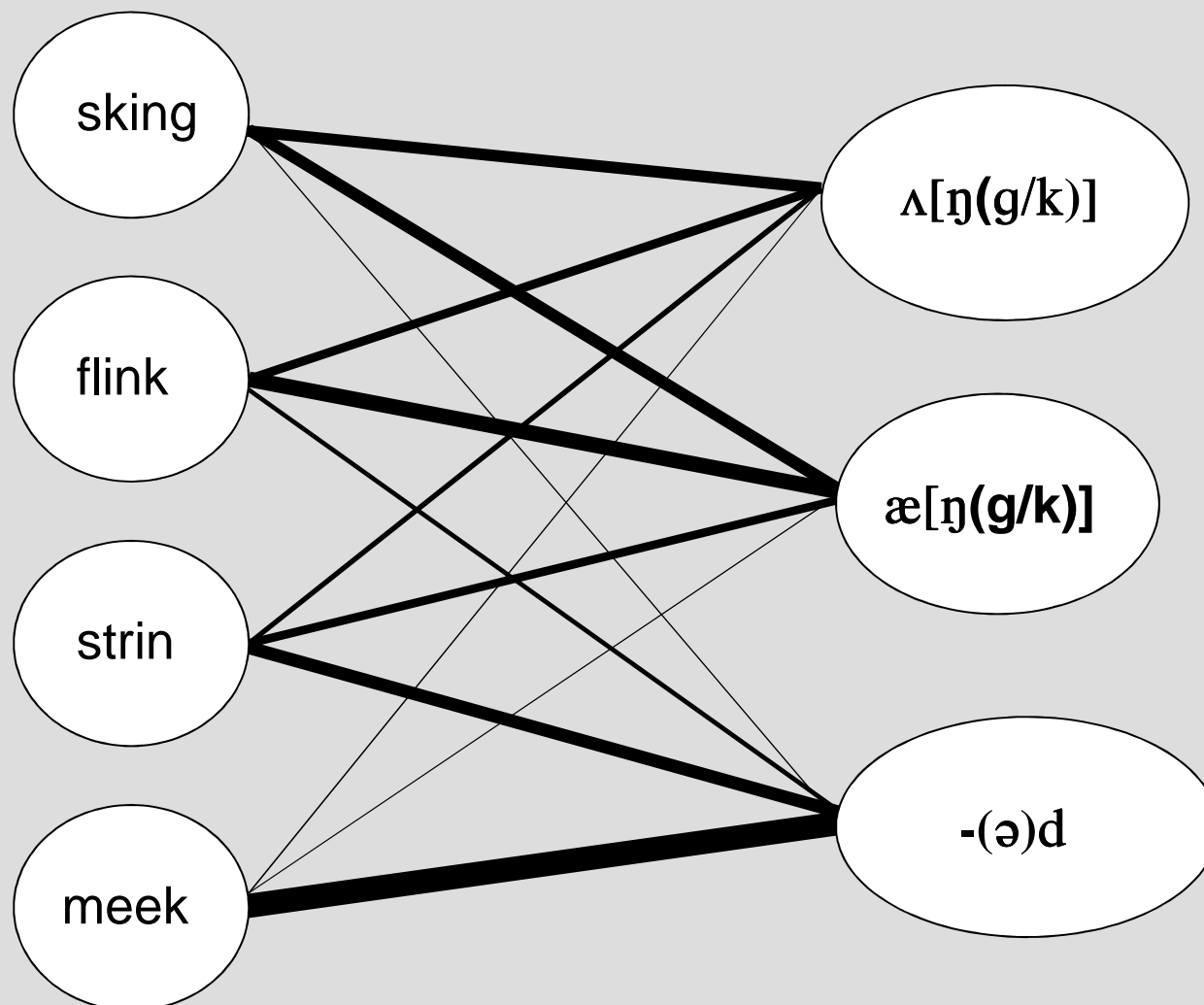
Bybee and Modor 1983

Bybee and Modor 1983
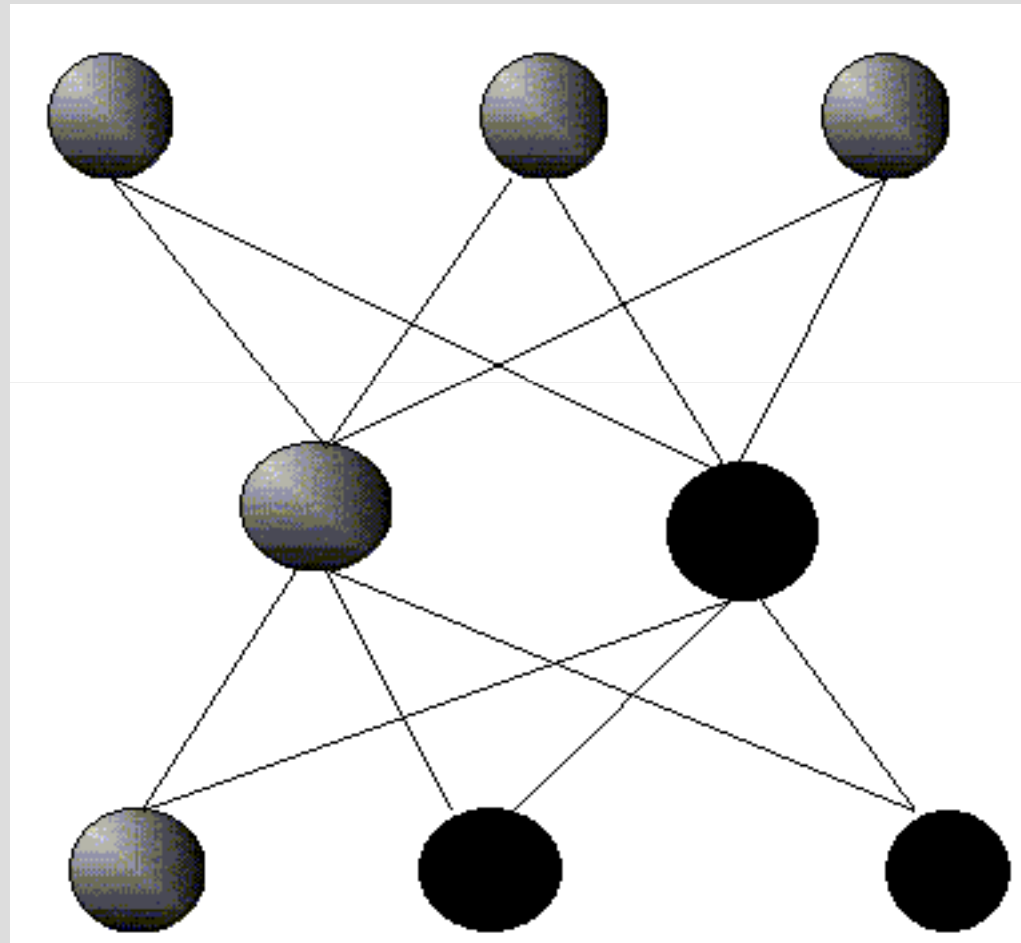
Bybee and Modor 1983

Bybee and Modor 1983

Bybee and Slobin 1982

Rules are like mathematical equations; they are categorical and independent of the language user's experience, whereas association are probabilistic links between symbolic elements that are shaped by frequency and (phonetic) similarity.
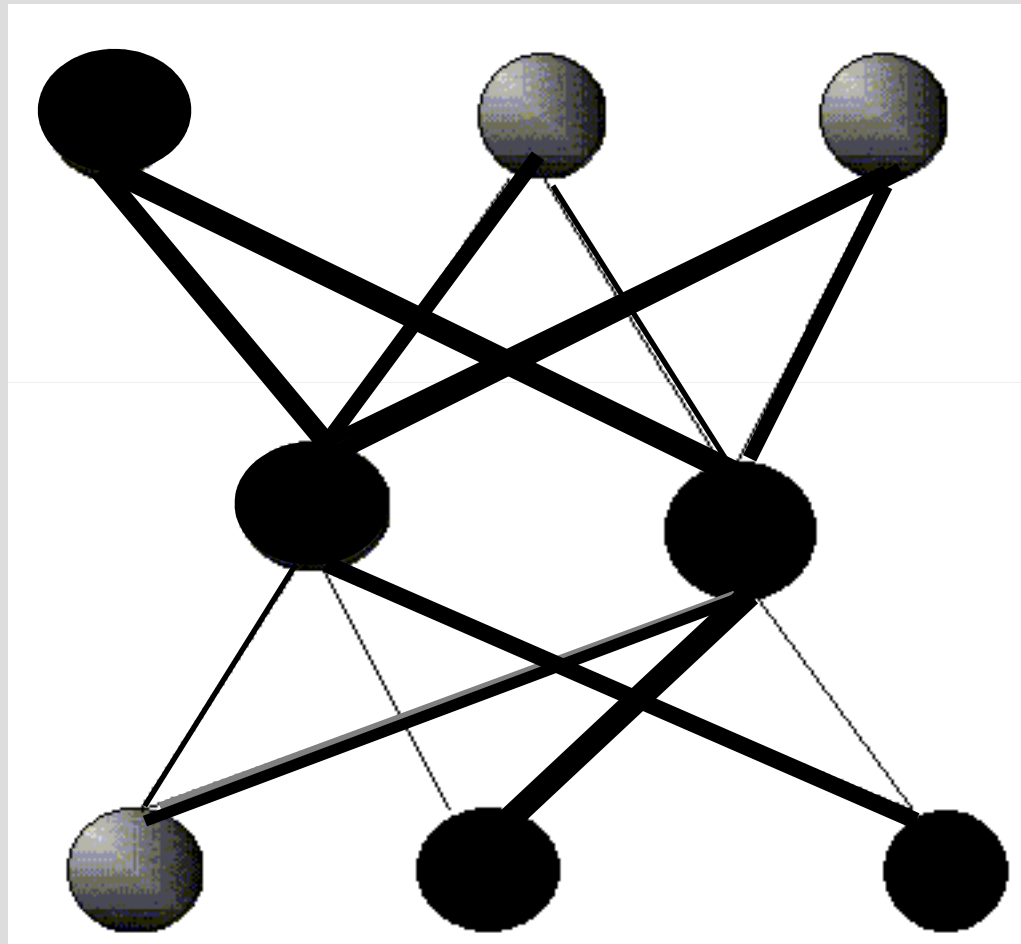
Connectionism

Output nodes

Input nodes

Connectionism

Output nodes

Input nodes

Connectionism

Rumelhart and McClelland. 1986. On learning the past tense of English verbs. In Rumelhart and McClelland (eds.), Parallel Distributed Processing: Exploration in the micostructure of cognition. Cambridge: MIT Press.

Encouraged by the success of connectionists modelling, some researchers have argued that the entire system of grammatical rules can be replaced by a network model in which linguistic productivity is determined by associations.

Is the network model also suitable to account for productivity in syntax?