

CHINESE STEPLADDERS

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Word Ways readers are familiar with Lewis Carroll's word ladders. As a variation, Dave Morice suggested in the August 1989 *Kickshaws* a game which he called Stepladders. Two words join only if the letters which are exchanged are adjacent to each other in the alphabet.

Unfortunately, Morice's rule does not allow enough joins for an interesting analysis. If one is restricted to words from the Official Scrabble Players Dictionary, the largest four-letter word network contains only 14 words of the form (KLMN)l(KLMN)(DE). Three other networks have 10 to 12 words apiece: (BCD)U(RST)(RST), (RST)A-(KLMN)E, and (BCD)A(RST)(RST). For details, see the November 1989 *Kickshaws* and the February 1990 *Colloquy*.

To get around this limitation, I investigated word ladders in which the mandated distance between exchanged letters is other than one step. The one system that seems to work very well uses six steps and goes around the world through ZA (hence, Chinese Stepladders). This results in letters dividing into two groups of size 13, one with the vowels and the other without (call them V and C, respectively):

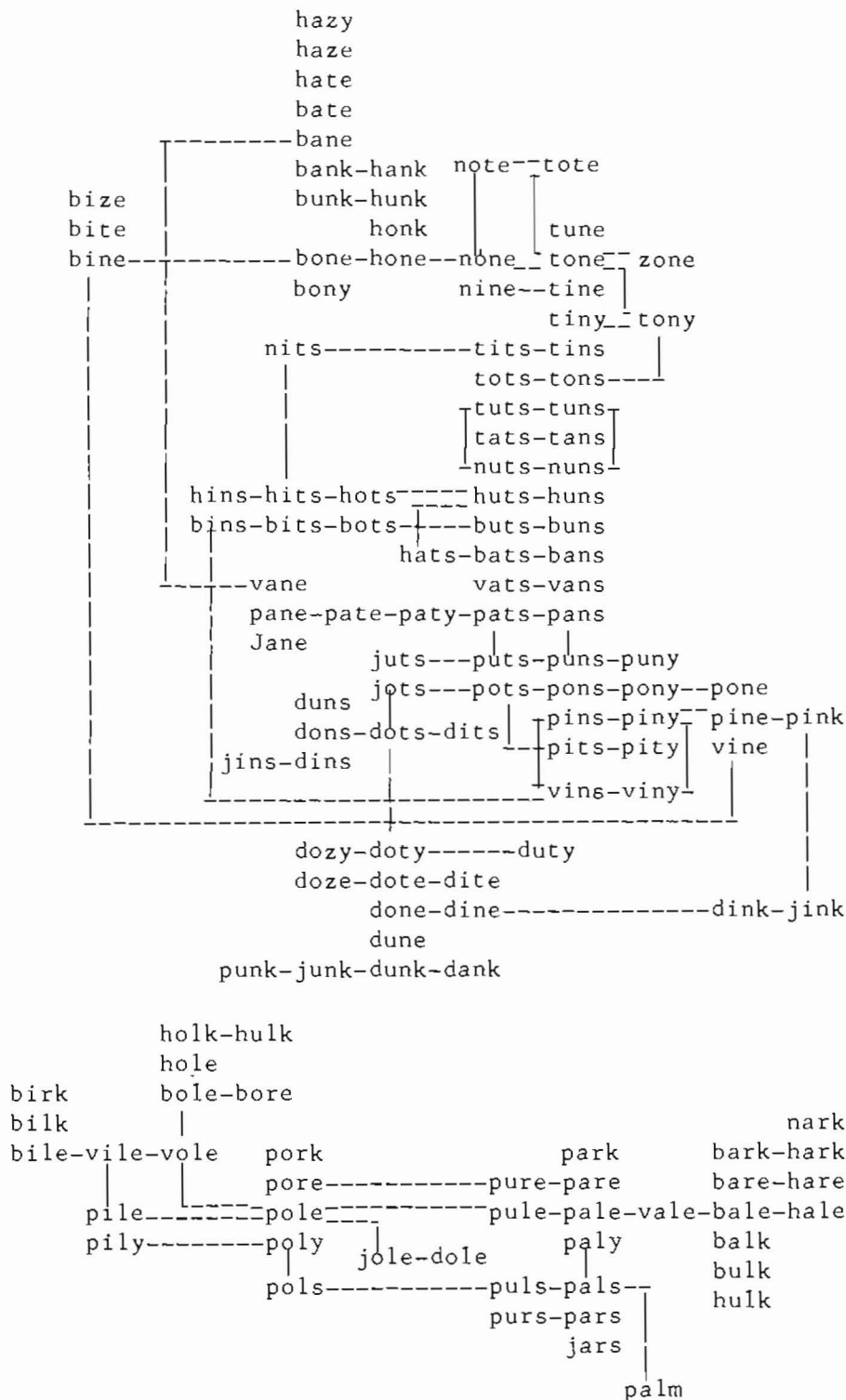
Vowels (V) -A-G-M-S-Y-E-K-Q-W-C-I-O-U-
No Vowels (C) -B-H-N-T-Z-F-L-R-X-D-J-P-V-

These parcel all four-letter words into 16 disjoint networks; there is no way (for example) that WORK can be transmuted into PLAY even if all four-letter strings were words. By far the most fecund network is the one formed from words with the pattern **cvcv** (such as TlLE or FARM).

The largest connected network with pattern **cvcv**, with 98 words, is diagrammed on the next page. Its span is 20, PUNK-junk-dunk-dune-done-dote-doty-dots-jots-juts-puts-pats-paty-pate-pane-vane-bane-bate-hate-haze-HAZY.

The second largest network has 42 words, followed closely by one with 39. The span of the former is 13 (HULK or B1RK to NARK), and of the second, 14 (LAZY, FAZE or RAZE to LATS). Next in size are three fragments with 18 to 21 words apiece; all are shown on the next two pages.

Can these networks be joined into a single network? ZONE can be joined to FINK (uniting the 98-word and 39-word networks) via ZONK (in *12000 Words*) and ZlNK (obsolete variant of zinc in Webster's *Second*). Similarly, RlFE can be joined to LONE (uniting the 39-word and 18-word networks) via RIZE (reformed spelling



of rise in Webster's Second), RITE, ROTE and LOTE. It appears very difficult to join the 42-letter network to any other one; a suitable word with F in the third position is the stumbling-block.

lazy
 faze-----laze---raze
 fate-----late rate
 | luny-----| lute rune
 fane-----lane-----lune-----lone-line-link-rink
 | lank---lunk
 | rank funk
 fine-fink
 liny
 rins-lins-lits-lots-rots
 fins-fits ruts-runs
 fons rats
 funs-fans-fats-lats

 bids
 bads-buds-bods-hods-nods-tods-tody-tidy
 | boxy-body-bode-bide-hide-nide-tide
 | vide node
 | nude

 ribs-libs-fibs lory
 robs-lobs-fobs luxe-lure-lore-lire
 rubs fubs fore-fire-file-fife
 ruby fork life
 rube-lube folk rife
 robe-lobe rile
 rove-love-live-five role
 opy-rope-lope rule
 ripe rale
 rare

What happens to the network if words not in the Official Scrabble Players Dictionary are allowed? Augmenting the OSPD list with words taken mainly from the Oxford English Dictionary to form a list of 7053 words, my computer found a network of 648 words with pattern *cvcv*; a portion of that network is given on the next page. The network has a span of 43, from *pavy* to *dods* or *pavy* to *five*. A key shortcut, *bode-boxe-bore*, is not shown. The OED gives *boxe* as an alternate for *box*; without it, the *bode-bore* distance is 8, and the span 49. Perhaps the reader can find other shortcuts.

Consider what happens if the mandated distance between letters is four instead of six. The alphabet again divides into two groups of size 13, with all the vowels in one group:

Vowels (V) -A-E-I-M-Q-U-Y-C-G-K-O-S-W-

No Vowels (C) -B-F-J-N-R-V-Z-D-H-L-P-T-X-

If only OSPD words are used, the largest network with pattern *cvcv* has a size of 37 (two pages ahead) and a span of 15: *TlRE-tine-pine-line-lire-hire-here-hare-have-lave-pave-pare-pere-peri-perm-TERM*. However, using the augmented list, the largest network contains 277 words, a part of which is shown below. The link *nele-nehe-nede* is not shown, but is used as part of the span of 25, from *bite* to *term*. *Nipe-nile*, *ripe-rile* and *pipe-pile* links are also not shown, but they are not part of the span.

Finally, consider what happens if the mandated distance between exchanged letters is twelve instead of six. The two alphabet groups:

tire	diva-deva	jive
tine	live-hive-dive	five
pine-line-lire-hire-dire-dine		fire-fine-bine
	here-dere-dene	fere bene
daze	hare-dare	fare-bare-bane
hade-haze-have	para	fane
lade-laze-lave-pave-pare-tare		jane
	lava pane	
	leva lane	pere-peri-perm-term

Vowels (V) -A-M-Y-K-W-l-U-G-S-E-Q-C-O-

No Vowels (C) -B-N-Z-L-X-J-V-H-T-F-R-D-P-

The largest network based on the augmented list contains 263 words and the span is 21; e--s links are significant. There are more cyclic links in this network than in the others, hence the shorter span. Nats, bahs, vats, hots, hahs and vote are all 21 links from lale.

		rode-
lale-laze		rope
lole-loze		robe
		tons-
lone-zone-none---	bone-pone-done-rone-fone-tone-hone-vone	
	-nane---bane-pane-dane-rane-fane	hane-vane-jane
	naze---baze	daze-raze-faze
	nale---bale-pale-dale-rale-fale-tale-hale-vale-jale	haze
	bole-pole-dole-role	tole-hole-vole
lobs-lobe		
lops-lope-zope-nope		
lode	node	bare-pare-dare-rare-fare-tare-hare-vare
lore-zore-nore---	bore-pore-dore-rose-fore-tore-hore-vore	
lofe		rofe
lote	-note---bote-pote-dote-rote	tote-hote-vote
	bate-pate-date-rate-fate-tate-hate	
	nats---bats-pats-dats-rats-fats-tats-hats-vats	
	bahs-pahs	fahs hahs
lots	-nots---bots-pots-dots	rots
		tots-hots

These networks are related to letter-shift words, discussed in earlier **Word Ways**. "Letter-Shift Words in the OSPD" (February 1990), based on a smaller database, noted that shift distances of 4, 6 and 12 produced the largest number of shifted pairs. Here are a few ideal (minimum) stepladders between shifted word pairs:

4-step: fang-fank-fenk-ferk-jerk, luna-puna-pune-pure-pyre,
sawn-sewn-sean-sear-wear, open-spen-spin-spir-stir

6-step: lion-loon-loot-root-rout, joey-joky-joke-poke-puke,
gulf-gull-gall-mall-marl, buff-huff-haff-half-hall

12-step: zips-lips-libs-lubs-lube, gobs-gons-gone-sone-sane,
boas-baas-bams-bame-name