

SUBSTITUTE-LETTER ISOGRAM NETWORKS

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In past **Word Ways** issues, I have explored (Carrollian) word networks (Feb, May, Aug 1989), insertion-deletion networks (Aug 1990) and directed word chain networks (Aug, Nov 1991); I now study substitute-letter transposition (SLT) networks. As defined by Dmitri Borgmann, a SLT is constructed by substituting a different letter in a word (as ASPEN to ACPEN) and rearranging the result to form another word (ACPEN to PECAN). A SLT network is a messy tangle; I chose instead to study the SLT network formed of words containing all different letters (non-pattern words, or isograms). As a bonus, isograms yield Baltimore transdeletions and pangrammatic chains which are described below.

Recently the editor sent me a floppy disk of boldface words in Webster's Second Edition. I extracted the lower case words, created plurals of a few and added it all to my database (mostly Official Scrabble Players Dictionary) words. With a few inclusions from Webster's Third Edition and Chambers Twentieth Century Dictionary, my data base (for words of nine letters or more) is summarized in the table below. The final column gives the number of different isograms after eliminating words that are transpositions of other words, keeping only the first word in each transposition set.

Size	Words	Isograms	
9	47400	5482	4832
10	40000	2704	2493
11	29900	892	858
12	23500	245	241
13	16800	52	52
14	11600	12	12
15	7100	1	1

Ten-Letter SLT Networks Of 2493 ten-letter isograms, 54 join (SLT to) CLARIONETS. Four isograms are eight steps away from it; the network on the next page joins these four far-out words. The span of the entire 2215-word main network is 15 (LACKEYDOMS or CHOKE-DAMPS to FADMONGERS). Of the 277 words not in main, 220 are isolanos and 57 are in small nets. Those with more than two words are given at the right on the next page. A few odd joins in the main SLT network: EARTHLINGS to NIGHTMARES, AUTOSEXING to EX-HAUSTING, POSTCLIMAX to COMPLAINTS.

Three minimum-length pangrammatic chains (all part of the main network, of course) are also given on the next page. All words can be found in Webster's Second.

		fadmongery--FADMONGERS	consumedly
		daemonurgy	confusedly
		dutymonger	unforcedly
		gymnetrous	
	germanious--augmentors--morganites		underbacks
	angiosperm		neckguards
porcelains--impersonal--neuroplasm			ravenducks
clarionets	supermanly		subworkman
interclash	permutably--presumably	meliorants	scrubwoman
starchlike	abruptedly	seralbumin	scrubwomen
	OB DURATELY	unriskable	
		shrinkable	bodymakers
		hacksilber	bankerdoms
		backslider--blockaders	breakdowns--break-
		blockheads	scowbanker winds
	CHOKEDAMPS--shackledom--LACKEYDOMS		

coadjutrix	underflows	overbuilds
judicatory Y	underblows B	underboils N
jocularly L	underboils I	brodequins Q
oscularity S	brodequins Q	boundaries A
secularity E	boundaries A	xenosaurid X
lacquerist Q	disenamour M	resudation T
revictuals V	randomizes Z	designator G
lubricates B	dragonizes G	dragonizes Z
brutalizes Z	jargonized J	jargonizes J
subretinal N	jeoparding P	morganizes M
neutralism M	pignorated T	promazines P
unstarlike K	overdating V	womanizers W
lupinaster P	overtaxing X	harmonizes H
plastering G	overtaking K	monarchies C
integraps H	overhating H	freshmanic F
spaewright W	athrogenic C	chrysamine Y
whipgrafts F	thyrogenic Y	hackneyism K

Eleven-Letter SLT Networks Eliminating 34 transpositions from 892 isograms of length eleven leaves a working list of 858: 642 in the main network, 173 isolanos, and the remaining 43 forming small groups. Thirty words join ULCERATIONS directly; the span of the network is 14 (KITCHENWARD to HYPERBOLISM or PUBOVESI-

KITCHENWARD	PUBOVESICAL	subchondral	underbishop
whatrecking	bicephalous	punchboards	foundership
nightwalker	pseudochina--dicephalous	hydnocarpus	unworshipped
wreathingly	endoplasmic		
breathingly	inspectoral	wordlengths	hypocentrum
unrightable	ULCERATIONS--chlorinates	worldthings	hyposternum
gaultherins--regulations		downrightly	neurolymphs
	lactigerous		
	elucidators--chloridates	spaceflight	lymphaticus
	chloramides	feldspathic	polychasium
	chrysolimid	dispatchful	sulphonamic
	syphiloderm		
	HYPERBOLISM		

CAL). At the right are the largest separate chains, all three links long. I have been unable to construct a minimum-length pangrammatic chain; the two below use every letter but J. There are several words containing J in the main network, but I haven't been able to work them in. The chain on the right, the shortest between CONJUGALITY and CONJUGATIVE, gives a clue as to why J-words don't make it in the minimum-length chain. JUXTAPOSING, JUNGLEWARDS, JACKLIGHTER, LUMBERJACKS and JACQUEMINOT are isolanos.

weaponsmith	weaponsmith	
phantomizes Z	phantomizes Z	
misanthrope R	misanthrope R	conjugality
pointmakers K	pointmakers K	conjugately E
spermatoxin X	spermatoxin X	granulocyte R
postmineral L	postmineral L	counterpaly P
tourmalines U	serpivolant V	neuroplasty S
regulations G	superlation U	superlation I
subrelation B	antifoulers F	regulations G
antifoulers F	quatrefoils Q	glauconites C
quatrefoils Q	lactiferous C	uncogitable B
fluoridates D	lactigerous G	biconjugate J
elucidators C	elucidatore D	conjugative V
dacryolites Y	orbiculated B	
valedictory V	elucidatory Y	

Twelve-Letter SLT Networks Of the 241 isograms, 107 are in the main network and 80 are isolanos. Three (CULTERANISMO, MALERUPTIONS and RECOMPLAINTS) have eight joins each. A portion of the main network is given below. The span of 13 is from PHYTALBUMOSE to either HUMBOLTINES or OUTFIELDSMAN. It is followed by the separate nets and the four transposition pairs. There is no hope for a minimum-length pangrammatic chain, but the portion of the main network shown includes all letters but Q. The letters V, W, F and K are almost as rare here as X and Z.

cephalodymus--splaymouthed--phytalbumose				
pachydermous				
parenchymous--psychoneural				
counterplays				
unepistolary				
compulsive	neuroplasmic--MALERUPTIONS--metrosalpinx			novelwrights
deutoplasmic				waterholings
pseudomantic				argentophils
consideratum-----	CULTERANISMO--	RECOMPLAINTS--	gastroplenic--	stenographic
	placentiform cryptomnesia--pyromagnetic			
	neuroblastic	prezygomatic		
	discountable-----bucklandites			
humboldtines--dismountable--outfieldsman				
bleachground	hydrocauline	hypogastrium	unimprovably	
chlorguanide	musicography--amphicyrtous		unimprovable	
declinograph	postbrachium		unprovidable	
lexicography	myelographic			
blacktongues	brachypodine	tympanichord	incomputably	mendaciously
bluestocking	hydrobiplane	hypodermatic	incomputable	sulfocyanide
ticklenburgs	imponderably	hydroclimate	consumptible	fuscohyaline

incomputable=uncompatible dasyproctine=trypanocides
 incomputably=uncompatibly amylopectins=polysemantic

Thirteen-Letter SLT Networks Partly by adding S to some of the twelve-letter words, I managed to find 52 isograms of size thirteen. None are transpositions of one another; 22 are in the main network, 26 are isolanos and the remaining four form two simple chains.

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                                salpingectomy
                endolymphatic--physicemental--lycanthropies--lycanthropize
                                |             |
        hemidactylous--hydroclimates--hypsometrical--embryoplastic
                                musicotherapy
                sulphozincate--courtezanship--unatmospheric--turbomachines
                                |             |
pervulgations--postneuralgic--pneumogastric--uncompahgrite
                dentosurgical
bleachgrounds--chlorguanides--declinographs

brachydontism--tympanichords      philydraceous--sulphocyanide

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Fourteen-Letter and Larger SLT Networks I have only twelve isograms of length fourteen. There are two joins: lycanthropized-lycanthropizes and sulphogermanic-uncompahgrites. There is only one size-fifteen isogram: DERMATOGLYPHICS. Borgmann went on to isograms of size twenty; his UNCOPYRIGHTABLE seems all right, but his ground is a bit shaky above that.

SLT Clusters A set of isograms that derive from the different possible transdeletions of a word form a SLT cluster; the same is true for the results of transaddition. If a word of length n can be transdeleted to n different words, each with a different letter removed, the result is known as a Baltimore transdeletion. Of my 2493 ten-letter isograms, 1888 can be transdeleted to at least one nine-letter isogram. Three words have Baltimore transdeletions, plus two "almosts" which **Word Ways** readers might be able to complete (as was done for John Holgate's work in the February 1989 **Word Ways**).

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clarionets: serotinal, ostracine, stercolin, coastline, consertal,
clarinets, sarcolite, contrails, acroleins, crotaline
nucleators: colatures, consertal, outlearns, nectarous, calutrons,
consulter, senocular, transluce, consulate, recountal
rediscount: seduction, inductors, courtside, construed, reduction,
unstoried, incrusted, centroids, countries, decurions
ulceration: clarionet, cautioner, outlinear, lucrations, inoculate,
cornulite, aleuronic, nucleator, centurial
postmedian: dominates, pedantism, tampioned, dopamines, pintadoes,
ptomaines, stonedamp, piedmonts, (postmedia)

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Here are some companion transadditions; the ideal would have 26 - 9 = 17 transadditions, using all the remaining letters in turn.

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crotaline: clarionet's, centroidal, francolite, chlorinate, pratincole,
melicraton, ulceration, intervocal, intercoxal, lectionary, relocating

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ostracine: clarionets, carbonites, draconites, fornicates, orchestian, cremations, recaptions, cautioners, contrawise, sectionary, zirconates
 serotinal: clarionets, obliterans, lorandites, lionhearts, meliorants, rantipoles, uranolites, loranskite
 trapesing: integraphs, plastering, restamping, sporangite, supergiant, departings, panegyrist, carpetings

Back To Networks Note that some words appear in several different SLT clusters; SLT networks of different word sizes can join each other to form a hypernet. (Kyle Corbin hints at this in his May 1989 **Word Ways** article.) Unfortunately, my attempts at drawing a hypernet produced a horrible tangle. Here are some SLT clusters organized so that some of the hypernet is evident.

uncompahgrites: unatmospheric: euchromatins
 lycanthropizes: lycanthropies: cheiroplasty, hyperactions, lycanthropes

hypsometrical: cheiroplasty
 turbomachines: euchromatins, turbomachine, bimucronates
 pervulgations: pervulgation, pulverations
 salpingectomy: polysemantic
 physicomental: polysemantic

cheiroplasty: spirochetal, rhyacolites, physiolater, polyarchist
 tricephalous: spirochetal, tricephalus, caulopteris
 recomplaints: postmineral, complainers, recomplaint, inspectoral, centropiasm

maleruptions: postmineral, maleruption, tourmalines, superlation
 metrosalpinx: postmineral, spermatoxin
 neuroblastic: ulcerations, inscrutable, construable, subrelation
 countervails: ulcerations, couniversal, involucrate, novaculites
 culteranismo: ulcerations, neuromastic, tourmalines
 bimucronates: bimucronate, neuromastic, tambourines
 euchromatins: anchoretism, neuromastic, euchromatin
 consideratum: desucration, neuromastic, endostracum, semirotunda
 hyperactions: neophrastic, hyperaction, acetopyrins, hypertonias, psychotrine

phantomizers: phantomizer, misanthrope
 lycanthropes: lycanthrope, hyposternal

spirochetal: sarcophile, proethical, phacolites, spirocheta, carpolites, aphrolites, strophical, splotchier
 postmineral: meliorants, impersonal, intemporal, reimplants, prestomial, rantipoles, spermatation
 tourmalines: meliorants, tourmaline, emulations, trimensual, uranolites, luminators
 misanthrope: morphinate, morphiates, opisthenar, matronship, spermatation, mentorship
 inspectoral: clarionets, psiloceran, pratincole, pleonastic, interclasp, carpolites, recaptions, rantipoles
 neuromastic: cremations, nectariums, nucronates, sanctorium, cautioners
 ulcerations: clarionets, isonuclear, inosculate, lacustrine, cautioners, nucleators, uranolites, lucrations, uncloister, ulceration

The capitalized Webster's Second word RETICULOSA added to the last, plus the coined UNEROTICAL, makes a Baltimore transdeletion.