

REVERSIBLE HETEROGRAMS

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In my article "Statistics of Word Neighbours" in the Nov 1997 Word Ways, I showed that theoretical expectations matched actuality quite well for heterograms, words of a given length which had all letters different (Graph 2 in that article). In "Snakes and Ladders" I attempted to make ladders between heterograms which were also words when reversed. This article gives fuller results of my investigation into reversible heterograms. The lists can act as a crib for people constructing palindromic phrases!

The frequencies were:

Word length	3	4	5	6	7	8	9	10
% Heterograms	86	76	61	46	32	20	11	6
% Reversible Heterograms	43	14	2.6	0.26	0.02	0	0	0

The figures in the last row should be halved to get the number of reversible pairs of words. Finding examples of lengths 9 and 10 seems to pose another Grand Challenge like that of the ten-square, but more difficult.

Although the prediction of the number of heterograms of a given length was quite successful, little success attended upon my attempt to predict the number of reversible heterograms. Suppose that we have a heterogram. We need one precisely defined set of letters to constitute its reversal, which may not be a word, so the probability of finding such a word is the number of words of that length divided by the number of possible letter sequences. We multiply the result by the number of heterograms to get an estimate of the number of reversal heterograms of that length. The results are always too low: by a factor of two for length 3, increasing to a factor of 60 for length 7. I conclude that the chance of finding a reversal of a given heterogram is larger than chance would indicate, and that the departure from chance increases with increasing word length.

I investigated the two letters at the beginning and the end of heterograms: the results, together with an explanation, are to be found in the table which accompanies this article. If every letter pair were equally common, each would occur $1/676 = 0.15\%$ of the time. The table records those pairs which occur about seven or more times as often as this. Two things struck me: the frequency of certain letter pairs

departs more from the norm as word length increases, and endings depart more from the norm than beginnings. Of course, as word length increases, so the number of words with prefixes and suffices can increase, giving more words with the same beginnings and the same (different!) endings.

Some letter pairs will appear more often than average, and some less. However, 21 (approximately) of the 26 letters of the alphabet are consonants, and many pairs of consonants such as CX, GV, JG or QZ do not occur. Even so, the number of letter pairs of the 676 (less the 26 doubled letters) that never occur at the start or the end of a heterogram is large. It grows from one-third in the case of four-letter heterograms, through half in the case of seven letters, to two-thirds in the case of ten letters. Thus there is a reason why some letter pairs in long words must occur frequently. Hence there are both negative reasons (large number of invalid pairs) and positive reasons (grammar) for the popularity of some starts and ends.

It is no surprise that the beginnings CO-, DI-, IN- and UN- are very popular, and HY- is explained by longer words beginning HYDRA-, HYDRO-, HYPER- and HYPO-. There are also simple explanations for the most common endings: -ED (past tense), -ER (agent of a verb), -ES (verb and plural), -IC (adjective), -LY (adverb), -NG (participle), and to some extent anything ending in S (plural and verb). The object was naturally to see which popular beginnings are also popular endings when reversed. These are marked in the table with asterisks: DE-, LA-, RA-, RE-, SC-, SP- and ST-. Of these, LA- was unexpected. At lengths 6 and 7, about 30 per cent of the reversible heterograms start with one of these seven doublets. These results may be some explanation for the results of the probability calculations noted above.

It was tricky to select the word pairs for the following lists. Roughly, I have included a pair only if at least one of the words is well-known or interesting. It turns out that approximately half of all the four- and five-letter pairs were thereby chosen, and a quarter of the three-letter word pairs. The reader with time to browse will find brief comments.

The words are to be found in the Oxford English Dictionary (OED), the Merriam-Webster Unabridged (Second Edition), the Official Scrabble Players Dictionary (OSPD), Stedman's Medical Dictionary or Pulliam and Carruth's The Complete Word Game Dictionary unless otherwise noted.

AmHer = American Heritage Dictionary
 DOST = Dictionary of the Older Scottish Tongue
 EDD = English Dialect Dictionary
 F&W = Funk & Wagnalls New Standard Dictionary
 PAW = Pears Advanced Word-Puzzlers Dictionary by Peter Newby
 Roget = Roget's original thesaurus
 SND = Scottish National Dictionary
 TIG = The Times Index-Gazetteer of the World (1965)
 TNWS = The New Welsh Dictionary by Evans and Thomas

WDOST = Wordsworth Dictionary of Science & Technology (1995)

Wyy-ppp = Word Ways year and page

Terminology: bl = below the line Webster's Second, fn = forename, Med. = medical, o. = obsolete, propr. = proprietary, vf = OED variant form

8-letter word pair (due to Dmitri Borgmann)

NICOLAUS (fn)—SUALOCIN (star)

7-letter word pairs (all)

DILATOR—ROTALID	LATIRUS?—SURITAL?	NILEVAR (Med.)—RAVELIN
NORITES—SETIRON?	REKNITS—STINKER	ROTANEV?—VENATOR

6-letter words (most)

ALERTS—STRELA (PAW)	AMENIC—CINEMA	AMICED—DECIMA	ANIMES—SEMINA
AUBREY (fn)—YERBUA	BRACED—DECARB	BRUTED—DETURB	CIDRON—NORDIC
DECAPS—SPACED	DECART—TRACED	DECURT—TRUCED	DEFLOW—WOLFED
DEFRUT—TURFED	DEGAMI—IMAGED	DEMITTS—STIMED (o. steemed)	
DELIAN—NAILED	DENIAL—LAINED (PAW)	DEPART—TRAPED	DEPOTS—STOPED
DERATS—STARED	DE TROP—PORTED	DEVILS—SLIVED	DEVOTS—STOVED
DEWANS—SNAWED	DIALER—RELAID	DIAPER—REPAID	DIBROM—MORBID
DORMIN—NIMROD	DRAZIL—LIZARD	EAIRTS (W81-105)—STRIAE	
ECITON (F&W NSD)—NOTICE		EDISON—NO SIDE (modest!)	ELUTOR—ROTULE
ENAMOR—ROMANE	ENIACS (early computer, though just one ENIAC!)	SCAINE	ENISYL?—LYSINE
GOLFER—REFLOG	GULPER—REPLUG	ILOREN—NEROLI	INAMOR—ROMANI
LAITER—RETIAL (PAW)	LANGER—REGNAL	LANRET—TERNAL	LARDET—TEDRAL?
LEVANS—SNAVEL	LEVINS—SNIVEL	LIBERO (soccer position)	OREBIL
LIGNES—SENGIL	MANITU—UTINAM	MUNGER—REGNUM	NITRAS—SARTIN
NOSIER—REISON	PERTIS—SITREP	RAKNIT—TINKAR	REBUTS—STUBER
RECAPS—SPACER	REDIPS—SPIDER	REFLOW—WOLFER	REKNIT—TINKER
RELATS (PAW)—STALER	REPINS—SNIPER	REPITS—STIPER	
REPOTS (as in snooker)—STOPER			

5-letter word pairs (selection of about half)

AGNUS—SUNGA (bridge)	AIDER—REDIA	AILED—DELIA (fn)!	AIRTS (Scot.)—STRIA
ALETS (o.)—STELA	ALSET (DOST)—TESLA	ANGER—REGNA	ANIMO—OMINA
ANOLI—ILONA (fn)	APRES—SERPA (o. Sherpa)	AREPO (famous Latin word square)	OPERA
ARGIN—NIGRA	ARTIC—CITRA (prefix)	ARTUS—SUTRA	AUGET—TEGUA
AXONE—ENOXA	BARES—SERAB	BATIK—KITAB (= Koran)	
BORAK—KAROB (o. carob)	BORED—DEROB (= rob!)	CAINE—ENIAC (computer)	CAMUS—SUMAC
CARES—SÉRAC	CARID—DIRAC (predicted positron, gave me cobnut)		
CARTS—STRACK (o. struck)		CIRES—SERIC	
CODEM (Roget)—MEDOC (France)		DAIRT—TRIAD	DALES—SELAD (o. salad)
DAMON (fn)—NOMAD!	DARTS—STRAD	DEBUT—TUBED	DECAF (AmHer)—FACED
DECAL—LACED	DECAP—PACED	DEGAS—SAGED	DEKAN—NAKED
DELIS—SILED	DELIT (= delight)—TILED	DEMAL (= domain)—LAMED	
DÉMAN (vf deem)—NAMED		DEMIT—TIMED	
DEMOS—SOMED (= samed)		DENIM—MINED	DEPOH—HOPED
DEPOT—TOPED	DERAH—HARED	DERAT—TARED	DETAR—RATED
DEVAL (vf devall)—LAVED	DEVAS (gods)—SAVED!	DEVIL—LIVED!	
DEVOR (o. devoir)—ROVED		DEVOW—WOVED	DEWAR—RAWED
DEYAR (o. dairyman)—RAYED		DIALS—SLAID (= slid)	DIANE (fn)—ENAID
DIBAR (o. diaper)—RABID	DIETS—STEID (= stead)	DILOS—SOLID	DINAR—RANID (frog)

DIPAR (o. diaper)—RAPID	DIRAL (o. dire)—LARID	DIRTS—STRID	DIRTY—YTRID
DORAS (fn)—SAROD	DORPS (= villages = thorps)—SPROD		
DOSER—RESOD (medical)!	DRAIF (o. drove)—FIARD	DRAIL—LIARD	DRAWS—SWARD
DROWS—SWORD	EDITS—STIDE (vf stead)	ELAPS(snake)—SPALE	ELFIN—NIFLE (= trifle)
ELGIN (marbles)—NIGLE (o. niggle)		ELIOT (fn)—TOILE	
ELOPS—SPOLE (o. shoulder)		EMITS—STIME	
EMONG (= among)—GNOME		ERVIL (o.)—LIVRE	ESROG (Web3)—GORSE
EVIAN (France, water)—NAIVE		EVILS—SLIVE	FILER—RELIF (o. relief)
FIRES—SERIF	FORTS—STROF (o. striven)	FUMER—REMUF (o. remove)	
GATER—RETAG	GIRTS—STRIG	GNATS—STANG	GNAWS—SWANG
HABUS (vipers)—SUBAH	HALES—SELAH	HARPO—OPRAH (Marx-Winfrey mates?)	
HENRY—YRNEH (DOST)	KELPS—SPLEK (vf spleck)	KISAN—NASIK (magic square)	KNAPS—SPANK
KNATS (bl)—STANK	KNITS—STINK	KNOPS—SPONK	KNOTS—STONK
KNOWS—SWONK (vf swink)		KNUTS—STUNK	KRANS—SNARK
KREMS (pigment)—SMERK (o. smirk)		LACER—RECALL (= recall)	LACET—TECAL (= tical)
LADES—SEDAL	LÆTS—STEAL	LAGER—REGAL	LANER—RENAL
LANES—SENAL	LAPES (o. laps)—SEPAL	LARES—SERAL	
LAROM (o. larum)—MORAL		LARUM—MURAL	LATES—SETAL
LATON (= latten)—NOTAL	LATOR—ROTAL	LAYER—REYAL (= real)	
LEMAN—NAMEL (o. enamel)		LEVAN—NAVEL	LEVAR—RAVEL
LEVIN—NIVEL	LEVIR—RIVEL	LIKER—REKIL (= rickle)	LIKES—SEKIL (o. siecle)
LINES—SENIL (= seldom)	LIVEN—NEVIL (fn)	LIVES—SEVIL (o. civil)	LOGES—SEGOL
LOREN (= leased)—NEROL	LOSER—RESOL	MALES—SELAM (salaam)	MANES—SENAM
MARCS (or Marcs!)—SCRAM		MARTS—STRAM (use of legs or Synchronous Transmit	
Receive Access Method)	MASER—RESAM (fern)	MELAS(religious fair)—SALEM!	
MILKS—SKLIM	MORTS (deaths)—STROM (o. storm)		MURES (walls)—SERUM
MUTON—NOTUM	NAGOR—ROGAN	NAGUS (miser)—SUGAN	NAMER—REMAN
NARCS—SCRAN	NARKS—SKRAN	NEVIR (o. never)—RIVEN	
NEVOW (= nephew)—WOVEN		NEVOY (= nephew)—YOVEN (o. given)	
NIDAL—LADIN (o. laden)	NIDOR—RODIN (sculptor)	NIEHT (o. night)—THEIN	
NIGER (negro / river)—REGIN		NIPAS—SAPIN	NIPER—REPIN
NITER—RETIN	NIVER (o. never)—Revin (vf raven)		NOPAL—LAPON
NOPEs—SEPON (vf, porage or UK share settlement coy)	NORES (o. nourice)—SERON		
NOSER—RESON (o. reason)	NOTES—SETON	OBMIT (o. omit)—TIMBO	ORCAS—SACRO (egoismo)
PACER—RECAP	PALER—RELAP	PARTS—STRAP	PEALS—SLÆP (vf sleep)
PERTS—STREP	PLATS—STALP (o.)	PLOTS—STOLP (o. stoop)	PORTS—STROP
PORYS—SYROP (o. syrup)	PURIS—SIRUP (= syrup)	RABUT (Scot. rebut)—TUBAR	
RACES—SECAR (o. saker)	RAEPS—SPEAR	RAGES—SEGAR (= cigar)	RAMON (fn)—NO-MAR
RAPES—SEPAR (in New Mexico)		RATES—SETAR (= sitar)	REALS—SLAER (o. slayer)
REAPS—SPAER (seer)	REBAT—TABER	REBIT—TIBER (Italy)	REBUS—SUBER (cork)
REBUT—TUBER	RÉCIT (music)—TICER	REILS (o. rails, or Med)—SLIER	
REIPS (o. reaps)—SPIER (o.)	RELIT—TILER	REMIT—TIMER	REPAT—TAPER
REPOT—TOPER	RESAT—TASER	REVIS (o. ravish)—SIVER	RIOTS—STOIR
RONES—SEHOR	ROTAS—SATOR (Latin word square)		RYBAT—TABYR (o. tabor)
SEBAT—TABES	SELAT (=sallet, SND)—TALES		SEMAT—TAMES
SENAW—WANES	SENIT—TINES	SERAT (Yemen, TIG)—TARES	
SERAW (obs = sera)—WARES		SEROY (o. serai)—YORES (= yours)	
SMART—TRAMS	SNART—TRANS	SNORT—TRONS	SPART—TRAPS
SPERT—TREPS (EDD)	SPIRT—TRIPS	SPLEY (= splay)—YELPS	SPRAT—TARPS
SPRET—TERPS	SPROT—TORPS	STRAW—WARTS	STREW—WERTS (= warts)
STROW—WORTS	SUROT—TORUS	SWERT—TREWS	WONKY—YKNOW

4-letter word pairs (selection of about half)

ABIR—RIBA (Royal Inst. Brit. Architects)	ABLE—ELBA	ABOS—SOBA
ABUT—TUBA	ACED—DECA (prefix)	ADEL (o. addle)—LEDA (& swan)
ADOS—SODA	ÆHT (o.)—THEA	AETS (EDD)—STEA (EDD) AGES—SEGA
AGIR (Roget)—RIGA (Latvia)	AGNI—INGA	AGOS—SOGA
AGUR(o. augur)—RUGA	AITU—UTIA	AGOT (o. agate)—TOGA
AMIR (= emir)—RIMA	AMIS—SIMA	AMIL—LIMA
AMYS—SYMA	ANET—TENA	AMOS—SOMA
ARCO (music)—OCRA(o. okra)		APUS—SUPA
ARON (o. are/arum)—NORA (fn)		ARIL—LIRA
ASIL—LISA (fn)	ASEM—MESA	ARYL—LYRA
ATES (o.)—SETA	ATEW—WETA	ASET (o.)—TESA (F&W = teesa)
ATON (= Aten, god)—NOTA (Bene)		ATIP—PITA
AVIS—SIVA	AVON (river, coy, county)—NOVA	ATIR (vf atter)—RITA
BACS (heart of cheque clearing in UK)—SCAB		AUKS—SKUA (two birds) AVID—DIVA
BANS—SNAB (Scot)	BARD—DRAB	
BARK—KRAB (= karabiner)	BATS—STAB	BAHS—SHAB
BIRD—DRIB (drip)	BITS—STIB (Chem. prefix)	BARF (vomit)—FRAB
BONK—KNOB (oh dear)	BONS—SNOB	BENS (mountains)—SNEB
BRAG—GARB	BRAW (Scot. brave)—WARB	BINS—SNIB
BREY (= braye)—YERB	BROS—SORB	BOHT (o. bought)—THOB
BUNS—SNUB	BURD (o. bird)—DRUB	BOWS—SWOB (= swab)
BUTS—STUB	BYRT (= birt)—TRYB (o. tribe)	BREK (o. break etc)—KERB
CATS—STAC (= stack)	CAWS—SWAC (o.)	BUNK—KNUB
CLAT—TALC	CLOT—TOLC (TNWD)	BURT—TRUB
CRAM—MARC (brandy)	CRAP—PARC (French. or old English park)	CART—TRAC (basketry)
CREM (o. cream)—MERC (Mercedes)		CIRÉ—ERIC
CROT (o.)—TORC	CRUT—TURC (o. Turk)	CNUT (= Canute)—TUNC
DAHS—SHAD	DAKS (also propr. clothing)—SKAD (= a lot)	
DALY—YLAD (= led)	DANS—SNAD (o. sned)	CROP—PORC
DAWS—SWAD	DECI (prefix)—ICED	DAER(daer-stock)—READ
DEIP (o. Scot deep)—PIED	DEIT (Scot)—TIED	DALS—SLAD
DENS—SNED	DEOR (o. dear/deer)—ROED	DART—TRAD
DEUS (o. dew etc)—SUED	DESY (o. dizzy)—YSED (= said)	DEIL—LIED
DIAS—SAID	DIAL—LAID	DELS—SLED
DINS (sixpence)—SNID	DILO(tree)—OLID (fetid)	DIAM (diameter)—MAID
DOLS—SLOD	DITS—STID (o. stead)	DINE—ENID (fn)
DORT—TROD	DONS—SNOD (= neat)	DOLP (Scot. doup)—PLOD
DRAG—GARD (= guard)	DOWS—SWOD (= swad)	DORP—PROD
DRAY—YARD	DRAT—TARD (o. tarred)	DOZE—EZOD (o. letter Z)
DRON (o. drown)—NORD (Roget)	DREY (= dray)—YERD	DRAW—WARD
DRUG—GURD (o. gird)	DROT (= drat)—TORD (o.)	DROW—WORD
DUCS (obs or Fr duke)—SCUD	DRUT—TURD	DUAL—LAUD
DYES—SEYD (= sayyid)	DUOS—SOD	DUPS (o. opens)—SPUD
EBUR—RUBE	EART (o. art)—TRAE (EDD)	EAWT (vf aught)—TWAE
EGOL—LOGE	EDAM (cheese)—MADE	EGAR (o.)—RAGE
ELAY (o.)—YALE	EITS (vf)—STIE (o. sty)	ELAM (var of helm, or country of Elamites)—MALE
EMIR—RIME	ELYS—SYLE	EMAN (Med)—NAME
EMYS—SYME	EMIT—TIME	EMIL (fn)—LIME
ENOS (propr. salts)—SONE (unit of loudness)	ENAM—MANE	EMUS—SUME (o. some etc)
ENOY (=ennoy)—YONE (o. yon)		ENID (fn)—DINE
		ENOW—WONE
		ENUS—SUNE (o.)

- ENYS (= enes)—SYNE (Auld Lang)
 ERAS—SARE (o. sore / sere) ERGO—OGRE
 EROS—SORE! EROT(Med)—TORE
 ETAS—SATE ETIN (Chem suffix or o. giant)—NITE
 EVAN (fn)—NAVE EVAT (bl = eft)—TAVE
 EZAN—NAZE FIRS—SRIF (Med)
 FLOW—WOLF FLUS—SULF
 FROT—TORF (o. TURF) FRUZ—ZURF
 GAPS—SPAG (spaghetti) GART—TRAG
 GERT (= great)—TREG (= trig)
 GIPS—SPIG (=spic) GIRT—TRIG
 GNAT—TANG GNAW—WANG
 GNEW (o. gnawed)—WENG GNIT (o.)—TING
 GOMS—SMOG GORP—PROG
 GREW—WERG GULP—PLUG
 GUNS—SNUG GUPS—SPUG
 GURT—TRUG GUTS—STUG (= stab)
 HITS—STIH (o. sty) HOLS—SLOH (o. slough)
 ICON—NOCI (Medical) IDEM—MEDI
 I-PUT (= was put)—TUPI (language)
 IRON—NORI (Jap food) ITAS (palms)—SATI (suttee)
 KATS (shrubs)—STAK (o. stack)
 KATY (fn)—YTAK (o. taken)
 KEPS (catches)—SPEK (o. speak etc)
 KETS (vectors in Hilbert space)—STEK (= stick)
 KIHT (o. caught)—THIK (o. thick)
 KITS—STIK (o. or commercial stick)
 KNAP—PANK (dial. pant) KNAR—RANK
 KNEV (vf know)—VENK KNIT—TINK
 KNUT—TUNK KRAN (Persian coin)—NARK
 LÆN—NEAL LAEP (EDD)—PEAL
 LAIR—RIAL (coin etc) LAIS—SIAL
 LAOS—SOAL (o. sole) LAPS—SPAL (o. spawl)
 LAWS—SWAL (o. swollen) LAYR (lair, layer)—RYAL
 LEAP—PAEL (EDD) LEAT—TAEI
 LEON—NOEL (reversible forenames)
 LEVY—YVEL (o. evil) LIAM (fn or o. leash)—MAIL
 LIEN—NEIL (fn or o. nail) LIER—REIL (o. rail or anatomist)
 LION—NOIL LIOS—SOIL
 LOTS—STOL (short take-off and landing)
 MAES (o. maize, or Maes)—SEAM
 MANS—SNAM MAOS—SOAM
 MART—TRAM MATS—STAM (= tem)
 MELY (obs)—YLEM (Big Bang)
 MIAS (MIAs or orang-utan)—SAIM (o. seam)
 MILS—SLIM MIRT (= myrt)—TRIM
 MOWS—SWOM (o. swam) MUNS (= face)—SNUM
 NAGY (Imre)—YGAN (= gone) NAHT (o. naught)—THAN
 NATS—STAN NAUT—TUAN
 NEAT—TA'EN (taken) NEMO—OMEN
 NERT (= art not)—TREN NETS—STEN (gun)
 EPOS (poetry or electronic tills)—SOPE (o. soap)
 ERIS (OED addenda)—SIRE ERIT (Roget)—TIRE
 ERPS (EDD)—SPRE (EDD) ETAR (vf eater)—RATE
 ETON (school)—NOTE EVIR (o. ivory)—RIVE
 FLEY (= flay)—YELF (= yelve) FLOG—GOLF
 FRAT—TARF (o.) FRET—TERF (o. turf)
 GALS—SLAG! GAMY—YMAG (o. image)
 GATS—STAG GENS (clan)—SNEG
 GETS—STEG GINS—SNIG
 GITS—STIG (o.) GNAR—RANG
 GNET (o. gnat)—TENG
 GNUS—SUNG! GOLS (o. goals)—SLOG
 GORT (= gorce)—TROG GRAM—MARG
 GULS (o. gull)—SLUG GUMS—SMUG
 GURK (belch)—KRUG (tankard or propr. champagne)
 HART—TRAH HIEW (o. hue)—WEIH
 HOPI (US Indians)—IPOH (tree)
 IKON—NOKI IMUS—SUMI
 IRES—SERI (o. sorry) I-REW—WERI
 KART—TRAK (o. track, except Amtrak)
 KAWS (o. caws)—SWAK (o. swack)
 KCAL (calories)—LACK KERP—PLEK (o. pleck)
 KERT (o. carte)—TREK
 KIEV—VEIK (Scot. weak)
 KIPS—SPIK (=spic) KITE—ETIK (o. hectic)
 KLEY (=clay)—YELK KLOP—POLK
 KNAT (o. gnat)—TANK KNAW (o. gnaw)—WANK
 KNOT—TONK KNOW—WONK
 KRAS—SARK KRAY—YARK
 LÆT—TEAL LÆV (leave)—VEAL
 LAIT—TIAL LAKS—SKAL (= skoal)
 LATS—STAL (o. stall) LATU—UTAL (o.)
 LAYT (o.)—TYAL (o.) LEAN—NAEL
 LEIT—TIEL LEKS—SKEL
 LEOS—SOEL (o. sole) LETS—STEL (o. stall)
 LIAR—RAIL LIAS (geology)—SAIL
 LIRT—TRIL (o. trill) LIES—SEIL (o. sail)
 MACS—SCAM MAER (o. more)—REAM
 MAIS—SIAM MALO (St. Malo)—OLAM
 MAPS—SPAM (meat or Internet verb)
 MAWS—SWAM
 METS—STEM MEWS—SWEM (= swim)
 MILO (fn or grass)—OLIM (Roget)
 MOHW (o. maugh)—WHOM MOTS—STOM (= stam)
 MUTS (o. moot etc)—STUM
 NAPS—SPAN NARW (o. narrow)—WRAN
 NEAP—PÆN (prefix) NEAR—RAEN (o. reign)
 NEPS—SPEN NERO—OREN (TNWD)
 NEUT (o. newt)—TUEN (o. to tee)

NEVO (o. nephew)—OVEN	NEVY (= nephew)—YVEN (o. ivy)		
NEWO (o. nephew)—OWEN!	NEWS—SWEN (swim)	NEWT—TWEN (o. twin)	NEYS—SYEN
NEYT (o. ait)—TYEN (o. t'ien)		NIAS (o. nyas)—SAIN	NIHT (o. night)—THIN
NIPS—SPIN	NIRT(o.)—TRIN	NOAT (o. note)—TAON	NODY (o.)—YDON
NOHT (o. nought)—THON (= yon)		NOIS (o. Scot nose)—SION	NORT (= thrust)—TRON
NORY—YRON	NOTS—STON (o. stone/stun)	NOWS—SWON (o. swan)	NOWT—TWON (o. twined)
NOWY—YWON (= won)	NOYS (nose/noise)—SYON	NURT (o.)—TRUN	NUTS—STUN
NYET—TEYN (o. tween)	NYHT (o. night)—THYN (o. thin)		
ODER (river or o. other)—REDO		OGPU—UPGO	OIKS—SKIO (= skeo)
ÖNER—RENO (Nevada or Med. prefix)		ONEZ (o. once)—ZENO (he of paradox fame, or prefix)	
ONIS (o. once)—SINO (prefix)		ORES—SERO (o. late, or Med prefix)	
ORTS—STRO (o. straw)	OSET (= osset)—TESO (tribe)	OSEY—YESO	
OTUS (OTUs)—SUTO (= sotho)		PACS—SCAP	PAET (EDD)—TEAP
PAHS—SHAP	PAIR—RIAP (EDD)	PALS—SLAP!	PANS—SNAP
PART—TRAP	PATS—STAP (my vitals)	PAWS—SWAP	
PEAR—RAEP (Scot. rape/rope)		PEAS—SAEP (vf soap)	
PECS (abbr. pectorals)—SCEP (o. sheep etc)		PELS (picture elements)—SLEP (o. slip)	
PERT—TREP (EDD)	PETS—STEP	PEWS—SWEP	PIAS—SAIP (Scot. soap)
PICS—SCIP (o. ship)	PIER—REIP (EDD)	PIES—SEIP (o. seep)	PIGS—SGIP (TNWD)
PILS—SLIP	PINS—SNIP	PITS—STIP (o. steep)	PLAS (o. place)—SALP
PLAY—YALP (yawp)	PLEW—WELP (o. whelp)	PLEY (= play)—YELP	PLOW—WOLP (o. wup)
PLOY—YOLP	PLUS—SULP (o. defile)	POHS—SHOP	POLS (politicians)—SLOP!
PONS—SNOP	PORT—TROP (de trop)	POSY—YSOP (o. hyssop)	POTS—STOP
POWS—SWOP	PRAT—TARP	PRAW(boat)—WARP (ship!)	PRET—TERP
PREW—WERP	PROT (Protestant)—TORP (torpedo)		PROW—WORP (o. warp)
PRUT—TURP	PSAW (= pshaw)—WASP	PUER (Latin, or o. pure)—REUP (re-up)	
PULS—SLUP	PUNS—SNUP	PUOY (= poy)—YOUP	PUTS—STUP
RAES (vf rese or plural Rae)—SEAR		RÆT (= rat)—TEAR	RÆW (o. rue)—WEAR
RAHS—SHAR (o. share)	RAHT (o. reached)—THAR	RAIT (o. rate)—TIAR (o. tear)	RAPS—SPAR
RAST (= rest)—TSAR	RATS—STAR	RAWS—SWAR (= sware)	RAYS—SYAR (o. sire)
RAYT (o. rate)—TYAR (o.)	REAS—SAER (o. sear)	REAT (o.)—TÆR (vf tear)	REFU (o.)—UFER
REHT (o. reached)—THER	REIS—SIER (o. sire)	REIT—TIER	
REOT (o. riot)—TOER (o. tower)		REPS—SPER(o. spar)	RETS—STER (o. star)
REUS (o. rue)—SUER	REUT (vf root)—TUER (o. tuyere)		
REVY (o. revie)—YVER (o. ivory)		REWS (o.)—SWER (o.)	REYS (= rays)—SYER
RIAS—SAIR (Scot. sore etc)	RIET (o. rete)—TEIR	RIEW (o. rue)—WEIR	RIHT (o. right)—THIR
RIPS—SPIR (o. sphere etc)	RITS—STIR	ROCS—SCOR (o. score)	ROTS—STOR (o. star/stour)
ROWS—SWOR (o. = swore)	RUMS—SMUR	RUMY (= romy)—YMUR (o.)	
RUNS—SNUR (o. snort)	RUTS—STUR (o. stur-apples)		SAIV (o. Scot. safe)—VIAS
SÆT (= set)—TEAS	SAHT (o. saught)—THAS (o. those)		SART—TRAS (o. trace)
SAWT—TWAS	SCAW—WACS	SEAT—TAES (Sc. to)	SEAW (= sew)—WAES
SEIT (o. says)—TIES	SEOW (o. sew)—WOES	SERT (o.)—TRES (o. trees)	SEYT (o. seat)—TYES
SGOT (Med)—TOGS	SHAY—YAHS	SIET (vf SIT)—TEIS (o. tie)	SIHT (o. sight)—THIS
SINU (o. sinew)—UNIS (universities)		SIOT—TOIS (o. toes)	SIRT (= syrt)—TRIS
SITU (in situ)—UTIS	SKAW—WAKS	SKOW—WOKS	SLAV—VALS
SLAW—WALS (o. Welsh)	SLEW—WELS (eg wells)	SLIT—TILS	SMAY—YAMS
SMEW—WEMS	SMIT—TIMS	SMOT—TOMS	SMUT—TUMS
SNAT (o. snot)—TANS	SNAW (Scot. snow)—WANS	SNET (dictionary error!)	TENS

SNEW (snow)—WENS	SNIT—TINS	SNOT—TONS!	SNOW—WONS (= once)
SORT—TROS	SOWT—TWOS	SPAT—TAPS	SPAW (o. spa)—WAPS
SPAY—YAPS	SPAZ (= spastic)—ZAPS	SPET—TEPS (= taps)	SPEY—YEPS
SPIT—TIPS	SPIV—VIPS	SPOT—TOPS	SPOW—WOPS
SPUT—TUPS	STAW—WATS	STEW—WETS	STOW—WOTS
SUEZ—ZEUS	SWAT—TAWs	SWAY—YAWS	SWET (o.)—TEWS
SWEY (o.)—YEWS	SWOT—TOWS	TANU (acronym)—UNAT (o.)	
TEAW (vf tew)—WAET (o. wet)		TEDY (vf)—Y-DET	TERU (= tar)—URET
THAW—WAHT (o. what)	TIEW—WEIT (o.)	TONY—YNOT (= I do not know)	
TRAU (= throw)—UART (comms in PC)		TRAW—WART	TREW—WERT T
REY—YERT (o.)	TROW—WORT	TROY—YORT	
ULEY (o. oil)—YELU (o. yellow)		WOSY—YSOW	

3-letter word pairs (selection of about a quarter)

ADO—ODA	AID—DIA	AIM—MIA (missing in action)	AND—DNA
ANE—ENA (fn)	AOB (meetings)—BOA	APE—EPA (Environmental Protection Agency)	ARE—ERA
ARK—KRA	ATE—ETA	AVE—EVA (fn or spacewalk)	
AVO (meter or Hung. secret police)—OVA	AXE—EXA (18th power of 10)		BAC—CAB
BAD—DAB	BAG—GAB	BAM—MAB	BAN—NAB
BAP—PAB (Scot. pob)	BAR—RAB	BAT—TAB	BED—DEB (utante!) BID—DIB
BIG—GIB	BIN—NIB	BOG—GOB	BON (not a good word!)—NOB
BOR (heard many times in my youth)—ROB	BOS (o. boss)—SOB	BOY—YOB!	
BRO (= brother)—ORB	BUD—DUB	BUG—GUB (dubious word!)	
BUN—NUB	BUR—RUB	BUS—SUB	BUT—TUB CAM—MAC
CAP—PAC	CAR—RAC (Royal Automobile Club, or o. rack)!	CAT—TAC (vf take)	
CAW—WAC (Women's Army Corps, or o. weak)	COD—DOC (abbr.)	COR—ROC	
COS—SOC (as in Sock of Peterborough)	COT—TOC (letter t, or Table of Contents)		
COW—WOC (o. woke)	CPU (computer)—UPC (barcode on foods etc)	CUD—DUC (Fr. or o. duke)	
DAH—HAD	DAM—MAD!	DAP—PAD	DAT—TAD DAW—WAD
DAY—YAD (going, going, yad!)	DEN (also fn)—NED (also fn)		
DEO (in excelsis)—OED!	DEW—WED	DIG—GID	
DIK (half a dik-dik, or o. dike)—KID	DIM—MID	DIN—NID	DIR—RID
DIS (= disconnected)—SID (Di's Sid!)	DOG—GOD	DOH—HOD	DOM—MOD
DON—NOD	DOP—POD	DOR—ROD	DOS (o. does, or opsys)—SOD
DOT—TOD	DUM (o. doom)—MUD	DUP—PUD	EAR—RAE (or fn)
EAT—TAE (Scot. to(e))	EDO (language)—ODE	ELI (fn or o. oil)—ILE	EMU—UME
ENO (propr. laxative)—ONE	ESU (electrostatic unit)—USE		
FAN—NAF (negative have)	FAO (UN Food & Agricultural Organisation)—OAF		
FAR—RAF (Royal Air Force etc)	FAY—YAF (o. gave)	FRO (= from)—ORF (= off, etc)	
GAL—LAG	GAM—MAG	GAR—RAG	GAS—SAG
GAT—TAG	GAW—WAG	GAZ—ZAG	GEL—LEG
GEM—MEG (valuable woman)	GET—TEG	GIM—MIG (also Mig 21 fighter)	
GIN—NIG	GIP—PIG	GIT—TIG	GIW (o. Jew)—WIG
GOM—MOG	GOS (hawk etc)—SOG	GOW—WOG	GUM—MUG
GUP—PUG	GUT—TUG	HAP—PAH	HAS—SAH (= sir etc) IBO—OBI
IVO (fn)—OVI (prefix)	JAR—RAJ	KAT (= qat)—TAK (Chamber's Scots Dict.)	KAY—YAK!
LAP—PAL	LAS (= alas etc)—SAL (also fn)	LAV(atory)—VAL	
LEM (o. learn or Lunar Excursion Module)—MEL		LET—TEL	LIM (o. limb etc)—MIL

LIP—PIL LIT—TIL MAN—NAM (am not, Vietnam etc)
 MAP—PAM (can read her backwards!) MAR—RAM MAS—SAM
 MAT—TAM (-o'-shanter) MAW—WAM MAY—YAM
 MEN—NEM (nem. con., or = name) MEW—WEM MHO—OHM MIN—NIM
 MIR—RIM MIT—TIM MOP—POM MOT—TOM
 MOW—WOM (o. whom) MUN—NUM MUS—SUM
 MUT (= mutt etc)—TUM NAP—PAN NAR (mostly o.)—RAN NAT (also fn)—TAN
 NAW (= no, know)—WAN NET—TEN NEW—WEN NIP—PIN
 NIS—SIN NIT—TIN NOS (o. or pl. or numbers)—SON NOT—TON
 NOW—WON NOY—YON NUP (o.)—PUN NUS (pl. or Nat. Union of Students)—SUN
 NUT—TUN OAT—TAO OLP (= alp = bullfinch)—PLO (Palestine Lib. Org.)
 OWT—TWO PAR—RAP PAS—SAP PAT—TAP PAW—WAP
 PAY—YAP PAZ (La Paz)—ZAP PER—REP PET—TEP (= tap)
 PEW—WEP (o. wap etc) PIR—RIP PIS (pis aller)—SIP PIT—TIP POS—SOP
 POT—TOP POW—WOP! PUS (also Permanent Under-Secretary)—SUP PUT—TUP
 RAT—TAR RAW—WAR RAY—YAR (= yah etc) REX—XER (Med)
 ROS (fn, Scot county etc)—SOR (vf sore) ROT—TOR ROW—WOR (= were etc)
 RUS—SUR (o. sir) RUT—TUR SAT—TAS (pl. or o.) SAY—YAS (= yes) SAW—WAS
 SET—TES (= 'tis) SEW—WES (fn or o. was) SEX—XES (W70-201)
 SEY—YES (proposal?) SIT—TIS ('tis) SIX—XIS (hyperon) SOW—WOS (o. woes, call etc)
 TAW—WAT (Thai temple etc) TAX—XAT (Indian pole, Web3)
 TAY (fish)—YAT (= yacht etc) TEY (o. tea, tie etc)—YET TEW (o.)—WET
 TIZ (= tizzy)—ZIT TOW—WOT (= what) TOY—YOT (=yet) WAY—YAW
 WEY (unit of weight)—YEW

FIRST TWO LETTERS, AND LAST TWO LETTERS, OF HETEROGRAMS OF VARIOUS LENGTHS

First two letters		A	B	C	D	E	F	G	H	I	L	M	N	O	P	R	S	T	U	W	
4	BB	1																			
5	BB		1																		
6	BB			1																	
7	BB				1																
8	BB					1															
9	BB						1														
10	BB							1													
4	BA																				
5	BA																				
6	BA																				
7	BA																				
8	BA																				
9	BA																				
10	BA																				

Last two letters

Last two letters		A	B	C	D	E	F	G	H	I	L	M	N	O	P	R	S	T	U	
4	AA	1																		
5	AA		1																	
6	AA			1																
7	AA				1															
8	AA					1														
9	AA						1													
10	AA							1												
4	AN																			
5	AN																			
6	AN																			
7	AN																			
8	AN																			
9	AN																			
10	AN																			

The tables show every letter pair that occurs more than 1% of the time for heterograms of a given length. The word lengths are 4 to 10 letters. The entry 1 means that the corresponding letter pair occurs between 1% and 1.99% of the time, etc. For example, CO starts between 3% and 3.99% of 8-letter heterograms. There are many other letter pairs which occur more than 0.9% but less than 1% of the time. The asterisks at the bottom of the first table indicate letter pairs that also occur in reverse in the lower table: thus LA starts many heterograms, and AL ends many words.