**Appendix 1** Variables in the analysis file (‘all.csv’), and in the materials file (‘norms.xlsx’). In parenthesis, the title of the variables left out of the materials file

|  |  |
| --- | --- |
| **Title** | **Definition** |
| id | Item identifier. Words that are coupled across norms have the same id. |
| (normed) | Languages in which the word has been normed |
| cat | Property or concept. Applies to Dutch and English norms. |
| word | Word. Properties are uninflected. Variables from here up to ‘word\_eng’ are for Dutch norms |
| wordcat | Linguistic word category: noun, adjective, verb, adverb |
| inflected\_prop | Where possible, the Dutch property appears in the inflected form. Non-speakers see https://www.duolingo.com/comment/3888221 |
| conc\_cat | Indicates the inflection category of the concept: definite article 'de' or 'het' |
| main | Dominant modality |
| Exclusivity | Modality-exclusivity. Better reported as a percentage |
| Auditory | Mean auditory rating |
| Haptic | Mean haptic rating |
| Visual | Mean visual rating |
| SD\_Auditory | Standard deviation of the mean auditory rating |
| SD\_Haptic | Standard deviation of the mean haptic rating |
| SD\_Visual | Standard deviation of the mean visual rating |
| freq\_lg10CD\_  SUBTLEXNL | Log 10 Contextual Diversity from SUBTLEX-NL corpus. See http://crr.ugent.be/programs-data/subtitle-frequencies/subtlex-nl |
| freq\_lg10WF\_  SUBTLEXNL | Log 10 Word Frequency from SUBTLEX-NL corpus. See http://crr.ugent.be/programs-data/subtitle-frequencies/subtlex-nl |
| freq\_CELEX  \_lem | Lemma frequency per million, from CELEX corpus. See https://catalog.ldc.upenn.edu/LDC96L14 |
| inflected\_adj\_  freq\_lg10CD  \_SUBTLEXNL | Log 10 SUBTLEX-NL Contextual Diversity for inflected property. See http://crr.ugent.be/programs-data/subtitle-frequencies/subtlex-nl |
| AoA\_  Brysbaertetal2014 | Age of acquisition, from Brysbaert et al.'s (2014) norms. See http://crr.ugent.be/archives/1602 |
| concrete\_  Brysbaertetal2014 | Concreteness, from Brysbaert et al.'s (2014) norms. See http://crr.ugent.be/archives/1602 |
| known\_  Brysbaertetal2014 | Known percentage, from Brysbaert et al.'s (2014) norms. See http://crr.ugent.be/archives/1602 |
| letters | Number of letters |
| phonemes\_  DUTCHPOND | Number of phonemes. Retrieved from http://clearpond.northwestern.edu/dutchpond.html |
| orth\_neighbours  \_DUTCHPOND | Orthographic neighbourhood size. Retrieved from http://clearpond.northwestern.edu/dutchpond.html |
| phon\_neighbours  \_DUTCHPOND | Phonological neighbourhood size. Retrieved from http://clearpond.northwestern.edu/dutchpond.html |
| (a1) | Auditory ratings from respondent number 1 in a file |
| (h1) | Haptic ratings from respondent number 1 in a file |
| (v1) | Visual ratings from respondent number 1 in a file |
| (a2) | Auditory ratings from respondent number 2 in a file |
| (h2) | Haptic ratings from respondent number 2 in a file |
| (v2) | Visual ratings from respondent number 2 in a file |
| (a3) | Auditory ratings from respondent number 3 in a file |
| (h3) | Haptic ratings from respondent number 3 in a file |
| (v3) | Visual ratings from respondent number 3 in a file |
| (a4) | Auditory ratings from respondent number 4 in a file |
| (h4) | Haptic ratings from respondent number 4 in a file |
| (v4) | Visual ratings from respondent number 4 in a file |
| (a5) | Auditory ratings from respondent number 5 in a file |
| (h5) | Haptic ratings from respondent number 5 in a file |
| (v5) | Visual ratings from respondent number 5 in a file |
| (a6) | Auditory ratings from respondent number 6 in a file |
| (h6) | Haptic ratings from respondent number 6 in a file |
| (v6) | Visual ratings from respondent number 6 in a file |
| (a7) | Auditory ratings from respondent number 7 in a file |
| (h7) | Haptic ratings from respondent number 7 in a file |
| (v7) | Visual ratings from respondent number 7 in a file |
| (a8) | Auditory ratings from respondent number 8 in a file |
| (h8) | Haptic ratings from respondent number 8 in a file |
| (v8) | Visual ratings from respondent number 8 in a file |
| (a9) | Auditory ratings from respondent number 9 in a file |
| (h9) | Haptic ratings from respondent number 9 in a file |
| (v9) | Visual ratings from respondent number 9 in a file |
| (a10) | Auditory ratings from respondent number 10 in a file |
| (h10) | Haptic ratings from respondent number 10 in a file |
| (v10) | Visual ratings from respondent number 10 in a file |
| (file) | Identifier of the file(s) in which the word was rated |
| (word\_eng) | English word. All variables hereafter for these words (Lynott and Connell, 2009, 2013). Retrieved from http://www.lancaster.ac.uk/people/connelll/lab/norms.html. |
| (main\_eng) | Dominant modality |
| (exc\_eng) | Modality exclusivity |
| (Aud\_eng) | Mean auditory rating |
| (Hap\_eng) | Mean haptic rating |
| (Vis\_eng) | Mean visual rating |
| (lett\_eng) | Number of letters |

**Appendix 2** Excerpt from the analysis file (‘all.csv’). This file was put together in Excel. For analysis purposes, it includes the individual ratings from each respondent, as well as the English means from Lynott and Connell (2009, 2013). For users’ convenience, however, the materials file (‘norms.xlsx’) does not include the individual ratings or the English ratings.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| normed | cat | word | main | Exclusivity | word\_eng | main\_eng | exc\_eng |
| Dutch | conc | aankondiging | a | 0.48 | announcement |  |  |
| Dut\_Eng | conc | aantekening | v | 0.22 | note | v | 0.46 |
| Dut\_Eng | conc | aanvraag | v | 0.32 | appeal | v | 0.22 |
| Dut\_Eng | prop | aards | v | 0.14 | earthy | v | 0.21 |
| Dut\_Eng | prop | absorberend | v | 0.27 | absorbent | v | 0.41 |
| Dut\_Eng | conc | academie | v | 0.36 | academy | v | 0.56 |
| Dut\_Eng | conc | achtergrond | v | 0.51 | background | v | 0.53 |
| Dut\_Eng | conc | administratie | v | 0.39 | administration | v | 0.49 |
| Dut\_Eng | conc | advies | a | 0.41 | advice | a | 0.70 |
| Dut\_Eng | conc | afbeelding | v | 0.58 | picture | v | 0.68 |
| Dut\_Eng | conc | afdeling | v | 0.57 | department | v | 0.51 |
| Dut\_Eng | conc | afsluiting | v | 0.35 | close | v | 0.36 |
| Dut\_Eng | conc | afstand | v | 0.46 | distance | v | 0.50 |
| Dut\_Eng | conc | afval | v | 0.34 | waste | v | 0.30 |
| Dut\_Eng | conc | amateur | v | 0.23 | amateur | v | 0.42 |
| Dut\_Eng | conc | ambacht | v | 0.33 | craft | v | 0.33 |
| Dut\_Eng | prop | amber | v | 0.42 | amber | v | 0.66 |
| Dut\_Eng | conc | angst | v | 0.14 | fear | v | 0.31 |
| Dut\_Eng | conc | antwoord | a | 0.42 | answer | a | 0.55 |
| Dut\_Eng | conc | apparaat | v | 0.10 | device | v | 0.38 |
| Dut\_Eng | conc | arbeider | v | 0.23 | worker | v | 0.44 |
| Dut\_Eng | conc | arrangement | v | 0.46 | arrangement | v | 0.42 |
| Dut\_Eng | conc | aspect | v | 0.38 | aspect | v | 0.29 |
| Dut\_Eng | conc | atoom | v | 0.29 | atom | v | 0.20 |
| Dut\_Eng | conc | baan | v | 0.24 | job | v | 0.33 |
| Dut\_Eng | conc | baas | v | 0.49 | boss | v | 0.42 |
| Dut\_Eng | conc | baby | v | 0.04 | baby | v | 0.24 |
| Dut\_Eng | conc | bad | h | 0.16 | bath | h | 0.30 |
| Dut\_Eng | conc | balans | v | 0.16 | balance | v | 0.40 |
| Dut\_Eng | conc | band | v | 0.33 | band | a | 0.46 |
| Dut\_Eng | conc | bank | v | 0.42 | bank | v | 0.60 |
| Dut\_Eng | prop | barstend | v | 0.11 | bursting | v | 0.26 |
| Dut\_Eng | conc | basis | v | 0.17 | base | v | 0.46 |
| Dut\_Eng | conc | bedrag | v | 0.23 | amount | v | 0.22 |
| Dut\_Eng | conc | been | v | 0.28 | leg | v | 0.41 |
| Dut\_Eng | conc | beer | v | 0.32 | bear | v | 0.32 |
| Dut\_Eng | conc | begin | v | 0.18 | beginning | v | 0.30 |
| Dut\_Eng | prop | behaard | v | 0.44 | hairy | v | 0.45 |
| Dut\_Eng | conc | beheer | v | 0.40 | management | v | 0.48 |
| Dut\_Eng | conc | behoefte | h | 0.09 | want | v | 0.12 |
| Dut\_Eng | prop | beige | v | 0.54 | beige | v | 0.92 |
| Dut\_Eng | conc | beker | v | 0.47 | cup | v | 0.27 |
| Dut\_Eng | conc | belading | v | 0.26 | load | v | 0.36 |
| Dut\_Eng | conc | belangrijkste | v | 0.26 | main | v | 0.37 |
| Dut\_Eng | conc | belasting | v | 0.20 | tax | v | 0.61 |
| Dut\_Eng | conc | beneden | v | 0.53 | down | v | 0.54 |
| Dut\_Eng | prop | beschimmeld | v | 0.50 | mouldy | v | 0.34 |
| Dutch | conc | besmetting | h | 0.15 | contagion |  |  |
| Dut\_Eng | conc | bestand | v | 0.48 | file | v | 0.52 |
| Dut\_Eng | prop | betoverend | v | 0.26 | glamorous | v | 0.47 |
| Dut\_Eng | conc | beurs | v | 0.05 | fair | v | 0.48 |
| Dut\_Eng | conc | beurt | v | 0.22 | turn | v | 0.50 |
| Dut\_Eng | prop | bevriezend | h | 0.38 | freezing | h | 0.34 |
| Dut\_Eng | conc | bewijs | v | 0.27 | proof | v | 0.24 |
| Dut\_Eng | prop | bewolkt | v | 0.53 | cloudy | v | 0.81 |
| Dut\_Eng | conc | bezit | v | 0.10 | estate | v | 0.53 |
| Dut\_Eng | conc | bibliotheek | v | 0.18 | library | v | 0.33 |
| Dut\_Eng | prop | blaffend | a | 0.47 | barking | a | 0.51 |
| Dut\_Eng | prop | blauw | v | 0.68 | blue | v | 0.80 |
| Dut\_Eng | prop | bleek | v | 0.62 | pale | v | 0.82 |
| Dut\_Eng | prop | blij | v | 0.20 | happy | v | 0.27 |
| Dut\_Eng | conc | blijven | v | 0.24 | stay | v | 0.38 |
| Dut\_Eng | conc | blik | v | 0.45 | look | v | 0.68 |
| Dut\_Eng | prop | blinkend | v | 0.53 | shiny | v | 0.70 |
| Dut\_Eng | prop | bloedig | v | 0.35 | bloody | v | 0.41 |
| Dut\_Eng | prop | bloemrijk | v | 0.40 | flowery | v | 0.41 |
| Dut\_Eng | prop | blond | v | 0.68 | blonde | v | 0.91 |
| Dut\_Eng | conc | bocht | v | 0.53 | curve | v | 0.51 |
| Dut\_Eng | conc | boerderij | v | 0.19 | farm | v | 0.25 |
| Dut\_Eng | conc | boete | v | 0.31 | fine | v | 0.41 |
| Dut\_Eng | prop | bolvormig | v | 0.49 | globular | v | 0.43 |
| Dut\_Eng | prop | bonzend | a | 0.32 | thudding | a | 0.46 |
| Dut\_Eng | conc | boosheid | v | 0.31 | anger | v | 0.41 |
| Dut\_Eng | prop | borstelig | h | 0.34 | bristly | h | 0.37 |
| Dut\_Eng | conc | bot | h | 0.19 | bone | h | 0.27 |
| Dut\_Eng | prop | botsend | a | 0.07 | crashing | v | 0.40 |
| Dut\_Eng | conc | bouw | v | 0.33 | construction | v | 0.39 |
| Dut\_Eng | conc | bouwer | v | 0.40 | builder | v | 0.38 |
| Dut\_Eng | prop | brak | v | 0.20 | brackish | h | 0.15 |
| Dut\_Eng | prop | breed | v | 0.45 | wide | v | 0.50 |
| Dut\_Eng | prop | breekbaar | v | 0.16 | breakable | v | 0.39 |
| Dut\_Eng | conc | breuk | h | 0.22 | break | v | 0.25 |
| Dut\_Eng | prop | briesend | a | 0.07 | snorting | a | 0.51 |
| Dut\_Eng | prop | briljant | v | 0.25 | brilliant | v | 0.13 |
| Dut\_Eng | prop | brommend | a | 0.29 | snarling | a | 0.54 |
| Dut\_Eng | prop | bronzen | v | 0.77 | bronze | v | 0.68 |
| Dut\_Eng | prop | broos | h | 0.30 | brittle | h | 0.42 |
| Dut\_Eng | prop | bruin | v | 0.62 | brown | v | 0.83 |
| Dut\_Eng | prop | bruinharig | v | 0.40 | brunette | v | 0.98 |
| Dut\_Eng | conc | bureau | v | 0.45 | desk | v | 0.43 |
| Dut\_Eng | conc | capaciteit | v | 0.14 | capacity | v | 0.37 |
| Dut\_Eng | conc | carrière | v | 0.25 | career | v | 0.39 |
| Dut\_Eng | conc | centrum | v | 0.60 | center | v | 0.47 |
| Dut\_Eng | conc | cijfer | v | 0.38 | grade | v | 0.61 |
| Dut\_Eng | prop | circulair | a | 0.06 | circular | v | 0.54 |
| Dut\_Eng | prop | compact | v | 0.38 | compact | v | 0.53 |
| Dutch | conc | compliment | a | 0.39 | compliment |  |  |
| Dut\_Eng | conc | concept | v | 0.34 | concept | v | 0.23 |
| Dut\_Eng | conc | concurrentie | v | 0.18 | competition | v | 0.37 |
| Dut\_Eng | conc | conditie | v | 0.15 | condition | v | 0.24 |
| Dut\_Eng | prop | conisch | v | 0.32 | conical | v | 0.52 |
| Dut\_Eng | conc | consequentie | v | 0.19 | consequence | v | 0.31 |
| Dut\_Eng | conc | contact | h | 0.14 | contact | h | 0.21 |
| Dut\_Eng | conc | contract | v | 0.27 | contract | v | 0.46 |
| Dut\_Eng | conc | crisis | v | 0.13 | crisis | v | 0.41 |
| Dut\_Eng | conc | dak | v | 0.48 | roof | v | 0.61 |
| Dut\_Eng | conc | dame | v | 0.18 | lady | v | 0.27 |
| Dut\_Eng | conc | dans | v | 0.21 | dance | v | 0.50 |
| Dut\_Eng | conc | deel | v | 0.55 | portion | v | 0.33 |
| Dut\_Eng | prop | deftig | v | 0.40 | portly | v | 0.44 |
| Dut\_Eng | conc | dek | v | 0.30 | deck | v | 0.47 |
| Dut\_Eng | conc | deken | h | 0.28 | blanket | h | 0.39 |
| Dut\_Eng | conc | democratie | v | 0.24 | democracy | v | 0.53 |
| Dut\_Eng | conc | depressie | v | 0.36 | depression | v | 0.43 |
| Dut\_Eng | conc | diameter | v | 0.68 | bore | v | 0.31 |
| Dut\_Eng | conc | dichter | a | 0.22 | poet | a | 0.47 |
| Dut\_Eng | conc | dichterbij | v | 0.24 | closer | v | 0.28 |
| Dut\_Eng | prop | diep | v | 0.25 | deep | v | 0.38 |
| Dut\_Eng | prop | dik | v | 0.34 | fat | v | 0.38 |
| Dut\_Eng | conc | dik | v | 0.53 | thick | v | 0.30 |
| Dut\_Eng | conc | doel | a | 0.21 | purpose | v | 0.40 |
| Dut\_Eng | prop | dof | v | 0.28 | dull | v | 0.39 |
| Dut\_Eng | conc | dokter | v | 0.08 | doctor | v | 0.34 |
| Dut\_Eng | prop | donderend | a | 0.36 | thunderous | a | 0.54 |
| Dut\_Eng | prop | donker | v | 0.63 | dark | v | 0.70 |
| Dut\_Eng | prop | donzig | h | 0.26 | downy | v | 0.52 |
| Dut\_Eng | prop | dood | v | 0.53 | dead | v | 0.37 |
| Dut\_Eng | conc | dood | v | 0.32 | death | v | 0.37 |
| Dut\_Eng | prop | doornig | v | 0.37 | thorny | h | 0.42 |
| Dut\_Eng | prop | doorschijnend | v | 0.70 | translucent | v | 0.68 |
| Dut\_Eng | prop | doorweekt | h | 0.30 | sodden | v | 0.42 |
| Dut\_Eng | conc | drama | v | 0.26 | drama | v | 0.42 |
| Dut\_Eng | prop | drapperig | h | 0.19 | slushy | v | 0.27 |
| Dut\_Eng | prop | drassig | h | 0.16 | soggy | h | 0.24 |
| Dut\_Eng | conc | drie | v | 0.63 | three | v | 0.39 |
| Dut\_Eng | prop | driehoekig | v | 0.51 | triangular | v | 0.54 |
| Dut\_Eng | prop | droog | v | 0.46 | dry | h | 0.35 |
| Dut\_Eng | conc | droom | v | 0.24 | dream | v | 0.35 |
| Dut\_Eng | prop | druk | v | 0.22 | crowded | v | 0.41 |
| Dut\_Eng | conc | druk | v | 0.27 | pressure | v | 0.36 |
| Dut\_Eng | conc | drukte | v | 0.20 | rush | v | 0.38 |
| Dut\_Eng | conc | duik | h | 0.11 | dive | v | 0.45 |
| Dut\_Eng | conc | duim | v | 0.41 | inch | v | 0.60 |
| Dut\_Eng | prop | echoënd | a | 0.80 | echoing | a | 0.85 |
| Dut\_Eng | conc | economie | a | 0.35 | economy | v | 0.44 |
| Dut\_Eng | conc | eenheid | v | 0.32 | unit | v | 0.37 |
| Dut\_Eng | conc | eeuw | v | 0.91 | century | v | 0.50 |
| Dut\_Eng | conc | effect | v | 0.41 | effect | v | 0.19 |
| Dut\_Eng | prop | effen | v | 0.46 | plain | v | 0.36 |
| Dut\_Eng | conc | eigenaar | v | 0.24 | owner | v | 0.46 |
| Dut\_Eng | conc | eigenschap | v | 0.10 | property | v | 0.44 |
| Dut\_Eng | conc | eis | a | 0.33 | requirement | v | 0.42 |
| Dut\_Eng | prop | elastisch | v | 0.25 | elastic | h | 0.34 |
| Dut\_Eng | prop | elegant | v | 0.50 | elegant | v | 0.41 |
| Dut\_Eng | conc | emotie | v | 0.14 | emotion | v | 0.27 |
| Dut\_Eng | prop | enorm | v | 0.28 | enormous | v | 0.46 |
| Dut\_Eng | conc | enthousiasme | a | 0.08 | enthusiasm | v | 0.34 |
| Dut\_Eng | conc | entree | v | 0.53 | entrance | v | 0.52 |
| Dut\_Eng | conc | erkenning | a | 0.18 | recognition | v | 0.15 |
| Dut\_Eng | conc | exemplaar | v | 0.27 | instance | v | 0.39 |
| Dut\_Eng | conc | expansie | v | 0.25 | expansion | v | 0.38 |
| Dut\_Eng | conc | extreem | v | 0.14 | extreme | v | 0.17 |
| Dut\_Eng | conc | fabriek | v | 0.41 | factory | v | 0.31 |
| Dut\_Eng | conc | factor | v | 0.09 | factor | v | 0.46 |
| Dut\_Eng | conc | feit | a | 0.30 | fact | a | 0.28 |
| Dutch | conc | felicitatie | a | 0.28 | congratulation |  |  |
| Dut\_Eng | conc | filosofie | a | 0.19 | philosophy | a | 0.64 |
| Dut\_Eng | conc | financiën | v | 0.39 | finance | v | 0.48 |
| Dut\_Eng | conc | firma | v | 0.13 | firm | h | 0.42 |
| Dut\_Eng | conc | flauwvallen | v | 0.24 | faint | v | 0.40 |
| Dut\_Eng | prop | flikkerend | v | 0.54 | flickering | v | 0.69 |
| Dut\_Eng | prop | floraal | v | 0.73 | floral | v | 0.40 |
| Dut\_Eng | prop | fluisterend | a | 0.39 | whispering | a | 0.62 |
| Dut\_Eng | prop | fluitend | a | 0.30 | bleeping | a | 0.69 |
| Dut\_Eng | prop | fonkelend | v | 0.38 | glistening | v | 0.67 |
| Dut\_Eng | conc | formatie | v | 0.38 | formation | v | 0.48 |
| Dut\_Eng | conc | fortuin | v | 0.25 | fortune | v | 0.43 |
| Dut\_Eng | conc | fout | v | 0.10 | wrong | v | 0.20 |
| Dut\_Eng | prop | fuchsia | v | 0.92 | tangerine | v | 0.29 |
| Dut\_Eng | conc | functie | v | 0.15 | function | v | 0.30 |
| Dut\_Eng | prop | galmend | a | 0.74 | resounding | a | 0.61 |
| Dut\_Eng | conc | gat | v | 0.33 | hole | v | 0.54 |
| Dut\_Eng | conc | gebaar | v | 0.59 | gesture | v | 0.60 |
| Dut\_Eng | conc | gebied | v | 0.35 | area | v | 0.50 |
| Dut\_Eng | prop | geblokt | v | 0.42 | chequered | v | 0.92 |
| Dut\_Eng | prop | gebogen | v | 0.27 | bent | v | 0.53 |
| Dut\_Eng | prop | gebroken | h | 0.11 | broken | v | 0.33 |
| Dut\_Eng | prop | gedempt | a | 0.68 | muffled | a | 0.60 |
| Dut\_Eng | prop | geel | v | 0.67 | yellow | v | 0.95 |
| Dut\_Eng | conc | geest | h | 0.24 | spirit | v | 0.35 |
| Dut\_Eng | conc | gelach | a | 0.33 | laughter | a | 0.49 |
| Dut\_Eng | conc | geld | v | 0.17 | cash | v | 0.37 |
| Dut\_Eng | conc | gelegenheid | v | 0.50 | opportunity | v | 0.37 |
| Dut\_Eng | conc | geluid | a | 0.57 | sound | a | 0.78 |
| Dut\_Eng | prop | geluidloos | a | 0.52 | soundless | a | 0.67 |
| Dut\_Eng | conc | gemak | v | 0.12 | ease | v | 0.41 |
| Dut\_Eng | prop | geneeskrachtig | h | 0.18 | medicinal | v | 0.28 |
| Dut\_Eng | conc | genezing | v | 0.14 | cure | v | 0.32 |
| Dut\_Eng | conc | genot | v | 0.03 | delight | v | 0.16 |
| Dut\_Eng | prop | gepatroneerd | v | 0.32 | patterned | v | 0.68 |
| Dut\_Eng | prop | geplooid | v | 0.16 | crinkled | v | 0.33 |
| Dut\_Eng | prop | gepolijst | v | 0.42 | polished | v | 0.45 |
| Dut\_Eng | conc | gereedschap | v | 0.24 | tool | v | 0.36 |
| Dutch | conc | gerucht | a | 0.46 | rumour |  |  |
| Dut\_Eng | conc | geschil | v | 0.20 | dispute | v | 0.44 |
| Dut\_Eng | prop | geschubd | h | 0.28 | scaly | h | 0.43 |
| Dut\_Eng | prop | gesmolten | v | 0.47 | melted | v | 0.29 |
| Dut\_Eng | prop | gespikkeld | v | 0.85 | speckled | v | 0.67 |
| Dut\_Eng | prop | gestreept | v | 0.64 | striped | v | 0.76 |
| Dut\_Eng | prop | getand | v | 0.29 | jagged | h | 0.42 |
| Dut\_Eng | prop | gevlekt | v | 0.68 | dappled | v | 0.55 |
| Dut\_Eng | conc | gevoel | v | 0.12 | feel | h | 0.41 |
| Dut\_Eng | prop | gevorkt | v | 0.37 | forked | v | 0.49 |
| Dut\_Eng | prop | gevormd | v | 0.15 | contoured | v | 0.50 |
| Dut\_Eng | prop | gevouwen | v | 0.49 | creased | v | 0.52 |
| Dut\_Eng | conc | geweer | h | 0.09 | rifle | a | 0.31 |
| Dut\_Eng | prop | gewelfd | v | 0.26 | curved | v | 0.52 |
| Dut\_Eng | prop | gewichtloos | h | 0.26 | weightless | h | 0.46 |
| Dut\_Eng | prop | gezet | v | 0.45 | rotund | v | 0.57 |
| Dut\_Eng | conc | gezondheid | v | 0.10 | health | v | 0.32 |
| Dut\_Eng | prop | gezwollen | v | 0.41 | puffy | v | 0.39 |
| Dut\_Eng | prop | giechelend | a | 0.39 | giggling | a | 0.51 |
| Dut\_Eng | prop | gierend | a | 0.50 | howling | a | 0.59 |
| Dut\_Eng | prop | gigantisch | v | 0.73 | gigantic | v | 0.47 |
| Dut\_Eng | prop | gillend | a | 0.33 | screaming | a | 0.61 |
| Dut\_Eng | conc | gips | v | 0.35 | cast | v | 0.47 |
| Dut\_Eng | prop | glad | h | 0.33 | slick | v | 0.40 |
| Dut\_Eng | prop | glanzend | v | 0.78 | glossy | v | 0.46 |
| Dut\_Eng | conc | glas | v | 0.15 | glass | v | 0.39 |
| Dut\_Eng | prop | glibberig | h | 0.36 | slippery | h | 0.35 |
| Dut\_Eng | prop | glimmend | v | 0.58 | gleaming | v | 0.65 |
| Dut\_Eng | prop | glinsterend | v | 0.68 | shimmering | v | 0.65 |
| Dut\_Eng | prop | glitterend | v | 0.52 | glittery | v | 0.61 |
| Dut\_Eng | prop | gloeiend | v | 0.50 | glowing | v | 0.74 |
| Dut\_Eng | conc | god | v | 0.11 | god | a | 0.33 |
| Dut\_Eng | prop | golvend | v | 0.17 | rippled | v | 0.37 |
| Dut\_Eng | prop | gorgelend | a | 0.29 | gurgling | a | 0.42 |
| Dut\_Eng | prop | gouden | v | 0.56 | gold | v | 0.72 |
| Dut\_Eng | conc | grafiek | v | 0.50 | chart | v | 0.74 |
| Dut\_Eng | conc | gras | v | 0.44 | grass | v | 0.35 |
| Dut\_Eng | prop | grasachtig | h | 0.32 | grassy | v | 0.39 |
| Dut\_Eng | conc | grens | v | 0.29 | border | v | 0.58 |
| Dut\_Eng | prop | grijs | v | 0.65 | grey | v | 0.85 |
| Dut\_Eng | prop | groeiend | v | 0.43 | booming | a | 0.57 |
| Dut\_Eng | prop | groen | v | 0.58 | green | v | 0.69 |
| Dut\_Eng | prop | grof | v | 0.25 | harsh | a | 0.12 |
| Dut\_Eng | prop | grommend | a | 0.48 | growling | a | 0.56 |
| Dut\_Eng | prop | groot | v | 0.38 | big | v | 0.36 |
| Dut\_Eng | prop | grotesk | v | 0.86 | grotesque | v | 0.18 |
| Dut\_Eng | conc | haat | v | 0.11 | hate | a | 0.31 |
| Dut\_Eng | prop | hard | h | 0.14 | hard | h | 0.42 |
| Dut\_Eng | conc | harmonie | v | 0.25 | harmony | a | 0.34 |
| Dut\_Eng | prop | hees | a | 0.71 | hoarse | a | 0.51 |
| Dut\_Eng | prop | heet | h | 0.40 | hot | h | 0.25 |
| Dutch | conc | heft | h | 0.33 | handle |  |  |
| Dut\_Eng | conc | hek | v | 0.36 | fence | v | 0.52 |
| Dut\_Eng | conc | hel | h | 0.19 | hell | a | 0.39 |
| Dut\_Eng | prop | helder | v | 0.54 | bright | v | 0.90 |
| Dut\_Eng | conc | hemel | v | 0.42 | heaven | a | 0.21 |
| Dut\_Eng | conc | herinnering | a | 0.25 | recall | v | 0.14 |
| Dut\_Eng | conc | hinder | v | 0.18 | bother | v | 0.34 |
| Dut\_Eng | prop | hitsig | h | 0.13 | searing | v | 0.36 |
| Dut\_Eng | prop | hobbelig | v | 0.32 | bumpy | h | 0.42 |
| Dut\_Eng | conc | hoed | v | 0.47 | hat | v | 0.52 |
| Dut\_Eng | prop | hoekig | v | 0.31 | angular | v | 0.49 |
| Dut\_Eng | conc | hoeveelheid | v | 0.30 | quantity | v | 0.40 |
| Dut\_Eng | prop | hol | v | 0.24 | hollow | v | 0.33 |
| Dut\_Eng | prop | hoog | v | 0.69 | high | v | 0.42 |
| Dut\_Eng | prop | hoorbaar | a | 0.77 | audible | a | 0.76 |
| Dut\_Eng | prop | huilend | v | 0.30 | crying | a | 0.43 |
| Dut\_Eng | prop | huilerig | v | 0.17 | wailing | a | 0.58 |
| Dut\_Eng | conc | huishouden | v | 0.17 | household | v | 0.22 |
| Dut\_Eng | conc | hulp | v | 0.04 | help | a | 0.37 |
| Dut\_Eng | conc | huur | v | 0.32 | rent | v | 0.50 |
| Dut\_Eng | conc | ideaal | v | 0.20 | ideal | v | 0.18 |
| Dut\_Eng | prop | iel | v | 0.26 | puny | v | 0.49 |
| Dut\_Eng | prop | ijsachtig | v | 0.35 | icy | v | 0.31 |
| Dut\_Eng | prop | ijzig | v | 0.17 | frosty | v | 0.30 |
| Dut\_Eng | conc | incident | v | 0.28 | incident | v | 0.35 |
| Dut\_Eng | conc | indruk | v | 0.15 | impression | v | 0.29 |
| Dut\_Eng | conc | informatie | v | 0.29 | information | a | 0.27 |
| Dut\_Eng | conc | inhoud | v | 0.37 | content | v | 0.20 |
| Dut\_Eng | conc | inkomen | v | 0.23 | income | v | 0.52 |
| Dut\_Eng | conc | inspanning | v | 0.15 | effort | v | 0.45 |
| Dut\_Eng | conc | interieur | v | 0.52 | interior | v | 0.44 |
| Dut\_Eng | conc | invloed | v | 0.21 | influence | v | 0.37 |
| Dut\_Eng | conc | item | v | 0.31 | item | h | 0.08 |
| Dut\_Eng | prop | jammerend | a | 0.25 | whimpering | a | 0.56 |
| Dut\_Eng | prop | jankend | v | 0.21 | squealing | a | 0.68 |
| Dut\_Eng | prop | jeukend | h | 0.33 | itchy | h | 0.46 |
| Dut\_Eng | prop | jodelend | a | 0.28 | warbling | a | 0.51 |
| Dut\_Eng | conc | juffrouw | v | 0.25 | miss | v | 0.34 |
| Dut\_Eng | conc | junior | v | 0.14 | junior | v | 0.38 |
| Dut\_Eng | prop | kaatsend | v | 0.24 | bouncy | h | 0.40 |
| Dut\_Eng | prop | kabbelend | v | 0.19 | rippling | v | 0.34 |
| Dut\_Eng | conc | kamp | v | 0.25 | camp | v | 0.30 |
| Dut\_Eng | prop | karmozijn | v | 0.75 | crimson | v | 0.87 |
| Dut\_Eng | conc | katoen | h | 0.51 | cotton | h | 0.44 |
| Dut\_Eng | conc | kelder | v | 0.41 | cellar | v | 0.36 |
| Dut\_Eng | conc | kennis | a | 0.32 | knowledge | a | 0.46 |
| Dut\_Eng | conc | kern | h | 0.18 | core | v | 0.35 |
| Dut\_Eng | conc | keten | v | 0.21 | chain | v | 0.38 |
| Dut\_Eng | prop | kietelend | h | 0.31 | ticklish | h | 0.52 |
| Dut\_Eng | prop | kil | v | 0.29 | chilly | h | 0.37 |
| Dut\_Eng | conc | kind | v | 0.10 | kid | v | 0.38 |
| Dut\_Eng | conc | kip | v | 0.06 | hen | v | 0.22 |
| Dut\_Eng | prop | kladderig | v | 0.54 | blotchy | v | 0.60 |
| Dut\_Eng | prop | klam | h | 0.47 | clammy | h | 0.41 |
| Dut\_Eng | conc | klant | v | 0.23 | customer | v | 0.37 |
| Dutch | conc | klap | h | 0.09 | slap |  |  |
| Dut\_Eng | prop | klappend | a | 0.08 | banging | a | 0.51 |
| Dut\_Eng | prop | klein | v | 0.48 | small | v | 0.55 |
| Dut\_Eng | prop | kleurrijk | v | 0.65 | colourful | v | 0.77 |
| Dut\_Eng | prop | kleverig | h | 0.32 | sticky | h | 0.43 |
| Dut\_Eng | prop | klonterig | v | 0.28 | lumpy | h | 0.34 |
| Dut\_Eng | prop | knallend | a | 0.37 | popping | a | 0.36 |
| Dut\_Eng | prop | knap | v | 0.52 | handsome | v | 0.51 |
| Dut\_Eng | prop | knapperend | a | 0.27 | crackling | a | 0.32 |
| Dut\_Eng | prop | knapperig | h | 0.00 | crisp | h | 0.18 |
| Dut\_Eng | prop | knarsend | a | 0.32 | creaking | a | 0.58 |
| Dutch | conc | knuffel | h | 0.44 | hug |  |  |
| Dut\_Eng | prop | koel | h | 0.46 | cool | h | 0.44 |
| Dut\_Eng | conc | koelkast | v | 0.23 | refrigerator | v | 0.26 |
| Dut\_Eng | prop | koerend | a | 0.65 | cooing | a | 0.68 |
| Dut\_Eng | conc | kogel | v | 0.15 | bullet | v | 0.32 |
| Dut\_Eng | prop | kokend | v | 0.14 | boiling | v | 0.24 |
| Dut\_Eng | prop | kolossaal | v | 0.29 | colossal | v | 0.47 |
| Dut\_Eng | conc | komedie | a | 0.22 | comedy | a | 0.51 |
| Dut\_Eng | conc | koninkrijk | v | 0.34 | kingdom | v | 0.39 |
| Dut\_Eng | prop | koortsig | v | 0.25 | feverish | h | 0.41 |
| Dut\_Eng | prop | korrelig | h | 0.34 | grainy | h | 0.32 |
| Dut\_Eng | prop | kort | v | 0.58 | short | v | 0.53 |
| Dut\_Eng | conc | kosten | v | 0.31 | cost | v | 0.45 |
| Dut\_Eng | prop | koud | h | 0.47 | cold | h | 0.34 |
| Dut\_Eng | prop | krakend | a | 0.48 | crunching | a | 0.29 |
| Dut\_Eng | prop | krassend | a | 0.18 | scratchy | h | 0.39 |
| Dut\_Eng | prop | kreunend | a | 0.50 | groaning | a | 0.66 |
| Dut\_Eng | prop | krijsend | a | 0.23 | screeching | a | 0.61 |
| Dut\_Eng | prop | krullend | v | 0.22 | curly | v | 0.53 |
| Dutch | conc | kus | h | 0.18 | kiss |  |  |
| Dut\_Eng | conc | kwaliteit | v | 0.12 | quality | v | 0.07 |
| Dut\_Eng | conc | kwestie | v | 0.24 | matter | v | 0.17 |
| Dut\_Eng | prop | laag | v | 0.63 | low | v | 0.46 |
| Dut\_Eng | prop | lachend | a | 0.50 | laughing | a | 0.48 |
| Dut\_Eng | conc | landschap | v | 0.34 | landscape | v | 0.55 |
| Dut\_Eng | prop | lang | v | 0.53 | long | v | 0.51 |
| Dut\_Eng | prop | langgerekt | v | 0.38 | tall | v | 0.63 |
| Dutch | conc | laster | a | 0.25 | libel |  |  |
| Dut\_Eng | prop | lauw | a | 0.66 | lukewarm | h | 0.50 |
| Dut\_Eng | prop | leeg | v | 0.44 | empty | v | 0.44 |
| Dut\_Eng | prop | leerachtig | v | 0.24 | leathery | h | 0.34 |
| Dut\_Eng | conc | leiding | a | 0.13 | lead | v | 0.33 |
| Dut\_Eng | prop | lelijk | v | 0.47 | ugly | v | 0.46 |
| Dut\_Eng | prop | lenig | v | 0.50 | lithe | v | 0.56 |
| Dutch | conc | letsel | v | 0.38 | injury |  |  |
| Dut\_Eng | conc | leven | v | 0.06 | life | v | 0.08 |
| Dut\_Eng | prop | levend | v | 0.10 | alive | v | 0.18 |
| Dut\_Eng | prop | levendig | v | 0.28 | vivid | v | 0.29 |
| Dut\_Eng | conc | levering | v | 0.05 | supply | v | 0.40 |
| Dut\_Eng | conc | lichaam | v | 0.27 | body | v | 0.19 |
| Dut\_Eng | prop | licht | v | 0.51 | faint | v | 0.24 |
| Dut\_Eng | prop | lichtbruin | v | 0.70 | khaki | v | 0.79 |
| Dut\_Eng | conc | lift | v | 0.15 | lift | v | 0.39 |
| Dut\_Eng | conc | links | v | 0.28 | left | v | 0.48 |
| Dut\_Eng | conc | loon | v | 0.16 | wage | v | 0.53 |
| Dut\_Eng | prop | los | v | 0.58 | loose | v | 0.48 |
| Dut\_Eng | prop | luchtig | v | 0.38 | breezy | v | 0.32 |
| Dut\_Eng | prop | luid | a | 0.63 | loud | a | 0.68 |
| Dut\_Eng | prop | luidruchtig | a | 0.53 | noisy | a | 0.70 |
| Dut\_Eng | conc | lus | v | 0.56 | loop | v | 0.43 |
| Dut\_Eng | conc | maat | v | 0.28 | measure | v | 0.32 |
| Dut\_Eng | conc | maatje | v | 0.09 | mate | v | 0.33 |
| Dut\_Eng | conc | machine | v | 0.21 | machine | v | 0.32 |
| Dut\_Eng | prop | mager | v | 0.47 | skinny | v | 0.50 |
| Dut\_Eng | conc | magie | v | 0.48 | magic | v | 0.51 |
| Dut\_Eng | prop | mals | h | 0.35 | tender | h | 0.22 |
| Dut\_Eng | conc | mandaat | v | 0.12 | brief | a | 0.34 |
| Dutch | conc | manipulatie | v | 0.05 | manipulation |  |  |
| Dut\_Eng | conc | mars | v | 0.14 | march | v | 0.42 |
| Dut\_Eng | conc | massa | v | 0.22 | mass | v | 0.43 |
| Dutch | conc | massage | h | 0.38 | massage |  |  |
| Dut\_Eng | conc | meerderheid | v | 0.42 | majority | v | 0.50 |
| Dut\_Eng | conc | meester | v | 0.41 | master | v | 0.41 |
| Dut\_Eng | prop | melodieus | a | 0.67 | melodious | a | 0.64 |
| Dut\_Eng | prop | metalen | v | 0.20 | metal | v | 0.24 |
| Dut\_Eng | conc | methode | v | 0.33 | method | v | 0.43 |
| Dut\_Eng | prop | miauwend | a | 0.54 | meowing | a | 0.59 |
| Dut\_Eng | prop | miniatuur | v | 0.49 | miniature | v | 0.51 |
| Dut\_Eng | conc | minuut | v | 0.34 | minute | v | 0.54 |
| Dut\_Eng | conc | misdrijf | v | 0.22 | crime | v | 0.45 |
| Dut\_Eng | conc | mislukking | v | 0.18 | failure | v | 0.31 |
| Dut\_Eng | conc | mist | v | 0.43 | fog | v | 0.66 |
| Dut\_Eng | prop | mistig | v | 0.46 | foggy | v | 0.72 |
| Dut\_Eng | prop | modderig | v | 0.44 | muddy | v | 0.30 |
| Dut\_Eng | prop | mollig | v | 0.31 | chubby | v | 0.47 |
| Dut\_Eng | conc | moment | v | 0.24 | moment | v | 0.33 |
| Dut\_Eng | prop | mompelend | a | 0.61 | mumbling | a | 0.66 |
| Dut\_Eng | conc | mond | v | 0.05 | mouth | v | 0.17 |
| Dut\_Eng | prop | mondig | a | 0.53 | mellow | v | 0.33 |
| Dut\_Eng | prop | mooi | v | 0.18 | beautiful | v | 0.12 |
| Dut\_Eng | prop | morrend | a | 0.53 | muttering | a | 0.60 |
| Dut\_Eng | prop | morsend | v | 0.29 | spilling | v | 0.45 |
| Dut\_Eng | prop | mottig | v | 0.14 | dank | v | 0.30 |
| Dut\_Eng | conc | muziek | a | 0.47 | music | a | 0.58 |
| Dut\_Eng | conc | mythe | a | 0.28 | myth | a | 0.73 |
| English | prop |  |  |  | whistling | a | 0.65 |
| English | prop |  |  |  | tepid | h | 0.49 |
| English | prop |  |  |  | spotted | v | 0.68 |
| English | prop |  |  |  | clear | v | 0.40 |
| English | prop |  |  |  | mottled | v | 0.48 |
| English | prop |  |  |  | light | v | 0.31 |
| English | prop |  |  |  | broad | v | 0.45 |
| English | conc |  |  |  | blame | a | 0.38 |
| English | conc |  |  |  | claim | a | 0.50 |
| English | conc |  |  |  | aim | v | 0.41 |
| English | conc |  |  |  | confidence | v | 0.39 |
| English | conc |  |  |  | money | v | 0.39 |
| Dut\_Eng | conc | nacht | v | 0.45 | night | v | 0.62 |
| Dut\_Eng | prop | nassig | v | 1.00 | damp | h | 0.32 |
| Dut\_Eng | prop | nat | h | 0.27 | wet | h | 0.21 |
| Dut\_Eng | prop | nattig | v | 0.14 | moist | h | 0.21 |
| Dut\_Eng | prop | nauw | v | 0.33 | narrow | v | 0.55 |
| Dut\_Eng | conc | nederlaag | v | 0.09 | defeat | v | 0.46 |
| Dut\_Eng | conc | neef | v | 0.15 | cousin | v | 0.34 |
| Dut\_Eng | conc | neiging | a | 0.19 | tendency | v | 0.47 |
| Dut\_Eng | conc | neus | h | 0.22 | nose | v | 0.30 |
| Dut\_Eng | prop | nevelig | v | 0.48 | misty | v | 0.54 |
| Dut\_Eng | conc | nieuwsgierigheid | v | 0.15 | curiosity | v | 0.22 |
| Dut\_Eng | conc | niveau | v | 0.48 | level | v | 0.44 |
| Dut\_Eng | conc | noodgeval | a | 0.25 | emergency | v | 0.38 |
| Dut\_Eng | conc | nul | v | 0.59 | zero | v | 0.55 |
| Dut\_Eng | conc | object | v | 0.26 | object | v | 0.13 |
| Dut\_Eng | prop | olieachtig | v | 0.47 | oily | v | 0.28 |
| Dut\_Eng | conc | omzoming | v | 0.66 | trim | v | 0.46 |
| Dut\_Eng | conc | onafhankelijkheid | h | 0.14 | independence | v | 0.43 |
| Dut\_Eng | prop | onbeweeglijk | v | 0.44 | motionless | v | 0.52 |
| Dut\_Eng | conc | onder | v | 0.47 | under | v | 0.51 |
| Dut\_Eng | conc | onderscheid | v | 0.19 | distinction | v | 0.15 |
| Dut\_Eng | conc | onderwijs | v | 0.39 | education | v | 0.35 |
| Dut\_Eng | conc | onderzoek | v | 0.14 | investigation | v | 0.41 |
| Dut\_Eng | conc | ondeugd | v | 0.16 | vice | v | 0.38 |
| Dut\_Eng | prop | ondiep | v | 0.42 | shallow | v | 0.43 |
| Dut\_Eng | prop | ongelijk | v | 0.25 | uneven | v | 0.37 |
| Dut\_Eng | prop | onmetelijk | v | 0.48 | immense | v | 0.20 |
| Dut\_Eng | prop | onrijp | v | 0.43 | unripe | v | 0.27 |
| Dutch | conc | ontharder | v | 0.42 | softener |  |  |
| Dut\_Eng | conc | ontwikkeling | v | 0.27 | development | v | 0.27 |
| Dut\_Eng | conc | oog | v | 0.66 | eye | v | 0.68 |
| Dut\_Eng | conc | oorsprong | v | 0.06 | origin | v | 0.36 |
| Dut\_Eng | prop | oorverdovend | a | 0.67 | deafening | a | 0.77 |
| Dut\_Eng | conc | oorzaak | v | 0.31 | cause | v | 0.36 |
| Dut\_Eng | conc | oosten | v | 0.64 | east | v | 0.63 |
| Dut\_Eng | prop | open | v | 0.33 | open | v | 0.48 |
| Dut\_Eng | conc | openbaar | v | 0.33 | public | v | 0.39 |
| Dut\_Eng | conc | opening | v | 0.14 | opening | v | 0.42 |
| Dut\_Eng | conc | oplossing | v | 0.31 | solution | v | 0.38 |
| Dut\_Eng | conc | opwinding | v | 0.01 | excitement | v | 0.23 |
| Dut\_Eng | prop | oranje | v | 0.66 | orange | v | 0.41 |
| Dut\_Eng | prop | ovaal | v | 0.51 | oval | v | 0.50 |
| Dut\_Eng | conc | overeenkomst | a | 0.15 | deal | v | 0.35 |
| Dut\_Eng | conc | overhemd | v | 0.37 | shirt | v | 0.42 |
| Dut\_Eng | conc | overwinning | a | 0.07 | win | v | 0.38 |
| Dut\_Eng | conc | paar | v | 0.48 | pair | v | 0.50 |
| Dut\_Eng | prop | paars | v | 0.79 | purple | v | 0.90 |
| Dutch | conc | palpatie | h | 0.42 | palpation |  |  |
| Dut\_Eng | conc | papier | v | 0.27 | paper | v | 0.32 |
| Dut\_Eng | prop | papperig | v | 0.22 | mushy | h | 0.28 |
| Dut\_Eng | conc | pels | v | 0.36 | hide | v | 0.50 |
| Dut\_Eng | conc | personeel | v | 0.38 | personnel | v | 0.47 |
| Dut\_Eng | prop | piekerig | v | 0.48 | wispy | v | 0.38 |
| Dut\_Eng | prop | piepend | a | 0.42 | squeaking | a | 0.65 |
| Dut\_Eng | prop | piepklein | v | 0.63 | tiny | v | 0.52 |
| Dut\_Eng | prop | pijnlijk | v | 0.05 | painful | h | 0.29 |
| Dut\_Eng | prop | pijnvol | h | 0.08 | aching | h | 0.55 |
| Dut\_Eng | conc | pistool | h | 0.09 | gun | v | 0.29 |
| Dut\_Eng | conc | plaats | v | 0.44 | site | v | 0.53 |
| Dut\_Eng | prop | plakkend | h | 0.24 | adhesive | h | 0.29 |
| Dut\_Eng | conc | plan | a | 0.26 | plan | a | 0.42 |
| Dut\_Eng | prop | plantaardig | v | 0.35 | vegetal | v | 0.33 |
| Dut\_Eng | prop | plastic | v | 0.23 | plastic | v | 0.27 |
| Dut\_Eng | conc | platform | v | 0.39 | platform | v | 0.55 |
| Dut\_Eng | conc | plicht | h | 0.19 | duty | v | 0.45 |
| Dut\_Eng | conc | plug | v | 0.40 | plug | v | 0.49 |
| Dut\_Eng | prop | pluizig | v | 0.46 | fluffy | h | 0.41 |
| Dut\_Eng | conc | poeder | v | 0.46 | powder | v | 0.24 |
| Dut\_Eng | conc | poëzie | a | 0.11 | poetry | a | 0.53 |
| Dut\_Eng | conc | poging | v | 0.03 | attempt | v | 0.41 |
| Dut\_Eng | conc | pond | v | 0.41 | pound | v | 0.39 |
| Dut\_Eng | prop | prachtig | v | 0.45 | gorgeous | v | 0.25 |
| Dut\_Eng | conc | president | v | 0.43 | president | v | 0.46 |
| Dut\_Eng | conc | prijs | v | 0.35 | prize | v | 0.33 |
| Dut\_Eng | prop | prikkelend | h | 0.35 | stinging | h | 0.66 |
| Dut\_Eng | conc | primair | v | 0.77 | primary | v | 0.39 |
| Dut\_Eng | conc | prins | v | 0.17 | prince | v | 0.45 |
| Dut\_Eng | conc | probleem | v | 0.07 | problem | a | 0.35 |
| Dut\_Eng | conc | productie | v | 0.12 | production | v | 0.24 |
| Dut\_Eng | conc | promotie | v | 0.28 | promotion | a | 0.41 |
| Dut\_Eng | conc | proportie | v | 0.48 | proportion | v | 0.32 |
| Dut\_Eng | prop | pulserend | h | 0.18 | pulsing | h | 0.36 |
| Dut\_Eng | prop | puntig | v | 0.42 | spiky | h | 0.43 |
| Dut\_Eng | conc | pupil | v | 0.56 | pupil | v | 0.46 |
| Dut\_Eng | prop | puur | v | 0.14 | sheer | v | 0.57 |
| Dut\_Eng | conc | raad | a | 0.44 | council | v | 0.45 |
| Dut\_Eng | conc | race | v | 0.34 | race | v | 0.50 |
| Dut\_Eng | conc | raket | v | 0.28 | missile | v | 0.41 |
| Dut\_Eng | conc | rand | v | 0.44 | edge | v | 0.46 |
| Dut\_Eng | prop | raspend | v | 0.17 | raspy | a | 0.39 |
| Dut\_Eng | prop | rauw | v | 0.46 | raucous | a | 0.52 |
| Dut\_Eng | prop | recht | v | 0.49 | straight | v | 0.53 |
| Dut\_Eng | prop | rechthoekig | v | 0.54 | rectangular | v | 0.54 |
| Dut\_Eng | conc | reflectie | v | 0.54 | reflection | v | 0.84 |
| Dut\_Eng | conc | rekening | v | 0.48 | account | a | 0.42 |
| Dut\_Eng | conc | relatie | v | 0.09 | relation | v | 0.39 |
| Dut\_Eng | conc | republiek | v | 0.36 | republic | v | 0.63 |
| Dut\_Eng | conc | reus | v | 0.33 | giant | v | 0.43 |
| Dut\_Eng | prop | reusachtig | v | 0.68 | huge | v | 0.43 |
| Dut\_Eng | conc | richting | v | 0.27 | direction | v | 0.43 |
| Dut\_Eng | conc | riem | v | 0.57 | belt | v | 0.41 |
| Dut\_Eng | prop | rinkelend | a | 0.52 | jingling | a | 0.52 |
| Dut\_Eng | prop | ritmisch | a | 0.20 | rhythmic | a | 0.54 |
| Dut\_Eng | prop | ritselend | a | 0.31 | rustling | a | 0.41 |
| Dut\_Eng | prop | robuust | v | 0.31 | sturdy | h | 0.41 |
| Dut\_Eng | prop | roestig | v | 0.43 | rusty | v | 0.34 |
| Dut\_Eng | conc | rok | h | 0.41 | skirt | v | 0.49 |
| Dut\_Eng | conc | rol | v | 0.08 | role | v | 0.48 |
| Dut\_Eng | prop | rommelend | v | 0.22 | rumbling | a | 0.46 |
| Dut\_Eng | prop | rond | v | 0.47 | round | v | 0.48 |
| Dut\_Eng | prop | rood | v | 0.74 | red | v | 0.83 |
| Dut\_Eng | prop | roodachtig | v | 0.74 | reddish | v | 0.86 |
| Dut\_Eng | prop | roosterend | v | 0.32 | roasting | v | 0.17 |
| Dut\_Eng | prop | rot | v | 0.47 | rotten | v | 0.28 |
| Dut\_Eng | conc | rots | h | 0.35 | rock | v | 0.41 |
| Dut\_Eng | prop | rotsig | v | 0.36 | craggy | v | 0.45 |
| Dut\_Eng | conc | route | v | 0.45 | route | v | 0.51 |
| Dut\_Eng | prop | roze | v | 0.65 | pink | v | 0.79 |
| Dut\_Eng | prop | rubberachtig | v | 0.24 | rubbery | h | 0.25 |
| Dut\_Eng | prop | ruig | v | 0.22 | shaggy | v | 0.49 |
| Dut\_Eng | prop | ruim | v | 0.55 | large | v | 0.39 |
| Dut\_Eng | prop | ruisend | a | 0.57 | murmuring | a | 0.63 |
| Dut\_Eng | prop | rustig | v | 0.27 | quiet | a | 0.67 |
| Dut\_Eng | prop | ruw | h | 0.32 | rough | h | 0.31 |
| Dut\_Eng | conc | ruzie | v | 0.15 | quarrel | a | 0.50 |
| Dut\_Eng | prop | saai | v | 0.15 | drab | v | 0.39 |
| Dut\_Eng | conc | schade | v | 0.08 | harm | v | 0.33 |
| Dut\_Eng | prop | schattig | v | 0.49 | cute | v | 0.41 |
| Dut\_Eng | conc | schatting | v | 0.12 | estimate | v | 0.27 |
| Dut\_Eng | prop | scheef | v | 0.46 | crooked | v | 0.48 |
| Dut\_Eng | prop | schel | a | 0.48 | shrill | a | 0.69 |
| Dut\_Eng | conc | schelp | v | 0.23 | shell | v | 0.31 |
| Dut\_Eng | prop | scherp | v | 0.22 | sharp | h | 0.37 |
| Dut\_Eng | prop | schetterend | a | 0.64 | blaring | a | 0.65 |
| Dut\_Eng | prop | schilferig | v | 0.23 | flaky | h | 0.33 |
| Dut\_Eng | prop | schimmig | v | 0.45 | shadowy | v | 0.82 |
| Dut\_Eng | prop | schitterend | v | 0.41 | dazzling | v | 0.77 |
| Dut\_Eng | conc | schok | h | 0.08 | shock | v | 0.35 |
| Dut\_Eng | conc | school | v | 0.19 | school | v | 0.36 |
| Dut\_Eng | prop | schoon | v | 0.31 | clean | v | 0.29 |
| Dut\_Eng | conc | schoonheid | v | 0.24 | beauty | v | 0.33 |
| Dut\_Eng | prop | schor | a | 0.59 | husky | a | 0.57 |
| Dut\_Eng | prop | schreeuwend | a | 0.22 | shrieking | a | 0.59 |
| Dut\_Eng | prop | schreeuwerig | a | 0.54 | clamorous | h | 0.32 |
| Dut\_Eng | prop | schriel | v | 0.40 | scrawny | v | 0.52 |
| Dut\_Eng | conc | schrift | v | 0.40 | writing | v | 0.60 |
| Dut\_Eng | prop | schuimig | v | 0.42 | foamy | v | 0.42 |
| Dut\_Eng | conc | schuld | v | 0.05 | guilt | v | 0.38 |
| Dut\_Eng | prop | schurend | h | 0.10 | abrasive | h | 0.33 |
| Dut\_Eng | conc | seconde | a | 0.11 | second | v | 0.45 |
| Dut\_Eng | conc | selectie | v | 0.21 | selection | v | 0.18 |
| Dut\_Eng | conc | sergeant | v | 0.36 | sergeant | v | 0.51 |
| Dut\_Eng | conc | sierlijkheid | v | 0.30 | grace | v | 0.43 |
| Dutch | conc | sirene | a | 0.47 | siren |  |  |
| Dut\_Eng | prop | sissend | a | 0.37 | hissing | a | 0.64 |
| Dut\_Eng | conc | situatie | v | 0.28 | situation | v | 0.30 |
| Dut\_Eng | prop | slap | h | 0.42 | floppy | v | 0.46 |
| Dut\_Eng | conc | slavernij | v | 0.19 | slavery | v | 0.41 |
| Dut\_Eng | prop | slijmerig | h | 0.29 | slimy | h | 0.31 |
| Dut\_Eng | prop | slissend | a | 0.46 | gooey | h | 0.29 |
| Dut\_Eng | prop | smakeloos | v | 0.20 | insipid | v | 0.30 |
| Dut\_Eng | prop | smerig | v | 0.31 | filthy | v | 0.47 |
| Dut\_Eng | conc | snee | v | 0.43 | cut | v | 0.36 |
| Dut\_Eng | prop | snel | v | 0.38 | swift | v | 0.50 |
| Dut\_Eng | conc | socialist | v | 0.20 | socialist | a | 0.44 |
| Dut\_Eng | prop | soepel | v | 0.33 | smooth | h | 0.36 |
| Dut\_Eng | prop | solide | v | 0.34 | solid | h | 0.35 |
| Dut\_Eng | prop | somber | v | 0.40 | dim | v | 0.75 |
| Dut\_Eng | prop | sonoor | h | 0.41 | sonorous | a | 0.74 |
| Dut\_Eng | conc | soort | v | 0.32 | kind | v | 0.33 |
| Dut\_Eng | conc | spanning | h | 0.01 | strain | h | 0.33 |
| Dut\_Eng | conc | spier | h | 0.29 | muscle | h | 0.40 |
| Dut\_Eng | prop | spinnend | a | 0.36 | purring | a | 0.59 |
| Dut\_Eng | prop | spits | v | 0.49 | tapering | v | 0.43 |
| Dutch | conc | spons | h | 0.42 | sponge |  |  |
| Dut\_Eng | conc | spoor | v | 0.34 | track | v | 0.49 |
| Dut\_Eng | prop | sprankelend | v | 0.40 | sparkly | v | 0.60 |
| Dut\_Eng | conc | stad | v | 0.29 | city | v | 0.26 |
| Dut\_Eng | prop | stampend | a | 0.18 | thumping | a | 0.40 |
| Dut\_Eng | prop | steil | v | 0.55 | steep | v | 0.57 |
| Dut\_Eng | prop | stekelig | h | 0.29 | prickly | h | 0.40 |
| Dut\_Eng | conc | stem | a | 0.64 | vote | v | 0.44 |
| Dut\_Eng | prop | sterk | v | 0.30 | strong | v | 0.13 |
| Dut\_Eng | conc | sterkte | h | 0.11 | strength | v | 0.36 |
| Dut\_Eng | conc | sterven | v | 0.31 | die | v | 0.34 |
| Dut\_Eng | prop | stevig | v | 0.23 | tough | h | 0.36 |
| Dutch | conc | stijfheid | h | 0.32 | stiffness |  |  |
| Dut\_Eng | conc | stijgen | v | 0.23 | rise | v | 0.43 |
| Dut\_Eng | prop | stil | a | 0.44 | silent | a | 0.70 |
| Dut\_Eng | prop | stilstaand | v | 0.41 | stagnant | v | 0.31 |
| Dut\_Eng | conc | stoel | h | 0.31 | chair | v | 0.46 |
| Dut\_Eng | conc | stof | v | 0.30 | dust | v | 0.47 |
| Dut\_Eng | prop | stoffig | v | 0.40 | dusty | v | 0.46 |
| Dut\_Eng | prop | stom | v | 0.25 | mute | a | 0.75 |
| Dut\_Eng | prop | stomp | v | 0.33 | blunt | h | 0.43 |
| Dut\_Eng | conc | stop | v | 0.15 | stop | v | 0.34 |
| Dut\_Eng | prop | stormachtig | a | 0.13 | stormy | v | 0.41 |
| Dut\_Eng | prop | strak | v | 0.36 | tight | h | 0.47 |
| Dut\_Eng | prop | stralend | v | 0.52 | radiant | v | 0.50 |
| Dutch | conc | streling | h | 0.59 | caress |  |  |
| Dut\_Eng | conc | student | v | 0.18 | student | v | 0.40 |
| Dut\_Eng | conc | stuk | v | 0.29 | piece | v | 0.28 |
| Dut\_Eng | conc | substituut | v | 0.35 | substitute | v | 0.30 |
| Dut\_Eng | conc | succes | v | 0.31 | success | v | 0.38 |
| Dut\_Eng | prop | swingend | v | 0.18 | swinging | v | 0.49 |
| Dut\_Eng | conc | symbool | v | 0.69 | symbol | v | 0.49 |
| Dut\_Eng | prop | taai | h | 0.30 | wiry | v | 0.38 |
| Dut\_Eng | conc | talent | v | 0.24 | talent | v | 0.27 |
| Dut\_Eng | conc | tante | v | 0.30 | aunt | v | 0.32 |
| Dut\_Eng | conc | team | v | 0.20 | team | v | 0.38 |
| Dut\_Eng | prop | teerachtig | v | 0.37 | tarry | v | 0.43 |
| Dut\_Eng | conc | tegenstand | v | 0.31 | opposition | v | 0.44 |
| Dut\_Eng | conc | tekst | v | 0.36 | text | v | 0.60 |
| Dut\_Eng | conc | telefoon | a | 0.08 | phone | a | 0.37 |
| Dut\_Eng | conc | telefoontje | a | 0.18 | call | a | 0.56 |
| Dut\_Eng | prop | tenger | v | 0.42 | petite | v | 0.60 |
| Dut\_Eng | conc | terug | v | 0.33 | back | v | 0.44 |
| Dut\_Eng | conc | tevredenheid | v | 0.27 | satisfaction | v | 0.15 |
| Dut\_Eng | conc | thema | v | 0.21 | theme | v | 0.35 |
| Dut\_Eng | conc | theorie | v | 0.31 | theory | a | 0.38 |
| Dut\_Eng | prop | tijlpend | a | 0.64 | beeping | a | 0.75 |
| Dut\_Eng | conc | tikje | h | 0.24 | pat | h | 0.44 |
| Dut\_Eng | prop | tinkelend | a | 0.17 | tinkling | a | 0.54 |
| Dut\_Eng | prop | tintelend | h | 0.54 | tingly | h | 0.57 |
| Dut\_Eng | conc | titel | v | 0.49 | title | v | 0.57 |
| Dut\_Eng | conc | toelating | v | 0.24 | admission | v | 0.52 |
| Dut\_Eng | conc | toename | v | 0.37 | increase | v | 0.25 |
| Dut\_Eng | conc | toestemming | a | 0.30 | permission | a | 0.42 |
| Dut\_Eng | conc | toevoeging | v | 0.39 | addition | v | 0.41 |
| Dut\_Eng | conc | tractor | v | 0.28 | tractor | v | 0.36 |
| Dut\_Eng | prop | transparant | v | 0.61 | transparent | v | 0.78 |
| Dutch | conc | trekker | v | 0.20 | trigger |  |  |
| Dut\_Eng | conc | trend | v | 0.41 | trend | v | 0.41 |
| Dut\_Eng | prop | troebel | v | 0.72 | murky | v | 0.51 |
| Dut\_Eng | conc | trots | v | 0.28 | pride | v | 0.45 |
| Dut\_Eng | conc | type | v | 0.27 | type | v | 0.15 |
| Dut\_Eng | conc | uitrusting | v | 0.44 | equipment | v | 0.37 |
| Dut\_Eng | conc | uitvinding | v | 0.07 | invention | v | 0.26 |
| Dut\_Eng | conc | uitwisseling | v | 0.22 | exchange | v | 0.33 |
| Dut\_Eng | conc | uitzicht | v | 0.66 | view | v | 0.65 |
| Dut\_Eng | conc | uur | v | 0.42 | hour | v | 0.59 |
| Dut\_Eng | prop | vaag | v | 0.30 | fuzzy | v | 0.43 |
| Dut\_Eng | conc | vacuüm | v | 0.11 | vacuum | v | 0.35 |
| Dut\_Eng | prop | vallend | v | 0.23 | falling | v | 0.46 |
| Dut\_Eng | conc | veiligheid | v | 0.32 | safety | v | 0.40 |
| Dut\_Eng | conc | vel | h | 0.36 | fell | v | 0.39 |
| Dut\_Eng | conc | venster | v | 0.66 | window | v | 0.49 |
| Dut\_Eng | conc | verbeelding | v | 0.37 | imagination | v | 0.23 |
| Dut\_Eng | conc | verf | v | 0.38 | paint | v | 0.34 |
| Dut\_Eng | conc | vergadering | a | 0.39 | meeting | v | 0.41 |
| Dut\_Eng | conc | verhoor | a | 0.43 | trial | v | 0.39 |
| Dut\_Eng | conc | verhulling | v | 0.37 | cope | v | 0.42 |
| Dut\_Eng | conc | verklaring | a | 0.29 | statement | v | 0.41 |
| Dut\_Eng | prop | verkoold | v | 0.33 | charred | v | 0.31 |
| Dut\_Eng | conc | verleden | a | 0.15 | past | a | 0.26 |
| Dut\_Eng | conc | verloving | v | 0.15 | engagement | v | 0.41 |
| Dut\_Eng | conc | vermindering | v | 0.26 | reduction | v | 0.33 |
| Dut\_Eng | prop | verouderd | v | 0.45 | wizened | v | 0.42 |
| Dut\_Eng | conc | verpleger | v | 0.30 | orderly | v | 0.50 |
| Dut\_Eng | conc | verscheidenheid | v | 0.21 | variety | v | 0.08 |
| Dut\_Eng | prop | verstild | a | 0.16 | hushed | a | 0.69 |
| Dut\_Eng | prop | vertakkend | v | 0.38 | branching | v | 0.51 |
| Dut\_Eng | conc | vertrouwen | v | 0.02 | trust | v | 0.39 |
| Dut\_Eng | conc | verzameling | v | 0.31 | collection | v | 0.41 |
| Dut\_Eng | prop | vetachtig | v | 0.28 | greasy | h | 0.27 |
| Dut\_Eng | prop | vierkant | v | 0.47 | square | v | 0.52 |
| Dut\_Eng | prop | vies | v | 0.56 | grubby | v | 0.48 |
| Dutch | conc | vijl | v | 0.13 | file |  |  |
| Dut\_Eng | conc | vilt | h | 0.40 | felt | h | 0.47 |
| Dut\_Eng | conc | vinden | v | 0.06 | find | v | 0.30 |
| Dut\_Eng | prop | vlak | v | 0.44 | flat | v | 0.44 |
| Dut\_Eng | conc | vlees | v | 0.32 | quick | v | 0.47 |
| Dut\_Eng | prop | vlekkeloos | v | 0.72 | spotless | v | 0.63 |
| Dut\_Eng | prop | vlezig | v | 0.36 | fleshy | v | 0.38 |
| Dut\_Eng | conc | vliegtuig | v | 0.14 | plane | v | 0.32 |
| Dut\_Eng | conc | vloeistof | h | 0.27 | liquid | v | 0.09 |
| Dut\_Eng | prop | vochtig | v | 0.25 | humid | h | 0.42 |
| Dut\_Eng | conc | voet | h | 0.26 | foot | v | 0.35 |
| Dut\_Eng | conc | voeten | v | 0.22 | feet | v | 0.32 |
| Dut\_Eng | conc | volume | a | 0.48 | volume | a | 0.55 |
| Dut\_Eng | prop | volumineus | v | 0.14 | bulky | v | 0.47 |
| Dut\_Eng | conc | vondst | v | 0.23 | finish | v | 0.33 |
| Dut\_Eng | conc | voorbereiding | v | 0.23 | preparation | v | 0.23 |
| Dut\_Eng | conc | voordeel | v | 0.17 | advantage | v | 0.45 |
| Dut\_Eng | conc | voornemen | a | 0.31 | intention | v | 0.46 |
| Dut\_Eng | conc | voorziening | a | 0.23 | provision | v | 0.33 |
| Dut\_Eng | conc | vorm | v | 0.46 | form | v | 0.40 |
| Dut\_Eng | conc | vraag | a | 0.33 | question | a | 0.63 |
| Dut\_Eng | prop | vreemd | v | 0.16 | strange | v | 0.10 |
| Dut\_Eng | conc | vreemdeling | v | 0.35 | stranger | v | 0.40 |
| Dut\_Eng | conc | vriend | a | 0.04 | peer | v | 0.31 |
| Dut\_Eng | conc | vrijheid | v | 0.20 | liberty | v | 0.43 |
| Dut\_Eng | conc | vrijwilliger | v | 0.21 | voluntary | v | 0.56 |
| Dut\_Eng | prop | vuil | v | 0.27 | dirty | v | 0.34 |
| Dut\_Eng | conc | waarde | v | 0.13 | value | v | 0.31 |
| Dut\_Eng | conc | wacht | v | 0.40 | hold | h | 0.52 |
| Dut\_Eng | conc | wachten | v | 0.28 | wait | v | 0.43 |
| Dut\_Eng | conc | wantrouwen | a | 0.19 | suspicion | v | 0.40 |
| Dut\_Eng | prop | warm | h | 0.39 | warm | h | 0.35 |
| Dut\_Eng | prop | wasachtig | h | 0.39 | waxy | h | 0.31 |
| Dut\_Eng | prop | wazig | v | 0.65 | hazy | v | 0.74 |
| Dut\_Eng | prop | weelderig | v | 0.65 | lush | v | 0.23 |
| Dut\_Eng | conc | weer | v | 0.29 | weather | v | 0.35 |
| Dut\_Eng | prop | weerkaatsend | v | 0.32 | reverberating | a | 0.43 |
| Dut\_Eng | conc | weerstand | v | 0.16 | resistance | v | 0.38 |
| Dut\_Eng | prop | weinig | v | 0.21 | little | v | 0.56 |
| Dut\_Eng | conc | welkom | a | 0.19 | welcome | a | 0.30 |
| Dut\_Eng | conc | welzijn | h | 0.16 | welfare | v | 0.35 |
| Dut\_Eng | conc | werk | v | 0.21 | work | v | 0.29 |
| Dut\_Eng | conc | westen | v | 0.39 | west | v | 0.61 |
| Dut\_Eng | conc | wiel | v | 0.27 | wheel | v | 0.45 |
| Dut\_Eng | prop | wild | v | 0.22 | gamy | h | 0.23 |
| Dutch | conc | wind | h | 0.19 | wind |  |  |
| Dut\_Eng | prop | wit | v | 0.80 | white | v | 0.87 |
| Dut\_Eng | prop | wollig | v | 0.38 | woolly | h | 0.47 |
| Dut\_Eng | conc | worp | v | 0.24 | throw | v | 0.47 |
| Dut\_Eng | conc | wrok | a | 0.09 | spite | a | 0.52 |
| Dut\_Eng | conc | zaad | h | 0.51 | seed | v | 0.31 |
| Dut\_Eng | prop | zacht | h | 0.24 | soft | h | 0.34 |
| Dut\_Eng | conc | zaken | v | 0.24 | business | v | 0.48 |
| Dut\_Eng | prop | zanderig | v | 0.13 | gritty | h | 0.35 |
| Dut\_Eng | prop | zangerig | a | 0.67 | lilting | v | 0.31 |
| Dut\_Eng | conc | zee | v | 0.10 | sea | v | 0.10 |
| Dut\_Eng | conc | zeep | h | 0.34 | soap | h | 0.27 |
| Dut\_Eng | prop | zeepachtig | v | 0.38 | soapy | v | 0.24 |
| Dut\_Eng | prop | zeer | h | 0.36 | sore | h | 0.48 |
| Dut\_Eng | conc | zeer | h | 0.16 | hurt | v | 0.32 |
| Dutch | conc | zenuw | h | 0.34 | nerve |  |  |
| Dut\_Eng | prop | zeurend | a | 0.27 | whining | a | 0.62 |
| Dut\_Eng | conc | zicht | v | 0.47 | sight | v | 0.80 |
| Dut\_Eng | conc | ziekte | v | 0.09 | disease | v | 0.23 |
| Dutch | conc | zijde | h | 0.45 | silk |  |  |
| Dut\_Eng | prop | zijdeachtig | h | 0.36 | silky | h | 0.53 |
| Dut\_Eng | prop | zilveren | v | 0.58 | silver | v | 0.77 |
| Dut\_Eng | prop | zoemend | a | 0.60 | buzzing | a | 0.55 |
| Dut\_Eng | prop | zonnig | v | 0.33 | sunny | v | 0.74 |
| Dut\_Eng | prop | zuchtend | a | 0.45 | moaning | a | 0.57 |
| Dut\_Eng | conc | zus | v | 0.18 | sister | a | 0.29 |
| Dut\_Eng | prop | zwaar | h | 0.14 | heavy | h | 0.37 |
| Dut\_Eng | prop | zwak | v | 0.28 | weak | v | 0.18 |
| Dut\_Eng | prop | zwart | v | 0.51 | black | v | 0.89 |
| Dut\_Eng | prop | zwoel | v | 0.25 | muggy | v | 0.34 |

**Appendix 3** R code for the analysis, with the results printed. Rendered automatically from the original script

# READ-ME  
# The 'all.csv' file, created outside of R, in Excel, compiles all individual ratings.  
# Dutch and English data are described in separate columns. All analyses separate for   
# properties and concepts, except for a translation check.   
# Stat tests (specifying treatment of English and Dutch norms): reliability analysis  
# (only Dutch norms), Pearson’s correlation (norms independent and paired), one-sample   
# t-test (norms independent), Principal Components Analysis (norms independent), ANOVA   
# (norms paired), and multiple regression (norms independent).  
# The code is extensively annotated, but some clarifications are in order. Subsetting is  
# done throughout the code, and is essential due to the different norms (see 'normed'  
# column: English, Dutch, or both). Subsetting is often done on the basis of variables  
# that are unique to either norms, especially, 'Exclusivity' and 'exc\_eng'.  
# At first, the code must be run right from the top, as different objects bear the   
# same name. In its entirety, it takes ~20 mins. Note the annotations for theoretical   
# matters. Long variables are never presented entirely, but rather in sections or via  
# summaries. Yet, the reader is invited to edit and present them entirely.  
# Written on R version 3.2.2 (2015-08-14). This script markdown presents each code chunk # followed by the results.   
  
  
# INDEX  
# Libraries: please ensure every library loads, and otherwise install it via   
# install.packages("")  
# Preprocessing  
# Translation-dependent results  
# Critical results  
# Modality  
# Sound-symbolism  
  
  
# \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ --- START --- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
# Set your working directory here, to yield figures output:  
# setwd('C:/.../.../...')   
  
**install.packages**("gdata")

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'gdata' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**("GPArotation")

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'GPArotation' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**("psych")

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'psych' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**("ggplot2")

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'ggplot2' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**("car")

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'car' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**("Rmisc")

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'Rmisc' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**("corpcor")

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'corpcor' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('contrast')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'contrast' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('doBy')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'doBy' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('ltm')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'ltm' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('MASS')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'MASS' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('QuantPsyc')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'QuantPsyc' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('qpcR')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'qpcR' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('corpcor')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'corpcor' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('lattice')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'lattice' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('car')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'car' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('pastecs')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'pastecs' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('scales')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'scales' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('reshape')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'reshape' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('arules')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'arules' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('plyr')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'plyr' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('RColorBrewer')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'RColorBrewer' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('dplyr')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'dplyr' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('gdata')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'gdata' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('gtools')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'gtools' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('Hmisc')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'Hmisc' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**install.packages**('png')

## Installing package into 'C:/Users/Pablo/Documents/R/win-library/3.3'  
## (as 'lib' is unspecified)

## package 'png' successfully unpacked and MD5 sums checked  
##   
## The downloaded binary packages are in  
## C:\Users\Pablo\AppData\Local\Temp\Rtmp4so1up\downloaded\_packages

**library**(ltm)

## Loading required package: MASS

## Loading required package: msm

## Loading required package: polycor

## Loading required package: mvtnorm

## Loading required package: sfsmisc

**library**(lattice)  
**library**(psych)

##   
## Attaching package: 'psych'

## The following object is masked from 'package:ltm':  
##   
## factor.scores

## The following object is masked from 'package:polycor':  
##   
## polyserial

**library**(car)

##   
## Attaching package: 'car'

## The following object is masked from 'package:psych':  
##   
## logit

**library**(doBy)  
**library**(contrast)

## Loading required package: rms

## Loading required package: Hmisc

## Loading required package: survival

## Loading required package: Formula

## Loading required package: ggplot2

##   
## Attaching package: 'ggplot2'

## The following objects are masked from 'package:psych':  
##   
## %+%, alpha

##   
## Attaching package: 'Hmisc'

## The following object is masked from 'package:psych':  
##   
## describe

## The following object is masked from 'package:sfsmisc':  
##   
## errbar

## The following objects are masked from 'package:base':  
##   
## format.pval, round.POSIXt, trunc.POSIXt, units

## Loading required package: SparseM

##   
## Attaching package: 'SparseM'

## The following object is masked from 'package:base':  
##   
## backsolve

##   
## Attaching package: 'rms'

## The following object is masked from 'package:car':  
##   
## vif

**library**(pastecs)

## Loading required package: boot

##   
## Attaching package: 'boot'

## The following object is masked from 'package:survival':  
##   
## aml

## The following object is masked from 'package:car':  
##   
## logit

## The following object is masked from 'package:psych':  
##   
## logit

## The following object is masked from 'package:lattice':  
##   
## melanoma

## The following object is masked from 'package:msm':  
##   
## cav

##   
## Attaching package: 'pastecs'

## The following object is masked from 'package:rms':  
##   
## specs

## The following object is masked from 'package:sfsmisc':  
##   
## last

**library**(scales)

##   
## Attaching package: 'scales'

## The following objects are masked from 'package:psych':  
##   
## alpha, rescale

**library**(ggplot2)  
**library**(psych)  
**library**(reshape)  
**library**(arules)

## Loading required package: Matrix

##   
## Attaching package: 'Matrix'

## The following object is masked from 'package:reshape':  
##   
## expand

##   
## Attaching package: 'arules'

## The following object is masked from 'package:car':  
##   
## recode

## The following objects are masked from 'package:base':  
##   
## abbreviate, write

**library**(plyr)

##   
## Attaching package: 'plyr'

## The following objects are masked from 'package:reshape':  
##   
## rename, round\_any

## The following objects are masked from 'package:Hmisc':  
##   
## is.discrete, summarize

**library**(RColorBrewer)  
**library**(Rmisc)  
**library**(corpcor)  
**library**(GPArotation)  
**library**(gdata)

## gdata: Unable to locate valid perl interpreter  
## gdata:   
## gdata: read.xls() will be unable to read Excel XLS and XLSX files  
## gdata: unless the 'perl=' argument is used to specify the location  
## gdata: of a valid perl intrpreter.  
## gdata:   
## gdata: (To avoid display of this message in the future, please  
## gdata: ensure perl is installed and available on the executable  
## gdata: search path.)

## gdata: Unable to load perl libaries needed by read.xls()  
## gdata: to support 'XLX' (Excel 97-2004) files.

##

## gdata: Unable to load perl libaries needed by read.xls()  
## gdata: to support 'XLSX' (Excel 2007+) files.

##

## gdata: Run the function 'installXLSXsupport()'  
## gdata: to automatically download and install the perl  
## gdata: libaries needed to support Excel XLS and XLSX formats.

##   
## Attaching package: 'gdata'

## The following objects are masked from 'package:pastecs':  
##   
## first, last

## The following object is masked from 'package:Hmisc':  
##   
## combine

## The following object is masked from 'package:sfsmisc':  
##   
## last

## The following object is masked from 'package:stats':  
##   
## nobs

## The following object is masked from 'package:utils':  
##   
## object.size

## The following object is masked from 'package:base':  
##   
## startsWith

**library**(QuantPsyc)

##   
## Attaching package: 'QuantPsyc'

## The following object is masked from 'package:Matrix':  
##   
## norm

## The following object is masked from 'package:SparseM':  
##   
## norm

## The following object is masked from 'package:base':  
##   
## norm

**library**(MASS)  
**library**(qpcR)

## Loading required package: minpack.lm

## Loading required package: rgl

## Loading required package: robustbase

##   
## Attaching package: 'robustbase'

## The following object is masked from 'package:boot':  
##   
## salinity

## The following object is masked from 'package:survival':  
##   
## heart

## The following object is masked from 'package:psych':  
##   
## cushny

**library**(dplyr)

##   
## Attaching package: 'dplyr'

## The following objects are masked from 'package:gdata':  
##   
## combine, first, last

## The following objects are masked from 'package:plyr':  
##   
## arrange, count, desc, failwith, id, mutate, rename, summarise,  
## summarize

## The following objects are masked from 'package:arules':  
##   
## intersect, recode, setdiff, setequal, union

## The following object is masked from 'package:reshape':  
##   
## rename

## The following objects are masked from 'package:pastecs':  
##   
## first, last

## The following objects are masked from 'package:Hmisc':  
##   
## combine, src, summarize

## The following object is masked from 'package:car':  
##   
## recode

## The following object is masked from 'package:sfsmisc':  
##   
## last

## The following object is masked from 'package:MASS':  
##   
## select

## The following objects are masked from 'package:stats':  
##   
## filter, lag

## The following objects are masked from 'package:base':  
##   
## intersect, setdiff, setequal, union

**library**(gtools)

##   
## Attaching package: 'gtools'

## The following objects are masked from 'package:boot':  
##   
## inv.logit, logit

## The following object is masked from 'package:car':  
##   
## logit

## The following object is masked from 'package:psych':  
##   
## logit

**library**(Hmisc)  
**library**(png)  
  
  
*# Calculate average percentange of unresponded items, i.e., unknown. Since there are*   
*# three ratings per word, and indeed the three were left blank whereever participants*  
*# ignored some word, the calculation includes a division by 3 (besides overall mean,*  
*# see specific percentage per file).*  
  
file1 <- **read.csv**('file1\_gral.csv')  
file2 <- **read.csv**('file2\_gral.csv')  
file3 <- **read.csv**('file3\_gral.csv')  
file4 <- **read.csv**('file4\_gral.csv')  
file5 <- **read.csv**('file5\_gral.csv')  
file6 <- **read.csv**('file6\_gral.csv')  
  
(((100 \* (**sum**(**is.na**(file1)))) / (**sum**(!**is.na**(file1[,-1])) + **sum**(**is.na**(file1))) /3) +  
*# 0.29*  
  
((100 \* (**sum**(**is.na**(file2)))) / (**sum**(!**is.na**(file2[,-1])) + **sum**(**is.na**(file2))) /3) +  
*# 1.42*  
  
((100 \* (**sum**(**is.na**(file3)))) / (**sum**(!**is.na**(file3[,-1])) + **sum**(**is.na**(file3))) /3) +  
*# 0.41*  
  
*# N.B. First participant is ignored because she completed only the first half of the*   
*# survey.*  
((100 \* (**sum**(**is.na**(file4[,-**c**(1:4)])))) / (**sum**(!**is.na**(file4[,-**c**(1:4)])) +   
**sum**(**is.na**(file4[,-**c**(1:4)]))) /3) +  
*# 2.85*  
  
((100 \* (**sum**(**is.na**(file5)))) / (**sum**(!**is.na**(file5[,-1])) + **sum**(**is.na**(file5))) /3) +  
*# 1.38*  
  
((100 \* (**sum**(**is.na**(file6)))) / (**sum**(!**is.na**(file6[,-1])) + **sum**(**is.na**(file6))) /3)) /6

## [1] 1.308878

*# 1.50*  
*# /6 = 1.31% = average unknown*  
*#\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  
  
*# Preprocessing:*  
*# There were 9 files with different items (mostly unrepeated) for concepts and*   
*# 10 files for properties. They were completed in different proportions, with an*  
*# average of eight participants per file.*   
  
*# RELIABILITY ANALYSIS: In putting together the ratings from each respondent, this*   
*# analysis allows to calculate the fit among those. In other words, is the mean*   
*# realistic or forced? Two measures are provided. First, interitem consistency*   
*# provides the fit among items independently of raters. Second, interrater*   
*# reliability measures the fit among raters, independently of items. A standard*   
*# minimum for both is alpha = .70.*  
  
*# Concepts*  
all <- **read.csv**('all.csv')  
concs <- all[all$cat == 'conc',]  
  
*# There were*   
a\_concs<-concs[, **c**('a1', 'a2', 'a3', 'a4', 'a5', 'a6', 'a7', 'a8', 'a9')]   
psych::**alpha**(a\_concs)

##   
## Reliability analysis   
## Call: psych::alpha(x = a\_concs)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd  
## 0.74 0.74 0.75 0.24 2.9 0.019 2 1  
##   
## lower alpha upper 95% confidence boundaries  
## 0.7 0.74 0.78   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se  
## a1 0.72 0.72 0.73 0.24 2.5 0.021  
## a2 0.73 0.73 0.74 0.25 2.7 0.020  
## a3 0.73 0.73 0.74 0.26 2.7 0.020  
## a4 0.71 0.71 0.71 0.24 2.5 0.021  
## a5 0.71 0.71 0.72 0.24 2.5 0.021  
## a6 0.73 0.74 0.75 0.26 2.8 0.020  
## a7 0.70 0.70 0.71 0.23 2.4 0.022  
## a8 0.71 0.72 0.71 0.24 2.5 0.021  
## a9 0.70 0.70 0.71 0.23 2.4 0.022  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## a1 398 0.59 0.57 0.49 0.42 2.9 1.9  
## a2 408 0.51 0.52 0.41 0.35 2.0 1.6  
## a3 410 0.54 0.50 0.40 0.33 1.9 1.9  
## a4 409 0.61 0.60 0.54 0.45 2.4 1.6  
## a5 409 0.60 0.60 0.54 0.44 1.3 1.9  
## a6 407 0.47 0.48 0.36 0.31 2.2 1.9  
## a7 410 0.65 0.65 0.60 0.51 1.9 1.9  
## a8 269 0.56 0.59 0.54 0.43 1.4 1.6  
## a9 263 0.64 0.64 0.59 0.51 1.5 1.8

h\_concs<-concs[, **c**('h1', 'h2', 'h3', 'h4', 'h5', 'h6', 'h7', 'h8', 'h9')]  
psych::**alpha**(h\_concs)

##   
## Reliability analysis   
## Call: psych::alpha(x = h\_concs)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd  
## 0.72 0.72 0.74 0.22 2.6 0.02 2 1  
##   
## lower alpha upper 95% confidence boundaries  
## 0.68 0.72 0.76   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se  
## h1 0.70 0.70 0.72 0.23 2.3 0.022  
## h2 0.72 0.72 0.72 0.24 2.5 0.021  
## h3 0.71 0.70 0.71 0.23 2.4 0.021  
## h4 0.71 0.72 0.72 0.24 2.5 0.021  
## h5 0.68 0.68 0.70 0.21 2.1 0.024  
## h6 0.70 0.70 0.71 0.23 2.3 0.022  
## h7 0.67 0.67 0.68 0.20 2.0 0.025  
## h8 0.69 0.69 0.71 0.22 2.2 0.023  
## h9 0.69 0.69 0.69 0.22 2.2 0.022  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## h1 397 0.56 0.54 0.44 0.38 3.4 1.9  
## h2 408 0.43 0.46 0.36 0.27 1.8 1.7  
## h3 410 0.59 0.52 0.44 0.36 2.4 2.2  
## h4 409 0.46 0.46 0.36 0.30 2.5 1.6  
## h5 409 0.62 0.63 0.56 0.48 1.2 1.9  
## h6 407 0.53 0.54 0.45 0.38 1.8 1.7  
## h7 410 0.69 0.68 0.65 0.54 1.5 1.9  
## h8 269 0.61 0.60 0.52 0.44 1.7 1.7  
## h9 263 0.57 0.58 0.53 0.41 1.1 1.6

v\_concs<-concs[, **c**('v1', 'v2', 'v3', 'v4', 'v5', 'v6', 'v7', 'v8', 'v9')]   
psych::**alpha**(v\_concs)

##   
## Reliability analysis   
## Call: psych::alpha(x = v\_concs)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd  
## 0.7 0.7 0.72 0.21 2.4 0.022 3.1 0.95  
##   
## lower alpha upper 95% confidence boundaries  
## 0.66 0.7 0.75   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se  
## v1 0.69 0.70 0.71 0.22 2.3 0.023  
## v2 0.70 0.70 0.70 0.23 2.4 0.022  
## v3 0.66 0.66 0.67 0.19 1.9 0.025  
## v4 0.68 0.67 0.68 0.21 2.1 0.024  
## v5 0.67 0.67 0.69 0.20 2.0 0.024  
## v6 0.70 0.70 0.71 0.22 2.3 0.022  
## v7 0.66 0.65 0.65 0.19 1.9 0.025  
## v8 0.69 0.69 0.70 0.22 2.2 0.023  
## v9 0.65 0.65 0.66 0.19 1.8 0.026  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## v1 398 0.45 0.46 0.34 0.28 4.1 1.4  
## v2 408 0.40 0.43 0.32 0.25 2.5 1.6  
## v3 409 0.63 0.62 0.57 0.47 3.3 1.9  
## v4 409 0.55 0.56 0.49 0.39 3.2 1.5  
## v5 409 0.64 0.58 0.49 0.42 2.4 2.2  
## v6 407 0.47 0.45 0.32 0.27 3.6 1.7  
## v7 410 0.64 0.64 0.62 0.49 3.1 1.7  
## v8 269 0.47 0.48 0.38 0.31 2.5 1.7  
## v9 263 0.64 0.66 0.62 0.53 3.3 1.6

*# RESULTS good. Lower than L&C, but they had more participants.*  
*# Interitem consistency*  
*# a: .74*  
*# h: .72*  
*# v: .70*  
  
*# Interrater reliability*  
*# a: .75*  
*# h: .74*  
*# v: .72*  
  
  
*# Properties*  
props <- all[all$cat == 'prop',]  
  
a\_props<-props[, **c**('a1', 'a2', 'a3', 'a4', 'a5', 'a6', 'a7', 'a8', 'a9', 'a10')]  
psych::**alpha**(a\_props)

## Warning in psych::alpha(a\_props): Some items were negatively correlated  
## with the total scale and probably should be reversed. To do this, run the  
## function again with the 'check.keys=TRUE' option

## Some items ( a10 ) were negatively correlated with the total scale and probably should be reversed. To do this, run the function again with the 'check.keys=TRUE' option

##   
## Reliability analysis   
## Call: psych::alpha(x = a\_props)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd  
## 0.78 0.78 0.89 0.27 3.6 0.016 1.7 1.3  
##   
## lower alpha upper 95% confidence boundaries  
## 0.75 0.78 0.81   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se  
## a1 0.71 0.72 0.83 0.22 2.6 0.022  
## a2 0.74 0.75 0.87 0.25 2.9 0.019  
## a3 0.77 0.78 0.87 0.28 3.5 0.017  
## a4 0.72 0.73 0.85 0.23 2.6 0.021  
## a5 0.79 0.79 0.87 0.30 3.8 0.015  
## a6 0.72 0.72 0.85 0.22 2.6 0.021  
## a7 0.73 0.74 0.86 0.24 2.8 0.020  
## a8 0.73 0.73 0.86 0.23 2.7 0.020  
## a9 0.80 0.81 0.90 0.33 4.4 0.016  
## a10 0.85 0.84 0.90 0.37 5.4 0.011  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## a1 256 0.863 0.840 0.86 0.805 1.32 2.0  
## a2 305 0.755 0.713 0.67 0.638 1.61 1.7  
## a3 319 0.490 0.501 0.45 0.345 2.51 1.9  
## a4 320 0.844 0.829 0.83 0.760 1.35 1.9  
## a5 321 0.440 0.399 0.35 0.220 2.20 2.1  
## a6 214 0.882 0.855 0.86 0.800 1.36 1.7  
## a7 213 0.808 0.771 0.76 0.669 1.42 2.0  
## a8 217 0.824 0.803 0.79 0.727 2.00 1.7  
## a9 109 0.225 0.205 0.10 0.035 0.91 1.1  
## a10 109 -0.028 -0.087 -0.19 -0.258 2.23 2.1  
##   
## Non missing response frequency for each item  
## 0 0.5 1 2 3 4 5 miss  
## a1 0.64 0 0.05 0.04 0.05 0.05 0.16 0.25  
## a2 0.42 0 0.07 0.21 0.15 0.07 0.08 0.11  
## a3 0.25 0 0.08 0.15 0.14 0.18 0.20 0.07  
## a4 0.54 0 0.12 0.09 0.06 0.03 0.15 0.07  
## a5 0.43 0 0.02 0.08 0.12 0.11 0.25 0.06  
## a6 0.49 0 0.17 0.08 0.10 0.08 0.08 0.38  
## a7 0.64 0 0.03 0.02 0.07 0.06 0.18 0.38  
## a8 0.14 0 0.45 0.09 0.08 0.08 0.16 0.37  
## a9 0.53 0 0.14 0.25 0.06 0.01 0.01 0.68  
## a10 0.42 0 0.04 0.03 0.13 0.17 0.21 0.68

h\_props<-props[, **c**('h1', 'h2', 'h3', 'h4', 'h5', 'h6', 'h7', 'h8', 'h9', 'h10')]  
psych::**alpha**(h\_props)

## Warning in psych::alpha(h\_props): Some items were negatively correlated  
## with the total scale and probably should be reversed. To do this, run the  
## function again with the 'check.keys=TRUE' option

## Some items ( h10 ) were negatively correlated with the total scale and probably should be reversed. To do this, run the function again with the 'check.keys=TRUE' option

##   
## Reliability analysis   
## Call: psych::alpha(x = h\_props)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd  
## 0.7 0.72 0.83 0.2 2.5 0.022 2 1.1  
##   
## lower alpha upper 95% confidence boundaries  
## 0.65 0.7 0.74   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se  
## h1 0.60 0.65 0.76 0.17 1.8 0.029  
## h2 0.64 0.67 0.80 0.19 2.0 0.026  
## h3 0.70 0.72 0.82 0.22 2.6 0.022  
## h4 0.66 0.68 0.80 0.19 2.2 0.025  
## h5 0.69 0.71 0.81 0.21 2.5 0.023  
## h6 0.61 0.63 0.77 0.16 1.7 0.029  
## h7 0.60 0.64 0.79 0.16 1.8 0.031  
## h8 0.63 0.65 0.78 0.17 1.9 0.027  
## h9 0.70 0.73 0.83 0.23 2.7 0.022  
## h10 0.81 0.81 0.87 0.32 4.2 0.014  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## h1 256 0.82 0.77 0.79 0.69 2.28 2.0  
## h2 306 0.67 0.65 0.62 0.54 1.62 1.7  
## h3 319 0.36 0.38 0.30 0.21 2.63 1.6  
## h4 320 0.61 0.60 0.54 0.44 1.48 1.9  
## h5 321 0.50 0.45 0.40 0.27 2.10 2.1  
## h6 214 0.79 0.82 0.83 0.73 1.78 1.7  
## h7 213 0.82 0.80 0.80 0.71 2.21 2.1  
## h8 217 0.71 0.75 0.75 0.62 2.54 1.6  
## h9 109 0.37 0.32 0.22 0.13 0.96 1.0  
## h10 109 -0.15 -0.24 -0.39 -0.40 1.72 2.2  
##   
## Non missing response frequency for each item  
## 0 1 1.5 2 3 3.5 4 5 miss  
## h1 0.36 0.05 0 0.09 0.19 0 0.11 0.21 0.25  
## h2 0.42 0.09 0 0.16 0.16 0 0.11 0.06 0.11  
## h3 0.15 0.11 0 0.20 0.21 0 0.18 0.16 0.07  
## h4 0.52 0.09 0 0.09 0.10 0 0.05 0.14 0.07  
## h5 0.41 0.05 0 0.11 0.11 0 0.08 0.23 0.06  
## h6 0.38 0.08 0 0.12 0.27 0 0.08 0.07 0.38  
## h7 0.43 0.03 0 0.05 0.12 0 0.17 0.21 0.38  
## h8 0.08 0.29 0 0.11 0.17 0 0.20 0.15 0.37  
## h9 0.36 0.45 0 0.10 0.07 0 0.00 0.02 0.68  
## h10 0.61 0.00 0 0.00 0.06 0 0.09 0.24 0.68

v\_props<-props[, **c**('v1', 'v2', 'v3', 'v4', 'v5', 'v6', 'v7', 'v8', 'v9', 'v10')]  
psych::**alpha**(v\_props)

##   
## Reliability analysis   
## Call: psych::alpha(x = v\_props)  
##   
## raw\_alpha std.alpha G6(smc) average\_r S/N ase mean sd  
## 0.85 0.85 0.87 0.36 5.5 0.012 3.2 1.2  
##   
## lower alpha upper 95% confidence boundaries  
## 0.82 0.85 0.87   
##   
## Reliability if an item is dropped:  
## raw\_alpha std.alpha G6(smc) average\_r S/N alpha se  
## v1 0.83 0.83 0.86 0.34 4.7 0.013  
## v2 0.84 0.83 0.86 0.36 5.0 0.013  
## v3 0.84 0.84 0.87 0.37 5.2 0.013  
## v4 0.82 0.82 0.85 0.34 4.5 0.014  
## v5 0.85 0.85 0.87 0.38 5.5 0.012  
## v6 0.81 0.81 0.84 0.32 4.3 0.015  
## v7 0.82 0.82 0.85 0.33 4.4 0.015  
## v8 0.82 0.82 0.84 0.33 4.5 0.014  
## v9 0.86 0.87 0.89 0.42 6.4 0.011  
## v10 0.84 0.84 0.85 0.37 5.3 0.012  
##   
## Item statistics   
## n raw.r std.r r.cor r.drop mean sd  
## v1 256 0.82 0.71 0.67 0.61 3.6 1.7  
## v2 305 0.72 0.63 0.59 0.52 2.9 1.5  
## v3 319 0.59 0.59 0.52 0.47 3.5 1.4  
## v4 320 0.76 0.76 0.73 0.68 3.1 1.9  
## v5 321 0.53 0.52 0.43 0.39 3.1 1.7  
## v6 214 0.83 0.84 0.84 0.78 3.1 1.5  
## v7 213 0.80 0.79 0.77 0.72 3.6 1.8  
## v8 217 0.73 0.78 0.78 0.72 3.7 1.4  
## v9 109 0.30 0.31 0.18 0.16 0.9 1.3  
## v10 109 0.67 0.57 0.54 0.45 3.8 1.9  
##   
## Non missing response frequency for each item  
## 0 1 2 3 3.5 4 4.333333333 4.5 5 miss  
## v1 0.14 0.02 0.05 0.15 0 0.20 0 0 0.44 0.25  
## v2 0.09 0.08 0.22 0.22 0 0.27 0 0 0.13 0.11  
## v3 0.04 0.06 0.15 0.17 0 0.24 0 0 0.34 0.07  
## v4 0.18 0.05 0.11 0.18 0 0.11 0 0 0.36 0.07  
## v5 0.12 0.06 0.14 0.20 0 0.17 0 0 0.30 0.06  
## v6 0.05 0.14 0.10 0.29 0 0.21 0 0 0.22 0.38  
## v7 0.15 0.02 0.04 0.14 0 0.15 0 0 0.50 0.38  
## v8 0.00 0.12 0.07 0.12 0 0.35 0 0 0.33 0.37  
## v9 0.58 0.17 0.07 0.15 0 0.00 0 0 0.03 0.68  
## v10 0.17 0.01 0.02 0.06 0 0.14 0 0 0.61 0.68

*# RESULTS: good. Lower than L&C, but they did have a few more participants.*  
*# Interitem consistency*  
*# a: .78*  
*# h: .70*  
*# v: .85*  
  
*# Interrater reliability*  
*# a: .89*  
*# h: .83*  
*# v: .87*  
*# \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  
  
  
*# TRANSLATION-DEPENDENT RESULTS*  
  
*# Read in the general norms file, 'all' (all seemed right, seeing as we have Dutch*   
*# and English properties and concepts)*  
  
all <- **read.csv**('all.csv')  
  
*# PROPERTIES*  
props <- all[all$cat=='prop',]  
**nrow**(props) *# 366 Dutch + a few from Lynott&Connell for comparisons*

## [1] 343

*# CONCEPTS*   
concs <- all[all$cat=='conc',]  
**nrow**(concs) *# 411 Dutch + a few from Lynott&Connell for comparison*

## [1] 416

*# Correlations*  
  
*# PROPERTIES*  
*# Modalities*  
**rcor.test**(props[, **c**('Auditory', 'Aud\_eng')], use = 'complete.obs')

##   
## Auditory Aud\_eng  
## Auditory \*\*\*\*\* 0.795   
## Aud\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

**rcor.test**(props[, **c**('Haptic', 'Hap\_eng')], use = 'complete.obs')

##   
## Haptic Hap\_eng  
## Haptic \*\*\*\*\* 0.690   
## Hap\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

**rcor.test**(props[, **c**('Visual', 'Vis\_eng')], use = 'complete.obs')

##   
## Visual Vis\_eng  
## Visual \*\*\*\*\* 0.711   
## Vis\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

*# Significant, large correlations ranging from .69 to .80*  
  
*# Exclusivity*   
**rcor.test**(props[, **c**('Exclusivity', 'exc\_eng')], use = 'complete.obs')

##   
## Exclusivity exc\_eng  
## Exclusivity \*\*\*\*\* 0.475   
## exc\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

*# Medium-sized corr Eng-Dutch*  
  
  
*# CONCEPTS*  
*# Modalities*  
**rcor.test**(concs[, **c**('Auditory', 'Aud\_eng')], use = 'complete.obs')

##   
## Auditory Aud\_eng  
## Auditory \*\*\*\*\* 0.683   
## Aud\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

**rcor.test**(concs[, **c**('Haptic', 'Hap\_eng')], use = 'complete.obs')

##   
## Haptic Hap\_eng  
## Haptic \*\*\*\*\* 0.624   
## Hap\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

**rcor.test**(concs[, **c**('Visual', 'Vis\_eng')], use = 'complete.obs')

##   
## Visual Vis\_eng  
## Visual \*\*\*\*\* 0.659   
## Vis\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

*# Significant, large correlations ranging from .63 to .69*  
  
*# Exclusivity*   
**rcor.test**(concs[, **c**('Exclusivity', 'exc\_eng')], use = 'complete.obs')

##   
## Exclusivity exc\_eng  
## Exclusivity \*\*\*\*\* 0.428   
## exc\_eng <0.001 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

*# Medium-sized corr Eng-Dutch*  
  
  
*# Descriptives: M, SD, SE...*  
*# English*  
psych::**describe**(props$Aud\_eng)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 343 1.73 1.67 1.05 1.54 1.2 0 5 5 0.86 -0.77 0.09

psych::**describe**(props$Hap\_eng)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 343 2.41 1.62 2.52 2.41 2.26 0 4.95 4.95 -0.07 -1.48  
## se  
## X1 0.09

psych::**describe**(props$Vis\_eng)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 343 3.8 1.06 4.17 3.94 0.81 0.52 5 4.48 -1.07 0.16  
## se  
## X1 0.06

psych::**describe**(concs$Aud\_eng)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 392 2.16 1.09 2.06 2.12 1.13 0 5 5 0.34 -0.49 0.06

psych::**describe**(concs$Hap\_eng)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 392 1.86 1.13 1.65 1.78 1.16 0 4.76 4.76 0.57 -0.63  
## se  
## X1 0.06

psych::**describe**(concs$Vis\_eng)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 392 3.55 0.8 3.65 3.61 0.87 0.76 5 4.24 -0.6 0.01 0.04

**stat.desc**(props$Aud\_eng)

## nbr.val nbr.null nbr.na min max   
## 343.0000000 7.0000000 0.0000000 0.0000000 5.0000000   
## range sum median mean SE.mean   
## 5.0000000 592.3040000 1.0480000 1.7268338 0.0900376   
## CI.mean.0.95 var std.dev coef.var   
## 0.1770972 2.7806219 1.6675197 0.9656515

**stat.desc**(props$Hap\_eng)

## nbr.val nbr.null nbr.na min max   
## 343.00000000 2.00000000 0.00000000 0.00000000 4.95200000   
## range sum median mean SE.mean   
## 4.95200000 828.33800000 2.52400000 2.41497959 0.08728861   
## CI.mean.0.95 var std.dev coef.var   
## 0.17169012 2.61342058 1.61660774 0.66940845

**stat.desc**(props$Vis\_eng)

## nbr.val nbr.null nbr.na min max   
## 3.430000e+02 0.000000e+00 0.000000e+00 5.240000e-01 5.000000e+00   
## range sum median mean SE.mean   
## 4.476000e+00 1.301717e+03 4.167000e+00 3.795093e+00 5.737112e-02   
## CI.mean.0.95 var std.dev coef.var   
## 1.128447e-01 1.128966e+00 1.062528e+00 2.799741e-01

**stat.desc**(concs$Aud\_eng)

## nbr.val nbr.null nbr.na min max   
## 392.00000000 1.00000000 24.00000000 0.00000000 5.00000000   
## range sum median mean SE.mean   
## 5.00000000 848.38600000 2.05900000 2.16425000 0.05501011   
## CI.mean.0.95 var std.dev coef.var   
## 0.10815262 1.18623618 1.08914470 0.50324348

**stat.desc**(concs$Hap\_eng)

## nbr.val nbr.null nbr.na min max   
## 392.0000000 1.0000000 24.0000000 0.0000000 4.7650000   
## range sum median mean SE.mean   
## 4.7650000 730.5720000 1.6470000 1.8637041 0.0569453   
## CI.mean.0.95 var std.dev coef.var   
## 0.1119573 1.2711649 1.1274595 0.6049563

**stat.desc**(concs$Vis\_eng)

## nbr.val nbr.null nbr.na min max   
## 3.920000e+02 0.000000e+00 2.400000e+01 7.650000e-01 5.000000e+00   
## range sum median mean SE.mean   
## 4.235000e+00 1.393415e+03 3.647000e+00 3.554630e+00 4.053360e-02   
## CI.mean.0.95 var std.dev coef.var   
## 7.969106e-02 6.440452e-01 8.025243e-01 2.257687e-01

*# Dutch*  
psych::**describe**(props$Auditory)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 336 1.74 1.29 1.33 1.55 0.96 0 5 5 1.14 0.26 0.07

psych::**describe**(props$Haptic)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 336 1.96 1.12 1.75 1.88 1.11 0 4.75 4.75 0.54 -0.58  
## se  
## X1 0.06

psych::**describe**(props$Visual)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 336 3.22 1.15 3.4 3.31 1.26 0.5 5 4.5 -0.53 -0.68  
## se  
## X1 0.06

psych::**describe**(concs$Auditory)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 411 1.97 1.03 1.86 1.9 1.04 0 4.89 4.89 0.59 0.16  
## se  
## X1 0.05

psych::**describe**(concs$Haptic)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 411 1.96 1.04 1.78 1.87 0.99 0 4.78 4.78 0.7 -0.25  
## se  
## X1 0.05

psych::**describe**(concs$Visual)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 411 3.13 0.95 3.22 3.16 0.99 0.33 5 4.67 -0.3 -0.49  
## se  
## X1 0.05

**stat.desc**(props$Auditory)

## nbr.val nbr.null nbr.na min max   
## 336.00000000 3.00000000 7.00000000 0.00000000 5.00000000   
## range sum median mean SE.mean   
## 5.00000000 584.54500000 1.33300000 1.73971726 0.07061977   
## CI.mean.0.95 var std.dev coef.var   
## 0.13891408 1.67568307 1.29448178 0.74407595

**stat.desc**(props$Haptic)

## nbr.val nbr.null nbr.na min max   
## 336.00000000 1.00000000 7.00000000 0.00000000 4.75000000   
## range sum median mean SE.mean   
## 4.75000000 657.73300000 1.75000000 1.95753869 0.06113725   
## CI.mean.0.95 var std.dev coef.var   
## 0.12026128 1.25588834 1.12066424 0.57248638

**stat.desc**(props$Visual)

## nbr.val nbr.null nbr.na min max   
## 3.360000e+02 0.000000e+00 7.000000e+00 5.000000e-01 5.000000e+00   
## range sum median mean SE.mean   
## 4.500000e+00 1.083009e+03 3.400000e+00 3.223241e+00 6.296073e-02   
## CI.mean.0.95 var std.dev coef.var   
## 1.238482e-01 1.331922e+00 1.154089e+00 3.580524e-01

**stat.desc**(concs$Auditory)

## nbr.val nbr.null nbr.na min max   
## 411.00000000 1.00000000 5.00000000 0.00000000 4.88900000   
## range sum median mean SE.mean   
## 4.88900000 808.11100000 1.85700000 1.96620681 0.05082869   
## CI.mean.0.95 var std.dev coef.var   
## 0.09991736 1.06184159 1.03045698 0.52408372

**stat.desc**(concs$Haptic)

## nbr.val nbr.null nbr.na min max   
## 411.00000000 2.00000000 5.00000000 0.00000000 4.77800000   
## range sum median mean SE.mean   
## 4.77800000 807.03000000 1.77800000 1.96357664 0.05141212   
## CI.mean.0.95 var std.dev coef.var   
## 0.10106424 1.08635771 1.04228485 0.53080935

**stat.desc**(concs$Visual)

## nbr.val nbr.null nbr.na min max   
## 4.110000e+02 0.000000e+00 5.000000e+00 3.330000e-01 5.000000e+00   
## range sum median mean SE.mean   
## 4.667000e+00 1.285371e+03 3.222000e+00 3.127423e+00 4.695101e-02   
## CI.mean.0.95 var std.dev coef.var   
## 9.229475e-02 9.060075e-01 9.518442e-01 3.043541e-01

*# Sample sizes for English and Dutch*  
**nrow**(props[!**is.na**(props$exc\_eng),]) *# total items w/ English norms = 343*

## [1] 343

**nrow**(props[props$main\_eng=='a' & !**is.na**(props$exc\_eng),])

## [1] 68

**nrow**(props[props$main\_eng=='h' & !**is.na**(props$exc\_eng),])

## [1] 70

**nrow**(props[props$main\_eng=='v' & !**is.na**(props$exc\_eng),])

## [1] 205

**nrow**(props[!**is.na**(concs$exc\_eng),]) *# total items w/ English norms = 392*

## [1] 392

**nrow**(props[concs$main\_eng=='a' & !**is.na**(concs$exc\_eng),])

## [1] 42

**nrow**(props[concs$main\_eng=='h' & !**is.na**(concs$exc\_eng),])

## [1] 14

**nrow**(props[concs$main\_eng=='v' & !**is.na**(concs$exc\_eng),])

## [1] 336

**nrow**(props[!**is.na**(props$Exclusivity),]) *# total props w/ Dutch norms = 336*

## [1] 336

**nrow**(props[props$main=='a' & !**is.na**(props$Exclusivity),])

## [1] 64

**nrow**(props[props$main=='h' & !**is.na**(props$Exclusivity),])

## [1] 45

**nrow**(props[props$main=='v' & !**is.na**(props$Exclusivity),])

## [1] 227

**nrow**(props[!**is.na**(concs$Exclusivity),]) *# total props w/ Dutch norms = 411*

## [1] 411

**nrow**(props[concs$main=='a' & !**is.na**(concs$Exclusivity),])

## [1] 48

**nrow**(props[concs$main=='h' & !**is.na**(concs$Exclusivity),])

## [1] 45

**nrow**(props[concs$main=='v' & !**is.na**(concs$Exclusivity),])

## [1] 318

*# \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  
  
  
*# CRITICAL RESULTS: not translation-influenced*  
  
*# Relation between modality strength, dominant modalities, and mod exclusivitY*  
*# ENGLISH*  
*# properties*  
**summaryBy**(Aud\_eng ~ main\_eng, data=props, FUN=mean)

## main\_eng Aud\_eng.mean  
## 1 a 4.5887941  
## 2 h 1.1219429  
## 3 v 0.9840488

**summaryBy**(Hap\_eng ~ main\_eng, data=props, FUN=mean)

## main\_eng Hap\_eng.mean  
## 1 a 0.7042941  
## 2 h 4.3319143  
## 3 v 2.3278634

**summaryBy**(Vis\_eng ~ main\_eng, data=props, FUN=mean)

## main\_eng Vis\_eng.mean  
## 1 a 2.305074  
## 2 h 3.447314  
## 3 v 4.408098

**summaryBy**(exc\_eng ~ main\_eng, data=props, FUN=mean)

## main\_eng exc\_eng.mean  
## 1 a 0.5739265  
## 2 h 0.3701571  
## 3 v 0.4891659

*# concepts*  
**summaryBy**(Aud\_eng ~ main\_eng, data=concs, FUN=mean)

## main\_eng Aud\_eng.mean  
## 1 a 3.542810  
## 2 h 1.347643  
## 3 v 2.025955  
## 4 <NA> NA

**summaryBy**(Hap\_eng ~ main\_eng, data=concs, FUN=mean)

## main\_eng Hap\_eng.mean  
## 1 a 1.032119  
## 2 h 4.143143  
## 3 v 1.872676  
## 4 <NA> NA

**summaryBy**(Vis\_eng ~ main\_eng, data=concs, FUN=mean)

## main\_eng Vis\_eng.mean  
## 1 a 2.711643  
## 2 h 3.428714  
## 3 v 3.665250  
## 4 <NA> NA

**summaryBy**(exc\_eng ~ main\_eng, data=concs, FUN=mean)

## main\_eng exc\_eng.mean  
## 1 a 0.4413571  
## 2 h 0.3530714  
## 3 v 0.3917173  
## 4 <NA> NA

*# DUTCH*   
*# properties*  
**summaryBy**(Auditory ~ main, data=props, FUN=mean)

## main Auditory.mean  
## 1 a 3.816750  
## 2 h 1.374711  
## 3 v 1.226480  
## 4 <NA> NA

**summaryBy**(Haptic ~ main, data=props, FUN=mean)

## main Haptic.mean  
## 1 a 1.220469  
## 2 h 3.545978  
## 3 v 1.850458  
## 4 <NA> NA

**summaryBy**(Visual ~ main, data=props, FUN=mean)

## main Visual.mean  
## 1 a 1.704125  
## 2 h 2.722356  
## 3 v 3.750833  
## 4 <NA> NA

**summaryBy**(Exclusivity ~ main, data=props, FUN=mean)

## main Exclusivity.mean  
## 1 a 0.4284531  
## 2 h 0.2922667  
## 3 v 0.4124714  
## 4 <NA> NA

*# concepts*  
**summaryBy**(Auditory ~ main, data=concs, FUN=mean)

## main Auditory.mean  
## 1 a 3.447500  
## 2 h 1.520956  
## 3 v 1.805623  
## 4 <NA> NA

**summaryBy**(Haptic ~ main, data=concs, FUN=mean)

## main Haptic.mean  
## 1 a 1.498063  
## 2 h 3.341511  
## 3 v 1.838852  
## 4 <NA> NA

**summaryBy**(Visual ~ main, data=concs, FUN=mean)

## main Visual.mean  
## 1 a 2.382125  
## 2 h 2.721467  
## 3 v 3.297368  
## 4 <NA> NA

**summaryBy**(Exclusivity ~ main, data=concs, FUN=mean)

## main Exclusivity.mean  
## 1 a 0.2806875  
## 2 h 0.2571778  
## 3 v 0.2905597  
## 4 <NA> NA

*# RESULTS: both languages strongly related on individual modalities and on*   
*# exclusivity. Correlations among modalities replicate previous norms, with visual*   
*# and haptic items related, and auditory ones independent.*  
  
*# Yet, there is clearly a greater exclusivity in the English norms.*  
*# Properties*  
psych::**describe**(props$exc\_eng) *# M = 0.48*

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 343 0.48 0.17 0.46 0.47 0.16 0.1 0.98 0.88 0.46 -0.11  
## se  
## X1 0.01

psych::**describe**(props$Exclusivity) *# M = 0.40*

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 336 0.4 0.18 0.38 0.39 0.18 0 1 1 0.42 -0.22 0.01

*# Concepts*  
psych::**describe**(concs$exc\_eng) *# M = 0.40*

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 392 0.4 0.12 0.39 0.39 0.1 0.07 0.84 0.77 0.2 0.8  
## se  
## X1 0.01

psych::**describe**(concs$Exclusivity) *# M = 0.29*

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 411 0.29 0.15 0.27 0.28 0.15 0.01 0.91 0.9 0.62 0.38  
## se  
## X1 0.01

*# Indeed lower exclusivity and higher SD for Dutch items >> Check significance*  
*# Because the English and the Dutch norms are paired, the difference has to be*   
*# checked through a one-sample t-test, checking the mean of one language against*   
*# the other language (see further below).*  
  
  
  
*# Correlations among modalities within each category and language:*  
  
*# ENGLISH*  
*# PROPERTIES*  
**rcor.test**(props[, **c**('Aud\_eng', 'Hap\_eng', 'Vis\_eng', 'exc\_eng')], use =   
'complete.obs')

##   
## Aud\_eng Hap\_eng Vis\_eng exc\_eng  
## Aud\_eng \*\*\*\*\* -0.417 -0.625 0.018   
## Hap\_eng <0.001 \*\*\*\*\* 0.234 -0.621   
## Vis\_eng <0.001 <0.001 \*\*\*\*\* -0.053   
## exc\_eng 0.740 <0.001 0.331 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

corr3 = **rcor.test**(props[, **c**('Aud\_eng', 'Hap\_eng', 'Vis\_eng', 'exc\_eng')],   
use = 'complete.obs')  
**write.csv**(corr3$cor.mat, file = "corr3.csv",na="") *# saved for manuscript*  
  
*# CONCEPTS*  
**rcor.test**(concs[, **c**('Aud\_eng', 'Hap\_eng', 'Vis\_eng', 'exc\_eng')], use = 'complete.obs')

##   
## Aud\_eng Hap\_eng Vis\_eng exc\_eng  
## Aud\_eng \*\*\*\*\* -0.176 -0.008 -0.276   
## Hap\_eng <0.001 \*\*\*\*\* 0.554 -0.393   
## Vis\_eng 0.868 <0.001 \*\*\*\*\* -0.065   
## exc\_eng <0.001 <0.001 0.202 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

corr4 = **rcor.test**(concs[, **c**('Aud\_eng', 'Hap\_eng', 'Vis\_eng', 'exc\_eng')], use =   
'complete.obs')  
**write.csv**(corr4$cor.mat, file = "corr4.csv",na="") *# saved for manuscript*  
  
  
*# DUTCH*  
*# PROPERTIES*  
**rcor.test**(props[, **c**('Auditory', 'Haptic', 'Visual', 'Exclusivity')], use =   
'complete.obs')

##   
## Auditory Haptic Visual Exclusivity  
## Auditory \*\*\*\*\* -0.228 -0.513 -0.173   
## Haptic <0.001 \*\*\*\*\* 0.193 -0.482   
## Visual <0.001 <0.001 \*\*\*\*\* 0.162   
## Exclusivity 0.001 <0.001 0.003 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

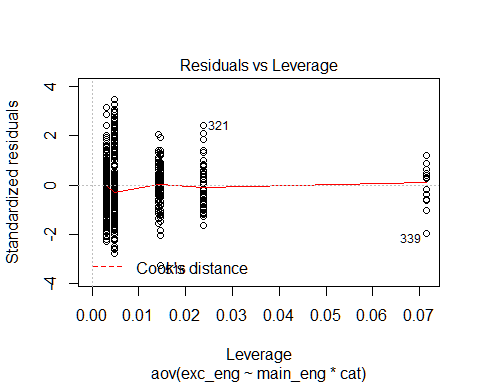
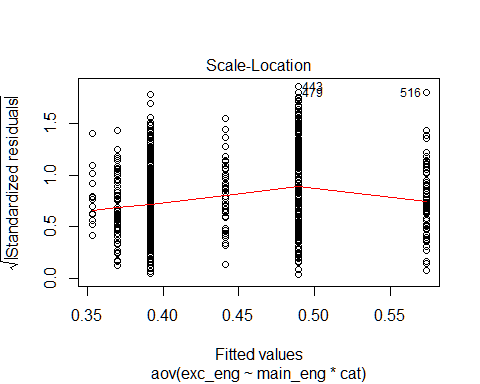
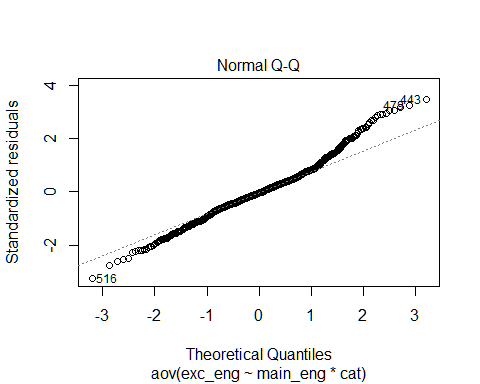
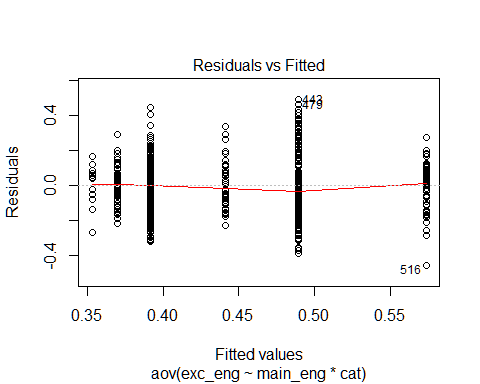
corr1 = **rcor.test**(props[, **c**('Auditory', 'Haptic', 'Visual', 'Exclusivity')],   
use = 'complete.obs')  
**write.csv**(corr1$cor.mat, file = "corr1.csv",na="") *# saved for manuscript*  
  
*# CONCEPTS*  
**rcor.test**(concs[, **c**('Auditory', 'Haptic', 'Visual', 'Exclusivity')], use =   
'complete.obs')

##   
## Auditory Haptic Visual Exclusivity  
## Auditory \*\*\*\*\* -0.009 0.085 -0.410   
## Haptic 0.863 \*\*\*\*\* 0.441 -0.317   
## Visual 0.086 <0.001 \*\*\*\*\* 0.122   
## Exclusivity <0.001 <0.001 0.013 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

corr2 = **rcor.test**(concs[, **c**('Auditory', 'Haptic', 'Visual', 'Exclusivity')], use =   
'complete.obs')  
**write.csv**(corr2$cor.mat, file = "corr2.csv",na="") *# saved for manuscript*  
  
  
*# Statistical tests for those differences*  
*# Yet the same again, but now with a statistical significance test*  
  
*# ENGLISH*  
*# Setting contrasts based on means*  
**contrasts**(all$main\_eng) <- **cbind**(**c**(2,0,-2), **c**(-1,2,-1))  
*# (1) Aud vs Vis; (2) Hap vs Aud-&-Vis*  
**contrasts**(all$main\_eng)

## [,1] [,2]  
## a 2 -1  
## h 0 2  
## v -2 -1

fitt <- **aov**(exc\_eng ~ main\_eng \* cat, data=all)  
**plot**(fitt)



**summary**(fitt)

## Df Sum Sq Mean Sq F value Pr(>F)   
## main\_eng 2 1.264 0.6321 31.507 7.52e-14 \*\*\*  
## cat 1 1.561 1.5614 77.832 < 2e-16 \*\*\*  
## main\_eng:cat 2 0.107 0.0537 2.676 0.0695 .   
## Residuals 729 14.625 0.0201   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
## 24 observations deleted due to missingness

**drop1**(fitt,~.,test="F")

## Single term deletions  
##   
## Model:  
## exc\_eng ~ main\_eng \* cat  
## Df Sum of Sq RSS AIC F value Pr(>F)   
## <none> 14.624 -2867.1   
## main\_eng 2 0.11832 14.743 -2865.2 2.949 0.05302 .   
## cat 1 0.46228 15.087 -2846.2 23.044 1.922e-06 \*\*\*  
## main\_eng:cat 2 0.10737 14.732 -2865.8 2.676 0.06951 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Anova**(fitt)

## Anova Table (Type II tests)  
##   
## Response: exc\_eng  
## Sum Sq Df F value Pr(>F)   
## main\_eng 1.4717 2 36.681 6.628e-16 \*\*\*  
## cat 1.5614 1 77.832 < 2.2e-16 \*\*\*  
## main\_eng:cat 0.1074 2 2.676 0.06951 .   
## Residuals 14.6245 729   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Anova**(fitt, type = "II")

## Anova Table (Type II tests)  
##   
## Response: exc\_eng  
## Sum Sq Df F value Pr(>F)   
## main\_eng 1.4717 2 36.681 6.628e-16 \*\*\*  
## cat 1.5614 1 77.832 < 2.2e-16 \*\*\*  
## main\_eng:cat 0.1074 2 2.676 0.06951 .   
## Residuals 14.6245 729   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Anova**(fitt, type = "III")

## Anova Table (Type III tests)  
##   
## Response: exc\_eng  
## Sum Sq Df F value Pr(>F)   
## (Intercept) 14.3252 1 714.082 < 2.2e-16 \*\*\*  
## main\_eng 0.1183 2 2.949 0.05302 .   
## cat 0.4623 1 23.044 1.922e-06 \*\*\*  
## main\_eng:cat 0.1074 2 2.676 0.06951 .   
## Residuals 14.6245 729   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

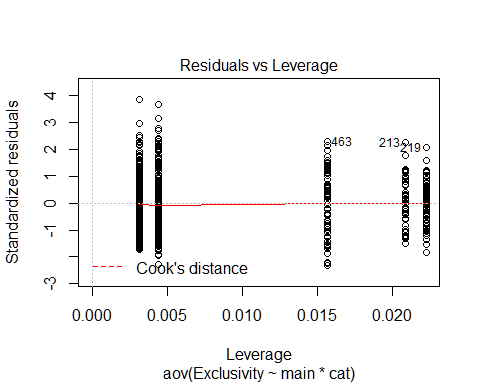
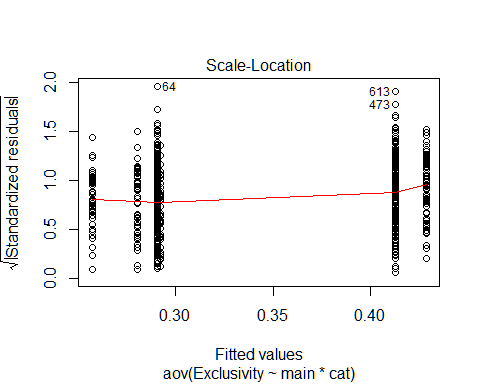
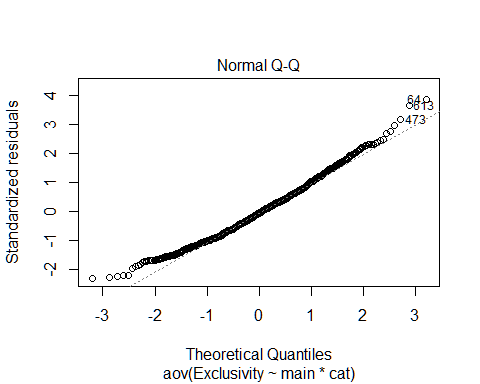
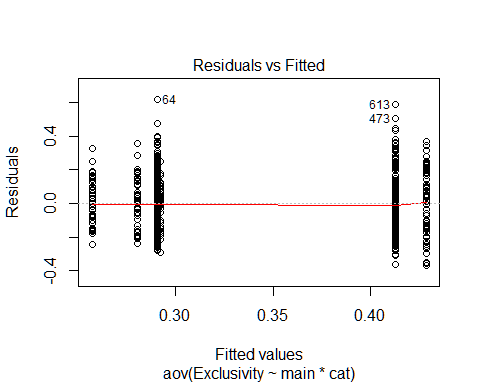
**summary.lm**(fitt)

##   
## Call:  
## aov(formula = exc\_eng ~ main\_eng \* cat, data = all)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.45793 -0.08089 -0.00472 0.06968 0.49083   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.395382 0.014796 26.722 < 2e-16 \*\*\*  
## main\_eng1 0.012410 0.005795 2.141 0.0326 \*   
## main\_eng2 -0.021155 0.013196 -1.603 0.1093   
## catprop 0.082368 0.017159 4.800 1.92e-06 \*\*\*  
## main\_eng1:catprop 0.008780 0.007625 1.152 0.2499   
## main\_eng2:catprop -0.032641 0.014727 -2.216 0.0270 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.1416 on 729 degrees of freedom  
## (24 observations deleted due to missingness)  
## Multiple R-squared: 0.167, Adjusted R-squared: 0.1613   
## F-statistic: 29.24 on 5 and 729 DF, p-value: < 2.2e-16

*# RESULTS: English properties with more exclusivity than concepts(\*\*\*)*  
*# Contrasts: (1) Aud vs Vis (\*)*  
*# (2) Haptic words show less exclusivity than auditory and visual ones within*   
*# properties but not within concepts (\*)*  
  
  
*# DUTCH*  
*# Setting contrasts based on means*  
**contrasts**(all$main) <- **cbind**(**c**(2,0,-2), **c**(-1,2,-1))  
*# (1) Aud vs Vis; (2) Hap vs Aud-&-Vis*  
**contrasts**(all$main)

## [,1] [,2]  
## a 2 -1  
## h 0 2  
## v -2 -1

fitt <- **aov**(Exclusivity ~ main \* cat, data=all)  
**plot**(fitt) *# must click over the plot several times in order to continue*



**summary**(fitt)

## Df Sum Sq Mean Sq F value Pr(>F)   
## main 2 0.448 0.2240 8.679 0.000188 \*\*\*  
## cat 1 2.416 2.4157 93.616 < 2e-16 \*\*\*  
## main:cat 2 0.179 0.0897 3.477 0.031399 \*   
## Residuals 741 19.121 0.0258   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
## 12 observations deleted due to missingness

**drop1**(fitt,~.,test="F")

## Single term deletions  
##   
## Model:  
## Exclusivity ~ main \* cat  
## Df Sum of Sq RSS AIC F value Pr(>F)   
## <none> 19.121 -2726.0   
## main 2 0.04532 19.166 -2728.2 0.8782 0.4160   
## cat 1 1.05008 20.171 -2688.0 40.6939 3.134e-10 \*\*\*  
## main:cat 2 0.17945 19.300 -2723.0 3.4772 0.0314 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Anova**(fitt)

## Anova Table (Type II tests)  
##   
## Response: Exclusivity  
## Sum Sq Df F value Pr(>F)   
## main 0.4752 2 9.2071 0.0001123 \*\*\*  
## cat 2.4157 1 93.6158 < 2.2e-16 \*\*\*  
## main:cat 0.1795 2 3.4772 0.0313993 \*   
## Residuals 19.1210 741   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Anova**(fitt, type = "II")

## Anova Table (Type II tests)  
##   
## Response: Exclusivity  
## Sum Sq Df F value Pr(>F)   
## main 0.4752 2 9.2071 0.0001123 \*\*\*  
## cat 2.4157 1 93.6158 < 2.2e-16 \*\*\*  
## main:cat 0.1795 2 3.4772 0.0313993 \*   
## Residuals 19.1210 741   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Anova**(fitt, type = "III")

## Anova Table (Type III tests)  
##   
## Response: Exclusivity  
## Sum Sq Df F value Pr(>F)   
## (Intercept) 14.8547 1 575.6647 < 2.2e-16 \*\*\*  
## main 0.0453 2 0.8782 0.4160   
## cat 1.0501 1 40.6939 3.134e-10 \*\*\*  
## main:cat 0.1795 2 3.4772 0.0314 \*   
## Residuals 19.1210 741   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary.lm**(fitt)

##   
## Call:  
## aov(formula = Exclusivity ~ main \* cat, data = all)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.36745 -0.11897 -0.00947 0.09959 0.61844   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.276142 0.011509 23.993 < 2e-16 \*\*\*  
## main1 -0.002468 0.006219 -0.397 0.69157   
## main2 -0.009482 0.008995 -1.054 0.29214   
## catprop 0.101589 0.015925 6.379 3.13e-10 \*\*\*  
## main1:catprop 0.006464 0.008425 0.767 0.44320   
## main2:catprop -0.033250 0.012608 -2.637 0.00854 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.1606 on 741 degrees of freedom  
## (12 observations deleted due to missingness)  
## Multiple R-squared: 0.1373, Adjusted R-squared: 0.1315   
## F-statistic: 23.59 on 5 and 741 DF, p-value: < 2.2e-16

*# RESULTS: Dutch properties with more exclusivity than concepts(\*\*\*)*  
*# Contrasts: (1) Aud vs Vis (non-sig)*  
*# (2) Haptic words show less exclusivity than auditory and visual ones within*   
*# properties but not within concepts (\*\*)*  
  
*# Overall, these results stem from the nature of human perception. What exclusivity*   
*# seems to be indexing is the degree to which percepts will naturally co-occur. Thus,*  
*# visual and auditory words have relatively higher exclusivities because what we*   
*# see and hear often stands on its own. We can often see thing but not hear or touch*   
*# them. By the same token, we often hear things that we cannot see or touch. Now, in*  
*# contrast, if we can touch something, we likely can see and hear it too--hence the*   
*# low exclusivity of haptic items.*  
  
  
  
*# SAME PLOT-WISE:*  
*# Barplot of exclusivity percentiles within modalities for Dutch items (as in*   
*# van Dantzig et al., 2011, but separately for properties and concepts)*  
  
all<-**read.csv**('all.csv')  
  
allNL = all[!all$main == '',]  
allNL$main = **levels**(**droplevels**(allNL$main))  
  
concs <- allNL[allNL$cat == 'conc' & !allNL$normed == 'English' & !allNL$main == '',]  
props <- allNL[allNL$cat == 'prop' & !allNL$normed == 'English' & !allNL$main == '',]  
  
concs$main = **levels**(**droplevels**(**as.factor**(concs$main)))  
props$main = **levels**(**droplevels**(**as.factor**(props$main)))  
concs$main = **as.factor**(concs$main)  
props$main = **as.factor**(props$main)  
**nrow**(concs$main)

## NULL

**nrow**(props$main)

## NULL

allNL$catmain <- **with**(allNL, **interaction**(cat, main))  
**str**(allNL$catmain)

## Factor w/ 6 levels "conc.a","prop.a",..: 1 3 5 1 3 5 1 3 5 1 ...

allNL$section = **floor**(allNL$Exclusivity \* 4)   
**table**(allNL$section)

##   
## 0 1 2 3 4   
## 252 368 114 12 1

**str**(allNL$section)

## num [1:759] 1 0 1 1 2 1 2 2 1 1 ...

**table**(allNL$section) *# order = 01234*

##   
## 0 1 2 3 4   
## 252 368 114 12 1

allNL$section = **as.factor**(allNL$section)  
**revalue**(allNL$section, **c**("0"="0-20%", "1"="20-40%", "2"="40-60%", "3"="60-80%",   
"4"="80-100%"))

## [1] 20-40% 0-20% 20-40% 20-40% 40-60% 20-40% 40-60% 40-60%   
## [9] 20-40% 20-40% 0-20% 0-20% 0-20% 0-20% 20-40% 0-20%   
## [17] 0-20% 20-40% 20-40% 0-20% 20-40% 0-20% 20-40% 20-40%   
## [25] 0-20% 40-60% 0-20% 0-20% 0-20% 0-20% 20-40% 40-60%   
## [33] 0-20% 20-40% 20-40% 20-40% 20-40% 0-20% 0-20% 20-40%   
## [41] 0-20% 0-20% 0-20% 0-20% 0-20% 0-20% 20-40% 0-20%   
## [49] 20-40% 40-60% 0-20% 0-20% 40-60% 0-20% 20-40% 40-60%   
## [57] 0-20% 20-40% 0-20% 0-20% 20-40% 20-40% 20-40% 60-80%   
## [65] 0-20% 0-20% 20-40% 0-20% 40-60% 0-20% 20-40% 0-20%   
## [73] 20-40% 0-20% 20-40% 0-20% 20-40% 0-20% 20-40% 0-20%   
## [81] 0-20% 0-20% 40-60% 0-20% 0-20% 0-20% 40-60% 20-40%   
## [89] 0-20% 0-20% 0-20% 20-40% 20-40% 0-20% 20-40% 20-40%   
## [97] 0-20% 20-40% 0-20% 20-40% 20-40% 0-20% 0-20% 20-40%   
## [105] 0-20% 20-40% 20-40% 0-20% 0-20% 0-20% 0-20% 0-20%   
## [113] 20-40% 0-20% 0-20% 0-20% 20-40% 0-20% 0-20% 0-20%   
## [121] 20-40% 0-20% 0-20% 0-20% 20-40% 40-60% 20-40% 0-20%   
## [129] 20-40% 0-20% 0-20% 0-20% 20-40% 20-40% 20-40% 20-40%   
## [137] 20-40% 0-20% 20-40% 0-20% 20-40% 20-40% 20-40% 0-20%   
## [145] 0-20% 0-20% 0-20% 0-20% 40-60% 40-60% 0-20% 0-20%   
## [153] 20-40% 20-40% 0-20% 20-40% 0-20% 20-40% 0-20% 0-20%   
## [161] 0-20% 20-40% 20-40% 20-40% 0-20% 20-40% 0-20% 0-20%   
## [169] 20-40% 20-40% 0-20% 0-20% 20-40% 20-40% 40-60% 20-40%   
## [177] 20-40% 20-40% 20-40% 40-60% 20-40% 0-20% 20-40% 20-40%   
## [185] 20-40% 40-60% 20-40% 0-20% 20-40% 20-40% 0-20% 0-20%   
## [193] 0-20% 0-20% 0-20% 0-20% 0-20% 0-20% 0-20% 0-20%   
## [201] 20-40% 20-40% 20-40% 20-40% 0-20% 20-40% 0-20% 20-40%   
## [209] 0-20% 20-40% 20-40% 20-40% 40-60% 0-20% 20-40% 20-40%   
## [217] 20-40% 0-20% 40-60% 0-20% 20-40% 20-40% 20-40% 20-40%   
## [225] 0-20% 20-40% 20-40% 20-40% 20-40% 0-20% 20-40% 20-40%   
## [233] 20-40% 20-40% 0-20% 20-40% 20-40% 20-40% 0-20% 0-20%   
## [241] 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 0-20%   
## [249] 20-40% 20-40% 0-20% 20-40% 0-20% 20-40% 20-40% 0-20%   
## [257] 0-20% 0-20% 0-20% 20-40% 20-40% 20-40% 0-20% 0-20%   
## [265] 0-20% 0-20% 20-40% 0-20% 0-20% 0-20% 0-20% 0-20%   
## [273] 0-20% 20-40% 20-40% 0-20% 20-40% 0-20% 20-40% 20-40%   
## [281] 20-40% 20-40% 0-20% 20-40% 20-40% 20-40% 0-20% 0-20%   
## [289] 20-40% 0-20% 20-40% 20-40% 20-40% 20-40% 0-20% 0-20%   
## [297] 0-20% 20-40% 40-60% 20-40% 20-40% 20-40% 0-20% 20-40%   
## [305] 20-40% 40-60% 20-40% 0-20% 20-40% 20-40% 0-20% 20-40%   
## [313] 20-40% 0-20% 20-40% 20-40% 40-60% 20-40% 20-40% 0-20%   
## [321] 40-60% 0-20% 0-20% 0-20% 20-40% 0-20% 0-20% 0-20%   
## [329] 20-40% 0-20% 20-40% 20-40% 20-40% 0-20% 0-20% 20-40%   
## [337] 0-20% 40-60% 20-40% 20-40% 40-60% 0-20% 20-40% 20-40%   
## [345] 20-40% 0-20% 20-40% 0-20% 0-20% 0-20% 0-20% 0-20%   
## [353] 20-40% 0-20% 20-40% 20-40% 0-20% 20-40% 0-20% 40-60%   
## [361] 40-60% 20-40% 20-40% 20-40% 20-40% 20-40% 0-20% 20-40%   
## [369] 20-40% 20-40% 20-40% 60-80% 0-20% 20-40% 20-40% 20-40%   
## [377] 0-20% 20-40% 20-40% 40-60% 0-20% 0-20% 0-20% 0-20%   
## [385] 0-20% 20-40% 40-60% 20-40% 0-20% 20-40% 40-60% 0-20%   
## [393] 0-20% 20-40% 0-20% 20-40% 0-20% 20-40% 0-20% 20-40%   
## [401] 20-40% 0-20% 20-40% 0-20% 0-20% 0-20% 20-40% 20-40%   
## [409] 40-60% 0-20% 20-40% 0-20% 20-40% 20-40% 0-20% 20-40%   
## [417] 40-60% 40-60% 20-40% 20-40% 40-60% 20-40% 40-60% 40-60%   
## [425] 0-20% 40-60% 20-40% 20-40% 40-60% 20-40% 20-40% 20-40%   
## [433] 0-20% 0-20% 20-40% 0-20% 0-20% 20-40% 20-40% 60-80%   
## [441] 20-40% 40-60% 20-40% 0-20% 20-40% 20-40% 20-40% 20-40%   
## [449] 20-40% 20-40% 20-40% 40-60% 20-40% 40-60% 20-40% 40-60%   
## [457] 20-40% 0-20% 0-20% 40-60% 20-40% 0-20% 60-80% 20-40%   
## [465] 20-40% 40-60% 20-40% 40-60% 40-60% 20-40% 20-40% 20-40%   
## [473] 60-80% 40-60% 20-40% 20-40% 0-20% 40-60% 40-60% 40-60%   
## [481] 0-20% 20-40% 0-20% 20-40% 20-40% 20-40% 60-80% 40-60%   
## [489] 20-40% 40-60% 20-40% 0-20% 20-40% 20-40% 20-40% 20-40%   
## [497] 20-40% 20-40% 40-60% 40-60% 20-40% 20-40% 60-80% 20-40%   
## [505] 40-60% 40-60% 40-60% 40-60% 0-20% 20-40% 40-60% 20-40%   
## [513] 40-60% 20-40% 40-60% 20-40% 20-40% 20-40% 60-80% 0-20%   
## [521] 40-60% 20-40% 40-60% 0-20% 20-40% 20-40% 0-20% 40-60%   
## [529] 60-80% 20-40% 0-20% 20-40% 20-40% 0-20% 20-40% 0-20%   
## [537] 20-40% 20-40% 0-20% 0-20% 60-80% 20-40% 20-40% 40-60%   
## [545] 20-40% 0-20% 20-40% 40-60% 20-40% 20-40% 20-40% 40-60%   
## [553] 20-40% 0-20% 20-40% 20-40% 40-60% 0-20% 20-40% 20-40%   
## [561] 20-40% 40-60% 20-40% 20-40% 0-20% 40-60% 0-20% 0-20%   
## [569] 40-60% 40-60% 40-60% 20-40% 40-60% 20-40% 0-20% 20-40%   
## [577] 40-60% 0-20% 20-40% 40-60% 40-60% 40-60% 20-40% 40-60%   
## [585] 40-60% 20-40% 20-40% 40-60% 0-20% 40-60% 20-40% 20-40%   
## [593] 20-40% 20-40% 40-60% 40-60% 0-20% 40-60% 20-40% 0-20%   
## [601] <NA> <NA> <NA> <NA> <NA> <NA> <NA> <NA>   
## [609] <NA> <NA> <NA> <NA> 80-100% 20-40% 0-20% 20-40%   
## [617] 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 40-60%   
## [625] 20-40% 40-60% 40-60% 60-80% 0-20% 20-40% 20-40% 40-60%   
## [633] 0-20% 0-20% 0-20% 20-40% 0-20% 20-40% 20-40% 20-40%   
## [641] 0-20% 20-40% 0-20% 0-20% 20-40% 20-40% 40-60% 40-60%   
## [649] 40-60% 0-20% 20-40% 20-40% 20-40% 0-20% 20-40% 40-60%   
## [657] 40-60% 20-40% 20-40% 20-40% 40-60% 0-20% 0-20% 40-60%   
## [665] 40-60% 20-40% 20-40% 0-20% 20-40% 20-40% 20-40% 0-20%   
## [673] 40-60% 0-20% 20-40% 20-40% 20-40% 40-60% 0-20% 40-60%   
## [681] 20-40% 20-40% 0-20% 20-40% 20-40% 20-40% 20-40% 0-20%   
## [689] 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 20-40%   
## [697] 20-40% 0-20% 40-60% 20-40% 20-40% 0-20% 20-40% 20-40%   
## [705] 20-40% 20-40% 20-40% 0-20% 20-40% 40-60% 0-20% 20-40%   
## [713] 20-40% 20-40% 40-60% 0-20% 40-60% 40-60% 40-60% 20-40%   
## [721] 0-20% 20-40% 20-40% 0-20% 20-40% 20-40% 20-40% 40-60%   
## [729] 20-40% 40-60% 20-40% 0-20% 0-20% 0-20% 20-40% 20-40%   
## [737] 20-40% 40-60% 40-60% 20-40% 0-20% 0-20% 60-80% 20-40%   
## [745] 0-20% 0-20% 40-60% 20-40% 20-40% 20-40% 20-40% 40-60%   
## [753] 40-60% 20-40% 20-40% 0-20% 20-40% 40-60% 20-40%   
## Levels: 0-20% 20-40% 40-60% 60-80% 80-100%

allNL$section = **mapvalues**(allNL$section, from = **c**(0, 1, 2, 3, 4), to = **c**("0-20%",   
"20-40%", "40-60%", "60-80%", "80-100%"))  
**table**(allNL$section)

##   
## 0-20% 20-40% 40-60% 60-80% 80-100%   
## 252 368 114 12 1

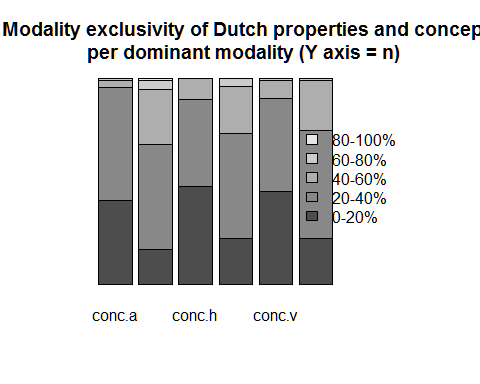
**str**(allNL$section)

## Factor w/ 5 levels "0-20%","20-40%",..: 2 1 2 2 3 2 3 3 2 2 ...

counts <- **table**(allNL$section, allNL$catmain)  
counts

##   
## conc.a prop.a conc.h prop.h conc.v prop.v  
## 0-20% 56 19 65 25 62 25  
## 20-40% 75 57 58 57 62 59  
## 40-60% 5 30 14 26 12 27  
## 60-80% 1 5 0 4 1 1  
## 80-100% 0 1 0 0 0 0

counts = **prop.table**(counts, 2)  
  
*# see plot:*  
**barplot**(counts, width=10, main = 'Modality exclusivity of Dutch properties and concepts   
per dominant modality (Y axis = n) ', legend = **rownames**(counts), xlim=**c**(0,100),   
axes=FALSE, args.legend = **list**(x = "topright", bty = "n", inset=**c**(.1, .2)))



*# ! THE PLOT IS SHOWN BADLY ON HERE. PLEASE SEE THE SAVED PLOT.*   
  
*# Below, run first line, then return and keep running:*  
**png**(file="stacked\_exc.png", units="in", width=6, height=6, res=1000)  
**par**(mar=**c**(2,-.3,3,-.3)+.4) *# run twice, if necessary*   
**barplot**(counts, width=10, main = 'Modality exclusivity of Dutch properties and concepts   
per dominant modality (Y axis = n) ', legend = **rownames**(counts), xlim=**c**(0,100),   
axes=FALSE, args.legend = **list**(x = "topright", bty = "n", inset=**c**(.1, .2)))  
**dev.off**()

## png   
## 2

*# Same plot for the English items of Lynott and Connell (of course w/out gustatory*   
*# or olfactory)*  
  
allENG = all[!all$main\_eng == '',]  
allENG$main\_eng = **levels**(**droplevels**(allENG$main\_eng))  
  
allENG$catmain <- **with**(allENG, **interaction**(cat, main\_eng))  
**str**(allENG$catmain)

## Factor w/ 6 levels "conc.a","prop.a",..: NA 3 5 1 3 5 1 3 5 1 ...

allENG$section = **floor**(allENG$exc\_eng \* 5)  
**table**(allENG$section)

##   
## 0 1 2 3 4   
## 33 288 313 81 20

**str**(allENG$section)

## num [1:759] NA 2 1 2 2 2 3 2 1 2 ...

**table**(allENG$section) *# order = 01234*

##   
## 0 1 2 3 4   
## 33 288 313 81 20

allENG$section = **as.factor**(allENG$section)  
**revalue**(allENG$section, **c**("0"="0-20%", "1"="20-40%", "2"="40-60%", "3"="60-80%",   
"4"="80-100%"))

## [1] <NA> 40-60% 20-40% 40-60% 40-60% 40-60% 60-80% 40-60%   
## [9] 20-40% 40-60% 40-60% 20-40% 40-60% 20-40% 40-60% 20-40%   
## [17] 20-40% 40-60% 40-60% 40-60% 20-40% 0-20% 20-40% 20-40%   
## [25] 60-80% 40-60% <NA> 40-60% 40-60% 20-40% 60-80% 40-60%   
## [33] 20-40% 40-60% 40-60% 20-40% 20-40% 20-40% 20-40% 20-40%   
## [41] 20-40% 20-40% 20-40% 40-60% 20-40% 40-60% 20-40% 40-60%   
## [49] 40-60% 20-40% 40-60% 20-40% 20-40% 20-40% 20-40% 20-40%   
## [57] 20-40% 20-40% 20-40% 40-60% 40-60% 40-60% 20-40% 40-60%   
## [65] 40-60% 40-60% 40-60% 20-40% 40-60% 0-20% 20-40% 0-20%   
## [73] 20-40% 40-60% <NA> 60-80% 40-60% 40-60% 40-60% 20-40%   
## [81] 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 60-80% 40-60%   
## [89] 20-40% 20-40% 20-40% 20-40% 0-20% 20-40% 40-60% 20-40%   
## [97] 20-40% 40-60% 20-40% 20-40% 20-40% 40-60% 20-40% 20-40%   
## [105] 20-40% 20-40% 40-60% 20-40% 20-40% 20-40% 20-40% <NA>   
## [113] <NA> 20-40% 20-40% 40-60% 40-60% <NA> 0-20% 0-20%   
## [121] <NA> 20-40% 40-60% 20-40% 40-60% 40-60% 20-40% 20-40%   
## [129] 40-60% <NA> 40-60% 40-60% <NA> 40-60% 40-60% 40-60%   
## [137] 40-60% 20-40% 60-80% 0-20% 40-60% 60-80% 60-80% 40-60%   
## [145] 20-40% 40-60% 20-40% 20-40% 40-60% 40-60% 40-60% 20-40%   
## [153] <NA> 20-40% 20-40% 20-40% 40-60% 20-40% 20-40% 20-40%   
## [161] 20-40% <NA> 40-60% 40-60% 40-60% 40-60% 40-60% 40-60%   
## [169] 40-60% 20-40% 40-60% 20-40% 40-60% 20-40% 40-60% 40-60%   
## [177] 40-60% 40-60% 40-60% 80-100% 40-60% 20-40% 60-80% 40-60%   
## [185] 40-60% 40-60% 40-60% 40-60% 40-60% 40-60% 40-60% 20-40%   
## [193] 20-40% 20-40% 20-40% 20-40% 20-40% 20-40% 40-60% 0-20%   
## [201] 40-60% 40-60% <NA> 20-40% 40-60% 20-40% 40-60% 20-40%   
## [209] 20-40% 20-40% <NA> 20-40% 40-60% 20-40% <NA> 40-60%   
## [217] 40-60% 20-40% <NA> 20-40% 20-40% 20-40% 40-60% 60-80%   
## [225] 20-40% 40-60% 0-20% 20-40% 40-60% 40-60% 20-40% 40-60%   
## [233] 40-60% 20-40% <NA> 40-60% 40-60% 20-40% 20-40% 20-40%   
## [241] 40-60% 20-40% 20-40% 40-60% 20-40% 40-60% 40-60% 40-60%   
## [249] 20-40% 40-60% 0-20% 40-60% <NA> 0-20% 20-40% 20-40%   
## [257] 20-40% 20-40% 20-40% 40-60% 60-80% 20-40% 20-40% 40-60%   
## [265] 40-60% 20-40% 40-60% 20-40% <NA> 40-60% 40-60% 40-60%   
## [273] 0-20% 20-40% <NA> 20-40% <NA> 20-40% 60-80% 20-40%   
## [281] 20-40% 40-60% 20-40% 40-60% 20-40% 0-20% 20-40% 20-40%   
## [289] 40-60% 20-40% 40-60% 20-40% 40-60% 20-40% 40-60% 20-40%   
## [297] 20-40% 40-60% 40-60% 60-80% <NA> 20-40% 20-40% 40-60%   
## [305] 60-80% 20-40% 40-60% 20-40% 40-60% 0-20% 20-40% 20-40%   
## [313] 20-40% 20-40% 40-60% 40-60% 40-60% 40-60% 40-60% 20-40%   
## [321] 60-80% 40-60% 0-20% 20-40% <NA> 40-60% 40-60% 20-40%   
## [329] 40-60% 20-40% 20-40% <NA> 40-60% 20-40% 0-20% 20-40%   
## [337] 40-60% 40-60% 0-20% 20-40% 40-60% 20-40% 20-40% 40-60%   
## [345] <NA> 0-20% 0-20% 40-60% 20-40% 20-40% 40-60% 20-40%   
## [353] 40-60% 20-40% 0-20% 40-60% 0-20% 20-40% 40-60% 60-80%   
## [361] 60-80% 20-40% 40-60% 40-60% 20-40% 40-60% 20-40% 40-60%   
## [369] 40-60% 20-40% 20-40% 20-40% 20-40% 40-60% 40-60% 20-40%   
## [377] 40-60% 20-40% 20-40% 40-60% 20-40% 20-40% 40-60% 20-40%   
## [385] 40-60% 0-20% 60-80% 40-60% 20-40% 20-40% 40-60% 20-40%   
## [393] 20-40% 40-60% 20-40% 40-60% 20-40% 40-60% 40-60% 40-60%   
## [401] 40-60% 20-40% 20-40% 20-40% 20-40% 20-40% 60-80% 40-60%   
## [409] 20-40% 20-40% 60-80% 20-40% 40-60% 60-80% 20-40% 40-60%   
## [417] 80-100% 20-40% 40-60% 20-40% 80-100% 40-60% 80-100% 80-100%  
## [425] 20-40% 60-80% 40-60% 40-60% 80-100% 40-60% 40-60% 20-40%   
## [433] 40-60% 0-20% 40-60% 20-40% 40-60% 0-20% 40-60% 60-80%   
## [441] 40-60% 80-100% 80-100% 40-60% 40-60% 40-60% 40-60% 20-40%   
## [449] 20-40% 20-40% 40-60% 60-80% 40-60% 20-40% 40-60% 60-80%   
## [457] 40-60% 20-40% 20-40% 40-60% 20-40% 40-60% 80-100% 20-40%   
## [465] 20-40% 40-60% 40-60% 60-80% 40-60% 60-80% 60-80% 60-80%   
## [473] 20-40% 60-80% 80-100% 40-60% 20-40% 40-60% 80-100% 60-80%   
## [481] 20-40% 60-80% 20-40% 40-60% 40-60% 20-40% 60-80% 60-80%   
## [489] 40-60% 40-60% 40-60% 40-60% 40-60% 40-60% 40-60% 40-60%   
## [497] 20-40% 40-60% 40-60% 40-60% 60-80% 20-40% 40-60% 20-40%   
## [505] 60-80% 60-80% 60-80% 60-80% 20-40% 40-60% 60-80% 20-40%   
## [513] 80-100% 40-60% 60-80% 0-20% 40-60% 20-40% 0-20% 40-60%   
## [521] 40-60% 20-40% 80-100% 20-40% 40-60% 40-60% 20-40% 40-60%   
## [529] 60-80% 40-60% 40-60% 40-60% 20-40% 20-40% 40-60% 60-80%   
## [537] 40-60% 40-60% 20-40% 20-40% 80-100% 40-60% 20-40% 40-60%   
## [545] 40-60% 40-60% 40-60% 60-80% 40-60% 20-40% 20-40% 40-60%   
## [553] 20-40% 0-20% 40-60% 40-60% 60-80% 20-40% 40-60% 40-60%   
## [561] 20-40% 40-60% 20-40% 20-40% 20-40% 60-80% 60-80% 40-60%   
## [569] 40-60% 40-60% 40-60% 60-80% 40-60% 40-60% 20-40% 40-60%   
## [577] 40-60% 0-20% 20-40% 20-40% 60-80% 40-60% 20-40% 60-80%   
## [585] 60-80% 40-60% 20-40% 60-80% 20-40% 40-60% 40-60% 60-80%   
## [593] 20-40% 40-60% 60-80% 20-40% 0-20% 60-80% 40-60% 20-40%   
## [601] 20-40% 40-60% 40-60% 20-40% 20-40% 60-80% 40-60% 60-80%   
## [609] 20-40% 40-60% 20-40% 40-60% 20-40% 20-40% 20-40% 40-60%   
## [617] 40-60% 20-40% 40-60% 40-60% 20-40% 20-40% 20-40% 60-80%   
## [625] 40-60% 40-60% 40-60% 80-100% 20-40% 20-40% 60-80% 40-60%   
## [633] 20-40% 40-60% 20-40% 20-40% 20-40% 40-60% 20-40% 60-80%   
## [641] 20-40% 40-60% 40-60% 20-40% 40-60% 40-60% 40-60% 40-60%   
## [649] 40-60% 40-60% 40-60% 40-60% 20-40% 40-60% 40-60% 80-100%  
## [657] 80-100% 0-20% 20-40% 40-60% 60-80% 20-40% 40-60% 20-40%   
## [665] 60-80% 60-80% 20-40% 20-40% 40-60% 40-60% 60-80% 20-40%   
## [673] 60-80% 20-40% 80-100% 60-80% 20-40% 40-60% 40-60% 20-40%   
## [681] 40-60% 40-60% 20-40% 60-80% 40-60% 20-40% 20-40% 20-40%   
## [689] 40-60% 40-60% 20-40% 20-40% 60-80% 60-80% 40-60% 40-60%   
## [697] 60-80% 40-60% 40-60% 40-60% 0-20% 20-40% 60-80% 20-40%   
## [705] 40-60% 60-80% 40-60% 40-60% 40-60% 40-60% 40-60% 20-40%   
## [713] 40-60% 60-80% 60-80% 40-60% 40-60% 60-80% 40-60% 40-60%   
## [721] 40-60% 20-40% 40-60% 60-80% 40-60% 20-40% 40-60% 40-60%   
## [729] 40-60% 60-80% 20-40% 40-60% 40-60% 0-20% 20-40% 20-40%   
## [737] 20-40% 60-80% 20-40% 40-60% 40-60% 20-40% 80-100% 40-60%   
## [745] 20-40% 20-40% 20-40% 20-40% 40-60% 60-80% 40-60% 60-80%   
## [753] 40-60% 60-80% 40-60% 20-40% 0-20% 80-100% 20-40%   
## Levels: 0-20% 20-40% 40-60% 60-80% 80-100%

allENG$section = **mapvalues**(allENG$section, from = **c**(0, 1, 2, 3, 4), to = **c**("0-20%",   
"20-40%", "40-60%", "60-80%", "80-100%"))  
**table**(allENG$section)

##   
## 0-20% 20-40% 40-60% 60-80% 80-100%   
## 33 288 313 81 20

**str**(allENG$section)

## Factor w/ 5 levels "0-20%","20-40%",..: NA 3 2 3 3 3 4 3 2 3 ...

counts <- **table**(allENG$section, allENG$catmain)  
counts

##   
## conc.a prop.a conc.h prop.h conc.v prop.v  
## 0-20% 6 2 10 5 6 4  
## 20-40% 60 27 61 42 64 34  
## 40-60% 54 54 58 44 52 51  
## 60-80% 7 23 4 18 9 20  
## 80-100% 0 8 0 5 1 6

counts = **prop.table**(counts, 2)  
  
*# below, run first line, then return and keep running:*  
**png**(file="stacked\_exc\_eng.png", units="in", width=6, height=6, res=1000)  
**par**(mar=**c**(2,-.3,3,-.3)+.4) *# run twice, if necessary*   
**barplot**(counts, width=10, main = 'Modality exclusivity of English properties and concepts   
per dominant modality (Y axis = n) ', legend = **rownames**(counts), xlim=**c**(0,100),   
axes=FALSE, args.legend = **list**(x = "topright", bty = "n", inset=**c**(.1, .2)))  
**dev.off**()

## png   
## 2

*# See in folder and compare.*  
  
  
*# Comparison English Dutch on exclusivity*  
*# Properties*  
**t.test**(props$exc\_eng, mu = 0.40)

##   
## One Sample t-test  
##   
## data: props$exc\_eng  
## t = 8.5326, df = 335, p-value = 5.031e-16  
## alternative hypothesis: true mean is not equal to 0.4  
## 95 percent confidence interval:  
## 0.4626335 0.5001642  
## sample estimates:  
## mean of x   
## 0.4813988

*# The difference is considerable, t(734) = 18.8, p < .001*  
*# dz = t/vn = 0.47*  
  
*# Concepts*  
**t.test**(concs$exc\_eng, mu = 0.29)

##   
## One Sample t-test  
##   
## data: concs$exc\_eng  
## t = 16.857, df = 386, p-value < 2.2e-16  
## alternative hypothesis: true mean is not equal to 0.29  
## 95 percent confidence interval:  
## 0.3831297 0.4077230  
## sample estimates:  
## mean of x   
## 0.3954264

*# The difference is considerable, t(734) = 18.8, p < .001*  
*# dz = t/vn = 0.83*  
*# \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  
  
*# RELATION AMONG MODALITIES*  
  
*# Below, very informative plots based on Principal Components Analysis (PCA),*   
*# as in Lynott and Connell (2009, 2013)*  
*# Firstly it is performed on the Dutch norms, then on the English ones, leaving out*   
*# gustatory and olfactory scores and words. At the end, Dutch and English plots are*   
*# compared.*  
  
all <- **read.csv**('all.csv')  
**nrow**(all) *# 747 used in Dutch norms + English not used*

## [1] 759

*# ON ENGLISH NORMS*  
*# PCA plotting on the English norms, as based on Lynott and Connell's*   
*# supplementary materials (http://www.lancaster.ac.uk/people/connelll/lab/norms.html).*   
  
*# ENG PROPERTIES*  
*# check conditions for a PCA*  
*# matrix*  
  
eng\_prop <- all[all$cat == 'prop', **c**('Aud\_eng', 'Hap\_eng', 'Vis\_eng')]  
**nrow**(eng\_prop)

## [1] 343

eng\_prop\_matrix <- **cor**(eng\_prop, use = 'complete.obs')  
eng\_prop\_matrix

## Aud\_eng Hap\_eng Vis\_eng  
## Aud\_eng 1.0000000 -0.4165084 -0.6247598  
## Hap\_eng -0.4165084 1.0000000 0.2344421  
## Vis\_eng -0.6247598 0.2344421 1.0000000

**round**(eng\_prop\_matrix, 2)

## Aud\_eng Hap\_eng Vis\_eng  
## Aud\_eng 1.00 -0.42 -0.62  
## Hap\_eng -0.42 1.00 0.23  
## Vis\_eng -0.62 0.23 1.00

*# OK: correlations good for a PCA, with enough < .3*  
  
*# now on the raw vars:*  
**nrow**(eng\_prop)

## [1] 343

**cortest.bartlett**(eng\_prop)

## R was not square, finding R from data

## $chisq  
## [1] 233.5851  
##   
## $p.value  
## [1] 2.320842e-50  
##   
## $df  
## [1] 3

*# GOOD: Bartlett's test significant*   
  
*# KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy*  
**KMO**(eng\_prop\_matrix)

## Kaiser-Meyer-Olkin factor adequacy  
## Call: KMO(r = eng\_prop\_matrix)  
## Overall MSA = 0.56  
## MSA for each item =   
## Aud\_eng Hap\_eng Vis\_eng   
## 0.54 0.64 0.55

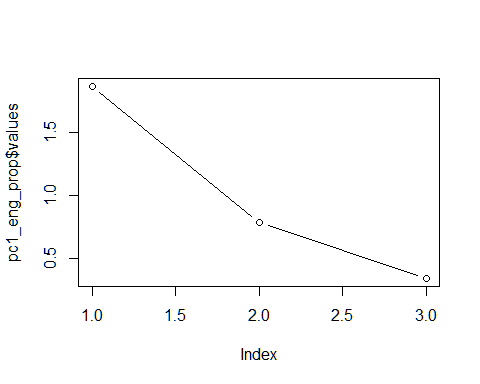
*# Result: .56 = mediocre. PCA not strongly recommended. But we still do it*  
*# because the purpose is graphical only.*  
  
*# check determinant*  
**det**(eng\_prop\_matrix)

## [1] 0.5032448

*# GOOD: >0.00001*  
  
*# start off with unrotated PCA*  
pc1\_eng\_prop <- psych::**principal**(eng\_prop, nfactors = 3, rotate = "none")  
pc1\_eng\_prop

## Principal Components Analysis  
## Call: psych::principal(r = eng\_prop, nfactors = 3, rotate = "none")  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## PC1 PC2 PC3 h2 u2 com  
## Aud\_eng -0.89 0.13 0.44 1 -2.2e-16 1.5  
## Hap\_eng 0.64 0.75 0.15 1 1.1e-16 2.0  
## Vis\_eng 0.81 -0.46 0.36 1 -4.4e-16 2.0  
##   
## PC1 PC2 PC3  
## SS loadings 1.87 0.79 0.34  
## Proportion Var 0.62 0.26 0.11  
## Cumulative Var 0.62 0.89 1.00  
## Proportion Explained 0.62 0.26 0.11  
## Cumulative Proportion 0.62 0.89 1.00  
##   
## Mean item complexity = 1.9  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0   
## with the empirical chi square 0 with prob < NA   
##   
## Fit based upon off diagonal values = 1

*# RESULT: Extract either one PC, acc to Kaiser's criterion, or two RCs, acc to*   
*# Joliffe's (Field, Miles, & Field, 2012)*  
  
*# Unrotated: scree plot*  
**plot**(pc1\_eng\_prop$values, type = "b")



*# Result: again one or two RCs should be extracted*  
  
*# Now with varimax rotation, Kaiser-normalized (by default)*  
pc2\_eng\_prop <- psych::**principal**(eng\_prop, nfactors = 2, rotate = "varimax",   
scores = TRUE)  
pc2\_eng\_prop

## Principal Components Analysis  
## Call: psych::principal(r = eng\_prop, nfactors = 2, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC1 RC2 h2 u2 com  
## Aud\_eng -0.82 -0.36 0.81 0.190 1.4  
## Hap\_eng 0.16 0.98 0.98 0.022 1.1  
## Vis\_eng 0.93 0.04 0.87 0.130 1.0  
##   
## RC1 RC2  
## SS loadings 1.57 1.09  
## Proportion Var 0.52 0.36  
## Cumulative Var 0.52 0.89  
## Proportion Explained 0.59 0.41  
## Cumulative Proportion 0.59 1.00  
##   
## Mean item complexity = 1.1  
## Test of the hypothesis that 2 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.1   
## with the empirical chi square 21.7 with prob < NA   
##   
## Fit based upon off diagonal values = 0.95

pc2\_eng\_prop$loadings

##   
## Loadings:  
## RC1 RC2   
## Aud\_eng -0.825 -0.360  
## Hap\_eng 0.156 0.977  
## Vis\_eng 0.932   
##   
## RC1 RC2  
## SS loadings 1.573 1.085  
## Proportion Var 0.524 0.362  
## Cumulative Var 0.524 0.886

*# two components are good, as they both have eigenvalues over 1*  
  
pc2\_eng\_prop$residual

## Aud\_eng Hap\_eng Vis\_eng  
## Aud\_eng 0.18971667 0.06403298 0.15723160  
## Hap\_eng 0.06403298 0.02161235 0.05306865  
## Vis\_eng 0.15723160 0.05306865 0.13030894

pc2\_eng\_prop$fit

## [1] 0.9724565

pc2\_eng\_prop$communality

## Aud\_eng Hap\_eng Vis\_eng   
## 0.8102833 0.9783877 0.8696911

*# Results based on a Kaiser-normalizalized orthogonal (varimax) rotation*  
*# (by default in psych::stats). Residuals bad: more than 50% have absolute*   
*# values > 0.05. Model fit good, > .90. Communalities good,*   
*# all > .7.*   
  
*# subset and add PCs*  
eng\_props <- all[all$cat == 'prop', ]  
**nrow**(eng\_props)

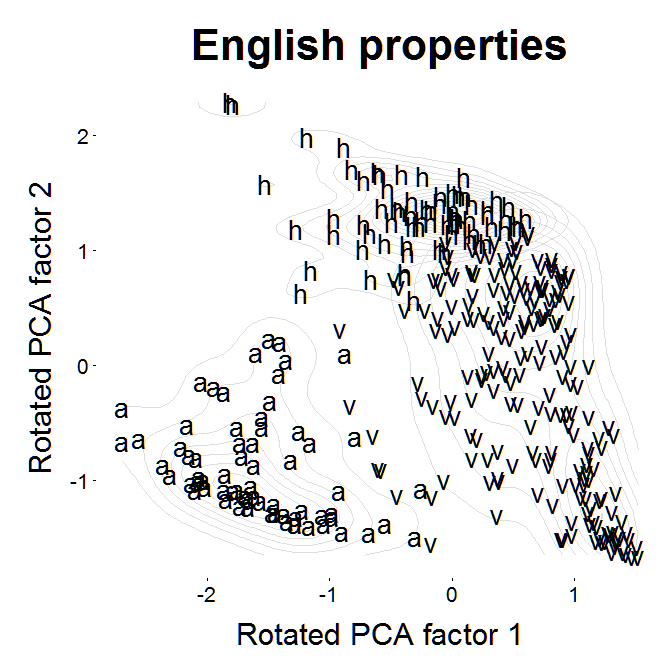
## [1] 343

eng\_props <- **cbind**(eng\_props, pc2\_eng\_prop$scores)  
**nrow**(eng\_props)

## [1] 343

*# Finally, plot*  
Engprops <- **ggplot**(eng\_props,  
 **aes**(RC1, RC2, label = **as.character**(main\_eng))) +  
 **aes** (x = RC1, y = RC2, by = main\_eng) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('English properties') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "Rotated PCA factor 1", y = "Rotated PCA factor 2") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))

**plot**(Engprops) *# ! THE PLOT IS SHOWN BADLY ON HERE. PLEASE SEE THE SAVED PLOT + THEN*



*# THE COMBINED PLOTS*  
  
*# Now to save, run first line below and return to keep running. See your folder.*  
**png**(file="Engprops\_highres.png", units="in", width=13, height=13, res=900)  
**plot**(Engprops)  
**dev.off**()

## png   
## 2

*# Adjust for combined plots:*  
  
Engprops4 <- **ggplot**(eng\_props,  
 **aes**(RC1, RC2, label = **as.character**(main\_eng))) +  
 **aes** (x = RC1, y = RC2, by = main\_eng) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('English properties') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "", y = "Rotated PCA factor 2") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))  
  
  
*# ENG CONCEPTS*  
*# check conditions for a PCA*  
*# matrix*  
eng\_conc <- all[all$cat == 'conc', **c**('Aud\_eng', 'Hap\_eng', 'Vis\_eng')]  
**nrow**(eng\_conc)

## [1] 416

eng\_conc\_matrix <- **cor**(eng\_conc, use = 'complete.obs')  
eng\_conc\_matrix

## Aud\_eng Hap\_eng Vis\_eng  
## Aud\_eng 1.000000000 -0.1760092 -0.008395838  
## Hap\_eng -0.176009214 1.0000000 0.554494445  
## Vis\_eng -0.008395838 0.5544944 1.000000000

**round**(eng\_conc\_matrix, 2)

## Aud\_eng Hap\_eng Vis\_eng  
## Aud\_eng 1.00 -0.18 -0.01  
## Hap\_eng -0.18 1.00 0.55  
## Vis\_eng -0.01 0.55 1.00

*# POOR: correlations not apt for a PCA, with too many below .3*  
  
*# now on the raw data:*  
**nrow**(eng\_conc)

## [1] 416

**cortest.bartlett**(eng\_conc)

## R was not square, finding R from data

## $chisq  
## [1] 169.7255  
##   
## $p.value  
## [1] 1.458581e-36  
##   
## $df  
## [1] 3

*# GOOD: Bartlett's test significant*   
  
*# KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy*  
**KMO**(eng\_conc\_matrix)

## Kaiser-Meyer-Olkin factor adequacy  
## Call: KMO(r = eng\_conc\_matrix)  
## Overall MSA = 0.48  
## MSA for each item =   
## Aud\_eng Hap\_eng Vis\_eng   
## 0.36 0.49 0.48

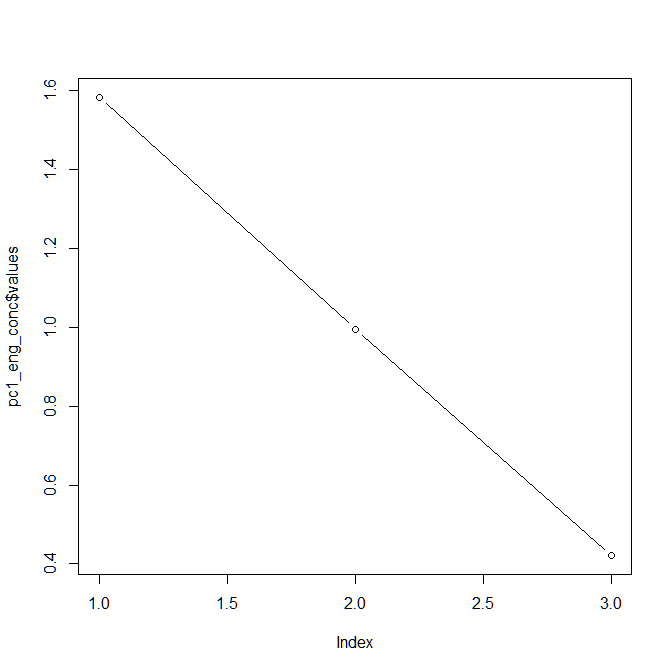
*# Result: .48 = poor. PCA not strongly recommended. But we still do it*  
*# because the purpose is graphical really.*  
  
*# check determinant*  
**det**(eng\_conc\_matrix)

## [1] 0.663125

*# GOOD: >0.00001*  
  
*# start off with unrotated PCA*  
pc1\_eng\_conc <- psych::**principal**(eng\_conc, nfactors = 3, rotate = "none")  
pc1\_eng\_conc

## Principal Components Analysis  
## Call: psych::principal(r = eng\_conc, nfactors = 3, rotate = "none")  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## PC1 PC2 PC3 h2 u2 com  
## Aud\_eng -0.28 0.95 0.13 1 0.0e+00 1.2  
## Hap\_eng 0.89 0.01 0.46 1 -2.2e-16 1.5  
## Vis\_eng 0.85 0.30 -0.44 1 0.0e+00 1.8  
##   
## PC1 PC2 PC3  
## SS loadings 1.58 1.00 0.42  
## Proportion Var 0.53 0.33 0.14  
## Cumulative Var 0.53 0.86 1.00  
## Proportion Explained 0.53 0.33 0.14  
## Cumulative Proportion 0.53 0.86 1.00  
##   
## Mean item complexity = 1.5  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0   
## with the empirical chi square 0 with prob < NA   
##   
## Fit based upon off diagonal values = 1

*# RESULT: Extract either one PC, acc to Kaiser's criterion, or two RCs, acc to*   
*# Joliffe's (Field, Miles, & Field, 2012)*  
  
*# Unrotated: scree plot*  
**plot**(pc1\_eng\_conc$values, type = "b")



*# Result: two PCs obtain.*  
  
*# Now with varimax rotation, Kaiser-normalized (by default):*  
*# always preferable because it captures explained variance best.*   
pc2\_eng\_conc <- psych::**principal**(eng\_conc, nfactors = 2, rotate = "varimax",   
scores = TRUE)  
pc2\_eng\_conc

## Principal Components Analysis  
## Call: psych::principal(r = eng\_conc, nfactors = 2, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC1 RC2 h2 u2 com  
## Aud\_eng -0.04 0.99 0.98 0.018 1.0  
## Hap\_eng 0.87 -0.20 0.79 0.211 1.1  
## Vis\_eng 0.89 0.09 0.81 0.192 1.0  
##   
## RC1 RC2  
## SS loadings 1.55 1.03  
## Proportion Var 0.52 0.34  
## Cumulative Var 0.52 0.86  
## Proportion Explained 0.60 0.40  
## Cumulative Proportion 0.60 1.00  
##   
## Mean item complexity = 1  
## Test of the hypothesis that 2 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.13   
## with the empirical chi square 39.63 with prob < NA   
##   
## Fit based upon off diagonal values = 0.86

pc2\_eng\_conc$loadings

##   
## Loadings:  
## RC1 RC2   
## Aud\_eng 0.990  
## Hap\_eng 0.865 -0.201  
## Vis\_eng 0.894   
##   
## RC1 RC2  
## SS loadings 1.551 1.029  
## Proportion Var 0.517 0.343  
## Cumulative Var 0.517 0.860

pc2\_eng\_conc$residual

## Aud\_eng Hap\_eng Vis\_eng  
## Aud\_eng 0.01775551 0.06123023 -0.05834261  
## Hap\_eng 0.06123023 0.21115367 -0.20119566  
## Vis\_eng -0.05834261 -0.20119566 0.19170728

pc2\_eng\_conc$fit

## [1] 0.9518855

pc2\_eng\_conc$communality

## Aud\_eng Hap\_eng Vis\_eng   
## 0.9822445 0.7888463 0.8082927

*# Results based on a Kaiser-normalizalized orthogonal (varimax) rotation*   
*# (by default in psych::stats). Residuals bad: over 50% have absolute*   
*# values > 0.05. Model fit good, > .90. Communalities good, all > .7.*  
  
*# subset and add PCs*  
eng\_concs <- all[all$cat == 'conc', ]  
**nrow**(eng\_concs)

## [1] 416

eng\_concs <- **cbind**(eng\_concs, pc2\_eng\_conc$scores)  
**summary**(eng\_concs$RC1, eng\_concs$RC2)

## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
## -2.52800 -0.72020 0.03826 0.00000 0.72380 2.18400 24

eng\_concs <- eng\_concs[eng\_concs$normed == 'Dut\_Eng' | eng\_concs$normed ==   
'English',]  
**nrow**(eng\_concs)

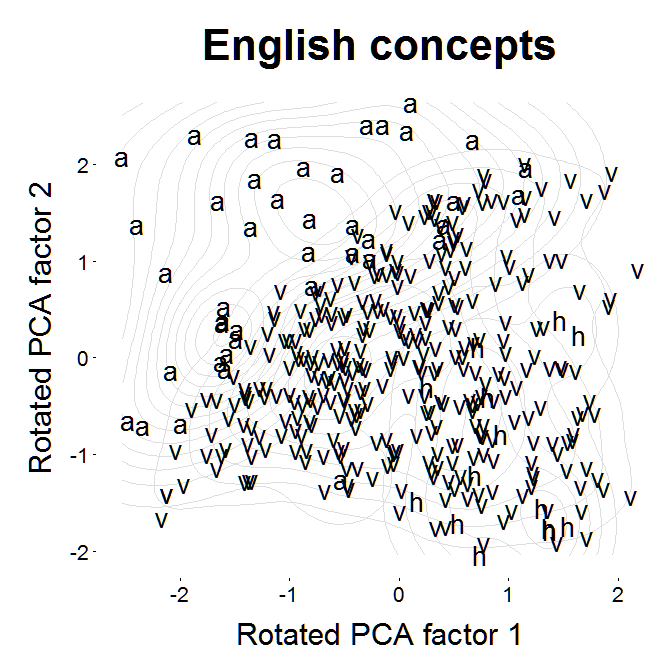
## [1] 392

**summary**(eng\_concs$RC1, eng\_concs$RC2)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -2.52800 -0.72020 0.03826 0.00000 0.72380 2.18400

*# Finally, plot*  
Engconcs <- **ggplot**(eng\_concs,  
 **aes**(RC1, RC2, label = **as.character**(main\_eng))) +  
 **aes** (x = RC1, y = RC2, by = main\_eng) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('English concepts') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "Rotated PCA factor 1", y = "Rotated PCA factor 2") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))

Engconcs *# ! THE PLOT IS SHOWN BADLY ON HERE. PLEASE SEE THE SAVED PLOT*



*# Now to save, run first line below and return to keep running. See your folder.*  
**png**(file="Engconcs\_highres.png", units="in", width=13, height=13, res=900)  
**plot**(Engconcs)  
**dev.off**()

## png   
## 2

*# ON DUTCH NORMS*  
  
*# properties*  
*# check conditions for a PCA*  
  
*# matrix*  
prop <- all[all$cat == 'prop', **c**('Auditory', 'Haptic', 'Visual')]  
**nrow**(prop)

## [1] 343

prop\_matrix <- **cor**(prop, use = 'complete.obs')  
prop\_matrix

## Auditory Haptic Visual  
## Auditory 1.0000000 -0.2280165 -0.5134304  
## Haptic -0.2280165 1.0000000 0.1930402  
## Visual -0.5134304 0.1930402 1.0000000

**round**(prop\_matrix, 2)

## Auditory Haptic Visual  
## Auditory 1.00 -0.23 -0.51  
## Haptic -0.23 1.00 0.19  
## Visual -0.51 0.19 1.00

*# POOR: correlations not apt for a PCA, with too many below .3*  
  
*# now on the raw vars:*  
**nrow**(prop)

## [1] 343

**cortest.bartlett**(prop)

## R was not square, finding R from data

## $chisq  
## [1] 125.0759  
##   
## $p.value  
## [1] 6.224181e-27  
##   
## $df  
## [1] 3

*# GOOD: Bartlett's test significant*   
  
*# KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy*  
**KMO**(prop\_matrix)

## Kaiser-Meyer-Olkin factor adequacy  
## Call: KMO(r = prop\_matrix)  
## Overall MSA = 0.56  
## MSA for each item =   
## Auditory Haptic Visual   
## 0.54 0.74 0.55

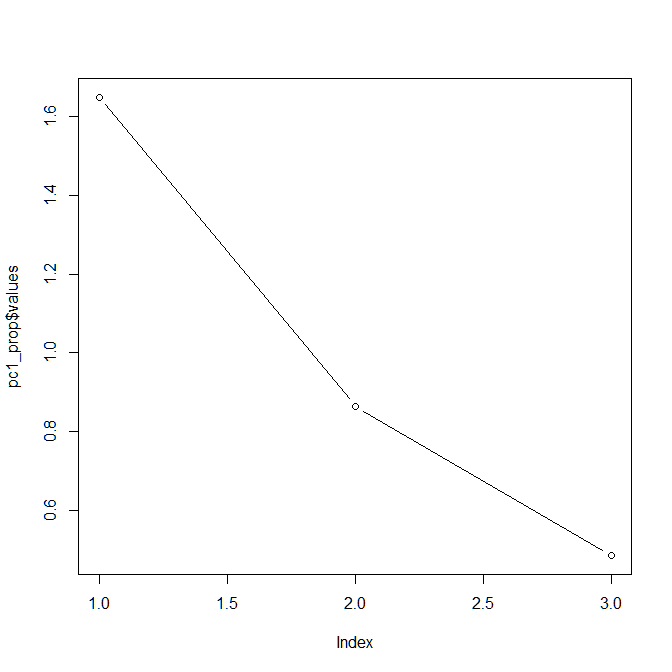
*# Result: .56 = mediocre. PCA not strongly recommended. But we still do it*  
*# because the purpose is graphical only.*  
  
*# check determinant*  
**det**(prop\_matrix)

## [1] 0.6923318

*# GOOD: >0.00001*  
  
*# start off with unrotated PCA*  
pc1\_prop <- psych::**principal**(prop, nfactors = 3, rotate = "none")  
pc1\_prop

## Principal Components Analysis  
## Call: psych::principal(r = prop, nfactors = 3, rotate = "none")  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## PC1 PC2 PC3 h2 u2 com  
## Auditory -0.83 0.23 0.50 1 0.0e+00 1.8  
## Haptic 0.54 0.84 0.04 1 -1.6e-15 1.7  
## Visual 0.82 -0.31 0.48 1 -8.9e-16 2.0  
##   
## PC1 PC2 PC3  
## SS loadings 1.65 0.86 0.49  
## Proportion Var 0.55 0.29 0.16  
## Cumulative Var 0.55 0.84 1.00  
## Proportion Explained 0.55 0.29 0.16  
## Cumulative Proportion 0.55 0.84 1.00  
##   
## Mean item complexity = 1.8  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0   
## with the empirical chi square 0 with prob < NA   
##   
## Fit based upon off diagonal values = 1

*# RESULT: Only PC1, with eigenvalue > 1, should be extracted,*   
*# acc to Kaiser's criterion (Jolliffe's threshold of 0.7 way too lax;*   
*# Field, Miles, & Field, 2012)*  
  
*# Unrotated: scree plot*  
**plot**(pc1\_prop$values, type = "b")



*# Result: one or two RCs should be extracted, converging with eigenvalues*  
  
*# Now with varimax rotation, Kaiser-normalized (by default).*   
*# Always preferable because it captures explained variance best.*   
*# Compare eigenvalues w/ 1 & 2 factors*  
  
pc2\_prop <- psych::**principal**(prop, nfactors = 2, rotate = "varimax", scores = TRUE)  
pc2\_prop

## Principal Components Analysis  
## Call: psych::principal(r = prop, nfactors = 2, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC1 RC2 h2 u2 com  
## Auditory -0.85 -0.16 0.75 0.2498 1.1  
## Haptic 0.11 0.99 1.00 0.0016 1.0  
## Visual 0.87 0.08 0.77 0.2337 1.0  
##   
## RC1 RC2  
## SS loadings 1.5 1.02  
## Proportion Var 0.5 0.34  
## Cumulative Var 0.5 0.84  
## Proportion Explained 0.6 0.40  
## Cumulative Proportion 0.6 1.00  
##   
## Mean item complexity = 1  
## Test of the hypothesis that 2 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.14   
## with the empirical chi square 40.59 with prob < NA   
##   
## Fit based upon off diagonal values = 0.83

pc2\_prop$loadings

##   
## Loadings:  
## RC1 RC2   
## Auditory -0.852 -0.158  
## Haptic 0.107 0.993  
## Visual 0.872   
##   
## RC1 RC2  
## SS loadings 1.497 1.018  
## Proportion Var 0.499 0.339  
## Cumulative Var 0.499 0.838

*# good to extract 2 factors, as they both explain quite the same variance,*  
*# and both surpass 1 eigenvalue*  
  
  
pc2\_prop$residual

## Auditory Haptic Visual  
## Auditory 0.24984223 0.020051207 0.24163179  
## Haptic 0.02005121 0.001609219 0.01939227  
## Visual 0.24163179 0.019392274 0.23369117

pc2\_prop$fit

## [1] 0.9364867

pc2\_prop$communality

## Auditory Haptic Visual   
## 0.7501578 0.9983908 0.7663088

*# Results based on a Kaiser-normalizalized orthogonal (varimax) rotation*  
*# (by default in psych::stats). Residuals OK: fewer than 50% have absolute*   
*# values > 0.05 (exactly 50% do).Model fit good, > .90.*   
*# Communalities good, all > .7 (av = .83).*   
  
*# subset and add PCs*  
props <- all[all$cat == 'prop', ]  
**nrow**(props)

## [1] 343

props <- **cbind**(props, pc2\_prop$scores)  
**nrow**(props)

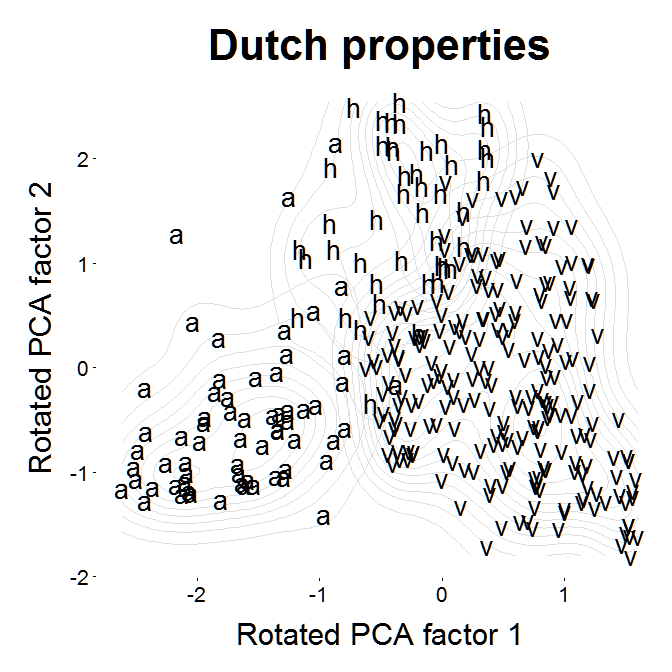
## [1] 343

*# Finally, plot: letters+density (cf. Lynott & Connell, 2009, 2013)*  
  
NLprops <- **ggplot**(props,  
 **aes**(RC1, RC2, label = **as.character**(main))) +  
 **aes** (x = RC1, y = RC2, by = main) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('Dutch properties') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "Rotated PCA factor 1", y = "Rotated PCA factor 2") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))

NLprops *# ! THE PLOT IS SHOWN BADLY ON HERE. PLEASE SEE THE SAVED PLOT*

## Warning: Removed 7 rows containing non-finite values (stat\_density2d).

## Warning: Removed 7 rows containing missing values (geom\_text).



*# Now to save, run first line below and return to keep running. See your folder.*  
**png**(file="NLprops\_highres.png", units="in", width=13, height=13, res=900)  
**plot**(NLprops)

## Warning: Removed 7 rows containing non-finite values (stat\_density2d).  
  
## Warning: Removed 7 rows containing missing values (geom\_text).

*# warning normal: just removing English properties not used in Dutch*  
**dev.off**()

## png   
## 2

*# Adjust for combined plots:*  
  
NLprops2 <- **ggplot**(props,  
 **aes**(RC1, RC2, label = **as.character**(main))) +  
 **aes** (x = RC1, y = RC2, by = main) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('Dutch properties') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "Rotated PCA factor 1", y = "") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))  
  
*# Next:*  
  
NLprops4 <- **ggplot**(props,  
 **aes**(RC1, RC2, label = **as.character**(main))) +  
 **aes** (x = RC1, y = RC2, by = main) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('Dutch properties') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "", y = "") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))  
  
  
  
*# CONCEPTS*  
*# check conditions for a PCA*  
*# matrix*  
conc <- all[all$cat == 'conc', **c**('Auditory', 'Haptic', 'Visual')]  
**nrow**(conc)

## [1] 416

conc\_matrix <- **cor**(conc, use = 'complete.obs')  
conc\_matrix

## Auditory Haptic Visual  
## Auditory 1.000000000 -0.008508063 0.08486561  
## Haptic -0.008508063 1.000000000 0.44144835  
## Visual 0.084865608 0.441448353 1.00000000

**round**(conc\_matrix, 2)

## Auditory Haptic Visual  
## Auditory 1.00 -0.01 0.08  
## Haptic -0.01 1.00 0.44  
## Visual 0.08 0.44 1.00

*# POOR: correlations not apt for a PCA, with too many below .3*  
  
*# now on the raw data:*  
**nrow**(conc)

## [1] 416

**cortest.bartlett**(conc)

## R was not square, finding R from data

## $chisq  
## [1] 93.63824  
##   
## $p.value  
## [1] 3.621992e-20  
##   
## $df  
## [1] 3

*# GOOD: Bartlett's test significant*   
  
*# KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy*  
**KMO**(conc\_matrix)

## Kaiser-Meyer-Olkin factor adequacy  
## Call: KMO(r = conc\_matrix)  
## Overall MSA = 0.49  
## MSA for each item =   
## Auditory Haptic Visual   
## 0.37 0.49 0.49

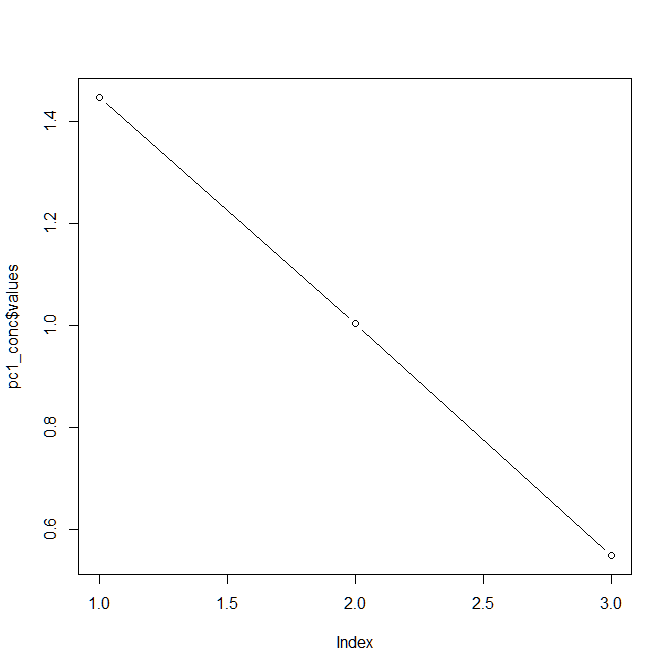
*# Result: .49 = poor. PCA not strongly recommended. But we still do it*  
*# because the purpose is graphical really.*  
  
*# check determinant*  
**det**(conc\_matrix)

## [1] 0.7972113

*# GOOD: >0.00001*  
  
*# start off with unrotated PCA*  
pc1\_conc <- psych::**principal**(conc, nfactors = 3, rotate = "none")  
pc1\_conc

## Principal Components Analysis  
## Call: psych::principal(r = conc, nfactors = 3, rotate = "none")  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## PC1 PC2 PC3 h2 u2 com  
## Auditory 0.15 0.98 0.11 1 1.1e-16 1.1  
## Haptic 0.84 -0.19 0.51 1 4.4e-16 1.8  
## Visual 0.85 0.02 -0.52 1 0.0e+00 1.7  
##   
## PC1 PC2 PC3  
## SS loadings 1.45 1.00 0.55  
## Proportion Var 0.48 0.33 0.18  
## Cumulative Var 0.48 0.82 1.00  
## Proportion Explained 0.48 0.33 0.18  
## Cumulative Proportion 0.48 0.82 1.00  
##   
## Mean item complexity = 1.5  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0   
## with the empirical chi square 0 with prob < NA   
##   
## Fit based upon off diagonal values = 1

*# RESULT good: PC1 and PC2, with eigenvalue > 1, should be extracted,*   
*# acc to Kaiser's criterion (Jolliffe's threshold of 0.7 way too lax;*   
*# Field, Miles, & Field, 2012)*  
  
*# Unrotated: scree plot*  
**plot**(pc1\_conc$values, type = "b")



*# Result: with no point of inflexion along the y axis, two PCs would obtain.*  
  
*# Now with varimax rotation, Kaiser-normalized (by default):*  
*# Always preferable because it captures explained variance best.*   
*# Compare eigenvalues w/ 1 & 2 factors*  
  
pc2\_conc <- psych::**principal**(conc, nfactors = 2, rotate = "varimax", scores = TRUE)  
pc2\_conc

## Principal Components Analysis  
## Call: psych::principal(r = conc, nfactors = 2, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC1 RC2 h2 u2 com  
## Auditory 0.03 0.99 0.99 0.012 1  
## Haptic 0.85 -0.09 0.74 0.264 1  
## Visual 0.84 0.12 0.73 0.273 1  
##   
## RC1 RC2  
## SS loadings 1.44 1.01  
## Proportion Var 0.48 0.34  
## Cumulative Var 0.48 0.82  
## Proportion Explained 0.59 0.41  
## Cumulative Proportion 0.59 1.00  
##   
## Mean item complexity = 1  
## Test of the hypothesis that 2 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.16   
## with the empirical chi square 65.21 with prob < NA   
##   
## Fit based upon off diagonal values = 0.61

pc2\_conc$loadings

##   
## Loadings:  
## RC1 RC2   
## Auditory 0.994  
## Haptic 0.854   
## Visual 0.844 0.120  
##   
## RC1 RC2  
## SS loadings 1.442 1.010  
## Proportion Var 0.481 0.337  
## Cumulative Var 0.481 0.817

*# good to extract 2 factors, as they both explain quite the same variance,*   
*# and both surpass 1 eigenvalue*  
  
pc2\_conc$residual

## Auditory Haptic Visual  
## Auditory 0.01167046 0.0554842 -0.05648251  
## Haptic 0.05548420 0.2637854 -0.26853166  
## Visual -0.05648251 -0.2685317 0.27336330

pc2\_conc$fit

## [1] 0.911523

pc2\_conc$communality

## Auditory Haptic Visual   
## 0.9883295 0.7362146 0.7266367

*# Results based on a Kaiser-normalizalized orthogonal (varimax) rotation*  
*# (by default in psych::stats). Residuals bad: over 50% have absolute*   
*# values > 0.05. Model fit good, > .90. Communalities good, all > .7 (av = .82).*   
  
*# subset and add PCs*  
concs <- all[all$cat == 'conc', ]  
**nrow**(concs)

## [1] 416

concs <- **cbind**(concs, pc2\_conc$scores)  
**nrow**(concs)

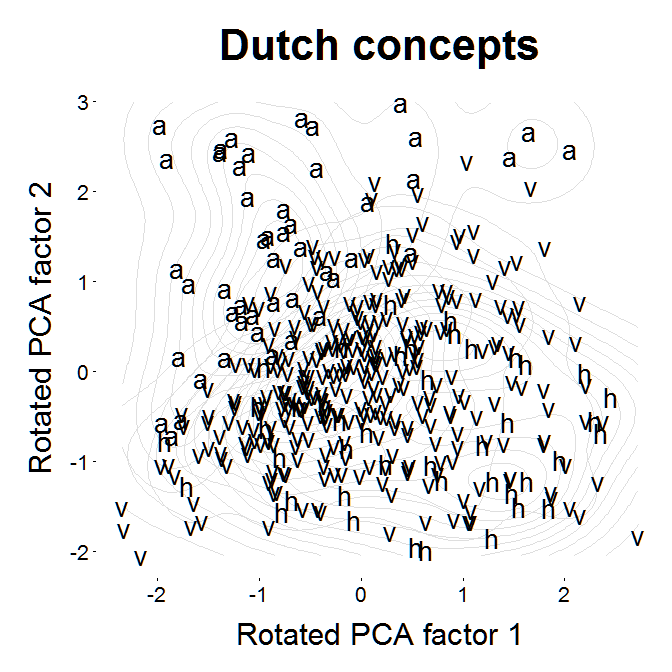
## [1] 416

*# Finally, plot*  
NLconcs <- **ggplot**(concs,  
 **aes**(RC1, RC2, label = **as.character**(main))) +  
 **aes** (x = RC1, y = RC2, by = main) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('Dutch concepts') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "Rotated PCA factor 1", y = "Rotated PCA factor 2") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))

NLconcs *# ! THE PLOT IS SHOWN BADLY ON HERE. PLEASE SEE THE SAVED PLOT*

## Warning: Removed 5 rows containing non-finite values (stat\_density2d).

## Warning: Removed 5 rows containing missing values (geom\_text).



*# Now to save, run first line below and return to keep running. See your folder.*  
**png**(file="NLconcs\_highres.png", units="in", width=13, height=13, res=900)  
**plot**(NLconcs)

## Warning: Removed 5 rows containing non-finite values (stat\_density2d).  
  
## Warning: Removed 5 rows containing missing values (geom\_text).

*# warning normal: just removing English concepts not used in Dutch*  
**dev.off**()

## png   
## 2

*# Adjust for combined plots:*  
  
NLconcs2 <- **ggplot**(concs,  
 **aes**(RC1, RC2, label = **as.character**(main))) +  
 **aes** (x = RC1, y = RC2, by = main) + **stat\_density2d** (color = "gray87") +  
 **geom\_text**(size = 7) +  
 **ggtitle** ('Dutch concepts') +  
 **theme\_bw**() + *# theme with white background*  
 **theme**( *# clear background, gridlines, chart border*  
 plot.background = **element\_blank**()  
 ,panel.grid.major = **element\_blank**()  
 ,panel.grid.minor = **element\_blank**()  
 ,panel.border = **element\_blank**()  
 ) +  
 **theme**(axis.line = **element\_line**(color = 'black')) + *# draw x and y lines*  
 **theme**(axis.title.x = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.title.y = **element\_text**(colour = 'black', size = 23,   
 margin=**margin**(15,15,15,15)),  
 axis.text.x = **element\_text**(size=16),  
 axis.text.y = **element\_text**(size=16)) +  
 **labs**(x = "Rotated PCA factor 1", y = "") +  
 **theme**(plot.title = **element\_text**(size = 32, face = "bold",   
 margin=**margin**(15,15,15,15)))  
  
  
  
*# Combined plots:*  
  
*# Below, run first line, get back and run next.*   
*# High resolution (may be changed at 'res='). Beware of high memory usage.*  
  
**png**(file="allfour\_highres.png", units="in", width=19, height=19, res=1200)  
**multiplot**(Engprops4, Engconcs, NLprops4, NLconcs2, cols = 2)

## Warning: Removed 7 rows containing non-finite values (stat\_density2d).

## Warning: Removed 7 rows containing missing values (geom\_text).

## Warning: Removed 5 rows containing non-finite values (stat\_density2d).

## Warning: Removed 5 rows containing missing values (geom\_text).

*# warning normal: just those English items that were not used in Dutch*  
**dev.off**()

## png   
## 2

**png**(file="proppair\_highres.png", units="in", width=18, height=9, res=1000)  
**multiplot**(Engprops, NLprops2, cols = 2)

## Warning: Removed 7 rows containing non-finite values (stat\_density2d).

## Warning: Removed 7 rows containing missing values (geom\_text).

*# warning normal: just those English items that were not used in Dutch*  
**dev.off**()

## png   
## 2

**png**(file="concpair\_highres.png", units="in", width=18, height=9, res=1000)  
**multiplot**(Engconcs, NLconcs2, cols = 2)

## Warning: Removed 5 rows containing non-finite values (stat\_density2d).

## Warning: Removed 5 rows containing missing values (geom\_text).

*# warning normal: just those English items that were not used in Dutch*  
**dev.off**()

## png   
## 2

*# Find all plots in your working directory*  
  
*# With a naked eye, one can see the different relationships. The significance of*   
*# these comparisons is notable. First, it demonstrates visually the difference*   
*# between modality exclusivity and each of the modality strengths (which of course*   
*# is only natural considering how modality exclusivity was calculated). The two*   
*# variables then must be different indeed because in the exclusivity analysis, the*   
*# visual and the auditory modalities were the most similar ones, with their higher*   
*# exclusivities. In contrast, in the independent strengths analysis, the visual and*   
*# the haptic modalities show a clear interlock, which leaves the auditory experience*   
*# rather on its own.*  
*# \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  
  
  
  
*# ICONICITY*  
  
*# Last tests: iconicity/sound symbolism on concepts and properties separately.*  
*# Regressions include same lexical vars (DVs) as Lynott and Connell, plus*   
*# concreteness and age of acquisition.*  
  
*# Note that the selection is based on p-value thresholds, as in L&C, but also on*  
*# AIC, which is a bayesian, relative method more appropriate with such a large*  
*# sample. Importantly, AIC and F/p-value criteria resulted in the same inclusions*   
*# and exclusions for every regression.*  
  
*# For both props and concs, we start with PCA with all lexical variables in order*  
*# to isolate them, because they are intercorrelated (see Table 5 in Lynott & Connell,*  
*# 2013)*  
  
all <- **read.csv**('all.csv')  
**nrow**(all)

## [1] 759

*# Length is 759 but only 747 are from these norms. Rest are from Lynott and Connell*   
*# (2009, 2013) for comparative analyses. These extra items do not have an id number*   
*# in the file.*

*# Iconicity within properties alone, as in Lynott and Connell (2013). As a novelty,*   
*# the iconicity analysis is hereby performed also on the Dutch properties, in*   
*# addition to the concepts.*  
  
props <- **subset**(all, subset = cat == 'prop')  
**nrow**(props)

## [1] 343

*# There aren't lexical data for every single word.*  
*# Nr of properties per lexical variable (from the Dutch items only of course)*  
**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$phonemes\_DUTCHPOND))

## complete.cases(props[complete.cases(props$Exclusivity), ]$phonemes\_DUTCHPOND)   
## n missing unique   
## 336 0 2   
##   
## FALSE (151, 45%), TRUE (185, 55%)

**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$phon\_neighbours\_DUTCHPOND))

## complete.cases(props[complete.cases(props$Exclusivity), ]$phon\_neighbours\_DUTCHPOND)   
## n missing unique value   
## 336 0 1 TRUE

**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$orth\_neighbours\_DUTCHPOND))

## complete.cases(props[complete.cases(props$Exclusivity), ]$orth\_neighbours\_DUTCHPOND)   
## n missing unique value   
## 336 0 1 TRUE

**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$freq\_lg10CD\_SUBTLEXNL))

## complete.cases(props[complete.cases(props$Exclusivity), ]$freq\_lg10CD\_SUBTLEXNL)   
## n missing unique   
## 336 0 2   
##   
## FALSE (46, 14%), TRUE (290, 86%)

**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$freq\_lg10WF\_SUBTLEXNL))

## complete.cases(props[complete.cases(props$Exclusivity), ]$freq\_lg10WF\_SUBTLEXNL)   
## n missing unique   
## 336 0 2   
##   
## FALSE (46, 14%), TRUE (290, 86%)

**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$freq\_CELEX\_lem))

## complete.cases(props[complete.cases(props$Exclusivity), ]$freq\_CELEX\_lem)   
## n missing unique   
## 336 0 2   
##   
## FALSE (89, 26%), TRUE (247, 74%)

**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$AoA\_Brysbaertetal2014))

## complete.cases(props[complete.cases(props$Exclusivity), ]$AoA\_Brysbaertetal2014)   
## n missing unique   
## 336 0 2   
##   
## FALSE (103, 31%), TRUE (233, 69%)

**describe**(**complete.cases**(props[**complete.cases**(props$Exclusivity),]  
$concrete\_Brysbaertetal2014))

## complete.cases(props[complete.cases(props$Exclusivity), ]$concrete\_Brysbaertetal2014)   
## n missing unique   
## 336 0 2   
##   
## FALSE (103, 31%), TRUE (233, 69%)

*# M, SD*  
**stat.desc**(props$letters)

## nbr.val nbr.null nbr.na min max   
## 336.0000000 0.0000000 7.0000000 3.0000000 14.0000000   
## range sum median mean SE.mean   
## 11.0000000 2391.0000000 7.0000000 7.1160714 0.1234165   
## CI.mean.0.95 var std.dev coef.var   
## 0.2427690 5.1178305 2.2622623 0.3179089

**stat.desc**(props$phonemes\_DUTCHPOND)

## nbr.val nbr.null nbr.na min max   
## 185.0000000 0.0000000 158.0000000 2.0000000 11.0000000   
## range sum median mean SE.mean   
## 9.0000000 996.0000000 5.0000000 5.3837838 0.1433762   
## CI.mean.0.95 var std.dev coef.var   
## 0.2828727 3.8029965 1.9501273 0.3622224

**stat.desc**(props$phon\_neighbours\_DUTCHPOND)

## nbr.val nbr.null nbr.na min max   
## 336.0000000 106.0000000 7.0000000 0.0000000 42.0000000   
## range sum median mean SE.mean   
## 42.0000000 1536.0000000 1.0000000 4.5714286 0.4126023   
## CI.mean.0.95 var std.dev coef.var   
## 0.8116178 57.2008529 7.5631245 1.6544335

**stat.desc**(props$orth\_neighbours\_DUTCHPOND)

## nbr.val nbr.null nbr.na min max   
## 336.0000000 102.0000000 7.0000000 0.0000000 24.0000000   
## range sum median mean SE.mean   
## 24.0000000 1115.0000000 1.0000000 3.3184524 0.2655425   
## CI.mean.0.95 var std.dev coef.var   
## 0.5223409 23.6923152 4.8674752 1.4667907

**stat.desc**(props$freq\_lg10CD\_SUBTLEXNL)

## nbr.val nbr.null nbr.na min max   
## 290.00000000 0.00000000 53.00000000 0.30000000 3.86000000   
## range sum median mean SE.mean   
## 3.56000000 521.89000000 1.61000000 1.79962069 0.05958115   
## CI.mean.0.95 var std.dev coef.var   
## 0.11726801 1.02947494 1.01463045 0.56380239

**stat.desc**(props$freq\_lg10WF\_SUBTLEXNL)

## nbr.val nbr.null nbr.na min max   
## 290.00000000 0.00000000 53.00000000 0.30000000 4.64000000   
## range sum median mean SE.mean   
## 4.34000000 545.51000000 1.69000000 1.88106897 0.06419049   
## CI.mean.0.95 var std.dev coef.var   
## 0.12634014 1.19492169 1.09312474 0.58111890

**stat.desc**(props$freq\_CELEX\_lem)

## nbr.val nbr.null nbr.na min max   
## 247.00000000 40.00000000 96.00000000 0.00000000 3.08600000   
## range sum median mean SE.mean   
## 3.08600000 266.89000000 0.95400000 1.08052632 0.05081189   
## CI.mean.0.95 var std.dev coef.var   
## 0.10008186 0.63771661 0.79857160 0.73905799

**stat.desc**(props$AoA\_Brysbaertetal2014)

## nbr.val nbr.null nbr.na min max   
## 233.0000000 0.0000000 110.0000000 3.9100000 14.0800000   
## range sum median mean SE.mean   
## 10.1700000 1857.6700000 8.0900000 7.9728326 0.1394971   
## CI.mean.0.95 var std.dev coef.var   
## 0.2748431 4.5340523 2.1293314 0.2670734

**stat.desc**(props$concrete\_Brysbaertetal2014)

## nbr.val nbr.null nbr.na min max   
## 233.00000000 0.00000000 110.00000000 1.33000000 4.67000000   
## range sum median mean SE.mean   
## 3.34000000 761.91000000 3.40000000 3.27000000 0.04601172   
## CI.mean.0.95 var std.dev coef.var   
## 0.09065422 0.49327931 0.70233846 0.21478240

*# See and print correlation of all lexical variables:*  
  
mat\_lexicals\_props <- **as.matrix**(props[**c**('letters', 'phonemes\_DUTCHPOND',   
'orth\_neighbours\_DUTCHPOND', 'phon\_neighbours\_DUTCHPOND', 'freq\_lg10CD\_SUBTLEXNL',   
'freq\_lg10WF\_SUBTLEXNL', 'freq\_CELEX\_lem', 'AoA\_Brysbaertetal2014',   
'concrete\_Brysbaertetal2014')])  
  
**rcor.test**(mat\_lexicals\_props, use='complete.obs')

##   
## letters phonemes\_DUTCHPOND  
## letters \*\*\*\*\* 0.940   
## phonemes\_DUTCHPOND <0.001 \*\*\*\*\*   
## orth\_neighbours\_DUTCHPOND <0.001 <0.001   
## phon\_neighbours\_DUTCHPOND <0.001 <0.001   
## freq\_lg10CD\_SUBTLEXNL <0.001 <0.001   
## freq\_lg10WF\_SUBTLEXNL <0.001 <0.001   
## freq\_CELEX\_lem <0.001 <0.001   
## AoA\_Brysbaertetal2014 <0.001 <0.001   
## concrete\_Brysbaertetal2014 0.300 0.187   
## orth\_neighbours\_DUTCHPOND  
## letters -0.727   
## phonemes\_DUTCHPOND -0.716   
## orth\_neighbours\_DUTCHPOND \*\*\*\*\*   
## phon\_neighbours\_DUTCHPOND <0.001   
## freq\_lg10CD\_SUBTLEXNL <0.001   
## freq\_lg10WF\_SUBTLEXNL <0.001   
## freq\_CELEX\_lem <0.001   
## AoA\_Brysbaertetal2014 <0.001   
## concrete\_Brysbaertetal2014 0.168   
## phon\_neighbours\_DUTCHPOND freq\_lg10CD\_SUBTLEXNL  
## letters -0.703 -0.508   
## phonemes\_DUTCHPOND -0.732 -0.486   
## orth\_neighbours\_DUTCHPOND 0.895 0.467   
## phon\_neighbours\_DUTCHPOND \*\*\*\*\* 0.477   
## freq\_lg10CD\_SUBTLEXNL <0.001 \*\*\*\*\*   
## freq\_lg10WF\_SUBTLEXNL <0.001 <0.001   
## freq\_CELEX\_lem <0.001 <0.001   
## AoA\_Brysbaertetal2014 <0.001 <0.001   
## concrete\_Brysbaertetal2014 0.060 0.088   
## freq\_lg10WF\_SUBTLEXNL freq\_CELEX\_lem  
## letters -0.509 -0.550   
## phonemes\_DUTCHPOND -0.486 -0.555   
## orth\_neighbours\_DUTCHPOND 0.470 0.518   
## phon\_neighbours\_DUTCHPOND 0.478 0.517   
## freq\_lg10CD\_SUBTLEXNL 0.995 0.838   
## freq\_lg10WF\_SUBTLEXNL \*\*\*\*\* 0.832   
## freq\_CELEX\_lem <0.001 \*\*\*\*\*   
## AoA\_Brysbaertetal2014 <0.001 <0.001   
## concrete\_Brysbaertetal2014 0.097 0.270   
## AoA\_Brysbaertetal2014  
## letters 0.405   
## phonemes\_DUTCHPOND 0.457   
## orth\_neighbours\_DUTCHPOND -0.417   
## phon\_neighbours\_DUTCHPOND -0.438   
## freq\_lg10CD\_SUBTLEXNL -0.654   
## freq\_lg10WF\_SUBTLEXNL -0.646   
## freq\_CELEX\_lem -0.700   
## AoA\_Brysbaertetal2014 \*\*\*\*\*   
## concrete\_Brysbaertetal2014 <0.001   
## concrete\_Brysbaertetal2014  
## letters -0.090   
## phonemes\_DUTCHPOND -0.090   
## orth\_neighbours\_DUTCHPOND 0.118   
## phon\_neighbours\_DUTCHPOND 0.156   
## freq\_lg10CD\_SUBTLEXNL -0.166   
## freq\_lg10WF\_SUBTLEXNL -0.161   
## freq\_CELEX\_lem -0.100   
## AoA\_Brysbaertetal2014 -0.254   
## concrete\_Brysbaertetal2014 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

corrs\_props = **rcor.test**(mat\_lexicals\_props, use='complete.obs')  
**write.csv**(corrs\_props$cor.mat, file = "corrs\_props.csv",na="") *# find table in folder*  
*# (saved just for the manuscript)*  
  
  
*# go on to PCA. This does not include age of acquisition or concreteness for a*   
*# better comparison with the English data, and because no correlations > .7 (i.e. half*  
*# of variance explained)*  
  
lexicals\_props <- props[**c**('letters', 'phonemes\_DUTCHPOND', 'orth\_neighbours\_DUTCHPOND',   
'phon\_neighbours\_DUTCHPOND', 'freq\_lg10CD\_SUBTLEXNL', 'freq\_lg10WF\_SUBTLEXNL',   
'freq\_CELEX\_lem')]  
  
**str**(lexicals\_props)

## 'data.frame': 343 obs. of 7 variables:  
## $ letters : int 5 11 5 8 7 5 11 10 10 7 ...  
## $ phonemes\_DUTCHPOND : int 4 NA 5 NA 6 4 NA 10 NA 7 ...  
## $ orth\_neighbours\_DUTCHPOND: int 6 1 1 2 6 1 0 2 1 1 ...  
## $ phon\_neighbours\_DUTCHPOND: int 4 1 1 2 3 1 0 1 1 1 ...  
## $ freq\_lg10CD\_SUBTLEXNL : num 1.53 0.3 1.97 0.3 1.45 1.76 1.26 2.06 0.3 1.79 ...  
## $ freq\_lg10WF\_SUBTLEXNL : num 1.71 0.3 2.55 0.3 1.52 1.88 1.26 2.14 0.3 1.84 ...  
## $ freq\_CELEX\_lem : num 1.431 NA 0 NA 0.699 ...

*# start with PCA for lexical variables, done as in Lynott and Connell (2013)*  
*# Check conditions for a PCA*  
*# Correlations*  
  
**cor**(lexicals\_props, use = 'complete.obs')

## letters phonemes\_DUTCHPOND  
## letters 1.0000000 0.9410143  
## phonemes\_DUTCHPOND 0.9410143 1.0000000  
## orth\_neighbours\_DUTCHPOND -0.7263499 -0.7167381  
## phon\_neighbours\_DUTCHPOND -0.7002995 -0.7304257  
## freq\_lg10CD\_SUBTLEXNL -0.5166005 -0.4955464  
## freq\_lg10WF\_SUBTLEXNL -0.5177211 -0.4961595  
## freq\_CELEX\_lem -0.5569857 -0.5623170  
## orth\_neighbours\_DUTCHPOND  
## letters -0.7263499  
## phonemes\_DUTCHPOND -0.7167381  
## orth\_neighbours\_DUTCHPOND 1.0000000  
## phon\_neighbours\_DUTCHPOND 0.8960621  
## freq\_lg10CD\_SUBTLEXNL 0.4715896  
## freq\_lg10WF\_SUBTLEXNL 0.4739747  
## freq\_CELEX\_lem 0.5187955  
## phon\_neighbours\_DUTCHPOND freq\_lg10CD\_SUBTLEXNL  
## letters -0.7002995 -0.5166005  
## phonemes\_DUTCHPOND -0.7304257 -0.4955464  
## orth\_neighbours\_DUTCHPOND 0.8960621 0.4715896  
## phon\_neighbours\_DUTCHPOND 1.0000000 0.4814090  
## freq\_lg10CD\_SUBTLEXNL 0.4814090 1.0000000  
## freq\_lg10WF\_SUBTLEXNL 0.4826222 0.9947196  
## freq\_CELEX\_lem 0.5185262 0.8423256  
## freq\_lg10WF\_SUBTLEXNL freq\_CELEX\_lem  
## letters -0.5177211 -0.5569857  
## phonemes\_DUTCHPOND -0.4961595 -0.5623170  
## orth\_neighbours\_DUTCHPOND 0.4739747 0.5187955  
## phon\_neighbours\_DUTCHPOND 0.4826222 0.5185262  
## freq\_lg10CD\_SUBTLEXNL 0.9947196 0.8423256  
## freq\_lg10WF\_SUBTLEXNL 1.0000000 0.8357985  
## freq\_CELEX\_lem 0.8357985 1.0000000

*# Result: all variables fit for PCA, as they have few scores below .3*   
*# The correlations broadly replicate Lynott and Connell.*   
  
*# now on the raw vars:*  
**cortest.bartlett**(lexicals\_props)

## R was not square, finding R from data

## $chisq  
## [1] 4265.57  
##   
## $p.value  
## [1] 0  
##   
## $df  
## [1] 21

*# GOOD: Bartlett's test significant*   
  
*# KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy*  
lexicals\_props\_matrix <- **cor**(lexicals\_props, use = 'complete.obs')  
**KMO**(lexicals\_props\_matrix)

## Kaiser-Meyer-Olkin factor adequacy  
## Call: KMO(r = lexicals\_props\_matrix)  
## Overall MSA = 0.78  
## MSA for each item =   
## letters phonemes\_DUTCHPOND   
## 0.76 0.75   
## orth\_neighbours\_DUTCHPOND phon\_neighbours\_DUTCHPOND   
## 0.78 0.77   
## freq\_lg10CD\_SUBTLEXNL freq\_lg10WF\_SUBTLEXNL   
## 0.73 0.73   
## freq\_CELEX\_lem   
## 0.97

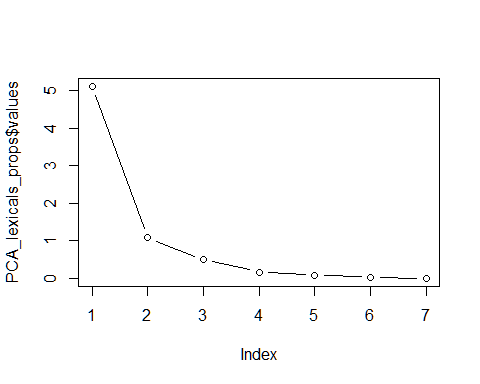
*# Result: .78 = good.*  
  
*# determinant*  
**det**(lexicals\_props\_matrix)

## [1] 1.766926e-05

*# GOOD: above 0.00001*  
  
*# start off with unrotated PCA*  
  
PCA\_lexicals\_props <- psych::**principal**(lexicals\_props, nfactors = 7, scores = TRUE)  
PCA\_lexicals\_props

## Principal Components Analysis  
## Call: psych::principal(r = lexicals\_props, nfactors = 7, scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC4 RC3 RC1 RC2 RC5 RC6 RC7 h2  
## letters -0.35 0.86 -0.33 -0.03 -0.04 0.15 0.00 1  
## phonemes\_DUTCHPOND -0.23 0.88 -0.38 -0.11 0.04 -0.14 0.00 1  
## orth\_neighbours\_DUTCHPOND 0.28 -0.37 0.86 0.09 0.20 -0.02 0.00 1  
## phon\_neighbours\_DUTCHPOND 0.30 -0.36 0.86 0.06 -0.20 0.02 0.00 1  
## freq\_lg10CD\_SUBTLEXNL 0.94 -0.25 0.24 0.02 0.00 0.00 -0.04 1  
## freq\_lg10WF\_SUBTLEXNL 0.94 -0.25 0.24 0.01 0.00 -0.01 0.04 1  
## freq\_CELEX\_lem 0.78 -0.25 0.29 0.49 0.00 0.00 0.00 1  
## u2 com  
## letters 1.1e-16 1.7  
## phonemes\_DUTCHPOND 1.6e-15 1.6  
## orth\_neighbours\_DUTCHPOND 1.2e-15 1.8  
## phon\_neighbours\_DUTCHPOND 1.4e-15 1.8  
## freq\_lg10CD\_SUBTLEXNL 1.4e-15 1.3  
## freq\_lg10WF\_SUBTLEXNL 1.6e-15 1.3  
## freq\_CELEX\_lem 1.6e-15 2.2  
##   
## RC4 RC3 RC1 RC2 RC5 RC6 RC7  
## SS loadings 2.71 1.98 1.92 0.27 0.08 0.04 0  
## Proportion Var 0.39 0.28 0.27 0.04 0.01 0.01 0  
## Cumulative Var 0.39 0.67 0.94 0.98 0.99 1.00 1  
## Proportion Explained 0.39 0.28 0.27 0.04 0.01 0.01 0  
## Cumulative Proportion 0.39 0.67 0.94 0.98 0.99 1.00 1  
##   
## Mean item complexity = 1.7  
## Test of the hypothesis that 7 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0   
## with the empirical chi square 0 with prob < NA   
##   
## Fit based upon off diagonal values = 1

*# By all standards, extract 3 components*  
  
  
*# scree analysis*  
**plot**(PCA\_lexicals\_props$values, type = "b")



*# result: again, extract 3 components*  
  
  
PCA\_lexicals\_props <- psych::**principal**(lexicals\_props, nfactors = 3, rotate =   
"varimax", scores = TRUE)  
  
PCA\_lexicals\_props *# eigenvalues and exp variances good*

## Principal Components Analysis  
## Call: psych::principal(r = lexicals\_props, nfactors = 3, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC2 RC1 RC3 h2 u2 com  
## letters -0.35 0.86 -0.33 0.98 0.024 1.6  
## phonemes\_DUTCHPOND -0.25 0.87 -0.39 0.98 0.025 1.6  
## orth\_neighbours\_DUTCHPOND 0.29 -0.37 0.86 0.96 0.042 1.6  
## phon\_neighbours\_DUTCHPOND 0.31 -0.36 0.86 0.96 0.040 1.6  
## freq\_lg10CD\_SUBTLEXNL 0.93 -0.25 0.23 0.98 0.023 1.3  
## freq\_lg10WF\_SUBTLEXNL 0.93 -0.25 0.23 0.98 0.024 1.3  
## freq\_CELEX\_lem 0.85 -0.24 0.31 0.88 0.120 1.4  
##   
## RC2 RC1 RC3  
## SS loadings 2.81 1.95 1.94  
## Proportion Var 0.40 0.28 0.28  
## Cumulative Var 0.40 0.68 0.96  
## Proportion Explained 0.42 0.29 0.29  
## Cumulative Proportion 0.42 0.71 1.00  
##   
## Mean item complexity = 1.5  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.02   
## with the empirical chi square 6.46 with prob < 0.091   
##   
## Fit based upon off diagonal values = 1

PCA\_lexicals\_props$loadings

##   
## Loadings:  
## RC2 RC1 RC3   
## letters -0.350 0.862 -0.332  
## phonemes\_DUTCHPOND -0.246 0.873 -0.392  
## orth\_neighbours\_DUTCHPOND 0.294 -0.368 0.858  
## phon\_neighbours\_DUTCHPOND 0.309 -0.355 0.859  
## freq\_lg10CD\_SUBTLEXNL 0.928 -0.252 0.227  
## freq\_lg10WF\_SUBTLEXNL 0.927 -0.250 0.233  
## freq\_CELEX\_lem 0.852 -0.244 0.309  
##   
## RC2 RC1 RC3  
## SS loadings 2.812 1.952 1.940  
## Proportion Var 0.402 0.279 0.277  
## Cumulative Var 0.402 0.681 0.958

*# The PCA replicates Lynott and Connell. Standdized correlation coeffs*  
*# between each PC and its corresponding set of variables are all above .89,*  
*# while the rest of coefficients are all below .33.*   
  
PCA\_lexicals\_props

## Principal Components Analysis  
## Call: psych::principal(r = lexicals\_props, nfactors = 3, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC2 RC1 RC3 h2 u2 com  
## letters -0.35 0.86 -0.33 0.98 0.024 1.6  
## phonemes\_DUTCHPOND -0.25 0.87 -0.39 0.98 0.025 1.6  
## orth\_neighbours\_DUTCHPOND 0.29 -0.37 0.86 0.96 0.042 1.6  
## phon\_neighbours\_DUTCHPOND 0.31 -0.36 0.86 0.96 0.040 1.6  
## freq\_lg10CD\_SUBTLEXNL 0.93 -0.25 0.23 0.98 0.023 1.3  
## freq\_lg10WF\_SUBTLEXNL 0.93 -0.25 0.23 0.98 0.024 1.3  
## freq\_CELEX\_lem 0.85 -0.24 0.31 0.88 0.120 1.4  
##   
## RC2 RC1 RC3  
## SS loadings 2.81 1.95 1.94  
## Proportion Var 0.40 0.28 0.28  
## Cumulative Var 0.40 0.68 0.96  
## Proportion Explained 0.42 0.29 0.29  
## Cumulative Proportion 0.42 0.71 1.00  
##   
## Mean item complexity = 1.5  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.02   
## with the empirical chi square 6.46 with prob < 0.091   
##   
## Fit based upon off diagonal values = 1

*# RC1 = length // RC2 = frequency // RC3 = distinctiveness*  
  
PCA\_lexicals\_props$residual

## letters phonemes\_DUTCHPOND  
## letters 0.023517045 -0.023962895  
## phonemes\_DUTCHPOND -0.023962895 0.024527905  
## orth\_neighbours\_DUTCHPOND -0.012514682 0.013421737  
## phon\_neighbours\_DUTCHPOND 0.007817494 -0.008192472  
## freq\_lg10CD\_SUBTLEXNL -0.004433168 0.005936642  
## freq\_lg10WF\_SUBTLEXNL -0.006253943 0.007759574  
## freq\_CELEX\_lem 0.015885789 -0.019361066  
## orth\_neighbours\_DUTCHPOND  
## letters -0.012514682  
## phonemes\_DUTCHPOND 0.013421737  
## orth\_neighbours\_DUTCHPOND 0.041585846  
## phon\_neighbours\_DUTCHPOND -0.039472453  
## freq\_lg10CD\_SUBTLEXNL 0.001286716  
## freq\_lg10WF\_SUBTLEXNL 0.001353789  
## freq\_CELEX\_lem -0.004178748  
## phon\_neighbours\_DUTCHPOND freq\_lg10CD\_SUBTLEXNL  
## letters 0.007817494 -0.004433168  
## phonemes\_DUTCHPOND -0.008192472 0.005936642  
## orth\_neighbours\_DUTCHPOND -0.039472453 0.001286716  
## phon\_neighbours\_DUTCHPOND 0.040374981 0.006222638  
## freq\_lg10CD\_SUBTLEXNL 0.006222638 0.023113551  
## freq\_lg10WF\_SUBTLEXNL 0.006494202 0.020975916  
## freq\_CELEX\_lem -0.014031271 -0.050843434  
## freq\_lg10WF\_SUBTLEXNL freq\_CELEX\_lem  
## letters -0.006253943 0.015885789  
## phonemes\_DUTCHPOND 0.007759574 -0.019361066  
## orth\_neighbours\_DUTCHPOND 0.001353789 -0.004178748  
## phon\_neighbours\_DUTCHPOND 0.006494202 -0.014031271  
## freq\_lg10CD\_SUBTLEXNL 0.020975916 -0.050843434  
## freq\_lg10WF\_SUBTLEXNL 0.023956553 -0.052102821  
## freq\_CELEX\_lem -0.052102821 0.119626897

PCA\_lexicals\_props$fit

## [1] 0.9985986

*# Results based on a Kaiser-normalizalized orthogonal (varimax) rotation*  
*# (by default in psych::stats pack). Residuals good: less than half w/ absolute*   
*# values > 0.05. Model fit good, > .90. Communalities (h2) good, all well > .7*  
  
props <- **cbind**(props, PCA\_lexicals\_props$scores)  
  
  
  
*# REGRESSION*  
  
*# standardize (mean-center and scale)*  
props$s\_Auditory <- **scale**(props$Auditory)  
props$s\_Haptic <- **scale**(props$Haptic)  
props$s\_Visual <- **scale**(props$Visual)  
props$s\_freq\_lg10CD\_SUBTLEXNL <- **scale**(props$freq\_lg10CD\_SUBTLEXNL)  
props$s\_freq\_lg10WF\_SUBTLEXNL <- **scale**(props$freq\_lg10WF\_SUBTLEXNL)  
props$s\_freq\_CELEX\_lem <- **scale**(props$freq\_CELEX\_lem)  
props$s\_AoA\_Brysbaertetal2014 <- **scale**(props$AoA\_Brysbaertetal2014)  
props$s\_concrete\_Brysbaertetal2014 <- **scale**(props$concrete\_Brysbaertetal2014)  
props$s\_letters <- **scale**(props$letters)  
props$s\_phonemes\_DUTCHPOND <- **scale**(props$phonemes\_DUTCHPOND)  
props$s\_orth\_neighbours\_DUTCHPOND <- **scale**(props$orth\_neighbours\_DUTCHPOND)  
props$s\_phon\_neighbours\_DUTCHPOND <- **scale**(props$phon\_neighbours\_DUTCHPOND)  
props$s\_RC1\_lexicals <- **scale**(props$RC1)  
props$s\_RC2\_lexicals <- **scale**(props$RC2)   
props$s\_RC3\_lexicals <- **scale**(props$RC3)  
  
*# length: letters*  
fit\_letters\_props <- **lm**(props$s\_letters ~ props$s\_Auditory + props$s\_Haptic +   
props$s\_Visual, data = props)  
**stat.desc**(fit\_letters\_props$residuals, norm = TRUE)

## x  
## nbr.val 3.360000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.951464e+00  
## max 3.056793e+00  
## range 5.008258e+00  
## sum 5.710710e-15  
## median -5.660484e-03  
## mean 1.694389e-17  
## SE.mean 5.381262e-02  
## CI.mean.0.95 1.058532e-01  
## var 9.729883e-01  
## std.dev 9.864017e-01  
## coef.var 5.821579e+16  
## skewness 2.021250e-01  
## skew.2SE 7.596443e-01  
## kurtosis -5.827220e-01  
## kurt.2SE -1.098206e+00  
## normtest.W 9.848674e-01  
## normtest.p 1.348370e-03

*# residuals distribution: kurtose. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_letters)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 336 0 1 -0.05 -0.03 1.31 -1.82 3.04 4.86 0.15 -0.63  
## se  
## X1 0.05

props$log\_s\_letters <- **log**(3 + props$s\_letters)  
  
fit\_letters\_props <- **lm**(props$log\_s\_letters ~ props$s\_Auditory + props$s\_Haptic +   
props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_letters\_props$residuals, norm = TRUE)

## x  
## nbr.val 3.360000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -9.191181e-01  
## max 7.831737e-01  
## range 1.702292e+00  
## sum 2.737394e-15  
## median 5.820411e-02  
## mean 8.121029e-18  
## SE.mean 1.947699e-02  
## CI.mean.0.95 3.831262e-02  
## var 1.274627e-01  
## std.dev 3.570191e-01  
## coef.var 4.396230e+16  
## skewness -4.372009e-01  
## skew.2SE -1.643128e+00  
## kurtosis -5.110083e-01  
## kurt.2SE -9.630531e-01  
## normtest.W 9.708083e-01  
## normtest.p 2.669646e-06

*# same; go back*  
fit\_letters\_props <- **lm**(props$s\_letters ~ props$s\_Auditory + props$s\_Haptic +   
props$s\_Visual, data = props)  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_letters\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.390569 1.063636 1.369298

**mean**(**vif**(fit\_letters\_props))

## [1] 1.274501

1/**vif**(fit\_letters\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7191299 0.9401711 0.7303013

*# RESULTS: all good*  
  
step\_letters\_props\_AIC <- **stepAIC**(fit\_letters\_props, direction="both")

## Start: AIC=-2.2  
## props$s\_letters ~ props$s\_Auditory + props$s\_Haptic + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Visual 1 0.05459 326.01 -4.1460  
## <none> 325.95 -2.2023  
## - props$s\_Haptic 1 2.28519 328.24 -1.8548  
## - props$s\_Auditory 1 3.10531 329.06 -1.0164  
##   
## Step: AIC=-4.15  
## props$s\_letters ~ props$s\_Auditory + props$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## <none> 326.01 -4.1460  
## - props$s\_Haptic 1 2.3695 328.38 -3.7127  
## + props$s\_Visual 1 0.0546 325.95 -2.2023  
## - props$s\_Auditory 1 4.6444 330.65 -1.3930

step\_letters\_props\_F <- **stepAIC**(fit\_letters\_props, direction="both", test="F")

## Start: AIC=-2.2  
## props$s\_letters ~ props$s\_Auditory + props$s\_Haptic + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Visual 1 0.05459 326.01 -4.1460 0.0556 0.81372   
## <none> 325.95 -2.2023   
## - props$s\_Haptic 1 2.28519 328.24 -1.8548 2.3276 0.12805   
## - props$s\_Auditory 1 3.10531 329.06 -1.0164 3.1629 0.07624 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-4.15  
## props$s\_letters ~ props$s\_Auditory + props$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 326.01 -4.1460   
## - props$s\_Haptic 1 2.3695 328.38 -3.7127 2.4203 0.1207   
## + props$s\_Visual 1 0.0546 325.95 -2.2023 0.0556 0.8137   
## - props$s\_Auditory 1 4.6444 330.65 -1.3930 4.7441 0.0301 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_letters\_props)

##   
## Call:  
## lm(formula = props$s\_letters ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.95146 -0.79178 -0.00566 0.71461 3.05679   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -6.413e-17 5.406e-02 0.000 1.0000   
## props$s\_Auditory 1.135e-01 6.384e-02 1.778 0.0762 .  
## props$s\_Haptic -8.518e-02 5.583e-02 -1.526 0.1280   
## props$s\_Visual -1.494e-02 6.335e-02 -0.236 0.8137   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9908 on 332 degrees of freedom  
## (7 observations deleted due to missingness)  
## Multiple R-squared: 0.02701, Adjusted R-squared: 0.01822   
## F-statistic: 3.072 on 3 and 332 DF, p-value: 0.02793

*# length: phonemes\_DUTCHPOND*  
fit\_phonemes\_DUTCHPOND\_props <- **lm**(props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_phonemes\_DUTCHPOND\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.850000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.781220e+00  
## max 2.893531e+00  
## range 4.674751e+00  
## sum -7.140122e-15  
## median -1.586697e-01  
## mean -3.864448e-17  
## SE.mean 7.203029e-02  
## CI.mean.0.95 1.421115e-01  
## var 9.598471e-01  
## std.dev 9.797179e-01  
## coef.var -2.535208e+16  
## skewness 3.927364e-01  
## skew.2SE 1.099162e+00  
## kurtosis -6.193431e-01  
## kurt.2SE -8.711822e-01  
## normtest.W 9.699743e-01  
## normtest.p 5.167728e-04

*# residuals distribution: skew. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_phonemes\_DUTCHPOND)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 185 0 1 -0.2 -0.05 1.52 -1.74 2.88 4.62 0.43 -0.54  
## se  
## X1 0.07

props$log\_s\_phonemes\_DUTCHPOND <- **log**(3 + props$s\_phonemes\_DUTCHPOND)  
  
fit\_phonemes\_DUTCHPOND\_props <- **lm**(props$log\_s\_phonemes\_DUTCHPOND ~ props$s\_Auditory  
 + props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_phonemes\_DUTCHPOND\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.850000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -8.201762e-01  
## max 7.325980e-01  
## range 1.552774e+00  
## sum 2.125036e-15  
## median 5.242801e-04  
## mean 1.148437e-17  
## SE.mean 2.459029e-02  
## CI.mean.0.95 4.851518e-02  
## var 1.118662e-01  
## std.dev 3.344641e-01  
## coef.var 2.912340e+16  
## skewness -1.073812e-01  
## skew.2SE -3.005307e-01  
## kurtosis -8.521788e-01  
## kurt.2SE -1.198694e+00  
## normtest.W 9.803325e-01  
## normtest.p 1.039941e-02

*# worse; back*  
fit\_phonemes\_DUTCHPOND\_props <- **lm**(props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_phonemes\_DUTCHPOND\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.106936 1.001006 1.107723

**mean**(**vif**(fit\_phonemes\_DUTCHPOND\_props))

## [1] 1.071888

1/**vif**(fit\_phonemes\_DUTCHPOND\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.9033949 0.9989951 0.9027527

*# RESULTS: all good*  
  
step\_phonemes\_DUTCHPOND\_props\_AIC <- **stepAIC**(fit\_phonemes\_DUTCHPOND\_props,   
direction="both")

## Start: AIC=-0.58  
## props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 1.3289 177.94 -1.1974  
## - props$s\_Visual 1 1.4171 178.03 -1.1057  
## <none> 176.61 -0.5842  
## - props$s\_Auditory 1 5.7163 182.33 3.3087  
##   
## Step: AIC=-1.2  
## props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Visual 1 1.5050 179.45 -1.63928  
## <none> 177.94 -1.19741  
## + props$s\_Haptic 1 1.3289 176.61 -0.58424  
## - props$s\_Auditory 1 5.8055 183.75 2.74206  
##   
## Step: AIC=-1.64  
## props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC  
## <none> 179.45 -1.63928  
## + props$s\_Visual 1 1.5050 177.94 -1.19741  
## + props$s\_Haptic 1 1.4168 178.03 -1.10571  
## - props$s\_Auditory 1 4.5542 184.00 0.99729

step\_phonemes\_DUTCHPOND\_props\_F <- **stepAIC**(fit\_phonemes\_DUTCHPOND\_props,   
direction="both", test="F")

## Start: AIC=-0.58  
## props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 1.3289 177.94 -1.1974 1.3619 0.24474   
## - props$s\_Visual 1 1.4171 178.03 -1.1057 1.4524 0.22972   
## <none> 176.61 -0.5842   
## - props$s\_Auditory 1 5.7163 182.33 3.3087 5.8584 0.01649 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-1.2  
## props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Visual 1 1.5050 179.45 -1.63928 1.5393 0.21631   
## <none> 177.94 -1.19741   
## + props$s\_Haptic 1 1.3289 176.61 -0.58424 1.3619 0.24474   
## - props$s\_Auditory 1 5.8055 183.75 2.74206 5.9380 0.01578 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-1.64  
## props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 179.45 -1.63928   
## + props$s\_Visual 1 1.5050 177.94 -1.19741 1.5393 0.21631   
## + props$s\_Haptic 1 1.4168 178.03 -1.10571 1.4484 0.23035   
## - props$s\_Auditory 1 4.5542 184.00 0.99729 4.6444 0.03246 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_phonemes\_DUTCHPOND\_props)

##   
## Call:  
## lm(formula = props$s\_phonemes\_DUTCHPOND ~ props$s\_Auditory +   
## props$s\_Haptic + props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.7812 -0.7401 -0.1587 0.8007 2.8935   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.05145 0.08057 0.639 0.5239   
## props$s\_Auditory 0.25688 0.10613 2.420 0.0165 \*  
## props$s\_Haptic -0.08477 0.07264 -1.167 0.2447   
## props$s\_Visual 0.10714 0.08891 1.205 0.2297   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9878 on 181 degrees of freedom  
## (158 observations deleted due to missingness)  
## Multiple R-squared: 0.04015, Adjusted R-squared: 0.02424   
## F-statistic: 2.524 on 3 and 181 DF, p-value: 0.05917

*# distinctiveness: orth neigh size*  
fit\_orth\_neighbours\_DUTCHPOND\_props <- **lm**(props$s\_orth\_neighbours\_DUTCHPOND ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_orth\_neighbours\_DUTCHPOND\_props$residuals, norm = TRUE)

## x  
## nbr.val 3.360000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -9.012905e-01  
## max 4.201627e+00  
## range 5.102917e+00  
## sum 1.110223e-15  
## median -3.445061e-01  
## mean 3.250509e-18  
## SE.mean 5.397738e-02  
## CI.mean.0.95 1.061773e-01  
## var 9.789552e-01  
## std.dev 9.894217e-01  
## coef.var 3.043898e+17  
## skewness 2.005223e+00  
## skew.2SE 7.536211e+00  
## kurtosis 4.014171e+00  
## kurt.2SE 7.565161e+00  
## normtest.W 7.527604e-01  
## normtest.p 4.267770e-22

*# residuals distribution: skewed and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_orth\_neighbours\_DUTCHPOND)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 336 0 1 -0.48 -0.22 0.3 -0.68 4.25 4.93 2.06 4.06 0.05

props$log\_s\_orth\_neighbours\_DUTCHPOND <- **log**(2 + props$s\_orth\_neighbours\_DUTCHPOND)  
  
fit\_orth\_neighbours\_DUTCHPOND\_props <- **lm**(props$log\_s\_orth\_neighbours\_DUTCHPOND ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_orth\_neighbours\_DUTCHPOND\_props$residuals, norm = TRUE)

## x  
## nbr.val 3.360000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -3.965545e-01  
## max 1.203044e+00  
## range 1.599599e+00  
## sum 2.985459e-15  
## median -1.371519e-01  
## mean 8.902735e-18  
## SE.mean 2.089711e-02  
## CI.mean.0.95 4.110610e-02  
## var 1.467276e-01  
## std.dev 3.830504e-01  
## coef.var 4.302615e+16  
## skewness 1.257764e+00  
## skew.2SE 4.727041e+00  
## kurtosis 7.776239e-01  
## kurt.2SE 1.465521e+00  
## normtest.W 8.480804e-01  
## normtest.p 1.534991e-17

*# quite better*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_orth\_neighbours\_DUTCHPOND\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.390569 1.063636 1.369298

**mean**(**vif**(fit\_orth\_neighbours\_DUTCHPOND\_props))

## [1] 1.274501

1/**vif**(fit\_orth\_neighbours\_DUTCHPOND\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7191299 0.9401711 0.7303013

*# RESULTS: all good*  
  
step\_orth\_neighbours\_DUTCHPOND\_props\_AIC <-   
**stepAIC**(fit\_orth\_neighbours\_DUTCHPOND\_props, direction="both")

## Start: AIC=-637.85  
## props$log\_s\_orth\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Visual 1 0.01250 49.166 -639.76  
## - props$s\_Haptic 1 0.05865 49.212 -639.44  
## <none> 49.154 -637.85  
## - props$s\_Auditory 1 0.69898 49.853 -635.10  
##   
## Step: AIC=-639.76  
## props$log\_s\_orth\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.05428 49.221 -641.39  
## <none> 49.166 -639.76  
## + props$s\_Visual 1 0.01250 49.154 -637.85  
## - props$s\_Auditory 1 0.80432 49.971 -636.31  
##   
## Step: AIC=-641.39  
## props$log\_s\_orth\_neighbours\_DUTCHPOND ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC  
## <none> 49.221 -641.39  
## + props$s\_Haptic 1 0.05428 49.166 -639.76  
## + props$s\_Visual 1 0.00813 49.212 -639.44  
## - props$s\_Auditory 1 0.95192 50.172 -636.95

step\_orth\_neighbours\_DUTCHPOND\_props\_F <-   
**stepAIC**(fit\_orth\_neighbours\_DUTCHPOND\_props, direction="both", test="F")

## Start: AIC=-637.85  
## props$log\_s\_orth\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Visual 1 0.01250 49.166 -639.76 0.0845 0.7715   
## - props$s\_Haptic 1 0.05865 49.212 -639.44 0.3962 0.5295   
## <none> 49.154 -637.85   
## - props$s\_Auditory 1 0.69898 49.853 -635.10 4.7212 0.0305 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-639.76  
## props$log\_s\_orth\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.05428 49.221 -641.39 0.3676 0.54471   
## <none> 49.166 -639.76   
## + props$s\_Visual 1 0.01250 49.154 -637.85 0.0845 0.77153   
## - props$s\_Auditory 1 0.80432 49.971 -636.31 5.4476 0.02019 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-641.39  
## props$log\_s\_orth\_neighbours\_DUTCHPOND ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 49.221 -641.39   
## + props$s\_Haptic 1 0.05428 49.166 -639.76 0.3676 0.54471   
## + props$s\_Visual 1 0.00813 49.212 -639.44 0.0550 0.81469   
## - props$s\_Auditory 1 0.95192 50.172 -636.95 6.4595 0.01149 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_orth\_neighbours\_DUTCHPOND\_props)

##   
## Call:  
## lm(formula = props$log\_s\_orth\_neighbours\_DUTCHPOND ~ props$s\_Auditory +   
## props$s\_Haptic + props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.3966 -0.2658 -0.1371 0.1314 1.2030   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.605335 0.020991 28.837 <2e-16 \*\*\*  
## props$s\_Auditory -0.053865 0.024790 -2.173 0.0305 \*   
## props$s\_Haptic 0.013646 0.021681 0.629 0.5295   
## props$s\_Visual -0.007149 0.024600 -0.291 0.7715   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3848 on 332 degrees of freedom  
## (7 observations deleted due to missingness)  
## Multiple R-squared: 0.0203, Adjusted R-squared: 0.01145   
## F-statistic: 2.294 on 3 and 332 DF, p-value: 0.07784

*# distinctiveness: phon neigh size*  
fit\_phon\_neighbours\_DUTCHPOND\_props <- **lm**(props$s\_phon\_neighbours\_DUTCHPOND ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_phon\_neighbours\_DUTCHPOND\_props$residuals, norm = TRUE)

## x  
## nbr.val 3.360000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -8.455782e-01  
## max 4.812038e+00  
## range 5.657616e+00  
## sum 2.758210e-16  
## median -3.634595e-01  
## mean 8.576410e-19  
## SE.mean 5.382661e-02  
## CI.mean.0.95 1.058807e-01  
## var 9.734942e-01  
## std.dev 9.866581e-01  
## coef.var 1.150432e+18  
## skewness 2.192935e+00  
## skew.2SE 8.241687e+00  
## kurtosis 4.900577e+00  
## kurt.2SE 9.235695e+00  
## normtest.W 7.165177e-01  
## normtest.p 1.771880e-23

*# residuals distribution: skewed and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_phon\_neighbours\_DUTCHPOND)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 336 0 1 -0.47 -0.24 0.2 -0.6 4.95 5.55 2.27 5.04 0.05

props$log\_s\_phon\_neighbours\_DUTCHPOND <- **log**(2 + props$s\_phon\_neighbours\_DUTCHPOND)  
  
fit\_phon\_neighbours\_DUTCHPOND\_props <- **lm**(props$log\_s\_phon\_neighbours\_DUTCHPOND ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_phon\_neighbours\_DUTCHPOND\_props$residuals, norm = TRUE)

## x  
## nbr.val 3.360000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -3.517218e-01  
## max 1.277575e+00  
## range 1.629297e+00  
## sum -3.259545e-15  
## median -1.356554e-01  
## mean -9.718796e-18  
## SE.mean 2.007484e-02  
## CI.mean.0.95 3.948862e-02  
## var 1.354077e-01  
## std.dev 3.679779e-01  
## coef.var -3.786250e+16  
## skewness 1.486941e+00  
## skew.2SE 5.588356e+00  
## kurtosis 1.393719e+00  
## kurt.2SE 2.626621e+00  
## normtest.W 8.046259e-01  
## normtest.p 8.008540e-20

*# quite better*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_phon\_neighbours\_DUTCHPOND\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.390569 1.063636 1.369298

**mean**(**vif**(fit\_phon\_neighbours\_DUTCHPOND\_props))

## [1] 1.274501

1/**vif**(fit\_phon\_neighbours\_DUTCHPOND\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7191299 0.9401711 0.7303013

*# RESULTS: all good*  
  
step\_phon\_neighbours\_DUTCHPOND\_props\_AIC <-   
**stepAIC**(fit\_phon\_neighbours\_DUTCHPOND\_props, direction="both")

## Start: AIC=-664.82  
## props$log\_s\_phon\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Visual 1 0.01518 45.377 -666.71  
## - props$s\_Haptic 1 0.08053 45.442 -666.23  
## <none> 45.362 -664.82  
## - props$s\_Auditory 1 0.87817 46.240 -660.38  
##   
## Step: AIC=-666.71  
## props$log\_s\_phon\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.07492 45.452 -668.16  
## <none> 45.377 -666.71  
## + props$s\_Visual 1 0.01518 45.362 -664.82  
## - props$s\_Auditory 1 1.01291 46.390 -661.29  
##   
## Step: AIC=-668.16  
## props$log\_s\_phon\_neighbours\_DUTCHPOND ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC  
## <none> 45.452 -668.16  
## + props$s\_Haptic 1 0.07492 45.377 -666.71  
## + props$s\_Visual 1 0.00957 45.442 -666.23  
## - props$s\_Auditory 1 1.20508 46.657 -661.36

step\_phon\_neighbours\_DUTCHPOND\_props\_F <-  
 **stepAIC**(fit\_phon\_neighbours\_DUTCHPOND\_props, direction="both", test="F")

## Start: AIC=-664.82  
## props$log\_s\_phon\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Visual 1 0.01518 45.377 -666.71 0.1111 0.7391   
## - props$s\_Haptic 1 0.08053 45.442 -666.23 0.5894 0.4432   
## <none> 45.362 -664.82   
## - props$s\_Auditory 1 0.87817 46.240 -660.38 6.4273 0.0117 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-666.71  
## props$log\_s\_phon\_neighbours\_DUTCHPOND ~ props$s\_Auditory + props$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.07492 45.452 -668.16 0.5498 0.458928   
## <none> 45.377 -666.71   
## + props$s\_Visual 1 0.01518 45.362 -664.82 0.1111 0.739066   
## - props$s\_Auditory 1 1.01291 46.390 -661.29 7.4333 0.006742 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-668.16  
## props$log\_s\_phon\_neighbours\_DUTCHPOND ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 45.452 -668.16   
## + props$s\_Haptic 1 0.07492 45.377 -666.71 0.5498 0.458928   
## + props$s\_Visual 1 0.00957 45.442 -666.23 0.0701 0.791309   
## - props$s\_Auditory 1 1.20508 46.657 -661.36 8.8555 0.003135 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_phon\_neighbours\_DUTCHPOND\_props)

##   
## Call:  
## lm(formula = props$log\_s\_phon\_neighbours\_DUTCHPOND ~ props$s\_Auditory +   
## props$s\_Haptic + props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.3517 -0.2599 -0.1357 0.1060 1.2776   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.609359 0.020165 30.218 <2e-16 \*\*\*  
## props$s\_Auditory -0.060376 0.023815 -2.535 0.0117 \*   
## props$s\_Haptic 0.015990 0.020828 0.768 0.4432   
## props$s\_Visual -0.007878 0.023632 -0.333 0.7391   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3696 on 332 degrees of freedom  
## (7 observations deleted due to missingness)  
## Multiple R-squared: 0.02776, Adjusted R-squared: 0.01897   
## F-statistic: 3.16 on 3 and 332 DF, p-value: 0.02486

*# freq: SUBTLEX-NL log-10 CD*  
  
fit\_freq\_lg10CD\_SUBTLEXNL\_props <- **lm**(props$s\_freq\_lg10CD\_SUBTLEXNL ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_freq\_lg10CD\_SUBTLEXNL\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.900000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.692625e+00  
## max 2.415049e+00  
## range 4.107675e+00  
## sum 1.418483e-14  
## median -2.189748e-01  
## mean 4.907464e-17  
## SE.mean 5.563757e-02  
## CI.mean.0.95 1.095062e-01  
## var 8.977063e-01  
## std.dev 9.474736e-01  
## coef.var 1.930679e+16  
## skewness 4.242613e-01  
## skew.2SE 1.482369e+00  
## kurtosis -7.702721e-01  
## kurt.2SE -1.350186e+00  
## normtest.W 9.623283e-01  
## normtest.p 7.531921e-07

*# residuals distribution: skew and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_freq\_lg10CD\_SUBTLEXNL)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 290 0 1 -0.19 -0.04 1.12 -1.48 2.03 3.51 0.35 -1.06  
## se  
## X1 0.06

props$log\_s\_freq\_lg10CD\_SUBTLEXNL <- **log**(3 + props$s\_freq\_lg10CD\_SUBTLEXNL)  
  
fit\_freq\_lg10CD\_SUBTLEXNL\_props <- **lm**(props$log\_s\_freq\_lg10CD\_SUBTLEXNL ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_freq\_lg10CD\_SUBTLEXNL\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.900000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -6.999745e-01  
## max 7.664373e-01  
## range 1.466412e+00  
## sum 9.454243e-16  
## median -3.012791e-02  
## mean 3.198747e-18  
## SE.mean 1.873435e-02  
## CI.mean.0.95 3.687306e-02  
## var 1.017829e-01  
## std.dev 3.190344e-01  
## coef.var 9.973731e+16  
## skewness 1.133701e-02  
## skew.2SE 3.961154e-02  
## kurtosis -8.184529e-01  
## kurt.2SE -1.434641e+00  
## normtest.W 9.840065e-01  
## normtest.p 2.534289e-03

*# quite better*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_freq\_lg10CD\_SUBTLEXNL\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.382103 1.039118 1.351219

**mean**(**vif**(fit\_freq\_lg10CD\_SUBTLEXNL\_props))

## [1] 1.25748

1/**vif**(fit\_freq\_lg10CD\_SUBTLEXNL\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7235353 0.9623547 0.7400726

*# RESULTS: all good*  
  
step\_freq\_lg10CD\_SUBTLEXNL\_props\_AIC <- **stepAIC**(fit\_freq\_lg10CD\_SUBTLEXNL\_props,   
direction="both")

## Start: AIC=-655.63  
## props$log\_s\_freq\_lg10CD\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.00023 29.416 -657.62  
## <none> 29.415 -655.63  
## - props$s\_Visual 1 1.01036 30.426 -647.83  
## - props$s\_Auditory 1 1.03613 30.451 -647.59  
##   
## Step: AIC=-657.62  
## props$log\_s\_freq\_lg10CD\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 29.416 -657.62  
## + props$s\_Haptic 1 0.00023 29.415 -655.63  
## - props$s\_Visual 1 1.01031 30.426 -649.83  
## - props$s\_Auditory 1 1.05585 30.471 -649.40

step\_freq\_lg10CD\_SUBTLEXNL\_\_propsF <- **stepAIC**(fit\_freq\_lg10CD\_SUBTLEXNL\_props,   
direction="both", test="F")

## Start: AIC=-655.63  
## props$log\_s\_freq\_lg10CD\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.00023 29.416 -657.62 0.0023 0.962128   
## <none> 29.415 -655.63   
## - props$s\_Visual 1 1.01036 30.426 -647.83 9.8236 0.001902 \*\*  
## - props$s\_Auditory 1 1.03613 30.451 -647.59 10.0742 0.001668 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-657.62  
## props$log\_s\_freq\_lg10CD\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 29.416 -657.62   
## + props$s\_Haptic 1 0.00023 29.415 -655.63 0.0023 0.962128   
## - props$s\_Visual 1 1.01031 30.426 -649.83 9.8574 0.001868 \*\*  
## - props$s\_Auditory 1 1.05585 30.471 -649.40 10.3017 0.001480 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_freq\_lg10CD\_SUBTLEXNL\_props)

##   
## Call:  
## lm(formula = props$log\_s\_freq\_lg10CD\_SUBTLEXNL ~ props$s\_Auditory +   
## props$s\_Haptic + props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.69997 -0.25070 -0.03013 0.26364 0.76644   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.0348471 0.0188686 54.845 < 2e-16 \*\*\*  
## props$s\_Auditory -0.0725470 0.0228568 -3.174 0.00167 \*\*   
## props$s\_Haptic -0.0009166 0.0192867 -0.048 0.96213   
## props$s\_Visual 0.0691961 0.0220773 3.134 0.00190 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3207 on 286 degrees of freedom  
## (53 observations deleted due to missingness)  
## Multiple R-squared: 0.1252, Adjusted R-squared: 0.116   
## F-statistic: 13.64 on 3 and 286 DF, p-value: 2.415e-08

*# freq: SUBTLEX-NL log-10 WF*  
fit\_freq\_lg10WF\_SUBTLEXNL\_props <- **lm**(props$s\_freq\_lg10WF\_SUBTLEXNL ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_freq\_lg10WF\_SUBTLEXNL\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.900000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.661721e+00  
## max 2.533130e+00  
## range 4.194851e+00  
## sum 8.913009e-15  
## median -2.272985e-01  
## mean 3.085995e-17  
## SE.mean 5.576327e-02  
## CI.mean.0.95 1.097536e-01  
## var 9.017672e-01  
## std.dev 9.496143e-01  
## coef.var 3.077174e+16  
## skewness 5.452976e-01  
## skew.2SE 1.905270e+00  
## kurtosis -5.163686e-01  
## kurt.2SE -9.051267e-01  
## normtest.W 9.599049e-01  
## normtest.p 3.588950e-07

*# residuals distribution: skew. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_freq\_lg10WF\_SUBTLEXNL)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 290 0 1 -0.17 -0.06 1.14 -1.45 2.52 3.97 0.46 -0.84  
## se  
## X1 0.06

props$log\_s\_freq\_lg10WF\_SUBTLEXNL <- **log**(3 + props$s\_freq\_lg10WF\_SUBTLEXNL)  
  
fit\_freq\_lg10WF\_SUBTLEXNL\_props <- **lm**(props$log\_s\_freq\_lg10WF\_SUBTLEXNL ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_freq\_lg10WF\_SUBTLEXNL\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.900000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -6.780013e-01  
## max 7.683617e-01  
## range 1.446363e+00  
## sum -9.228729e-16  
## median -3.591764e-02  
## mean -3.201621e-18  
## SE.mean 1.847247e-02  
## CI.mean.0.95 3.635763e-02  
## var 9.895732e-02  
## std.dev 3.145748e-01  
## coef.var -9.825486e+16  
## skewness 9.385398e-02  
## skew.2SE 3.279259e-01  
## kurtosis -7.561993e-01  
## kurt.2SE -1.325519e+00  
## normtest.W 9.858284e-01  
## normtest.p 5.880988e-03

*# quite better*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_freq\_lg10WF\_SUBTLEXNL\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.382103 1.039118 1.351219

**mean**(**vif**(fit\_freq\_lg10WF\_SUBTLEXNL\_props))

## [1] 1.25748

1/**vif**(fit\_freq\_lg10WF\_SUBTLEXNL\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7235353 0.9623547 0.7400726

*# RESULTS: all good*  
  
step\_freq\_lg10WF\_SUBTLEXNL\_props\_AIC <- **stepAIC**(fit\_freq\_lg10WF\_SUBTLEXNL\_props,   
direction="both")

## Start: AIC=-663.79  
## props$log\_s\_freq\_lg10WF\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.00042 28.599 -665.79  
## <none> 28.599 -663.79  
## - props$s\_Visual 1 0.97077 29.569 -656.11  
## - props$s\_Auditory 1 0.97099 29.570 -656.11  
##   
## Step: AIC=-665.79  
## props$log\_s\_freq\_lg10WF\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 28.599 -665.79  
## + props$s\_Haptic 1 0.00042 28.599 -663.79  
## - props$s\_Visual 1 0.97040 29.570 -658.11  
## - props$s\_Auditory 1 0.98769 29.587 -657.94

step\_freq\_lg10WF\_SUBTLEXNL\_props\_F <- **stepAIC**(fit\_freq\_lg10WF\_SUBTLEXNL\_props,   
direction="both", test="F")

## Start: AIC=-663.79  
## props$log\_s\_freq\_lg10WF\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.00042 28.599 -665.79 0.0042 0.948236   
## <none> 28.599 -663.79   
## - props$s\_Visual 1 0.97077 29.569 -656.11 9.7082 0.002021 \*\*  
## - props$s\_Auditory 1 0.97099 29.570 -656.11 9.7103 0.002019 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-665.79  
## props$log\_s\_freq\_lg10WF\_SUBTLEXNL ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 28.599 -665.79   
## + props$s\_Haptic 1 0.00042 28.599 -663.79 0.0042 0.948236   
## - props$s\_Visual 1 0.97040 29.570 -658.11 9.7383 0.001989 \*\*  
## - props$s\_Auditory 1 0.98769 29.587 -657.94 9.9118 0.001815 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_freq\_lg10WF\_SUBTLEXNL\_props)

##   
## Call:  
## lm(formula = props$log\_s\_freq\_lg10WF\_SUBTLEXNL ~ props$s\_Auditory +   
## props$s\_Haptic + props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.67800 -0.23858 -0.03592 0.25485 0.76836   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.036229 0.018605 55.697 < 2e-16 \*\*\*  
## props$s\_Auditory -0.070229 0.022537 -3.116 0.00202 \*\*   
## props$s\_Haptic -0.001236 0.019017 -0.065 0.94824   
## props$s\_Visual 0.067827 0.021769 3.116 0.00202 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3162 on 286 degrees of freedom  
## (53 observations deleted due to missingness)  
## Multiple R-squared: 0.1224, Adjusted R-squared: 0.1132   
## F-statistic: 13.3 on 3 and 286 DF, p-value: 3.75e-08

*# freq: CELEX log-10 lemma WF*  
fit\_freq\_CELEX\_lem\_props <- **lm**(props$s\_freq\_CELEX\_lem ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_freq\_CELEX\_lem\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.470000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.514183e+00  
## max 2.434544e+00  
## range 3.948728e+00  
## sum -9.034440e-15  
## median -1.388975e-01  
## mean -3.669410e-17  
## SE.mean 6.316656e-02  
## CI.mean.0.95 1.244163e-01  
## var 9.855335e-01  
## std.dev 9.927404e-01  
## coef.var -2.705450e+16  
## skewness 3.722828e-01  
## skew.2SE 1.201518e+00  
## kurtosis -8.446284e-01  
## kurt.2SE -1.368342e+00  
## normtest.W 9.590002e-01  
## normtest.p 1.738309e-06

*# residuals distribution: skew and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_freq\_CELEX\_lem)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 247 0 1 -0.16 -0.06 1.21 -1.35 2.51 3.86 0.37 -0.84  
## se  
## X1 0.06

props$log\_s\_freq\_CELEX\_lem <- **log**(3 + props$s\_freq\_CELEX\_lem)  
  
fit\_freq\_CELEX\_lem\_props <- **lm**(props$log\_s\_freq\_CELEX\_lem ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_freq\_CELEX\_lem\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.470000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -6.009444e-01  
## max 6.821853e-01  
## range 1.283130e+00  
## sum -6.834810e-16  
## median 1.096647e-02  
## mean -2.754839e-18  
## SE.mean 2.162772e-02  
## CI.mean.0.95 4.259913e-02  
## var 1.155363e-01  
## std.dev 3.399063e-01  
## coef.var -1.233852e+17  
## skewness -1.081089e-01  
## skew.2SE -3.489141e-01  
## kurtosis -1.047055e+00  
## kurt.2SE -1.696284e+00  
## normtest.W 9.622853e-01  
## normtest.p 4.369197e-06

*# same; go back*  
fit\_freq\_CELEX\_lem\_props <- **lm**(props$s\_freq\_CELEX\_lem ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_freq\_CELEX\_lem\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.263215 1.013850 1.259341

**mean**(**vif**(fit\_freq\_CELEX\_lem\_props))

## [1] 1.178802

1/**vif**(fit\_freq\_CELEX\_lem\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7916311 0.9863389 0.7940662

*# RESULTS: all good*  
  
step\_freq\_CELEX\_lem\_props\_AIC <- **stepAIC**(fit\_freq\_CELEX\_lem\_props, direction="both")

## Start: AIC=3.4  
## props$s\_freq\_CELEX\_lem ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.2674 242.71 1.6709  
## - props$s\_Auditory 1 0.3161 242.76 1.7205  
## <none> 242.44 3.3986  
## - props$s\_Visual 1 3.3187 245.76 4.7568  
##   
## Step: AIC=1.67  
## props$s\_freq\_CELEX\_lem ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Auditory 1 0.3623 243.07 0.0393  
## <none> 242.71 1.6709  
## - props$s\_Visual 1 3.2356 245.94 2.9420  
## + props$s\_Haptic 1 0.2674 242.44 3.3986  
##   
## Step: AIC=0.04  
## props$s\_freq\_CELEX\_lem ~ props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 243.07 0.03930  
## - props$s\_Visual 1 2.92911 246.00 0.99797  
## + props$s\_Auditory 1 0.36229 242.71 1.67087  
## + props$s\_Haptic 1 0.31352 242.76 1.72050

step\_freq\_CELEX\_lem\_props\_F <- **stepAIC**(fit\_freq\_CELEX\_lem\_props, direction="both",   
test="F")

## Start: AIC=3.4  
## props$s\_freq\_CELEX\_lem ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.2674 242.71 1.6709 0.2680 0.60516   
## - props$s\_Auditory 1 0.3161 242.76 1.7205 0.3169 0.57402   
## <none> 242.44 3.3986   
## - props$s\_Visual 1 3.3187 245.76 4.7568 3.3264 0.06941 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=1.67  
## props$s\_freq\_CELEX\_lem ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Auditory 1 0.3623 243.07 0.0393 0.3642 0.54673   
## <none> 242.71 1.6709   
## - props$s\_Visual 1 3.2356 245.94 2.9420 3.2529 0.07253 .  
## + props$s\_Haptic 1 0.2674 242.44 3.3986 0.2680 0.60516   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=0.04  
## props$s\_freq\_CELEX\_lem ~ props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 243.07 0.03930   
## - props$s\_Visual 1 2.92911 246.00 0.99797 2.95236 0.08702 .  
## + props$s\_Auditory 1 0.36229 242.71 1.67087 0.36422 0.54673   
## + props$s\_Haptic 1 0.31352 242.76 1.72050 0.31513 0.57507   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_freq\_CELEX\_lem\_props)

##   
## Call:  
## lm(formula = props$s\_freq\_CELEX\_lem ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.5142 -0.8016 -0.1389 0.7363 2.4345   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.01352 0.06784 -0.199 0.8422   
## props$s\_Auditory 0.05143 0.09137 0.563 0.5740   
## props$s\_Haptic -0.03235 0.06250 -0.518 0.6052   
## props$s\_Visual 0.14572 0.07990 1.824 0.0694 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9988 on 243 degrees of freedom  
## (96 observations deleted due to missingness)  
## Multiple R-squared: 0.01447, Adjusted R-squared: 0.002299   
## F-statistic: 1.189 on 3 and 243 DF, p-value: 0.3146

*# length: RC1 lexicals*  
fit\_RC1\_lexicals\_props <- **lm**(props$s\_RC1\_lexicals ~ props$s\_Auditory + props$s\_Haptic   
+ props$s\_Visual, data = props)  
**stat.desc**(fit\_RC1\_lexicals\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.700000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.822622e+00  
## max 3.222212e+00  
## range 5.044834e+00  
## sum -3.788636e-15  
## median -1.386471e-01  
## mean -2.226473e-17  
## SE.mean 7.506144e-02  
## CI.mean.0.95 1.481788e-01  
## var 9.578174e-01  
## std.dev 9.786814e-01  
## coef.var -4.395658e+16  
## skewness 7.538996e-01  
## skew.2SE 2.024025e+00  
## kurtosis 2.557611e-01  
## kurt.2SE 3.452572e-01  
## normtest.W 9.558991e-01  
## normtest.p 3.484999e-05

*# residuals distribution: skewed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_RC1\_lexicals)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 170 0 1 -0.11 -0.09 0.93 -2.08 3.63 5.71 0.93 0.94  
## se  
## X1 0.08

props$log\_s\_RC1\_lexicals\_props <- **log**(4 + props$s\_RC1\_lexicals)  
  
fit\_RC1\_lexicals\_props <- **lm**(props$log\_s\_RC1\_lexicals ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_RC1\_lexicals\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.700000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -6.408548e-01  
## max 6.186645e-01  
## range 1.259519e+00  
## sum 6.973588e-16  
## median -9.930210e-03  
## mean 4.093142e-18  
## SE.mean 1.804027e-02  
## CI.mean.0.95 3.561330e-02  
## var 5.532672e-02  
## std.dev 2.352163e-01  
## coef.var 5.746595e+16  
## skewness 1.943265e-01  
## skew.2SE 5.217161e-01  
## kurtosis -4.515675e-01  
## kurt.2SE -6.095802e-01  
## normtest.W 9.897230e-01  
## normtest.p 2.566697e-01

*# good!*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_RC1\_lexicals\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.139419 1.002843 1.141874

**mean**(**vif**(fit\_RC1\_lexicals\_props))

## [1] 1.094712

1/**vif**(fit\_RC1\_lexicals\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.8776401 0.9971650 0.8757534

*# RESULTS: all good*  
  
step\_RC1\_lexicals\_props\_AIC <- **stepAIC**(fit\_RC1\_lexicals\_props, direction="both")

## Start: AIC=-485.07  
## props$log\_s\_RC1\_lexicals ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.075722 9.4259 -485.70  
## - props$s\_Visual 1 0.080229 9.4304 -485.62  
## <none> 9.3502 -485.07  
## - props$s\_Auditory 1 0.246461 9.5967 -482.64  
##   
## Step: AIC=-485.7  
## props$log\_s\_RC1\_lexicals ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Visual 1 0.088911 9.5148 -486.10  
## <none> 9.4259 -485.70  
## + props$s\_Haptic 1 0.075722 9.3502 -485.07  
## - props$s\_Auditory 1 0.253554 9.6795 -483.18  
##   
## Step: AIC=-486.1  
## props$log\_s\_RC1\_lexicals ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC  
## <none> 9.5148 -486.10  
## + props$s\_Visual 1 0.088911 9.4259 -485.70  
## + props$s\_Haptic 1 0.084404 9.4304 -485.62  
## - props$s\_Auditory 1 0.181715 9.6966 -484.88

step\_RC1\_lexicals\_props\_F <- **stepAIC**(fit\_RC1\_lexicals\_props, direction="both",   
test="F")

## Start: AIC=-485.07  
## props$log\_s\_RC1\_lexicals ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.075722 9.4259 -485.70 1.3443 0.24794   
## - props$s\_Visual 1 0.080229 9.4304 -485.62 1.4243 0.23439   
## <none> 9.3502 -485.07   
## - props$s\_Auditory 1 0.246461 9.5967 -482.64 4.3756 0.03798 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-485.7  
## props$log\_s\_RC1\_lexicals ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Visual 1 0.088911 9.5148 -486.10 1.5752 0.21120   
## <none> 9.4259 -485.70   
## + props$s\_Haptic 1 0.075722 9.3502 -485.07 1.3443 0.24794   
## - props$s\_Auditory 1 0.253554 9.6795 -483.18 4.4922 0.03553 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-486.1  
## props$log\_s\_RC1\_lexicals ~ props$s\_Auditory  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 9.5148 -486.10   
## + props$s\_Visual 1 0.088911 9.4259 -485.70 1.5752 0.21120   
## + props$s\_Haptic 1 0.084404 9.4304 -485.62 1.4947 0.22322   
## - props$s\_Auditory 1 0.181715 9.6966 -484.88 3.2085 0.07506 .  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_RC1\_lexicals\_props)

##   
## Call:  
## lm(formula = props$log\_s\_RC1\_lexicals ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.64085 -0.18979 -0.00993 0.15912 0.61866   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.37128 0.02076 66.043 <2e-16 \*\*\*  
## props$s\_Auditory 0.05991 0.02864 2.092 0.038 \*   
## props$s\_Haptic -0.02067 0.01783 -1.159 0.248   
## props$s\_Visual 0.02760 0.02313 1.193 0.234   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.2373 on 166 degrees of freedom  
## (173 observations deleted due to missingness)  
## Multiple R-squared: 0.03572, Adjusted R-squared: 0.01829   
## F-statistic: 2.05 on 3 and 166 DF, p-value: 0.1089

*# distinctiveness: RC3 lexicals*  
fit\_RC3\_lexicals\_props <- **lm**(props$s\_RC3\_lexicals ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_RC3\_lexicals\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.700000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.355748e+00  
## max 4.005520e+00  
## range 5.361267e+00  
## sum 2.810252e-15  
## median -2.582047e-01  
## mean 1.657107e-17  
## SE.mean 7.489141e-02  
## CI.mean.0.95 1.478432e-01  
## var 9.534830e-01  
## std.dev 9.764646e-01  
## coef.var 5.892585e+16  
## skewness 1.582698e+00  
## skew.2SE 4.249133e+00  
## kurtosis 2.764799e+00  
## kurt.2SE 3.732258e+00  
## normtest.W 8.564774e-01  
## normtest.p 1.279852e-11

*# residuals distribution: skewed and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_RC3\_lexicals)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 170 0 1 -0.37 -0.17 0.57 -1.16 4.03 5.19 1.62 2.42  
## se  
## X1 0.08

props$log\_s\_RC3\_lexicals <- **log**(3 + props$s\_RC3\_lexicals)  
  
fit\_RC3\_lexicals\_props <- **lm**(props$log\_s\_RC3\_lexicals ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_RC3\_lexicals\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.700000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -4.797756e-01  
## max 9.240221e-01  
## range 1.403798e+00  
## sum -5.325601e-16  
## median -7.295993e-02  
## mean -3.147455e-18  
## SE.mean 2.151459e-02  
## CI.mean.0.95 4.247196e-02  
## var 7.868919e-02  
## std.dev 2.805159e-01  
## coef.var -8.912469e+16  
## skewness 9.224203e-01  
## skew.2SE 2.476459e+00  
## kurtosis 4.920814e-01  
## kurt.2SE 6.642707e-01  
## normtest.W 9.373994e-01  
## normtest.p 8.913216e-07

*# quite better*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_RC3\_lexicals\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.139419 1.002843 1.141874

**mean**(**vif**(fit\_RC3\_lexicals\_props))

## [1] 1.094712

1/**vif**(fit\_RC3\_lexicals\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.8776401 0.9971650 0.8757534

*# RESULTS: all good*  
  
step\_RC3\_lexicals\_props\_AIC <- **stepAIC**(fit\_RC3\_lexicals\_props, direction="both")

## Start: AIC=-425.19  
## props$log\_s\_RC3\_lexicals ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.01036 13.309 -427.05  
## <none> 13.299 -425.19  
## - props$s\_Auditory 1 0.17132 13.470 -425.01  
## - props$s\_Visual 1 0.59945 13.898 -419.69  
##   
## Step: AIC=-427.05  
## props$log\_s\_RC3\_lexicals ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 13.309 -427.05  
## - props$s\_Auditory 1 0.17356 13.482 -426.85  
## + props$s\_Haptic 1 0.01036 13.299 -425.19  
## - props$s\_Visual 1 0.60949 13.918 -421.44

step\_RC3\_lexicals\_props\_F <- **stepAIC**(fit\_RC3\_lexicals\_props, direction="both",   
test="F")

## Start: AIC=-425.19  
## props$log\_s\_RC3\_lexicals ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.01036 13.309 -427.05 0.1293 0.719589   
## <none> 13.299 -425.19   
## - props$s\_Auditory 1 0.17132 13.470 -425.01 2.1386 0.145527   
## - props$s\_Visual 1 0.59945 13.898 -419.69 7.4828 0.006907 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-427.05  
## props$log\_s\_RC3\_lexicals ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 13.309 -427.05   
## - props$s\_Auditory 1 0.17356 13.482 -426.85 2.1779 0.141891   
## + props$s\_Haptic 1 0.01036 13.299 -425.19 0.1293 0.719589   
## - props$s\_Visual 1 0.60949 13.918 -421.44 7.6480 0.006323 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_RC3\_lexicals\_props)

##   
## Call:  
## lm(formula = props$log\_s\_RC3\_lexicals ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.47978 -0.20764 -0.07296 0.13226 0.92402   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.058987 0.024762 42.766 < 2e-16 \*\*\*  
## props$s\_Auditory -0.049950 0.034157 -1.462 0.14553   
## props$s\_Haptic 0.007645 0.021259 0.360 0.71959   
## props$s\_Visual -0.075441 0.027579 -2.735 0.00691 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.283 on 166 degrees of freedom  
## (173 observations deleted due to missingness)  
## Multiple R-squared: 0.04616, Adjusted R-squared: 0.02892   
## F-statistic: 2.678 on 3 and 166 DF, p-value: 0.04882

*# freq: RC2 lexicals*  
fit\_RC2\_lexicals\_props <- **lm**(props$s\_RC2\_lexicals ~ props$s\_Auditory + props$s\_Haptic  
 + props$s\_Visual, data = props)  
**stat.desc**(fit\_RC2\_lexicals\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.700000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.521274e+00  
## max 2.428216e+00  
## range 4.949490e+00  
## sum -3.816392e-15  
## median -1.168067e-01  
## mean -2.235880e-17  
## SE.mean 7.481168e-02  
## CI.mean.0.95 1.476858e-01  
## var 9.514538e-01  
## std.dev 9.754249e-01  
## coef.var -4.362600e+16  
## skewness 2.099120e-01  
## skew.2SE 5.635592e-01  
## kurtosis -7.566392e-01  
## kurt.2SE -1.021403e+00  
## normtest.W 9.788257e-01  
## normtest.p 1.063544e-02

*# residuals distribution: kurtosed. Raw scores/2.SE < 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_RC2\_lexicals)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 170 0 1 -0.02 -0.03 1.15 -2.37 2.29 4.66 0.2 -0.67  
## se  
## X1 0.08

props$log\_s\_RC2\_lexicals <- **log**(3 + props$s\_RC2\_lexicals)  
  
fit\_RC2\_lexicals\_props <- **lm**(props$log\_s\_RC2\_lexicals ~ props$s\_Auditory +   
props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_RC2\_lexicals\_props$residuals, norm = TRUE)

## x  
## nbr.val 1.700000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.548065e+00  
## max 7.294142e-01  
## range 2.277479e+00  
## sum 8.968520e-16  
## median 1.992494e-02  
## mean 5.315142e-18  
## SE.mean 2.746269e-02  
## CI.mean.0.95 5.421412e-02  
## var 1.282139e-01  
## std.dev 3.580697e-01  
## coef.var 6.736786e+16  
## skewness -6.661503e-01  
## skew.2SE -1.788441e+00  
## kurtosis 9.513419e-01  
## kurt.2SE 1.284236e+00  
## normtest.W 9.666991e-01  
## normtest.p 4.244338e-04

*# worse; back*  
fit\_RC2\_lexicals\_props <- **lm**(props$s\_RC2\_lexicals ~ props$s\_Auditory + props$s\_Haptic  
 + props$s\_Visual, data = props)  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_RC2\_lexicals\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.139419 1.002843 1.141874

**mean**(**vif**(fit\_RC2\_lexicals\_props))

## [1] 1.094712

1/**vif**(fit\_RC2\_lexicals\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.8776401 0.9971650 0.8757534

*# RESULTS: all good*  
  
step\_RC2\_lexicals\_props\_AIC <- **stepAIC**(fit\_RC2\_lexicals\_props, direction="both")

## Start: AIC=-1.46  
## props$s\_RC2\_lexicals ~ props$s\_Auditory + props$s\_Haptic + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.8921 161.69 -2.5223  
## <none> 160.80 -1.4629  
## - props$s\_Visual 1 3.7779 164.57 0.4851  
## - props$s\_Auditory 1 5.6714 166.47 2.4298  
##   
## Step: AIC=-2.52  
## props$s\_RC2\_lexicals ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 161.69 -2.52228  
## + props$s\_Haptic 1 0.8921 160.80 -1.46286  
## - props$s\_Visual 1 3.9852 165.67 -0.38301  
## - props$s\_Auditory 1 5.7890 167.48 1.45786

step\_RC2\_lexicals\_props\_F <- **stepAIC**(fit\_RC2\_lexicals\_props, direction="both",   
test="F")

## Start: AIC=-1.46  
## props$s\_RC2\_lexicals ~ props$s\_Auditory + props$s\_Haptic + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.8921 161.69 -2.5223 0.9210 0.33861   
## <none> 160.80 -1.4629   
## - props$s\_Visual 1 3.7779 164.57 0.4851 3.9002 0.04994 \*  
## - props$s\_Auditory 1 5.6714 166.47 2.4298 5.8549 0.01661 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-2.52  
## props$s\_RC2\_lexicals ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 161.69 -2.52228   
## + props$s\_Haptic 1 0.8921 160.80 -1.46286 0.9210 0.33861   
## - props$s\_Visual 1 3.9852 165.67 -0.38301 4.1161 0.04406 \*  
## - props$s\_Auditory 1 5.7890 167.48 1.45786 5.9792 0.01551 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_RC2\_lexicals\_props)

##   
## Call:  
## lm(formula = props$s\_RC2\_lexicals ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.5213 -0.8128 -0.1168 0.7561 2.4282   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.04703 0.08610 0.546 0.5856   
## props$s\_Auditory 0.28739 0.11877 2.420 0.0166 \*  
## props$s\_Haptic -0.07094 0.07392 -0.960 0.3386   
## props$s\_Visual 0.18939 0.09590 1.975 0.0499 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9842 on 166 degrees of freedom  
## (173 observations deleted due to missingness)  
## Multiple R-squared: 0.04855, Adjusted R-squared: 0.03135   
## F-statistic: 2.823 on 3 and 166 DF, p-value: 0.04046

*# additional var: age of acquisition*  
fit\_AoA\_Brysbaertetal2014\_props <- **lm**(props$s\_AoA\_Brysbaertetal2014 ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_AoA\_Brysbaertetal2014\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.330000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.112829e+00  
## max 2.593592e+00  
## range 4.706422e+00  
## sum 2.532696e-16  
## median 3.452361e-02  
## mean 1.144694e-18  
## SE.mean 6.406750e-02  
## CI.mean.0.95 1.262285e-01  
## var 9.563821e-01  
## std.dev 9.779479e-01  
## coef.var 8.543312e+17  
## skewness 7.860513e-02  
## skew.2SE 2.464866e-01  
## kurtosis -4.681725e-01  
## kurt.2SE -7.370869e-01  
## normtest.W 9.881971e-01  
## normtest.p 5.248873e-02

*# residuals distribution: good*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_AoA\_Brysbaertetal2014\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.292539 1.013180 1.284802

**mean**(**vif**(fit\_AoA\_Brysbaertetal2014\_props))

## [1] 1.19684

1/**vif**(fit\_AoA\_Brysbaertetal2014\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7736713 0.9869918 0.7783300

*# RESULTS: all good*  
  
step\_AoA\_Brysbaertetal2014\_props\_AIC <- **stepAIC**(fit\_AoA\_Brysbaertetal2014\_props,  
direction="both")

## Start: AIC=-3.39  
## props$s\_AoA\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 0.0101 221.89 -5.3829  
## - props$s\_Auditory 1 0.1463 222.03 -5.2398  
## <none> 221.88 -3.3934  
## - props$s\_Visual 1 6.7408 228.62 1.5798  
##   
## Step: AIC=-5.38  
## props$s\_AoA\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Auditory 1 0.1538 222.04 -7.2214  
## <none> 221.89 -5.3829  
## + props$s\_Haptic 1 0.0101 221.88 -3.3934  
## - props$s\_Visual 1 6.7630 228.65 -0.3874  
##   
## Step: AIC=-7.22  
## props$s\_AoA\_Brysbaertetal2014 ~ props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 222.04 -7.2214  
## + props$s\_Auditory 1 0.1538 221.89 -5.3829  
## + props$s\_Haptic 1 0.0176 222.03 -5.2398  
## - props$s\_Visual 1 9.9555 232.00 0.9978

step\_AoA\_Brysbaertetal2014\_props\_F <- **stepAIC**(fit\_AoA\_Brysbaertetal2014\_props,   
direction="both", test="F")

## Start: AIC=-3.39  
## props$s\_AoA\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 0.0101 221.89 -5.3829 0.0104 0.918933   
## - props$s\_Auditory 1 0.1463 222.03 -5.2398 0.1510 0.697929   
## <none> 221.88 -3.3934   
## - props$s\_Visual 1 6.7408 228.62 1.5798 6.9571 0.008921 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-5.38  
## props$s\_AoA\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Auditory 1 0.1538 222.04 -7.2214 0.1594 0.690035   
## <none> 221.89 -5.3829   
## + props$s\_Haptic 1 0.0101 221.88 -3.3934 0.0104 0.918933   
## - props$s\_Visual 1 6.7630 228.65 -0.3874 7.0101 0.008666 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-7.22  
## props$s\_AoA\_Brysbaertetal2014 ~ props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 222.04 -7.2214   
## + props$s\_Auditory 1 0.1538 221.89 -5.3829 0.1594 0.690035   
## + props$s\_Haptic 1 0.0176 222.03 -5.2398 0.0182 0.892810   
## - props$s\_Visual 1 9.9555 232.00 0.9978 10.3570 0.001475 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_AoA\_Brysbaertetal2014\_props)

##   
## Call:  
## lm(formula = props$s\_AoA\_Brysbaertetal2014 ~ props$s\_Auditory +   
## props$s\_Haptic + props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.11283 -0.73187 0.03452 0.64255 2.59359   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.054540 0.067911 0.803 0.42274   
## props$s\_Auditory 0.035560 0.091508 0.389 0.69793   
## props$s\_Haptic -0.006453 0.063334 -0.102 0.91893   
## props$s\_Visual -0.209357 0.079373 -2.638 0.00892 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9843 on 229 degrees of freedom  
## (110 observations deleted due to missingness)  
## Multiple R-squared: 0.04362, Adjusted R-squared: 0.03109   
## F-statistic: 3.481 on 3 and 229 DF, p-value: 0.01667

*# additional var: concreteness*  
fit\_concrete\_Brysbaertetal2014\_props <- **lm**(props$s\_concrete\_Brysbaertetal2014 ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
**stat.desc**(fit\_concrete\_Brysbaertetal2014\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.330000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.594543e+00  
## max 1.852867e+00  
## range 4.447410e+00  
## sum -2.477185e-14  
## median 1.768909e-01  
## mean -1.062963e-16  
## SE.mean 6.295441e-02  
## CI.mean.0.95 1.240354e-01  
## var 9.234389e-01  
## std.dev 9.609573e-01  
## coef.var -9.040369e+15  
## skewness -4.207250e-01  
## skew.2SE -1.319291e+00  
## kurtosis -3.351918e-01  
## kurt.2SE -5.277232e-01  
## normtest.W 9.790502e-01  
## normtest.p 1.581048e-03

*# residuals distribution: skew. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(props$s\_concrete\_Brysbaertetal2014)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 233 0 1 0.19 0.04 0.99 -2.76 1.99 4.76 -0.37 -0.41  
## se  
## X1 0.07

props$log\_s\_concrete\_Brysbaertetal2014 <- **log**(4 + props$s\_concrete\_Brysbaertetal2014)  
  
fit\_concrete\_Brysbaertetal2014\_props <- **lm**(props$log\_s\_concrete\_Brysbaertetal2014 ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
  
*# check residuals again*  
**stat.desc**(fit\_concrete\_Brysbaertetal2014\_props$residuals, norm = TRUE)

## x  
## nbr.val 2.330000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.084648e+00  
## max 4.612322e-01  
## range 1.545880e+00  
## sum -4.888451e-15  
## median 8.076837e-02  
## mean -2.101351e-17  
## SE.mean 1.814043e-02  
## CI.mean.0.95 3.574103e-02  
## var 7.667449e-02  
## std.dev 2.769016e-01  
## coef.var -1.317731e+16  
## skewness -1.152705e+00  
## skew.2SE -3.614602e+00  
## kurtosis 1.563516e+00  
## kurt.2SE 2.461586e+00  
## normtest.W 9.220715e-01  
## normtest.p 1.003247e-09

*# worse; back*  
fit\_concrete\_Brysbaertetal2014\_props <- **lm**(props$s\_concrete\_Brysbaertetal2014 ~   
props$s\_Auditory + props$s\_Haptic + props$s\_Visual, data = props)  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_concrete\_Brysbaertetal2014\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 1.292539 1.013180 1.284802

**mean**(**vif**(fit\_concrete\_Brysbaertetal2014\_props))

## [1] 1.19684

1/**vif**(fit\_concrete\_Brysbaertetal2014\_props)

## props$s\_Auditory props$s\_Haptic props$s\_Visual   
## 0.7736713 0.9869918 0.7783300

*# RESULTS: all good*  
  
step\_concrete\_Brysbaertetal2014\_props\_AIC <-   
**stepAIC**(fit\_concrete\_Brysbaertetal2014\_props, direction="both")

## Start: AIC=-11.56  
## props$s\_concrete\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - props$s\_Haptic 1 1.2182 215.46 -12.2396  
## <none> 214.24 -11.5607  
## - props$s\_Auditory 1 3.2391 217.48 -10.0643  
## - props$s\_Visual 1 5.0553 219.29 -8.1266  
##   
## Step: AIC=-12.24  
## props$s\_concrete\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 215.46 -12.240  
## + props$s\_Haptic 1 1.2182 214.24 -11.561  
## - props$s\_Auditory 1 3.6026 219.06 -10.376  
## - props$s\_Visual 1 5.2123 220.67 -8.670

step\_concrete\_Brysbaertetal2014\_props\_F <-   
**stepAIC**(fit\_concrete\_Brysbaertetal2014\_props, direction="both", test="F")

## Start: AIC=-11.56  
## props$s\_concrete\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Haptic +   
## props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - props$s\_Haptic 1 1.2182 215.46 -12.2396 1.3022 0.25501   
## <none> 214.24 -11.5607   
## - props$s\_Auditory 1 3.2391 217.48 -10.0643 3.4623 0.06406 .  
## - props$s\_Visual 1 5.0553 219.29 -8.1266 5.4036 0.02097 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-12.24  
## props$s\_concrete\_Brysbaertetal2014 ~ props$s\_Auditory + props$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 215.46 -12.240   
## + props$s\_Haptic 1 1.2182 214.24 -11.561 1.3022 0.25501   
## - props$s\_Auditory 1 3.6026 219.06 -10.376 3.8457 0.05108 .  
## - props$s\_Visual 1 5.2123 220.67 -8.670 5.5641 0.01917 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_concrete\_Brysbaertetal2014\_props)

##   
## Call:  
## lm(formula = props$s\_concrete\_Brysbaertetal2014 ~ props$s\_Auditory +   
## props$s\_Haptic + props$s\_Visual, data = props)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.5945 -0.6710 0.1769 0.6787 1.8529   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.08550 0.06673 -1.281 0.2014   
## props$s\_Auditory -0.16731 0.08992 -1.861 0.0641 .  
## props$s\_Haptic 0.07102 0.06223 1.141 0.2550   
## props$s\_Visual 0.18130 0.07799 2.325 0.0210 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9672 on 229 degrees of freedom  
## (110 observations deleted due to missingness)  
## Multiple R-squared: 0.07656, Adjusted R-squared: 0.06446   
## F-statistic: 6.329 on 3 and 229 DF, p-value: 0.0003852

*# RESULTS: iconicity properties:*   
*# Auditory strength either was the strongest predictor or presented an opposite*   
*# polarity from the main predictor. This held for all lexical DVs except age of*   
*# acquisition.*  
  
  
  
*# \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  
  
*# Iconicity within concepts alone, as in Lynott and Connell (2013)*  
  
concs <- all[all$cat == 'conc' & **c**(all$normed == 'Dutch' | all$normed == 'Dut\_Eng'),]  
**nrow**(concs)

## [1] 411

*# There aren't lexical data for every single word.*  
*# Percentage of concepts per lexical variable (from items w/ Dutch norms)*  
**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$phonemes\_DUTCHPOND))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$phonemes\_DUTCHPOND)   
## n missing unique   
## 411 0 2   
##   
## FALSE (22, 5%), TRUE (389, 95%)

**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$phon\_neighbours\_DUTCHPOND))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$phon\_neighbours\_DUTCHPOND)   
## n missing unique value   
## 411 0 1 TRUE

**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$orth\_neighbours\_DUTCHPOND))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$orth\_neighbours\_DUTCHPOND)   
## n missing unique value   
## 411 0 1 TRUE

**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$freq\_lg10CD\_SUBTLEXNL))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$freq\_lg10CD\_SUBTLEXNL)   
## n missing unique   
## 411 0 2   
##   
## FALSE (4, 1%), TRUE (407, 99%)

**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$freq\_lg10WF\_SUBTLEXNL))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$freq\_lg10WF\_SUBTLEXNL)   
## n missing unique   
## 411 0 2   
##   
## FALSE (4, 1%), TRUE (407, 99%)

**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$freq\_CELEX\_lem))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$freq\_CELEX\_lem)   
## n missing unique   
## 411 0 2   
##   
## FALSE (12, 3%), TRUE (399, 97%)

**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$AoA\_Brysbaertetal2014))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$AoA\_Brysbaertetal2014)   
## n missing unique   
## 411 0 2   
##   
## FALSE (13, 3%), TRUE (398, 97%)

**describe**(**complete.cases**(concs[**complete.cases**(concs$Exclusivity),]  
$concrete\_Brysbaertetal2014))

## complete.cases(concs[complete.cases(concs$Exclusivity), ]$concrete\_Brysbaertetal2014)   
## n missing unique   
## 411 0 2   
##   
## FALSE (13, 3%), TRUE (398, 97%)

*# M, SD*  
**stat.desc**(concs$letters)

## nbr.val nbr.null nbr.na min max   
## 411.0000000 0.0000000 0.0000000 3.0000000 17.0000000   
## range sum median mean SE.mean   
## 14.0000000 2759.0000000 6.0000000 6.7128954 0.1254065   
## CI.mean.0.95 var std.dev coef.var   
## 0.2465199 6.4637114 2.5423830 0.3787312

**stat.desc**(concs$phonemes\_DUTCHPOND)

## nbr.val nbr.null nbr.na min max   
## 389.0000000 0.0000000 22.0000000 2.0000000 15.0000000   
## range sum median mean SE.mean   
## 13.0000000 2265.0000000 6.0000000 5.8226221 0.1104353   
## CI.mean.0.95 var std.dev coef.var   
## 0.2171266 4.7442292 2.1781252 0.3740798

**stat.desc**(concs$phon\_neighbours\_DUTCHPOND)

## nbr.val nbr.null nbr.na min max   
## 411.0000000 139.0000000 0.0000000 0.0000000 49.0000000   
## range sum median mean SE.mean   
## 49.0000000 2273.0000000 1.0000000 5.5304136 0.4080256   
## CI.mean.0.95 var std.dev coef.var   
## 0.8020832 68.4252923 8.2719582 1.4957214

**stat.desc**(concs$orth\_neighbours\_DUTCHPOND)

## nbr.val nbr.null nbr.na min max   
## 411.0000000 143.0000000 0.0000000 0.0000000 32.0000000   
## range sum median mean SE.mean   
## 32.0000000 1658.0000000 1.0000000 4.0340633 0.2825354   
## CI.mean.0.95 var std.dev coef.var   
## 0.5553987 32.8085930 5.7278786 1.4198782

**stat.desc**(concs$freq\_lg10CD\_SUBTLEXNL)

## nbr.val nbr.null nbr.na min max   
## 4.070000e+02 0.000000e+00 4.000000e+00 6.000000e-01 3.900000e+00   
## range sum median mean SE.mean   
## 3.300000e+00 1.080720e+03 2.700000e+00 2.655332e+00 3.275722e-02   
## CI.mean.0.95 var std.dev coef.var   
## 6.439494e-02 4.367254e-01 6.608521e-01 2.488774e-01

**stat.desc**(concs$freq\_lg10WF\_SUBTLEXNL)

## nbr.val nbr.null nbr.na min max   
## 4.070000e+02 0.000000e+00 4.000000e+00 6.000000e-01 4.770000e+00   
## range sum median mean SE.mean   
## 4.170000e+00 1.157980e+03 2.850000e+00 2.845160e+00 3.775280e-02   
## CI.mean.0.95 var std.dev coef.var   
## 7.421538e-02 5.800866e-01 7.616342e-01 2.676947e-01

**stat.desc**(concs$freq\_CELEX\_lem)

## nbr.val nbr.null nbr.na min max   
## 399.00000000 11.00000000 12.00000000 0.00000000 3.18800000   
## range sum median mean SE.mean   
## 3.18800000 612.79100000 1.55600000 1.53581704 0.03185900   
## CI.mean.0.95 var std.dev coef.var   
## 0.06263295 0.40498325 0.63638294 0.41436117

**stat.desc**(concs$AoA\_Brysbaertetal2014)

## nbr.val nbr.null nbr.na min max   
## 398.0000000 0.0000000 13.0000000 3.4100000 13.1800000   
## range sum median mean SE.mean   
## 9.7700000 3210.3200000 8.1500000 8.0661307 0.1086208   
## CI.mean.0.95 var std.dev coef.var   
## 0.2135439 4.6957941 2.1669781 0.2686515

**stat.desc**(concs$concrete\_Brysbaertetal2014)

## nbr.val nbr.null nbr.na min max   
## 3.980000e+02 0.000000e+00 1.300000e+01 1.200000e+00 5.000000e+00   
## range sum median mean SE.mean   
## 3.800000e+00 1.203330e+03 2.800000e+00 3.023442e+00 5.356266e-02   
## CI.mean.0.95 var std.dev coef.var   
## 1.053019e-01 1.141845e+00 1.068572e+00 3.534288e-01

*# See and print correlation of all lexical variables:*  
  
mat\_lexicals\_concs <- **as.matrix**(concs[**c**('letters', 'phonemes\_DUTCHPOND',   
'orth\_neighbours\_DUTCHPOND', 'phon\_neighbours\_DUTCHPOND', 'freq\_lg10CD\_SUBTLEXNL',   
'freq\_lg10WF\_SUBTLEXNL', 'freq\_CELEX\_lem', 'AoA\_Brysbaertetal2014',   
'concrete\_Brysbaertetal2014')])  
  
**rcor.test**(mat\_lexicals\_concs, use='complete.obs')

##   
## letters phonemes\_DUTCHPOND  
## letters \*\*\*\*\* 0.942   
## phonemes\_DUTCHPOND <0.001 \*\*\*\*\*   
## orth\_neighbours\_DUTCHPOND <0.001 <0.001   
## phon\_neighbours\_DUTCHPOND <0.001 <0.001   
## freq\_lg10CD\_SUBTLEXNL <0.001 <0.001   
## freq\_lg10WF\_SUBTLEXNL <0.001 <0.001   
## freq\_CELEX\_lem <0.001 <0.001   
## AoA\_Brysbaertetal2014 <0.001 <0.001   
## concrete\_Brysbaertetal2014 <0.001 <0.001   
## orth\_neighbours\_DUTCHPOND  
## letters -0.647   
## phonemes\_DUTCHPOND -0.617   
## orth\_neighbours\_DUTCHPOND \*\*\*\*\*   
## phon\_neighbours\_DUTCHPOND <0.001   
## freq\_lg10CD\_SUBTLEXNL <0.001   
## freq\_lg10WF\_SUBTLEXNL <0.001   
## freq\_CELEX\_lem <0.001   
## AoA\_Brysbaertetal2014 <0.001   
## concrete\_Brysbaertetal2014 <0.001   
## phon\_neighbours\_DUTCHPOND freq\_lg10CD\_SUBTLEXNL  
## letters -0.630 -0.364   
## phonemes\_DUTCHPOND -0.633 -0.362   
## orth\_neighbours\_DUTCHPOND 0.879 0.329   
## phon\_neighbours\_DUTCHPOND \*\*\*\*\* 0.349   
## freq\_lg10CD\_SUBTLEXNL <0.001 \*\*\*\*\*   
## freq\_lg10WF\_SUBTLEXNL <0.001 <0.001   
## freq\_CELEX\_lem <0.001 <0.001   
## AoA\_Brysbaertetal2014 <0.001 <0.001   
## concrete\_Brysbaertetal2014 <0.001 0.378   
## freq\_lg10WF\_SUBTLEXNL freq\_CELEX\_lem  
## letters -0.381 -0.212   
## phonemes\_DUTCHPOND -0.369 -0.237   
## orth\_neighbours\_DUTCHPOND 0.338 0.201   
## phon\_neighbours\_DUTCHPOND 0.352 0.220   
## freq\_lg10CD\_SUBTLEXNL 0.987 0.776   
## freq\_lg10WF\_SUBTLEXNL \*\*\*\*\* 0.757   
## freq\_CELEX\_lem <0.001 \*\*\*\*\*   
## AoA\_Brysbaertetal2014 <0.001 <0.001   
## concrete\_Brysbaertetal2014 0.157 0.028   
## AoA\_Brysbaertetal2014  
## letters 0.491   
## phonemes\_DUTCHPOND 0.513   
## orth\_neighbours\_DUTCHPOND -0.467   
## phon\_neighbours\_DUTCHPOND -0.437   
## freq\_lg10CD\_SUBTLEXNL -0.585   
## freq\_lg10WF\_SUBTLEXNL -0.601   
## freq\_CELEX\_lem -0.430   
## AoA\_Brysbaertetal2014 \*\*\*\*\*   
## concrete\_Brysbaertetal2014 <0.001   
## concrete\_Brysbaertetal2014  
## letters -0.415   
## phonemes\_DUTCHPOND -0.397   
## orth\_neighbours\_DUTCHPOND 0.391   
## phon\_neighbours\_DUTCHPOND 0.348   
## freq\_lg10CD\_SUBTLEXNL 0.007   
## freq\_lg10WF\_SUBTLEXNL 0.039   
## freq\_CELEX\_lem -0.124   
## AoA\_Brysbaertetal2014 -0.569   
## concrete\_Brysbaertetal2014 \*\*\*\*\*   
##   
## upper diagonal part contains correlation coefficient estimates   
## lower diagonal part contains corresponding p-values

corrs\_concs = **rcor.test**(mat\_lexicals\_concs, use='complete.obs')  
**write.csv**(corrs\_concs$cor.mat, file = "corrs\_concs.csv",na="") *# find table in folder*  
  
  
*# go on to PCA. This does not include age of acquisition or concreteness for a*   
*# better comparison with the English data, and because no correlations > .7 (i.e. half*  
*# of variance explained)*  
  
lexicals\_concs <- concs[**c**('letters', 'phonemes\_DUTCHPOND', 'orth\_neighbours\_DUTCHPOND',   
'phon\_neighbours\_DUTCHPOND', 'freq\_lg10CD\_SUBTLEXNL', 'freq\_lg10WF\_SUBTLEXNL',   
'freq\_CELEX\_lem')]  
  
**nrow**(lexicals\_concs)

## [1] 411

*# start with PCA for lexical variables, done as in Lynott and Connell (2013)*  
*# Check conditions for a PCA*  
*# Correlations*  
  
**cor**(lexicals\_concs, use = 'complete.obs')

## letters phonemes\_DUTCHPOND  
## letters 1.0000000 0.9458316  
## phonemes\_DUTCHPOND 0.9458316 1.0000000  
## orth\_neighbours\_DUTCHPOND -0.6300830 -0.6067762  
## phon\_neighbours\_DUTCHPOND -0.6130258 -0.6214952  
## freq\_lg10CD\_SUBTLEXNL -0.3777808 -0.3760751  
## freq\_lg10WF\_SUBTLEXNL -0.3915313 -0.3811413  
## freq\_CELEX\_lem -0.2145080 -0.2359925  
## orth\_neighbours\_DUTCHPOND  
## letters -0.6300830  
## phonemes\_DUTCHPOND -0.6067762  
## orth\_neighbours\_DUTCHPOND 1.0000000  
## phon\_neighbours\_DUTCHPOND 0.8793924  
## freq\_lg10CD\_SUBTLEXNL 0.3333547  
## freq\_lg10WF\_SUBTLEXNL 0.3431698  
## freq\_CELEX\_lem 0.2009497  
## phon\_neighbours\_DUTCHPOND freq\_lg10CD\_SUBTLEXNL  
## letters -0.6130258 -0.3777808  
## phonemes\_DUTCHPOND -0.6214952 -0.3760751  
## orth\_neighbours\_DUTCHPOND 0.8793924 0.3333547  
## phon\_neighbours\_DUTCHPOND 1.0000000 0.3535024  
## freq\_lg10CD\_SUBTLEXNL 0.3535024 1.0000000  
## freq\_lg10WF\_SUBTLEXNL 0.3561152 0.9874908  
## freq\_CELEX\_lem 0.2178926 0.7693247  
## freq\_lg10WF\_SUBTLEXNL freq\_CELEX\_lem  
## letters -0.3915313 -0.2145080  
## phonemes\_DUTCHPOND -0.3811413 -0.2359925  
## orth\_neighbours\_DUTCHPOND 0.3431698 0.2009497  
## phon\_neighbours\_DUTCHPOND 0.3561152 0.2178926  
## freq\_lg10CD\_SUBTLEXNL 0.9874908 0.7693247  
## freq\_lg10WF\_SUBTLEXNL 1.0000000 0.7508591  
## freq\_CELEX\_lem 0.7508591 1.0000000

*# Result: all variables fit for PCA, as they have few scores below .3*   
*# The correlations broadly replicate Lynott and Connell.*   
  
*# now on the raw vars:*  
**cortest.bartlett**(lexicals\_concs)

## R was not square, finding R from data

## $chisq  
## [1] 3798.943  
##   
## $p.value  
## [1] 0  
##   
## $df  
## [1] 21

*# GOOD: Bartlett's test significant*   
  
*# KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy*  
lexicals\_concs\_matrix <- **cor**(lexicals\_concs, use = 'complete.obs')  
**KMO**(lexicals\_concs\_matrix)

## Kaiser-Meyer-Olkin factor adequacy  
## Call: KMO(r = lexicals\_concs\_matrix)  
## Overall MSA = 0.71  
## MSA for each item =   
## letters phonemes\_DUTCHPOND   
## 0.68 0.68   
## orth\_neighbours\_DUTCHPOND phon\_neighbours\_DUTCHPOND   
## 0.71 0.72   
## freq\_lg10CD\_SUBTLEXNL freq\_lg10WF\_SUBTLEXNL   
## 0.67 0.68   
## freq\_CELEX\_lem   
## 0.94

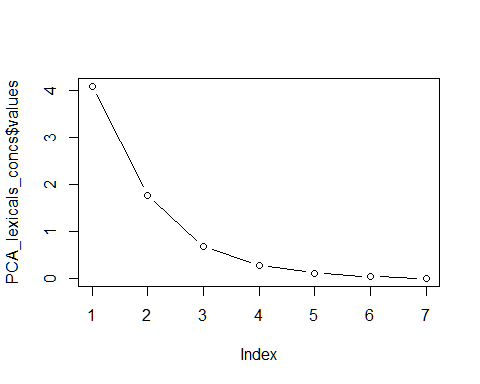
*# Result: .71 = good.*  
  
*# determinant*  
**det**(lexicals\_concs\_matrix)

## [1] 0.000105064

*# GOOD: above 0.00001*  
  
*# start off with unrotated PCA*  
  
PCA\_lexicals\_concs <- psych::**principal**(lexicals\_concs, nfactors = 7, scores = TRUE)  
PCA\_lexicals\_concs

## Principal Components Analysis  
## Call: psych::principal(r = lexicals\_concs, nfactors = 7, scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC2 RC1 RC3 RC4 RC5 RC6 RC7 h2  
## letters -0.19 0.91 -0.32 -0.04 0.03 0.16 0.00 1  
## phonemes\_DUTCHPOND -0.16 0.92 -0.31 -0.05 -0.03 -0.16 0.00 1  
## orth\_neighbours\_DUTCHPOND 0.15 -0.33 0.90 0.04 -0.24 -0.01 0.00 1  
## phon\_neighbours\_DUTCHPOND 0.17 -0.33 0.90 0.05 0.24 0.01 0.00 1  
## freq\_lg10CD\_SUBTLEXNL 0.96 -0.17 0.15 0.17 0.01 0.01 0.07 1  
## freq\_lg10WF\_SUBTLEXNL 0.96 -0.18 0.16 0.15 0.00 -0.01 -0.07 1  
## freq\_CELEX\_lem 0.65 -0.07 0.07 0.75 0.00 0.00 0.00 1  
## u2 com  
## letters 4.4e-16 1.4  
## phonemes\_DUTCHPOND 8.9e-16 1.4  
## orth\_neighbours\_DUTCHPOND 1.2e-15 1.5  
## phon\_neighbours\_DUTCHPOND 2.0e-15 1.5  
## freq\_lg10CD\_SUBTLEXNL 1.8e-15 1.2  
## freq\_lg10WF\_SUBTLEXNL 1.6e-15 1.2  
## freq\_CELEX\_lem 2.0e-15 2.0  
##   
## RC2 RC1 RC3 RC4 RC5 RC6 RC7  
## SS loadings 2.37 1.96 1.86 0.62 0.12 0.05 0.01  
## Proportion Var 0.34 0.28 0.27 0.09 0.02 0.01 0.00  
## Cumulative Var 0.34 0.62 0.89 0.97 0.99 1.00 1.00  
## Proportion Explained 0.34 0.28 0.27 0.09 0.02 0.01 0.00  
## Cumulative Proportion 0.34 0.62 0.89 0.97 0.99 1.00 1.00  
##   
## Mean item complexity = 1.5  
## Test of the hypothesis that 7 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0   
## with the empirical chi square 0 with prob < NA   
##   
## Fit based upon off diagonal values = 1

*# by Kaiser's and Joliffe's standard, extract 3 RCs*  
  
*# scree analysis*  
**plot**(PCA\_lexicals\_concs$values, type = "b")



*# result: again, extract 3 components*  
  
PCA\_lexicals\_concs <- psych::**principal**(lexicals\_concs, nfactors = 3, rotate =   
"varimax", scores = TRUE)  
  
PCA\_lexicals\_concs *#-> check explained variance along components*

## Principal Components Analysis  
## Call: psych::principal(r = lexicals\_concs, nfactors = 3, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC2 RC1 RC3 h2 u2 com  
## letters -0.19 0.91 -0.33 0.97 0.027 1.4  
## phonemes\_DUTCHPOND -0.16 0.92 -0.33 0.97 0.027 1.3  
## orth\_neighbours\_DUTCHPOND 0.15 -0.32 0.90 0.94 0.058 1.3  
## phon\_neighbours\_DUTCHPOND 0.17 -0.32 0.90 0.94 0.059 1.3  
## freq\_lg10CD\_SUBTLEXNL 0.95 -0.18 0.16 0.95 0.048 1.1  
## freq\_lg10WF\_SUBTLEXNL 0.94 -0.19 0.17 0.94 0.056 1.2  
## freq\_CELEX\_lem 0.89 -0.05 0.07 0.81 0.193 1.0  
##   
## RC2 RC1 RC3  
## SS loadings 2.68 1.94 1.90  
## Proportion Var 0.38 0.28 0.27  
## Cumulative Var 0.38 0.66 0.93  
## Proportion Explained 0.41 0.30 0.29  
## Cumulative Proportion 0.41 0.71 1.00  
##   
## Mean item complexity = 1.2  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.03   
## with the empirical chi square 20.18 with prob < 0.00016   
##   
## Fit based upon off diagonal values = 1

PCA\_lexicals\_concs$loadings

##   
## Loadings:  
## RC2 RC1 RC3   
## letters -0.185 0.910 -0.334  
## phonemes\_DUTCHPOND -0.163 0.917 -0.326  
## orth\_neighbours\_DUTCHPOND 0.148 -0.322 0.903  
## phon\_neighbours\_DUTCHPOND 0.169 -0.317 0.901  
## freq\_lg10CD\_SUBTLEXNL 0.945 -0.181 0.161  
## freq\_lg10WF\_SUBTLEXNL 0.937 -0.192 0.168  
## freq\_CELEX\_lem 0.894   
##   
## RC2 RC1 RC3  
## SS loadings 2.683 1.945 1.905  
## Proportion Var 0.383 0.278 0.272  
## Cumulative Var 0.383 0.661 0.933

*# The PCA replicates Lynott and Connell. Standdized correlation coefficients*  
*# between each PC and its corresponding set of variables are all above .89,*  
*# while the rest of coefficients are all below .33.*   
  
PCA\_lexicals\_concs

## Principal Components Analysis  
## Call: psych::principal(r = lexicals\_concs, nfactors = 3, rotate = "varimax",   
## scores = TRUE)  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC2 RC1 RC3 h2 u2 com  
## letters -0.19 0.91 -0.33 0.97 0.027 1.4  
## phonemes\_DUTCHPOND -0.16 0.92 -0.33 0.97 0.027 1.3  
## orth\_neighbours\_DUTCHPOND 0.15 -0.32 0.90 0.94 0.058 1.3  
## phon\_neighbours\_DUTCHPOND 0.17 -0.32 0.90 0.94 0.059 1.3  
## freq\_lg10CD\_SUBTLEXNL 0.95 -0.18 0.16 0.95 0.048 1.1  
## freq\_lg10WF\_SUBTLEXNL 0.94 -0.19 0.17 0.94 0.056 1.2  
## freq\_CELEX\_lem 0.89 -0.05 0.07 0.81 0.193 1.0  
##   
## RC2 RC1 RC3  
## SS loadings 2.68 1.94 1.90  
## Proportion Var 0.38 0.28 0.27  
## Cumulative Var 0.38 0.66 0.93  
## Proportion Explained 0.41 0.30 0.29  
## Cumulative Proportion 0.41 0.71 1.00  
##   
## Mean item complexity = 1.2  
## Test of the hypothesis that 3 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.03   
## with the empirical chi square 20.18 with prob < 0.00016   
##   
## Fit based upon off diagonal values = 1

*# RC1 = length // RC2 = frequency // RC3 = distinctiveness*  
  
PCA\_lexicals\_concs$residual

## letters phonemes\_DUTCHPOND  
## letters 0.026594010 -0.025634342  
## phonemes\_DUTCHPOND -0.025634342 0.027463542  
## orth\_neighbours\_DUTCHPOND -0.007939846 0.007595230  
## phon\_neighbours\_DUTCHPOND 0.007967311 -0.008984482  
## freq\_lg10CD\_SUBTLEXNL 0.004139691 0.006696974  
## freq\_lg10WF\_SUBTLEXNL 0.001306927 0.010591926  
## freq\_CELEX\_lem -0.005090237 -0.018061566  
## orth\_neighbours\_DUTCHPOND  
## letters -0.007939846  
## phonemes\_DUTCHPOND 0.007595230  
## orth\_neighbours\_DUTCHPOND 0.058173584  
## phon\_neighbours\_DUTCHPOND -0.058160242  
## freq\_lg10CD\_SUBTLEXNL -0.003609941  
## freq\_lg10WF\_SUBTLEXNL -0.000955949  
## freq\_CELEX\_lem 0.005890390  
## phon\_neighbours\_DUTCHPOND freq\_lg10CD\_SUBTLEXNL  
## letters 0.007967311 0.004139691  
## phonemes\_DUTCHPOND -0.008984482 0.006696974  
## orth\_neighbours\_DUTCHPOND -0.058160242 -0.003609941  
## phon\_neighbours\_DUTCHPOND 0.058821233 -0.001681398  
## freq\_lg10CD\_SUBTLEXNL -0.001681398 0.048039445  
## freq\_lg10WF\_SUBTLEXNL -0.004899638 0.040904630  
## freq\_CELEX\_lem 0.005469160 -0.090683850  
## freq\_lg10WF\_SUBTLEXNL freq\_CELEX\_lem  
## letters 0.001306927 -0.005090237  
## phonemes\_DUTCHPOND 0.010591926 -0.018061566  
## orth\_neighbours\_DUTCHPOND -0.000955949 0.005890390  
## phon\_neighbours\_DUTCHPOND -0.004899638 0.005469160  
## freq\_lg10CD\_SUBTLEXNL 0.040904630 -0.090683850  
## freq\_lg10WF\_SUBTLEXNL 0.055871031 -0.098544553  
## freq\_CELEX\_lem -0.098544553 0.192845909

PCA\_lexicals\_concs$fit

## [1] 0.9950821

PCA\_lexicals\_concs$communality

## letters phonemes\_DUTCHPOND   
## 0.9734060 0.9725365   
## orth\_neighbours\_DUTCHPOND phon\_neighbours\_DUTCHPOND   
## 0.9418264 0.9411788   
## freq\_lg10CD\_SUBTLEXNL freq\_lg10WF\_SUBTLEXNL   
## 0.9519606 0.9441290   
## freq\_CELEX\_lem   
## 0.8071541

*# Results based on a Kaiser-normalizalized orthogonal (varimax) rotation*  
*# (by default in psych::stats pack). Residuals good: less than half w/ absolute*   
*# values > 0.05. Model fit good, > .90. Communalities (h2) good, all well > .7*  
  
concs <- **cbind**(concs, PCA\_lexicals\_concs$scores)  
  
  
*# REGRESSION*  
  
*# standardize (mean-center and scale)*  
concs$s\_Auditory <- **scale**(concs$Auditory)  
concs$s\_Haptic <- **scale**(concs$Haptic)  
concs$s\_Visual <- **scale**(concs$Visual)  
concs$s\_freq\_lg10CD\_SUBTLEXNL <- **scale**(concs$freq\_lg10CD\_SUBTLEXNL)  
concs$s\_freq\_lg10WF\_SUBTLEXNL <- **scale**(concs$freq\_lg10WF\_SUBTLEXNL)  
concs$s\_freq\_CELEX\_lem <- **scale**(concs$freq\_CELEX\_lem)  
concs$s\_AoA\_Brysbaertetal2014 <- **scale**(concs$AoA\_Brysbaertetal2014)  
concs$s\_concrete\_Brysbaertetal2014 <- **scale**(concs$concrete\_Brysbaertetal2014)  
concs$s\_letters <- **scale**(concs$letters)  
concs$s\_phonemes\_DUTCHPOND <- **scale**(concs$phonemes\_DUTCHPOND)  
concs$s\_orth\_neighbours\_DUTCHPOND <- **scale**(concs$orth\_neighbours\_DUTCHPOND)  
concs$s\_phon\_neighbours\_DUTCHPOND <- **scale**(concs$phon\_neighbours\_DUTCHPOND)  
concs$s\_RC1\_lexicals <- **scale**(concs$RC1)  
concs$s\_RC2\_lexicals <- **scale**(concs$RC2)   
concs$s\_RC3\_lexicals <- **scale**(concs$RC3)  
  
*# length: letters*  
fit\_letters\_concs <- **lm**(concs$s\_letters ~ concs$s\_Auditory + concs$s\_Haptic +   
concs$s\_Visual, data = concs)  
**stat.desc**(fit\_letters\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.110000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.869411e+00  
## max 4.100072e+00  
## range 5.969482e+00  
## sum -2.588207e-15  
## median -1.709015e-01  
## mean -6.333218e-18  
## SE.mean 4.751817e-02  
## CI.mean.0.95 9.340965e-02  
## var 9.280284e-01  
## std.dev 9.633423e-01  
## coef.var -1.521095e+17  
## skewness 7.313500e-01  
## skew.2SE 3.037507e+00  
## kurtosis 3.972703e-01  
## kurt.2SE 8.269597e-01  
## normtest.W 9.582384e-01  
## normtest.p 2.101496e-09

*# residuals distribution: skew. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_letters)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 411 0 1 -0.28 -0.09 1.17 -1.46 4.05 5.51 0.74 0.28  
## se  
## X1 0.05

concs$log\_s\_letters <- **log**(3 + concs$s\_letters)  
  
fit\_letters\_concs <- **lm**(concs$log\_s\_letters ~ concs$s\_Auditory + concs$s\_Haptic +   
concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_letters\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.110000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -7.546621e-01  
## max 9.308451e-01  
## range 1.685507e+00  
## sum 9.228729e-16  
## median -1.147895e-02  
## mean 2.265877e-18  
## SE.mean 1.549036e-02  
## CI.mean.0.95 3.045044e-02  
## var 9.862002e-02  
## std.dev 3.140382e-01  
## coef.var 1.385946e+17  
## skewness 9.384492e-02  
## skew.2SE 3.897649e-01  
## kurtosis -6.833286e-01  
## kurt.2SE -1.422420e+00  
## normtest.W 9.883934e-01  
## normtest.p 2.360257e-03

*# better though still skew/kurtose*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1),*   
*# and tolerance (pref. > 0.2)*  
**vif**(fit\_letters\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.009925 1.245338 1.254282

**mean**(**vif**(fit\_letters\_concs))

## [1] 1.169848

1/**vif**(fit\_letters\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9901729 0.8029946 0.7972690

*# RESULTS: all good*  
  
step\_letters\_concs\_AIC <- **stepAIC**(fit\_letters\_concs, direction="both")

## Start: AIC=-945.07  
## concs$log\_s\_letters ~ concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Visual 1 0.19201 40.626 -945.13  
## <none> 40.434 -945.07  
## - concs$s\_Auditory 1 0.99968 41.434 -937.04  
## - concs$s\_Haptic 1 1.51007 41.944 -932.01  
##   
## Step: AIC=-945.13  
## concs$log\_s\_letters ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## <none> 40.626 -945.13  
## + concs$s\_Visual 1 0.19201 40.434 -945.07  
## - concs$s\_Auditory 1 0.92402 41.550 -937.88  
## - concs$s\_Haptic 1 2.52263 43.149 -922.37

step\_letters\_concs\_F <- **stepAIC**(fit\_letters\_concs, direction="both", test="F")

## Start: AIC=-945.07  
## concs$log\_s\_letters ~ concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Visual 1 0.19201 40.626 -945.13 1.9327 0.1652242   
## <none> 40.434 -945.07   
## - concs$s\_Auditory 1 0.99968 41.434 -937.04 10.0625 0.0016279 \*\*   
## - concs$s\_Haptic 1 1.51007 41.944 -932.01 15.1999 0.0001131 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-945.13  
## concs$log\_s\_letters ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 40.626 -945.13   
## + concs$s\_Visual 1 0.19201 40.434 -945.07 1.9327 0.165224   
## - concs$s\_Auditory 1 0.92402 41.550 -937.88 9.2797 0.002468 \*\*   
## - concs$s\_Haptic 1 2.52263 43.149 -922.37 25.3342 7.245e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_letters\_concs)

##   
## Call:  
## lm(formula = concs$log\_s\_letters ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.75466 -0.24161 -0.01148 0.23692 0.93085   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.04489 0.01555 67.207 < 2e-16 \*\*\*  
## concs$s\_Auditory 0.04962 0.01564 3.172 0.001628 \*\*   
## concs$s\_Haptic -0.06773 0.01737 -3.899 0.000113 \*\*\*  
## concs$s\_Visual -0.02424 0.01743 -1.390 0.165224   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3152 on 407 degrees of freedom  
## Multiple R-squared: 0.08311, Adjusted R-squared: 0.07635   
## F-statistic: 12.3 on 3 and 407 DF, p-value: 1.025e-07

*# length: phonemes\_DUTCHPOND*  
fit\_phonemes\_DUTCHPOND\_concs <- **lm**(concs$s\_phonemes\_DUTCHPOND ~ concs$s\_Auditory +   
concs$s\_Haptic + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_phonemes\_DUTCHPOND\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.890000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.130401e+00  
## max 4.299017e+00  
## range 6.429418e+00  
## sum 5.016820e-15  
## median -1.585982e-01  
## mean 1.286522e-17  
## SE.mean 4.897103e-02  
## CI.mean.0.95 9.628179e-02  
## var 9.328850e-01  
## std.dev 9.658597e-01  
## coef.var 7.507528e+16  
## skewness 6.756933e-01  
## skew.2SE 2.730764e+00  
## kurtosis 6.167434e-01  
## kurt.2SE 1.249403e+00  
## normtest.W 9.707429e-01  
## normtest.p 4.832522e-07

*# residuals distribution: skew and kurtose. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_phonemes\_DUTCHPOND)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 389 0 1 0.08 -0.07 1.36 -1.76 4.21 5.97 0.7 0.41  
## se  
## X1 0.05

concs$log\_s\_phonemes\_DUTCHPOND <- **log**(3 + concs$s\_phonemes\_DUTCHPOND)  
  
fit\_phonemes\_DUTCHPOND\_concs <- **lm**(concs$log\_s\_phonemes\_DUTCHPOND ~ concs$s\_Auditory  
 + concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_phonemes\_DUTCHPOND\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.890000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -9.530293e-01  
## max 9.618234e-01  
## range 1.914853e+00  
## sum -4.623038e-15  
## median -2.033824e-03  
## mean -1.187383e-17  
## SE.mean 1.628015e-02  
## CI.mean.0.95 3.200835e-02  
## var 1.031018e-01  
## std.dev 3.210947e-01  
## coef.var -2.704223e+16  
## skewness -1.089115e-01  
## skew.2SE -4.401577e-01  
## kurtosis -2.710183e-01  
## kurt.2SE -5.490309e-01  
## normtest.W 9.942364e-01  
## normtest.p 1.496887e-01

*# good*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_phonemes\_DUTCHPOND\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.005252 1.250064 1.252494

**mean**(**vif**(fit\_phonemes\_DUTCHPOND\_concs))

## [1] 1.16927

1/**vif**(fit\_phonemes\_DUTCHPOND\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9947753 0.7999588 0.7984071

*# RESULTS: all good*  
  
step\_phonemes\_DUTCHPOND\_concs\_AIC <- **stepAIC**(fit\_phonemes\_DUTCHPOND\_concs,   
direction="both")

## Start: AIC=-876.82  
## concs$log\_s\_phonemes\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Visual 1 0.07544 40.079 -878.09  
## <none> 40.004 -876.82  
## - concs$s\_Haptic 1 1.11568 41.119 -868.12  
## - concs$s\_Auditory 1 1.20234 41.206 -867.30  
##   
## Step: AIC=-878.09  
## concs$log\_s\_phonemes\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## <none> 40.079 -878.09  
## + concs$s\_Visual 1 0.07544 40.004 -876.82  
## - concs$s\_Auditory 1 1.16707 41.246 -868.93  
## - concs$s\_Haptic 1 1.73650 41.815 -863.59

step\_phonemes\_DUTCHPOND\_concs\_F <- **stepAIC**(fit\_phonemes\_DUTCHPOND\_concs,   
direction="both", test="F")

## Start: AIC=-876.82  
## concs$log\_s\_phonemes\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Visual 1 0.07544 40.079 -878.09 0.7261 0.3946957   
## <none> 40.004 -876.82   
## - concs$s\_Haptic 1 1.11568 41.119 -868.12 10.7374 0.0011452 \*\*   
## - concs$s\_Auditory 1 1.20234 41.206 -867.30 11.5715 0.0007399 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-878.09  
## concs$log\_s\_phonemes\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 40.079 -878.09   
## + concs$s\_Visual 1 0.07544 40.004 -876.82 0.7261 0.3946957   
## - concs$s\_Auditory 1 1.16707 41.246 -868.93 11.2401 0.0008796 \*\*\*  
## - concs$s\_Haptic 1 1.73650 41.815 -863.59 16.7242 5.263e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_phonemes\_DUTCHPOND\_concs)

##   
## Call:  
## lm(formula = concs$log\_s\_phonemes\_DUTCHPOND ~ concs$s\_Auditory +   
## concs$s\_Haptic + concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.95303 -0.22895 -0.00203 0.23763 0.96182   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.04396 0.01636 63.821 < 2e-16 \*\*\*  
## concs$s\_Auditory 0.05577 0.01640 3.402 0.00074 \*\*\*  
## concs$s\_Haptic -0.05941 0.01813 -3.277 0.00115 \*\*   
## concs$s\_Visual -0.01571 0.01844 -0.852 0.39470   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3223 on 385 degrees of freedom  
## (22 observations deleted due to missingness)  
## Multiple R-squared: 0.07083, Adjusted R-squared: 0.06359   
## F-statistic: 9.783 on 3 and 385 DF, p-value: 3.109e-06

*# distinctiveness: orth neigh size*  
fit\_orth\_neighbours\_DUTCHPOND\_concs <- **lm**(concs$s\_orth\_neighbours\_DUTCHPOND ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_orth\_neighbours\_DUTCHPOND\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.110000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.418943e+00  
## max 4.983802e+00  
## range 6.402745e+00  
## sum 1.929013e-15  
## median -3.388470e-01  
## mean 4.732767e-18  
## SE.mean 4.699016e-02  
## CI.mean.0.95 9.237170e-02  
## var 9.075189e-01  
## std.dev 9.526379e-01  
## coef.var 2.012856e+17  
## skewness 1.758073e+00  
## skew.2SE 7.301783e+00  
## kurtosis 3.397510e+00  
## kurt.2SE 7.072272e+00  
## normtest.W 8.209900e-01  
## normtest.p 4.657007e-21

*# residuals distribution: skewed and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_orth\_neighbours\_DUTCHPOND)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 411 0 1 -0.53 -0.22 0.26 -0.7 4.88 5.59 1.88 3.42 0.05

concs$log\_s\_orth\_neighbours\_DUTCHPOND <- **log**(2 + concs$s\_orth\_neighbours\_DUTCHPOND)  
  
fit\_orth\_neighbours\_DUTCHPOND\_concs <- **lm**(concs$log\_s\_orth\_neighbours\_DUTCHPOND ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_orth\_neighbours\_DUTCHPOND\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.110000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -6.413729e-01  
## max 1.377855e+00  
## range 2.019228e+00  
## sum 2.515349e-15  
## median -1.365831e-01  
## mean 6.152518e-18  
## SE.mean 1.874673e-02  
## CI.mean.0.95 3.685169e-02  
## var 1.444417e-01  
## std.dev 3.800549e-01  
## coef.var 6.177226e+16  
## skewness 1.033319e+00  
## skew.2SE 4.291669e+00  
## kurtosis 3.381673e-01  
## kurt.2SE 7.039305e-01  
## normtest.W 9.016737e-01  
## normtest.p 1.225133e-15

*# better though still skew/kurtose*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_orth\_neighbours\_DUTCHPOND\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.009925 1.245338 1.254282

**mean**(**vif**(fit\_orth\_neighbours\_DUTCHPOND\_concs))

## [1] 1.169848

1/**vif**(fit\_orth\_neighbours\_DUTCHPOND\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9901729 0.8029946 0.7972690

*# RESULTS: all good*  
  
step\_orth\_neighbours\_DUTCHPOND\_concs\_AIC <-   
**stepAIC**(fit\_orth\_neighbours\_DUTCHPOND\_concs, direction="both")

## Start: AIC=-788.24  
## concs$log\_s\_orth\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Visual 1 0.0959 59.317 -789.57  
## <none> 59.221 -788.24  
## - concs$s\_Auditory 1 0.9578 60.179 -783.64  
## - concs$s\_Haptic 1 3.8929 63.114 -764.07  
##   
## Step: AIC=-789.57  
## concs$log\_s\_orth\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## <none> 59.317 -789.57  
## + concs$s\_Visual 1 0.0959 59.221 -788.24  
## - concs$s\_Auditory 1 0.9077 60.225 -785.33  
## - concs$s\_Haptic 1 5.5464 64.863 -754.83

step\_orth\_neighbours\_DUTCHPOND\_concs\_F <-   
**stepAIC**(fit\_orth\_neighbours\_DUTCHPOND\_concs, direction="both", test="F")

## Start: AIC=-788.24  
## concs$log\_s\_orth\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Visual 1 0.0959 59.317 -789.57 0.6590 0.41737   
## <none> 59.221 -788.24   
## - concs$s\_Auditory 1 0.9578 60.179 -783.64 6.5826 0.01065 \*   
## - concs$s\_Haptic 1 3.8929 63.114 -764.07 26.7539 3.634e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-789.57  
## concs$log\_s\_orth\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 59.317 -789.57   
## + concs$s\_Visual 1 0.0959 59.221 -788.24 0.659 0.41737   
## - concs$s\_Auditory 1 0.9077 60.225 -785.33 6.244 0.01286 \*   
## - concs$s\_Haptic 1 5.5464 64.863 -754.83 38.150 1.586e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_orth\_neighbours\_DUTCHPOND\_concs)

##   
## Call:  
## lm(formula = concs$log\_s\_orth\_neighbours\_DUTCHPOND ~ concs$s\_Auditory +   
## concs$s\_Haptic + concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.6414 -0.2734 -0.1366 0.1982 1.3779   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.60117 0.01882 31.951 < 2e-16 \*\*\*  
## concs$s\_Auditory -0.04857 0.01893 -2.566 0.0107 \*   
## concs$s\_Haptic 0.10874 0.02102 5.172 3.63e-07 \*\*\*  
## concs$s\_Visual 0.01713 0.02110 0.812 0.4174   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3815 on 407 degrees of freedom  
## Multiple R-squared: 0.1001, Adjusted R-squared: 0.09348   
## F-statistic: 15.09 on 3 and 407 DF, p-value: 2.477e-09

*# distinctiveness: phon neigh size*  
fit\_phon\_neighbours\_DUTCHPOND\_concs <- **lm**(concs$s\_phon\_neighbours\_DUTCHPOND ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_phon\_neighbours\_DUTCHPOND\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.110000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.352384e+00  
## max 4.807540e+00  
## range 6.159924e+00  
## sum -1.264613e-15  
## median -3.437850e-01  
## mean -3.056870e-18  
## SE.mean 4.739867e-02  
## CI.mean.0.95 9.317474e-02  
## var 9.233666e-01  
## std.dev 9.609197e-01  
## coef.var -3.143476e+17  
## skewness 2.025920e+00  
## skew.2SE 8.414228e+00  
## kurtosis 4.788769e+00  
## kurt.2SE 9.968323e+00  
## normtest.W 7.877461e-01  
## normtest.p 9.278171e-23

*# residuals distribution: skewed and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_phon\_neighbours\_DUTCHPOND)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 411 0 1 -0.55 -0.22 0.18 -0.67 5.26 5.92 2.06 4.49  
## se  
## X1 0.05

concs$log\_s\_phon\_neighbours\_DUTCHPOND <- **log**(2 + concs$s\_phon\_neighbours\_DUTCHPOND)  
  
fit\_phon\_neighbours\_DUTCHPOND\_concs <- **lm**(concs$log\_s\_phon\_neighbours\_DUTCHPOND ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_phon\_neighbours\_DUTCHPOND\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.110000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -6.105674e-01  
## max 1.390839e+00  
## range 2.001407e+00  
## sum 2.714842e-15  
## median -1.406069e-01  
## mean 6.635001e-18  
## SE.mean 1.839574e-02  
## CI.mean.0.95 3.616174e-02  
## var 1.390838e-01  
## std.dev 3.729394e-01  
## coef.var 5.620788e+16  
## skewness 1.199464e+00  
## skew.2SE 4.981718e+00  
## kurtosis 9.001905e-01  
## kurt.2SE 1.873840e+00  
## normtest.W 8.836707e-01  
## normtest.p 4.522529e-17

*# better but not perfect*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_phon\_neighbours\_DUTCHPOND\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.009925 1.245338 1.254282

**mean**(**vif**(fit\_phon\_neighbours\_DUTCHPOND\_concs))

## [1] 1.169848

1/**vif**(fit\_phon\_neighbours\_DUTCHPOND\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9901729 0.8029946 0.7972690

*# RESULTS: all good*  
  
step\_phon\_neighbours\_DUTCHPOND\_concs\_AIC <-   
**stepAIC**(fit\_phon\_neighbours\_DUTCHPOND\_concs, direction="both")

## Start: AIC=-803.77  
## concs$log\_s\_phon\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Visual 1 0.0168 57.041 -805.65  
## <none> 57.024 -803.77  
## - concs$s\_Auditory 1 0.6885 57.713 -800.84  
## - concs$s\_Haptic 1 3.8278 60.852 -779.07  
##   
## Step: AIC=-805.65  
## concs$log\_s\_phon\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## <none> 57.041 -805.65  
## + concs$s\_Visual 1 0.0168 57.024 -803.77  
## - concs$s\_Auditory 1 0.6740 57.715 -802.82  
## - concs$s\_Haptic 1 5.0509 62.092 -772.78

step\_phon\_neighbours\_DUTCHPOND\_concs\_F <- **stepAIC**(fit\_phon\_neighbours\_DUTCHPOND\_concs,   
direction="both", test="F")

## Start: AIC=-803.77  
## concs$log\_s\_phon\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Visual 1 0.0168 57.041 -805.65 0.1199 0.72937   
## <none> 57.024 -803.77   
## - concs$s\_Auditory 1 0.6885 57.713 -800.84 4.9142 0.02719 \*   
## - concs$s\_Haptic 1 3.8278 60.852 -779.07 27.3204 2.761e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-805.65  
## concs$log\_s\_phon\_neighbours\_DUTCHPOND ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 57.041 -805.65   
## + concs$s\_Visual 1 0.0168 57.024 -803.77 0.120 0.72937   
## - concs$s\_Auditory 1 0.6740 57.715 -802.82 4.821 0.02868 \*   
## - concs$s\_Haptic 1 5.0509 62.092 -772.78 36.128 4.101e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_phon\_neighbours\_DUTCHPOND\_concs)

##   
## Call:  
## lm(formula = concs$log\_s\_phon\_neighbours\_DUTCHPOND ~ concs$s\_Auditory +   
## concs$s\_Haptic + concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.6106 -0.2524 -0.1406 0.1897 1.3908   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.604084 0.018463 32.718 < 2e-16 \*\*\*  
## concs$s\_Auditory -0.041182 0.018577 -2.217 0.0272 \*   
## concs$s\_Haptic 0.107827 0.020629 5.227 2.76e-07 \*\*\*  
## concs$s\_Visual 0.007167 0.020703 0.346 0.7294   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3743 on 407 degrees of freedom  
## Multiple R-squared: 0.09194, Adjusted R-squared: 0.08525   
## F-statistic: 13.74 on 3 and 407 DF, p-value: 1.499e-08

*# freq: SUBTLEX-NL log-10 CD*  
  
fit\_freq\_lg10CD\_SUBTLEXNL\_concs <- **lm**(concs$s\_freq\_lg10CD\_SUBTLEXNL ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.070000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -3.048064e+00  
## max 2.307864e+00  
## range 5.355928e+00  
## sum -7.049916e-15  
## median 1.144372e-02  
## mean -1.729615e-17  
## SE.mean 4.797448e-02  
## CI.mean.0.95 9.430939e-02  
## var 9.367312e-01  
## std.dev 9.678487e-01  
## coef.var -5.595745e+16  
## skewness -2.807029e-01  
## skew.2SE -1.160194e+00  
## kurtosis 7.175888e-02  
## kurt.2SE 1.486536e-01  
## normtest.W 9.927886e-01  
## normtest.p 4.745518e-02

*# residuals distribution: skew. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_freq\_lg10CD\_SUBTLEXNL)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 407 0 1 0.07 0.04 1.01 -3.11 1.88 4.99 -0.39 -0.14  
## se  
## X1 0.05

concs$log\_s\_freq\_lg10CD\_SUBTLEXNL <- **log**(5 + concs$s\_freq\_lg10CD\_SUBTLEXNL)  
  
fit\_freq\_lg10CD\_SUBTLEXNL\_concs <- **lm**(concs$log\_s\_freq\_lg10CD\_SUBTLEXNL ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.070000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -9.360006e-01  
## max 4.459662e-01  
## range 1.381967e+00  
## sum -2.066923e-15  
## median 2.387622e-02  
## mean -5.070726e-18  
## SE.mean 1.060014e-02  
## CI.mean.0.95 2.083802e-02  
## var 4.573176e-02  
## std.dev 2.138498e-01  
## coef.var -4.217342e+16  
## skewness -9.892655e-01  
## skew.2SE -4.088806e+00  
## kurtosis 1.832425e+00  
## kurt.2SE 3.795999e+00  
## normtest.W 9.507730e-01  
## normtest.p 2.130839e-10

*# worse! back*   
fit\_freq\_lg10CD\_SUBTLEXNL\_concs <- **lm**(concs$s\_freq\_lg10CD\_SUBTLEXNL ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.007087 1.251386 1.256979

**mean**(**vif**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs))

## [1] 1.171817

1/**vif**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9929629 0.7991139 0.7955584

*# RESULTS: all good*  
  
step\_freq\_lg10CD\_SUBTLEXNL\_concs\_AIC <- **stepAIC**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs,   
direction="both")

## Start: AIC=-19.6  
## concs$s\_freq\_lg10CD\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Haptic 1 1.122 381.43 -20.4034  
## <none> 380.31 -19.6023  
## - concs$s\_Visual 1 3.709 384.02 -17.6523  
## - concs$s\_Auditory 1 16.168 396.48 -4.6579  
##   
## Step: AIC=-20.4  
## concs$s\_freq\_lg10CD\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 381.43 -20.4034  
## + concs$s\_Haptic 1 1.1220 380.31 -19.6023  
## - concs$s\_Visual 1 7.2094 388.64 -14.7826  
## - concs$s\_Auditory 1 15.7897 397.22 -5.8947

step\_freq\_lg10CD\_SUBTLEXNL\_\_concsF <- **stepAIC**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs,   
direction="both", test="F")

## Start: AIC=-19.6  
## concs$s\_freq\_lg10CD\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Haptic 1 1.122 381.43 -20.4034 1.1889 0.2762   
## <none> 380.31 -19.6023   
## - concs$s\_Visual 1 3.709 384.02 -17.6523 3.9302 0.0481 \*   
## - concs$s\_Auditory 1 16.168 396.48 -4.6579 17.1321 4.248e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-20.4  
## concs$s\_freq\_lg10CD\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 381.43 -20.4034   
## + concs$s\_Haptic 1 1.1220 380.31 -19.6023 1.1889 0.276198   
## - concs$s\_Visual 1 7.2094 388.64 -14.7826 7.6359 0.005983 \*\*   
## - concs$s\_Auditory 1 15.7897 397.22 -5.8947 16.7238 5.219e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_freq\_lg10CD\_SUBTLEXNL\_concs)

##   
## Call:  
## lm(formula = concs$s\_freq\_lg10CD\_SUBTLEXNL ~ concs$s\_Auditory +   
## concs$s\_Haptic + concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -3.04806 -0.54760 0.01144 0.66048 2.30786   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.00433 0.04816 -0.090 0.9284   
## concs$s\_Auditory 0.20136 0.04865 4.139 4.25e-05 \*\*\*  
## concs$s\_Haptic 0.05869 0.05382 1.090 0.2762   
## concs$s\_Visual 0.10775 0.05435 1.982 0.0481 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9714 on 403 degrees of freedom  
## (4 observations deleted due to missingness)  
## Multiple R-squared: 0.06327, Adjusted R-squared: 0.0563   
## F-statistic: 9.073 on 3 and 403 DF, p-value: 7.971e-06

*# freq: SUBTLEX-NL log-10 WF*  
fit\_freq\_lg10WF\_SUBTLEXNL\_concs <-   
**lm**(concs$s\_freq\_lg10WF\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual,  
 data = concs)  
**stat.desc**(fit\_freq\_lg10WF\_SUBTLEXNL\_concs$residuals, norm = TRUE)

## x  
## nbr.val 4.070000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.895265e+00  
## max 2.942859e+00  
## range 5.838124e+00  
## sum 6.078471e-15  
## median 2.548493e-02  
## mean 1.480728e-17  
## SE.mean 4.802025e-02  
## CI.mean.0.95 9.439937e-02  
## var 9.385194e-01  
## std.dev 9.687721e-01  
## coef.var 6.542537e+16  
## skewness 2.645810e-02  
## skew.2SE 1.093559e-01  
## kurtosis 1.608904e-01  
## kurt.2SE 3.332959e-01  
## normtest.W 9.969441e-01  
## normtest.p 6.460055e-01

*# residuals distribution: good. Raw scores/2.SE < 1*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_freq\_lg10WF\_SUBTLEXNL\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.007087 1.251386 1.256979

**mean**(**vif**(fit\_freq\_lg10WF\_SUBTLEXNL\_concs))

## [1] 1.171817

1/**vif**(fit\_freq\_lg10WF\_SUBTLEXNL\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9929629 0.7991139 0.7955584

*# RESULTS: all good*  
  
step\_freq\_lg10WF\_SUBTLEXNL\_concs\_AIC <- **stepAIC**(fit\_freq\_lg10WF\_SUBTLEXNL\_concs,   
direction="both")

## Start: AIC=-18.83  
## concs$s\_freq\_lg10WF\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Haptic 1 0.6561 381.70 -20.1258  
## <none> 381.04 -18.8261  
## - concs$s\_Visual 1 4.3316 385.37 -16.2255  
## - concs$s\_Auditory 1 15.5396 396.58 -4.5572  
##   
## Step: AIC=-20.13  
## concs$s\_freq\_lg10WF\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 381.70 -20.1258  
## + concs$s\_Haptic 1 0.6561 381.04 -18.8261  
## - concs$s\_Visual 1 7.4743 389.17 -14.2330  
## - concs$s\_Auditory 1 15.2642 396.96 -6.1667

step\_freq\_lg10WF\_SUBTLEXNL\_concs\_F <- **stepAIC**(fit\_freq\_lg10WF\_SUBTLEXNL\_concs,   
direction="both", test="F")

## Start: AIC=-18.83  
## concs$s\_freq\_lg10WF\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Haptic 1 0.6561 381.70 -20.1258 0.6940 0.40531   
## <none> 381.04 -18.8261   
## - concs$s\_Visual 1 4.3316 385.37 -16.2255 4.5812 0.03292 \*   
## - concs$s\_Auditory 1 15.5396 396.58 -4.5572 16.4352 6.043e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-20.13  
## concs$s\_freq\_lg10WF\_SUBTLEXNL ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 381.70 -20.1258   
## + concs$s\_Haptic 1 0.6561 381.04 -18.8261 0.6940 0.405312   
## - concs$s\_Visual 1 7.4743 389.17 -14.2330 7.9111 0.005153 \*\*   
## - concs$s\_Auditory 1 15.2642 396.96 -6.1667 16.1561 6.959e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_freq\_lg10WF\_SUBTLEXNL\_concs)

##   
## Call:  
## lm(formula = concs$s\_freq\_lg10WF\_SUBTLEXNL ~ concs$s\_Auditory +   
## concs$s\_Haptic + concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.89527 -0.59131 0.02548 0.59277 2.94286   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.004361 0.048207 -0.090 0.9280   
## concs$s\_Auditory 0.197415 0.048696 4.054 6.04e-05 \*\*\*  
## concs$s\_Haptic 0.044880 0.053875 0.833 0.4053   
## concs$s\_Visual 0.116441 0.054402 2.140 0.0329 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9724 on 403 degrees of freedom  
## (4 observations deleted due to missingness)  
## Multiple R-squared: 0.06148, Adjusted R-squared: 0.05449   
## F-statistic: 8.8 on 3 and 403 DF, p-value: 1.155e-05

*# freq: CELEX log-10 lemma WF*  
fit\_freq\_CELEX\_lem\_concs <- **lm**(concs$s\_freq\_CELEX\_lem ~ concs$s\_Auditory +   
concs$s\_Haptic + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_freq\_CELEX\_lem\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.990000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.596448e+00  
## max 2.747406e+00  
## range 5.343854e+00  
## sum -3.178013e-15  
## median 1.094298e-02  
## mean -7.790903e-18  
## SE.mean 4.913264e-02  
## CI.mean.0.95 9.659194e-02  
## var 9.631926e-01  
## std.dev 9.814237e-01  
## coef.var -1.259705e+17  
## skewness -3.551406e-02  
## skew.2SE -1.453467e-01  
## kurtosis -8.965432e-02  
## kurt.2SE -1.839131e-01  
## normtest.W 9.973725e-01  
## normtest.p 7.811050e-01

*# residuals distribution: good. Raw scores/2.SE < 1*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_freq\_CELEX\_lem\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.009928 1.241384 1.249539

**mean**(**vif**(fit\_freq\_CELEX\_lem\_concs))

## [1] 1.16695

1/**vif**(fit\_freq\_CELEX\_lem\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9901697 0.8055526 0.8002952

*# RESULTS: all good*  
  
step\_freq\_CELEX\_lem\_concs\_AIC <- **stepAIC**(fit\_freq\_CELEX\_lem\_concs, direction="both")

## Start: AIC=-7.96  
## concs$s\_freq\_CELEX\_lem ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Haptic 1 0.7423 384.09 -9.1927  
## <none> 383.35 -7.9645  
## - concs$s\_Visual 1 4.5620 387.91 -5.2444  
## - concs$s\_Auditory 1 8.7073 392.06 -1.0032  
##   
## Step: AIC=-9.19  
## concs$s\_freq\_CELEX\_lem ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 384.09 -9.1927  
## + concs$s\_Haptic 1 0.7423 383.35 -7.9645  
## - concs$s\_Visual 1 3.8276 387.92 -7.2362  
## - concs$s\_Auditory 1 9.0221 393.12 -1.9288

step\_freq\_CELEX\_lem\_concs\_F <- **stepAIC**(fit\_freq\_CELEX\_lem\_concs, direction="both",   
test="F")

## Start: AIC=-7.96  
## concs$s\_freq\_CELEX\_lem ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Haptic 1 0.7423 384.09 -9.1927 0.7649 0.382346   
## <none> 383.35 -7.9645   
## - concs$s\_Visual 1 4.5620 387.91 -5.2444 4.7006 0.030749 \*   
## - concs$s\_Auditory 1 8.7073 392.06 -1.0032 8.9719 0.002914 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-9.19  
## concs$s\_freq\_CELEX\_lem ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 384.09 -9.1927   
## + concs$s\_Haptic 1 0.7423 383.35 -7.9645 0.7649 0.382346   
## - concs$s\_Visual 1 3.8276 387.92 -7.2362 3.9462 0.047665 \*   
## - concs$s\_Auditory 1 9.0221 393.12 -1.9288 9.3018 0.002443 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_freq\_CELEX\_lem\_concs)

##   
## Call:  
## lm(formula = concs$s\_freq\_CELEX\_lem ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.59645 -0.62930 0.01094 0.68222 2.74741   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.0005927 0.0493208 0.012 0.99042   
## concs$s\_Auditory 0.1484357 0.0495560 2.995 0.00291 \*\*  
## concs$s\_Haptic -0.0479850 0.0548676 -0.875 0.38235   
## concs$s\_Visual 0.1190287 0.0549004 2.168 0.03075 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9851 on 395 degrees of freedom  
## (12 observations deleted due to missingness)  
## Multiple R-squared: 0.03681, Adjusted R-squared: 0.02949   
## F-statistic: 5.032 on 3 and 395 DF, p-value: 0.001966

*# length: RC1 lexicals*  
fit\_RC1\_lexicals\_concs <- **lm**(concs$s\_RC1\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic   
+ concs$s\_Visual, data = concs)  
**stat.desc**(fit\_RC1\_lexicals\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.830000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.790833e+00  
## max 4.935675e+00  
## range 6.726507e+00  
## sum 2.078199e-14  
## median -1.912252e-01  
## mean 5.428045e-17  
## SE.mean 4.997352e-02  
## CI.mean.0.95 9.825761e-02  
## var 9.564860e-01  
## std.dev 9.780010e-01  
## coef.var 1.801755e+16  
## skewness 1.096509e+00  
## skew.2SE 4.397413e+00  
## kurtosis 1.924309e+00  
## kurt.2SE 3.868479e+00  
## normtest.W 9.373125e-01  
## normtest.p 1.267186e-11

*# residuals distribution: skewed and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_RC1\_lexicals)

## vars n mean sd median trimmed mad min max range skew kurtosis se  
## X1 1 383 0 1 -0.23 -0.1 0.83 -1.7 4.9 6.6 1.14 1.84 0.05

concs$log\_s\_RC1\_lexicals\_concs <- **log**(3 + concs$s\_RC1\_lexicals)  
  
fit\_RC1\_lexicals\_concs <- **lm**(concs$log\_s\_RC1\_lexicals ~ concs$s\_Auditory +   
concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_RC1\_lexicals\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.830000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -7.573554e-01  
## max 1.034698e+00  
## range 1.792054e+00  
## sum -6.081941e-15  
## median -1.684797e-02  
## mean -1.589181e-17  
## SE.mean 1.574504e-02  
## CI.mean.0.95 3.095779e-02  
## var 9.494806e-02  
## std.dev 3.081364e-01  
## coef.var -1.938964e+16  
## skewness 1.960662e-01  
## skew.2SE 7.862989e-01  
## kurtosis -1.815582e-01  
## kurt.2SE -3.649903e-01  
## normtest.W 9.946692e-01  
## normtest.p 2.064935e-01

*# good*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_RC1\_lexicals\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.005934 1.244426 1.246755

**mean**(**vif**(fit\_RC1\_lexicals\_concs))

## [1] 1.165705

1/**vif**(fit\_RC1\_lexicals\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9941011 0.8035830 0.8020825

*# RESULTS: all good*  
  
step\_RC1\_lexicals\_concs\_AIC <- **stepAIC**(fit\_RC1\_lexicals\_concs, direction="both")

## Start: AIC=-894.75  
## concs$log\_s\_RC1\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Visual 1 0.05502 36.325 -896.17  
## <none> 36.270 -894.75  
## - concs$s\_Haptic 1 0.37136 36.642 -892.84  
## - concs$s\_Auditory 1 1.08098 37.351 -885.50  
##   
## Step: AIC=-896.17  
## concs$log\_s\_RC1\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## <none> 36.325 -896.17  
## + concs$s\_Visual 1 0.05502 36.270 -894.75  
## - concs$s\_Haptic 1 0.63244 36.958 -891.55  
## - concs$s\_Auditory 1 1.05179 37.377 -887.23

step\_RC1\_lexicals\_concs\_F <- **stepAIC**(fit\_RC1\_lexicals\_concs, direction="both",   
test="F")

## Start: AIC=-894.75  
## concs$log\_s\_RC1\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Visual 1 0.05502 36.325 -896.17 0.5749 0.4487959   
## <none> 36.270 -894.75   
## - concs$s\_Haptic 1 0.37136 36.642 -892.84 3.8805 0.0495776 \*   
## - concs$s\_Auditory 1 1.08098 37.351 -885.50 11.2955 0.0008559 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-896.17  
## concs$log\_s\_RC1\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 36.325 -896.17   
## + concs$s\_Visual 1 0.05502 36.270 -894.75 0.5749 0.4487959   
## - concs$s\_Haptic 1 0.63244 36.958 -891.55 6.6159 0.0104860 \*   
## - concs$s\_Auditory 1 1.05179 37.377 -887.23 11.0028 0.0009974 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_RC1\_lexicals\_concs)

##   
## Call:  
## lm(formula = concs$log\_s\_RC1\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.75736 -0.21704 -0.01685 0.21379 1.03470   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.04781 0.01582 66.251 < 2e-16 \*\*\*  
## concs$s\_Auditory 0.05347 0.01591 3.361 0.000856 \*\*\*  
## concs$s\_Haptic -0.03450 0.01751 -1.970 0.049578 \*   
## concs$s\_Visual -0.01345 0.01774 -0.758 0.448796   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.3094 on 379 degrees of freedom  
## (28 observations deleted due to missingness)  
## Multiple R-squared: 0.04695, Adjusted R-squared: 0.03941   
## F-statistic: 6.224 on 3 and 379 DF, p-value: 0.0003907

*# distinctiveness: RC3 lexicals*  
fit\_RC3\_lexicals\_concs <- **lm**(concs$s\_RC3\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic   
+ concs$s\_Visual, data = concs)  
**stat.desc**(fit\_RC3\_lexicals\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.830000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -1.701688e+00  
## max 4.550983e+00  
## range 6.252670e+00  
## sum -1.091835e-14  
## median -2.680258e-01  
## mean -2.845592e-17  
## SE.mean 4.911158e-02  
## CI.mean.0.95 9.656288e-02  
## var 9.237760e-01  
## std.dev 9.611326e-01  
## coef.var -3.377619e+16  
## skewness 1.673295e+00  
## skew.2SE 6.710544e+00  
## kurtosis 3.357824e+00  
## kurt.2SE 6.750305e+00  
## normtest.W 8.551890e-01  
## normtest.p 2.367318e-18

*# residuals distribution: skewed and kurtosed. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_RC3\_lexicals)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 383 0 1 -0.27 -0.17 0.59 -1.44 4.99 6.43 1.83 3.67  
## se  
## X1 0.05

concs$log\_s\_RC3\_lexicals <- **log**(3 + concs$s\_RC3\_lexicals)  
  
fit\_RC3\_lexicals\_concs <- **lm**(concs$log\_s\_RC3\_lexicals ~ concs$s\_Auditory +   
concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_RC3\_lexicals\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.830000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -6.271740e-01  
## max 9.026380e-01  
## range 1.529812e+00  
## sum -4.562323e-15  
## median -5.616343e-02  
## mean -1.190429e-17  
## SE.mean 1.395190e-02  
## CI.mean.0.95 2.743214e-02  
## var 7.455311e-02  
## std.dev 2.730442e-01  
## coef.var -2.293663e+16  
## skewness 8.766790e-01  
## skew.2SE 3.515812e+00  
## kurtosis 7.122003e-01  
## kurt.2SE 1.431751e+00  
## normtest.W 9.479679e-01  
## normtest.p 2.347627e-10

*# better though still non-normal*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_RC3\_lexicals\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.005934 1.244426 1.246755

**mean**(**vif**(fit\_RC3\_lexicals\_concs))

## [1] 1.165705

1/**vif**(fit\_RC3\_lexicals\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9941011 0.8035830 0.8020825

*# RESULTS: all good*  
  
step\_RC3\_lexicals\_concs\_AIC <- **stepAIC**(fit\_RC3\_lexicals\_concs, direction="both")

## Start: AIC=-987.36  
## concs$log\_s\_RC3\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Visual 1 0.02418 28.503 -989.04  
## <none> 28.479 -987.36  
## - concs$s\_Auditory 1 0.43934 28.919 -983.50  
## - concs$s\_Haptic 1 1.64314 30.122 -967.88  
##   
## Step: AIC=-989.04  
## concs$log\_s\_RC3\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC  
## <none> 28.503 -989.04  
## + concs$s\_Visual 1 0.02418 28.479 -987.36  
## - concs$s\_Auditory 1 0.45652 28.960 -984.95  
## - concs$s\_Haptic 1 1.82968 30.333 -967.21

step\_RC3\_lexicals\_concs\_F <- **stepAIC**(fit\_RC3\_lexicals\_concs, direction="both",   
test="F")

## Start: AIC=-987.36  
## concs$log\_s\_RC3\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Visual 1 0.02418 28.503 -989.04 0.3218 0.57085   
## <none> 28.479 -987.36   
## - concs$s\_Auditory 1 0.43934 28.919 -983.50 5.8467 0.01608 \*   
## - concs$s\_Haptic 1 1.64314 30.122 -967.88 21.8668 4.071e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-989.04  
## concs$log\_s\_RC3\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 28.503 -989.04   
## + concs$s\_Visual 1 0.02418 28.479 -987.36 0.3218 0.57085   
## - concs$s\_Auditory 1 0.45652 28.960 -984.95 6.0862 0.01406 \*   
## - concs$s\_Haptic 1 1.82968 30.333 -967.21 24.3927 1.179e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_RC3\_lexicals\_concs)

##   
## Call:  
## lm(formula = concs$log\_s\_RC3\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.62717 -0.18400 -0.05616 0.13150 0.90264   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.054305 0.014015 75.229 < 2e-16 \*\*\*  
## concs$s\_Auditory -0.034090 0.014098 -2.418 0.0161 \*   
## concs$s\_Haptic 0.072572 0.015520 4.676 4.07e-06 \*\*\*  
## concs$s\_Visual -0.008916 0.015716 -0.567 0.5708   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.2741 on 379 degrees of freedom  
## (28 observations deleted due to missingness)  
## Multiple R-squared: 0.07665, Adjusted R-squared: 0.06934   
## F-statistic: 10.49 on 3 and 379 DF, p-value: 1.216e-06

*# freq: RC2 lexicals*  
fit\_RC2\_lexicals\_concs <- **lm**(concs$s\_RC2\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic  
 + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_RC2\_lexicals\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.830000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.701781e+00  
## max 2.799024e+00  
## range 5.500804e+00  
## sum -9.728329e-15  
## median -5.204421e-03  
## mean -2.532129e-17  
## SE.mean 4.939207e-02  
## CI.mean.0.95 9.711437e-02  
## var 9.343578e-01  
## std.dev 9.666218e-01  
## coef.var -3.817428e+16  
## skewness 1.177816e-01  
## skew.2SE 4.723486e-01  
## kurtosis -3.253570e-02  
## kurt.2SE -6.540720e-02  
## normtest.W 9.975488e-01  
## normtest.p 8.476297e-01

*# residuals distribution: good. Raw scores/2.SE < 1*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_RC2\_lexicals\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.005934 1.244426 1.246755

**mean**(**vif**(fit\_RC2\_lexicals\_concs))

## [1] 1.165705

1/**vif**(fit\_RC2\_lexicals\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9941011 0.8035830 0.8020825

*# RESULTS: all good*  
  
step\_RC2\_lexicals\_concs\_AIC <- **stepAIC**(fit\_RC2\_lexicals\_concs, direction="both")

## Start: AIC=-19.01  
## concs$s\_RC2\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## - concs$s\_Haptic 1 0.5196 357.44 -20.4482  
## <none> 356.92 -19.0054  
## - concs$s\_Visual 1 3.1284 360.05 -17.6631  
## - concs$s\_Auditory 1 20.6663 377.59 0.5524  
##   
## Step: AIC=-20.45  
## concs$s\_RC2\_lexicals ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 357.44 -20.4482  
## - concs$s\_Visual 1 2.6135 360.06 -19.6580  
## + concs$s\_Haptic 1 0.5196 356.92 -19.0054  
## - concs$s\_Auditory 1 21.1095 378.55 -0.4722

step\_RC2\_lexicals\_concs\_F <- **stepAIC**(fit\_RC2\_lexicals\_concs, direction="both",   
test="F")

## Start: AIC=-19.01  
## concs$s\_RC2\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## - concs$s\_Haptic 1 0.5196 357.44 -20.4482 0.5518 0.45806   
## <none> 356.92 -19.0054   
## - concs$s\_Visual 1 3.1284 360.05 -17.6631 3.3219 0.06915 .   
## - concs$s\_Auditory 1 20.6663 377.59 0.5524 21.9445 3.918e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Step: AIC=-20.45  
## concs$s\_RC2\_lexicals ~ concs$s\_Auditory + concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 357.44 -20.4482   
## - concs$s\_Visual 1 2.6135 360.06 -19.6580 2.7785 0.09636 .   
## + concs$s\_Haptic 1 0.5196 356.92 -19.0054 0.5518 0.45806   
## - concs$s\_Auditory 1 21.1095 378.55 -0.4722 22.4415 3.065e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_RC2\_lexicals\_concs)

##   
## Call:  
## lm(formula = concs$s\_RC2\_lexicals ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -2.7018 -0.6471 -0.0052 0.6136 2.7990   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.006071 0.049614 -0.122 0.9027   
## concs$s\_Auditory 0.233808 0.049911 4.684 3.92e-06 \*\*\*  
## concs$s\_Haptic -0.040811 0.054942 -0.743 0.4581   
## concs$s\_Visual 0.101407 0.055638 1.823 0.0691 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.9704 on 379 degrees of freedom  
## (28 observations deleted due to missingness)  
## Multiple R-squared: 0.06564, Adjusted R-squared: 0.05825   
## F-statistic: 8.875 on 3 and 379 DF, p-value: 1.067e-05

*# additional var: age of acquisition*  
fit\_AoA\_Brysbaertetal2014\_concs <- **lm**(concs$s\_AoA\_Brysbaertetal2014 ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_AoA\_Brysbaertetal2014\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.980000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -3.025869e+00  
## max 2.147610e+00  
## range 5.173479e+00  
## sum 1.313359e-14  
## median -1.358284e-02  
## mean 3.302938e-17  
## SE.mean 4.390837e-02  
## CI.mean.0.95 8.632199e-02  
## var 7.673221e-01  
## std.dev 8.759693e-01  
## coef.var 2.652091e+16  
## skewness -8.877953e-02  
## skew.2SE -3.628914e-01  
## kurtosis -2.872845e-01  
## kurt.2SE -5.885934e-01  
## normtest.W 9.957891e-01  
## normtest.p 3.666147e-01

*# residuals distribution: good. Raw scores/2.SE < 1*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_AoA\_Brysbaertetal2014\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.006555 1.256294 1.261234

**mean**(**vif**(fit\_AoA\_Brysbaertetal2014\_concs))

## [1] 1.174694

1/**vif**(fit\_AoA\_Brysbaertetal2014\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9934875 0.7959923 0.7928746

*# RESULTS: all good*  
  
step\_AoA\_Brysbaertetal2014\_concs\_AIC <- **stepAIC**(fit\_AoA\_Brysbaertetal2014\_concs,  
direction="both")

## Start: AIC=-98.41  
## concs$s\_AoA\_Brysbaertetal2014 ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 304.63 -98.411  
## - concs$s\_Auditory 1 4.3063 308.93 -94.824  
## - concs$s\_Haptic 1 20.6142 325.24 -74.350  
## - concs$s\_Visual 1 27.0765 331.70 -66.520

step\_AoA\_Brysbaertetal2014\_concs\_F <- **stepAIC**(fit\_AoA\_Brysbaertetal2014\_concs,   
direction="both", test="F")

## Start: AIC=-98.41  
## concs$s\_AoA\_Brysbaertetal2014 ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 304.63 -98.411   
## - concs$s\_Auditory 1 4.3063 308.93 -94.824 5.570 0.01876 \*   
## - concs$s\_Haptic 1 20.6142 325.24 -74.350 26.662 3.854e-07 \*\*\*  
## - concs$s\_Visual 1 27.0765 331.70 -66.520 35.020 7.097e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_AoA\_Brysbaertetal2014\_concs)

##   
## Call:  
## lm(formula = concs$s\_AoA\_Brysbaertetal2014 ~ concs$s\_Auditory +   
## concs$s\_Haptic + concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -3.02587 -0.58392 -0.01358 0.66456 2.14761   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.007778 0.044092 0.176 0.8601   
## concs$s\_Auditory -0.104344 0.044213 -2.360 0.0188 \*   
## concs$s\_Haptic -0.254806 0.049347 -5.164 3.85e-07 \*\*\*  
## concs$s\_Visual -0.294074 0.049693 -5.918 7.10e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.8793 on 394 degrees of freedom  
## (13 observations deleted due to missingness)  
## Multiple R-squared: 0.2327, Adjusted R-squared: 0.2268   
## F-statistic: 39.82 on 3 and 394 DF, p-value: < 2.2e-16

*# additional var: concreteness*  
fit\_concrete\_Brysbaertetal2014\_concs <- **lm**(concs$s\_concrete\_Brysbaertetal2014 ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
**stat.desc**(fit\_concrete\_Brysbaertetal2014\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.980000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -2.047456e+00  
## max 2.338430e+00  
## range 4.385886e+00  
## sum 1.426810e-14  
## median -3.294205e-02  
## mean 3.585668e-17  
## SE.mean 3.940998e-02  
## CI.mean.0.95 7.747834e-02  
## var 6.181523e-01  
## std.dev 7.862266e-01  
## coef.var 2.192692e+16  
## skewness 2.636678e-01  
## skew.2SE 1.077757e+00  
## kurtosis -8.873867e-02  
## kurt.2SE -1.818093e-01  
## normtest.W 9.907920e-01  
## normtest.p 1.382913e-02

*# residuals distribution: skew. Raw scores/2.SE > 1*  
*# have to log-transform DV and re-run regression*  
  
psych::**describe**(concs$s\_concrete\_Brysbaertetal2014)

## vars n mean sd median trimmed mad min max range skew kurtosis  
## X1 1 398 0 1 -0.21 -0.04 1.11 -1.71 1.85 3.56 0.38 -1.13  
## se  
## X1 0.05

concs$log\_s\_concrete\_Brysbaertetal2014 <- **log**(3 + concs$s\_concrete\_Brysbaertetal2014)  
  
fit\_concrete\_Brysbaertetal2014\_concs <- **lm**(concs$log\_s\_concrete\_Brysbaertetal2014 ~   
concs$s\_Auditory + concs$s\_Haptic + concs$s\_Visual, data = concs)  
  
*# check residuals again*  
**stat.desc**(fit\_concrete\_Brysbaertetal2014\_concs$residuals, norm = TRUE)

## x  
## nbr.val 3.980000e+02  
## nbr.null 0.000000e+00  
## nbr.na 0.000000e+00  
## min -7.098116e-01  
## max 8.091234e-01  
## range 1.518935e+00  
## sum -2.052178e-15  
## median 2.483684e-02  
## mean -5.137822e-18  
## SE.mean 1.358202e-02  
## CI.mean.0.95 2.670168e-02  
## var 7.341959e-02  
## std.dev 2.709605e-01  
## coef.var -5.273840e+16  
## skewness -8.997464e-03  
## skew.2SE -3.677765e-02  
## kurtosis -2.456084e-01  
## kurt.2SE -5.032068e-01  
## normtest.W 9.933368e-01  
## normtest.p 7.598647e-02

*# good*  
  
*# Check multicollinearity: largest VIF (pref. < 10), mean VIF (pref. around 1), and*   
*# tolerance (pref. > 0.2)*  
**vif**(fit\_concrete\_Brysbaertetal2014\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 1.006555 1.256294 1.261234

**mean**(**vif**(fit\_concrete\_Brysbaertetal2014\_concs))

## [1] 1.174694

1/**vif**(fit\_concrete\_Brysbaertetal2014\_concs)

## concs$s\_Auditory concs$s\_Haptic concs$s\_Visual   
## 0.9934875 0.7959923 0.7928746

*# RESULTS: all good*  
  
step\_concrete\_Brysbaertetal2014\_concs\_AIC <-   
**stepAIC**(fit\_concrete\_Brysbaertetal2014\_concs, direction="both")

## Start: AIC=-1032.4  
## concs$log\_s\_concrete\_Brysbaertetal2014 ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC  
## <none> 29.148 -1032.40  
## - concs$s\_Auditory 1 1.1547 30.302 -1018.94  
## - concs$s\_Haptic 1 3.5383 32.686 -988.80  
## - concs$s\_Visual 1 4.8804 34.028 -972.79

step\_concrete\_Brysbaertetal2014\_concs\_F <-   
**stepAIC**(fit\_concrete\_Brysbaertetal2014\_concs, direction="both", test="F")

## Start: AIC=-1032.4  
## concs$log\_s\_concrete\_Brysbaertetal2014 ~ concs$s\_Auditory + concs$s\_Haptic +   
## concs$s\_Visual  
##   
## Df Sum of Sq RSS AIC F Value Pr(F)   
## <none> 29.148 -1032.40   
## - concs$s\_Auditory 1 1.1547 30.302 -1018.94 15.609 9.230e-05 \*\*\*  
## - concs$s\_Haptic 1 3.5383 32.686 -988.80 47.828 1.888e-11 \*\*\*  
## - concs$s\_Visual 1 4.8804 34.028 -972.79 65.971 5.946e-15 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**summary**(fit\_concrete\_Brysbaertetal2014\_concs)

##   
## Call:  
## lm(formula = concs$log\_s\_concrete\_Brysbaertetal2014 ~ concs$s\_Auditory +   
## concs$s\_Haptic + concs$s\_Visual, data = concs)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.70981 -0.21810 0.02484 0.19189 0.80912   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.04056 0.01364 76.294 < 2e-16 \*\*\*  
## concs$s\_Auditory -0.05403 0.01368 -3.951 9.23e-05 \*\*\*  
## concs$s\_Haptic 0.10557 0.01526 6.916 1.89e-11 \*\*\*  
## concs$s\_Visual 0.12485 0.01537 8.122 5.95e-15 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.272 on 394 degrees of freedom  
## (13 observations deleted due to missingness)  
## Multiple R-squared: 0.3571, Adjusted R-squared: 0.3522   
## F-statistic: 72.94 on 3 and 394 DF, p-value: < 2.2e-16

*# Results: Iconicity of concepts and comparison with properties:*   
*# The properties sample was characterized by smaller advantages for Auditory*   
*# predictor, compared to the concepts sample. The tendency of either larger or*   
*# opposite scores for the Auditory strength was less evident, even though it was*   
*# still marginally present. This raw-figure difference was not statistically tested.*  
  
  
*# END*