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Word frequency predicts translation asymmetry

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Abstract

Bilingualism studies report asymmetries in word processing across languages. Access to L2 words is slower and sensitive to semantic blocking. These observations inform influential models of bilingual processing, which propose autonomous lexicons with different processing routes. In a series of experiments, we explored an alternative hypothesis that the asymmetries are due to frequency of use. Using a within-language 'translation' task, involving high/low frequency (HF/LF) synonyms, we obtained parallel results to bilingual studies. Experiment 1 revealed that HF synonyms were accessed faster than LF ones. Experiment 2 showed that semantic blocking slowed retrieval only of LF synonyms, while form blocking produced powerful interference of both HF and LF words. Experiment 3 examined translation speed and sensitivity to blocking in two groups of Russian-English bilinguals who differed in frequency of use of their languages. Translation asymmetries were modulated by frequency of use. The results support an integrated lexicon model of bilingual processing.

Key words

Bilingualism; Frequency effects; Translation asymmetry; Language dominance; RHM.

Frequency effects are widely documented in language processing. High frequency (HF) words are processed faster and are more robust to various types of interference. Effects of frequency are found in picture naming (Oldfield & Wingfield, 1965), visual word recognition (Howes & Solomon, 1951) and lexical decision (Paap, McDonald, Schvaneveldt, & Noel, 1987). In aphasia, low frequency (LF) words are more susceptible to disruption than HF ones (Camarazza & Hillis, 1990). In healthy lexical processing, stimulus degradation impacts more on LF forms (Bangert, Abrams, & Balota, 2012). Furthermore, Michael and Gollan (2005) report that LF words are more vulnerable to Tip-Of-the-Tongue states than HF ones. Bilingual studies reveal faster access to words of a frequently-used language (usually the L1) as opposed to the one used less often (Kroll & Stewart, 1994). However, with more frequent use of L2, the frequency bias can change, with faster access to L2 words (Basnight-Brown & Altarriba, 2007; Heredia, 1996; Heredia & Altarriba, 2001; Sunderman & Priya, 2012). Overall, there is extensive evidence of processing advantage for HF over LF forms in monolingual and bilingual speakers.

In bilingual translation, greater susceptibility of L2 than L1 forms to interference (e.g., presentation of stimulus words blocked into semantic categories) has also been reported (Kroll & Stewart, 1994). In the Revised Hierarchical Model (RHM), Kroll and Stewart developed an influential account of processing asymmetries between languages. The basic architecture of the RHM is that words from each language are stored in separate lexicons, and their semantic representations in a single shared module. In its early formulation, Kroll and Stewart proposed that the connections between the lexicons and meanings were asymmetrical. L1 words had direct connections to their meanings, while L2 words accessed them via their L1 equivalents. During translation, presentation of L1 forms resulted in automatic semantic activation prior to access to the L2 forms. As a consequence of this semantic mediation, L1→L2 translation is slower than in the reverse direction. Furthermore, semantic manipulation, such as blocking stimuli into semantic categories, results in activation of multiple overlapping conceptual representations and further slows processing from L1 to L2 due to the need to inhibit non-target items. By contrast, L2→L1 translation proceeds by direct lexical connections and is therefore faster and immune to semantic manipulation.

In support of the RHM, Kroll and Stewart (1994) conducted an experiment investigating bidirectional translation between L1 and L2. The study had two components: first, examining translation speeds from L2→L1 and vice versa; second, determining the impact of semantic interference (created by blocking stimulus lists into semantically-related items) on translations in both directions. They recruited Dutch (native and dominant) – English bilinguals and presented them with sets of nouns that were organised into random lists or blocked into semantic categories. Words were translated in both directions. The results were consistent with the predictions of the RHM: participants were slower translating L1→L2 than in reverse. Furthermore, L1→L2 translations were slowed under semantic blocking conditions, while L2→L1 translations were immune to semantic blocking.

A core aspect of the RHM is that it is a developmental model. It describes processing in states of non-balanced bilingualism where the L1 remains the dominant language, such as in early L2 acquisition. Kroll and De Groot (1997) propose that with increased proficiency, links between the lexicons and the semantic, conceptual levels become more similar and, therefore, asymmetries in lexical access become less pronounced. Furthermore, the model has been modified in response to evidence that speakers even in the early stages of L2 acquisition can show direct semantic mediation of both L1 and L2 words (Poarch, Van Hell, & Kroll, 2015). Experiments employing tasks such as semantic priming have shown that response times in lexical decision can be facilitated by brief presentation of a semantic prime in either language (Brysbaert & Duyck, 2010; Dimitropoulou, Duñabeitia, & Carreiras, 2011; Duyck & Warlop, 2009; Perea, Duñabeitia, & Carreiras, 2008; Schoonbaert, Duyck, Brysbaert, & Hartsuiker, 2009). Consistent with the RHM developmental aspect, patterns of semantic modulation vary with exposure and competence in the L2. Typically, semantic priming is stronger in the dominant language but may shift to the L2 in instances where that is the commonly used language.

Although aspects of the RHM have been modified in the face of evidence of early semantic mediation and to address evolving patterns of asymmetry related to language use, the model still holds to core assumptions of independent lexicons and different structural and sequential processing routes in L1 and L2 access, particularly in the case of imbalanced bilingual states. However, Brysbaert and Duyck (2010) question the assumption of functional and structural autonomy between L1 and L2 lexicons. Evidence of automatic and simultaneous access to words from both languages has accrued from paradigms such as eye-tracking (Spivey & Marian, 1999) and lexical decision (Van Heuven, Dijkstra, & Grainger, 1998). These studies report interference from words of one language when accessing words of another language in monolingual tasks performed by bilinguals. In response, Kroll, Van Hell, Tokowicz, and Green (2010) suggest that perceptual level orthographic and phonological similarity between L1 and L2 forms might be the source of parallel activation of forms in separate lexicons. However, a number of studies report parallel activation of L1 and L2 items in instances where there was little form similarity between words of different languages (e.g., Von Holzen & Mani, 2012), and in the case of stimuli involving different scripts such as English and Mandarin Chinese (e.g., Moon & Jiang, 2012; Thierry & Wu, 2007). An alternative to the RHM architecture of independent lexicons is the proposal of a single integrated lexicon, where both L1 and L2 items are stored and accessed based on common processing mechanisms.

In the face of conflicting accounts of bilingual lexical processing, we attempt to explain the source of the asymmetries that Kroll and Stewart observed. We present a series of experiments that focus on word production and develop an alternative account of asymmetries in processing speed and susceptibility to interference. We propose that the asymmetries may result from differences in the frequency of word use across languages. In most bilingual states, there are imbalances of language use, with the L1 often being the dominant language. As a result, L1 (higher frequency) words are easier to access and more robust to interference than their L2 equivalents. The frequency account does not involve structural or functional differences in processing between lexicons. The same asymmetry might be observed within a language when 'translating' between two frequency-contrasted synonyms, as well as across L1→L2 translation equivalents. Furthermore, LF words will also be more sensitive to interference resulting from blocked presentation (e.g., into semantic categories) than their HF equivalents within or across languages.

We explored this hypothesis in three experiments. First, we developed a within-language 'translation' task involving synonyms where one member of the pair was of higher frequency than its twin. This allowed us to model 'translation' effects in a paradigm where explanation could not rest upon multiple distinctly-processed lexicons. Further, the frequency imbalance allowed us to model the developmental perspective of the RHM as the experiments involved retrieval of more/less entrenched forms. Thus, Experiment 1 compared access to a HF versus LF synonym, determining if there were asymmetries in processing speed, dependent upon the direction of 'translation'. Using the same task, Experiment 2 explored the impact of blocking stimuli on retrieval of LF (Experiment 2A) and HF (Experiment 2B) members of a synonym pair. We examined if asymmetry in the effect of stimulus blocking was unique to semantics, or whether grouping by form produced similar asymmetry.

Interference related to blocking of stimuli into form-related categories is predicted by connectionist models, such as BIA+ (Dijkstra & Van Heuven, 2002) and stems from the necessity to inhibit competing overlapping word forms in recognition and production. Such form-similarity interference effects are reported in word recognition (Davis & Lupker, 2006; Grainger & Van Heuven, 2003) and production (in overt articulation and inner speech access to tongue twisters) (Dell, 1986, 1988; Dell & Reich, 1981; Oppenheim & Dell, 2008). In bilingualism studies, Sunderman and Kroll (2006) and Sunderman and Priya (2012) also observed form-similarity interference in translation recognition tasks.

In Experiment 3, we explored whether bilingual speakers also demonstrated frequency-modulated behaviour in a traditional translation task. We recruited two groups of Russian(native)-English bilinguals who differed in their frequency of use of L2. We predicted that frequent (dominant) users of L1 would translate faster and show greater resilience to blocking conditions in the L2→L1 direction. Dominant users of L2, however, were predicted to show a reversed effect with faster translations and resilience to blocking conditions in the L1→L2 direction.

Methodology

All experiments were granted ethical approval by an institutional ethics panel. Volunteers in experiments gave informed consent to participation.

Across experiments, stimuli included abstract and concrete nouns (see Appendix A for the stimulus lists). Polysemous nouns were avoided, although this was problematic for abstract nouns, some of which had more diffuse semantic representations (Kroll & Tokowicz, 2007). Experiments 1 and 2 employed English synonym pairs selected from the Longman Synonym Dictionary (Urdang, 1986). Members of each pair contrasted in frequency of use (British

National Corpus)[1] with one being of markedly higher frequency than its twin, e.g., Enemy (HF, 49 instances per million (ipm)) – Foe (LF, 3.8 ipm). Bilingual stimuli (Experiment 3) were Russian-English translation equivalents. They were matched on frequency of use (I-RU (Russian) and I-EN (English) corpora (Sharoff, 2006)). In each experiment, a participant saw only one member of the synonym/translation pair in order to avoid priming of responses.

The monolingual word lists were piloted to determine if synonyms were bidirectional (Experiment 1) (i.e., both synonyms elicit each other as responses), or predictable (Experiment 2A and B) (i.e., synonyms reliably elicit intended responses). Participants in each pilot study were ten British English-speaking monolingual adults. They were instructed to write down a synonym to a stimulus word. In the bilingual Experiment 3, stimuli were piloted for their equivalence predictability. Participants were ten Russian(native)-English bilinguals. They were asked to write a translation for each word. Pairs were deemed bidirectional (Experiment 1) or predictable (Experiments 2A and B, and 3) if the target word appeared in the responses of eight or more participants.

Concreteness ratings were obtained for word lists in additional pilot studies (Gillette, Gleitman, Gleitman, & Lederer, 1999)[2]. Ten British English-speaking monolingual adults were recruited for each pilot of the monolingual stimuli, and 10 Russian-English bilingual adults judged the concreteness of the translation stimuli. Participants were given a written list of words, which they judged on a 0-7 scale of concreteness (where *zero* indicates minimal mental representation, which could be an image, a sound, a taste, a smell or a tactile

[1] Word frequency matching in monolingual experiments (1 and 2) was also performed on BNC Zipf-scale values (Van Heuven, Mandera, Keuleers, & Brysbaert, 2014) available subsequent to the data collection for this study. The results were consistent with those reported in this paper for both experiments. It was not possible to obtain Zipf-scale values for the bilingual Experiment 3, as no comparison corpus was available.

[2] Stimuli for the three experiments reported in this paper were also roughly matched on mean concreteness ratings proposed by Brysbaert, Warriner, and Kuperman (2014). These were available subsequent to the data collection for this study.

perception, and *seven* entails a multi-sensory representation). Words that were rated *four* or more by at least eight participants were classed as concrete, and pairs that were rated *three* or less by at least eight participants, were classed as abstract. Participants from pilot studies were not recruited to the main studies.

Item lists in all experiments were also roughly matched on word length across conditions and frequency contours.

Effect sizes, presented in Partial Eta Squared (η_p^2) values, are reported alongside the main significant effects.

Experiment 1

Stimuli

There were two stimulus lists (30 nouns each), each consisting of 15 HF and 15 LF nouns (with 8 abstract and 7 concrete in both HF and LF word sets). Each list contained only one member of the synonym pair. The stimulus sets were closely controlled for word frequency measured in instances per million (ipm) and orthographic length measured by number of letters (see Table 1).

	LF words			HF words			ANOVA results		
	Concrete	Abstract	Total	Concrete	Abstract	Total	Set (HF vs. LF)	Concreteness (Concrete vs. Abstract)	Set x Concreteness
Frequency (ipm)	23 (7)	19 (5)	21 (4)	148 (52)	78 (18)	111 (26)	F (1, 56) = 12.13, p = .001	F (1, 56) = 1.90, p = .174	F (1, 56) = 1.55, p = .218
Length (number of letters)	5 (.5)	6 (.6)	5 (.4)	6 (.4)	6 (.3)	6 (.3)	F (1, 56) = .66, p > .250	F (1, 56) = 2.91, p = .093	F (1, 56) = 1.84, p = .180

Table 1. Word frequency (ipm) means, Word Length means and ANOVA matching results for Experiment 1 stimuli. Standard Errors (SE) are in brackets. HF = High Frequency; LF = Low Frequency.

ANOVA conducted with word Set (HF vs. LF) and Concreteness (Concrete vs. Abstract), as independent measures and word frequency as the dependent variable, showed a significant effect of Set, which confirmed frequency differences for words in the HF and LF word sets (Table 1). Concreteness was not significant, indicating that concrete and abstract words were of comparable frequency. Set did not interact with Concreteness, indicating that the frequency contrast was consistent for abstract and concrete items. An identical ANOVA with word length as the dependent variable confirmed matching for word length. Neither Concreteness, Set nor the interaction between these two variables were significant, which indicates consistent length matching within and across the HF and LF word sets.

Participants

16 male and 16 female participants were recruited, all of whom were monolingual native speakers of British English with no history of speech and language disorders, and who reported normal or corrected-to-normal vision. They were pseudo-randomly assigned into one of two groups (each n = 16; males/females balanced) to 'translate' (produce synonyms for) either List 1 or 2. Mean age of participants presented with List 1 was M = 28.95, range = 22 – 42 years, and List 2 M = 29.25, range = 22 – 42 years.

Procedure

Each participant was presented with stimuli from either List 1 or List 2 in written form on a computer screen, and requested to produce a spoken synonym.

Participants were tested individually in a session lasting approximately 30 minutes. An instruction sheet was presented that contained an explanation of synonymy together with examples and word class definition to eliminate noun-verb ambiguity, e.g., *Purchase – Buy*. Participants were informed that both speed and accuracy of response were equally important.

In cases of synonym uncertainty, participants were instructed not to produce any response and wait for the next stimulus to appear on the screen. A practice set of six nouns was presented prior to experimental trials to ensure the procedure was understood.

The written stimuli were presented consecutively in the centre of a Sony Vaio laptop screen (VGN-SZ2XP/C) by means of DMDX software (Forster & Forster, 2003). Each noun was presented in black type against a white background in font size 36 until either the participant produced a spoken response or a 6500ms cut-off. Response time was measured with a synchronised timer from the presentation of the stimulus word to the first phone of the response. Participants were instructed not to produce any other utterance, such as "er", or "uhm" before responding. The spoken responses were recorded by a built-in voice activated microphone. Praat software (Boersma & Weenink, 2015) was used to obtain RT measures where responses were too quiet to trigger the timer or a non-speech sound (such as "Uhm" or background noise) preceded the response[3].

Results

The recorded speech data were coded as to whether responses were acceptable synonyms to the stimulus word. A response was discarded from the analyses if: a) it was not a synonym; or b) non-target noise (e.g., unrelated noise or non-speech sound) triggered the timer and no response was recoverable by Praat. On this basis, 87 (9.1%) out of 960 cases were removed. 29 responses were errors, i.e., responses that were not synonymous to the target word (13 were from HF→LF and 16 were from LF→HF), and the remaining 58 cases (29 from HF→LF and 29 from LF→HF) were due to non-target noise triggering the timer.

[3] Some responses were not recoverable by Praat. This was the case when accidental triggers, such as participant movements, occurred early in the stimulus presentation time window (e.g., 200 ms from the onset). In these cases, the DMDX recording had terminated before a participant produced a response.

Mean response times and standard deviations (SDs) were calculated for each condition (frequency direction for concrete and abstract items (using by-item analyses)). Mean RTs ± 2 SDs were set as minimum and maximum values. Any RTs outside this range were removed from analyses. This method of data trimming affected 62 cases (7.1% of the data). New means were computed for each item in each condition and were classed as trimmed means.

ANOVAs were performed by-subject (F_1) with Direction (HF→LF/LF→HF) and Concreteness (Abstract/Concrete) treated as within-subject factors and Trimmed Response Time as the dependent variable, and by-item (F_2) with Trimmed Response Time as the dependent variable. Direction and Concreteness were treated as fixed factors.

The results revealed a significant effect of Direction in both analyses: F_1 (1, 31) = 132.08; p < .001 (η_p^2 = .810); F_2 (1, 56) = 44.27; p < .001 (η_p^2 = .442) with translations in the LF→HF contour being faster than in reverse (Figure 1). Effect of Concreteness was also significant: F_1 (1, 31) = 108.71, p < .001 (η_p^2 = .778); F_2 (1, 56) = 22.46; p < .001 (η_p^2 = .286) with concrete items (M = 2019 ms, SE = 76) processed faster than abstract items (M = 2889 ms, SE = 103). The interaction of Direction and Concreteness was also significant: F_1 (1, 31) = 48.75, p < .001 (η_p2 = .611); F_2 (1, 56) = 8.07; p = .006 (η_p^2 = .126), with a larger difference in means between concrete and abstract items in the direction of HF→LF (abstract: M = 3679 ms; SE = 156; concrete: M = 2004 ms; SE = 97) than in the LF→HF direction (abstract: M = 1830 ms, SE = 74; concrete: M = 1574 ms, SE = 69), indicating that abstractness had more influence on the production of LF items compared to production of HF items.

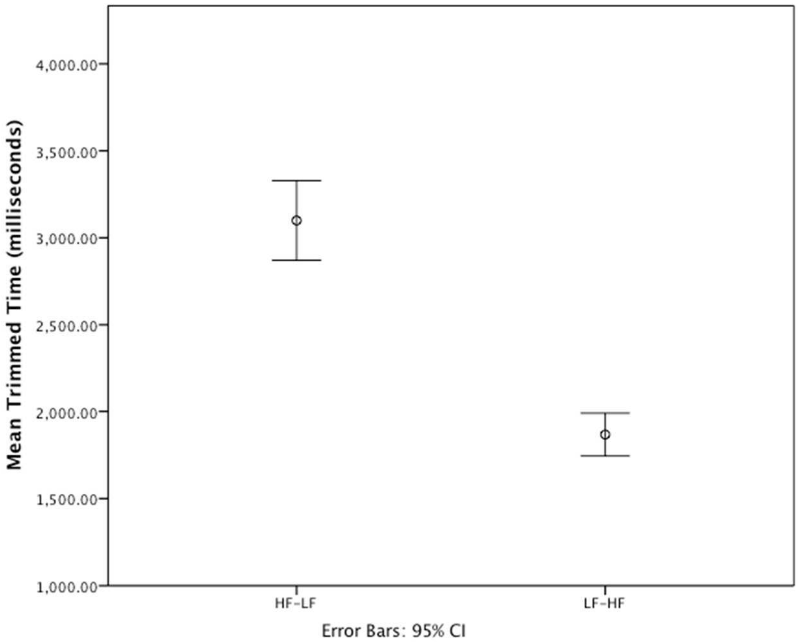


Figure 1.

Mean Response Times and 95% confidence intervals of synonym production in HF → LF and LF → HF frequency contours.

Discussion

Word frequency had a significant effect on speed of 'translation': HF synonyms were accessed faster than their LF twins. These results parallel bilingual translation patterns (Kroll & Stewart, 1994), where, in L1-dominant bilingualism, L1 forms are used more frequently than their L2 equivalents. Furthermore, the semantic variable of concreteness impacted upon retrieval of LF forms more than HF ones. This result mirrors the greater sensitivity of L2 (LF) words to another meaning-based variable, that of semantic blocking. In monolingual processing, such directional asymmetries cannot be attributed to structural differences in lexical organisation or distinct processing routes in the retrieval of HF and LF forms. Instead, general processing principles, such as higher resting states of HF words than LF counterparts (Jiang, 1999), may account for differences in processing speed.

Experiment 2

Experiment 1 revealed response time asymmetries in accessing the HF and LF members of synonym pairs. In this experiment, word lists were largely semantically and formally unrelated. Experiment 2 explored the possibility of asymmetrical sensitivity of HF and LF words to the blocking of stimuli. Using the same within-language 'translation' task, we examined the effects of semantic and form-based blocking on HF (L1-equivalent) and LF (L2-equivalent) items. In Kroll and Stewart's original experiment (Kroll & Stewart, 1994), the impact of organising word lists into semantically-related categories was compared with that of random presentation of stimuli. Kroll and Stewart observed slowed access to L2 words under conditions of semantic blocking. We hypothesized that both semantic- and form-based interference would disrupt retrieval of LF synonyms (L2 equivalent) more than retrieval of their HF twins (L1 equivalent). Experiment 2A explored synonym production in the HF→LF frequency contour. Experiment 2B employed an identical task in the reversed frequency contour (LF→HF). Separate experiments were conducted as it was not possible to design stimulus lists in both frequency contours that were matched across and within lists on linguistic parameters such as word frequency, concreteness, word length and response predictability.

Experiment 2A: Synonym production in the HF→LF frequency contour

Stimuli

Three stimulus lists were developed. The lists consisted of HF members of synonym pairs (stimuli), which participants 'translated' into their LF twins (targets). The form-related list (F-List) consisted of stimuli with shared onsets: *pro-; con -; for-; pa-*. In the semantic-related list (S-List) the stimuli were blocked into categories of: *vehicles; emotions, crimes* and *professions.* In the blocked lists, related items were presented in a sequence. The Random list

(R-List) included words which were not grouped by meaning or form. All three lists consisted of 25 (16 abstract and 9 concrete) words. The stimuli were of higher frequency than their anticipated twins (Table 2).

	Stimuli (HF words)			Targets (LF words)			ANOVA results		
	F-List	S-List	R-List	F-List	S-List	R-List	List Type (F/S/R-Lists)	Item Function (Stimulus/Target)	List Type x Item Function
Frequency (ipm)	80 (16)	74 (13)	73 (12)	18 (4)	18 (3)	18 (4)	F (2, 144) = .06; p >.250	F (1, 144) = 49.12; p < .001	F (2, 144) = .06; p > .250,
Word length (number of letters)	7 (.3)	6 (.4)	6 (.3)	7 (.5)	7 (.4)	6 (.4)	F (2, 144) = 3.59; p = .030*	F (1, 144) = 2.13; p = .146	F (2, 144) = .726; p > .468

Table 2. Word frequency (ipm) means, Word Length means and ANOVA results for Experiment 2 stimuli. Standard Errors (SE) are in brackets. HF = High Frequency; LF = Low Frequency; F = form; S = Semantic; R = Random.

*F-List items were longer than R-List items (Bonferroni correction: α = 0.05 ÷ 3 = 0.016): F (1, 98) = 7.99; p < .001. However, there was no significant difference between R-List and S-List Items: F (1, 98) = .800; p > .250, or S-List and F-List: F (1, 98) = 2.64; p = .107.

ANOVA conducted with List Type (Form vs. Semantic vs. Random) and Item Function (Stimulus-HF vs. Target-LF), as independent measures and word frequency as the dependent variable, showed a significant main effect of Item Function indicating a clear frequency contrast within stimulus-target synonym pairs. There was no effect of List Type and no interaction between List Type and Item Function: indicating that the frequency contrast for synonyms and targets was consistent across the three lists. The stimuli and targets were also roughly matched for word length. ANOVA revealed a significant effect of List Type, where an F-List items were longer than R-List items (see Table 2 for comparisons). However, there was no significant difference between R-List and S-List Items. There was no effect of Item Function, or interaction between List Type and Item Function indicating that mean letter counts for stimulus-target pairs were comparable across the three lists.

Participants

17 male and 13 female participants were recruited (mean age of M = 32.09, Range = 20 – 45 years). All were monolingual native speakers of British English with no history of speech and language disorders and reported normal or corrected to normal vision. None had participated in Experiment 1.

Procedure

The stimulus presentation procedure was identical to that of Experiment 1, except that the cut-off time for responses was 7000ms. Response time measurement, criteria for discarding responses and data trimming method were identical to those of Experiment 1. Three experimental lists were presented (S-List, F-List, R-List). The presentation of the lists was counterbalanced across participants to minimise possible order effects.

Results

281 (12.5%) out of 2250 cases were removed. Of these, 168 responses were errors (98 in F-List; 27 in S-List and 43 in R-List). The remaining 113 cases were due to non-target noise triggering the timer. Data trimming affected 1.2% of all valid data (28 cases). Subsequent analyses were performed on trimmed data. ANOVAs were performed by-subject (F_1) with List Type (F-List/S-List/R-List) and Concreteness (Abstract/Concrete) as within-subject factors and Trimmed Time as the dependent variable, and by-item (F_2) with Trimmed Response Time as the dependent variable and List Type and Concreteness as fixed factors (Table 3).

Measure	R-List		S-List		F-List	
	Abstract	Concrete	Abstract	Concrete	Abstract	Concrete
Mean (SE)	3330 (147)	2048 (82)	3689 (141)	3236 (146)	4305 (160)	4177 (154)

Table 3. Synonym conversion response time means (ms) and SEs as a function of concreteness and list type (F = Form; S = Semantic; R = Random) in the HF→LF direction.

The analysis yielded a highly significant main effect of List Type: F_1 (2, 58) = 124.76, p < .001 (η_p^2 = .811) and F_2 (2, 69) = 14.17; p < .001 (η_p^2 = .291) (see Figure 2). Bonferroni-corrected post-hoc comparisons (at α = 0.016 (p = 0.05÷3)) were performed to compare lists. The difference between R- and S-List RTs was significant by-subject: F_1 (1, 29) = 66.32; p < .001 (η_p^2 = .696), and neared significance by-item F_2 (1, 48) = 4.37; p = .042 (η_p^2 = .083); R-List RTs were significantly faster than the F-List RTs in both analyses: F_1 (1, 29) = 186.62; p < .001; (η_p^2 = .866) and F_2 (1, 48) = 24.11; p < .001 (η_p^2 = .334); S-List RTs were also significantly faster than the F-List RTs in both analyses: F_1 (1, 29) = 49.10; p <.001; (η_p^2 = .629) and F_2 (1, 48) = 6.84; p < .012 (η_p^2 = .125).

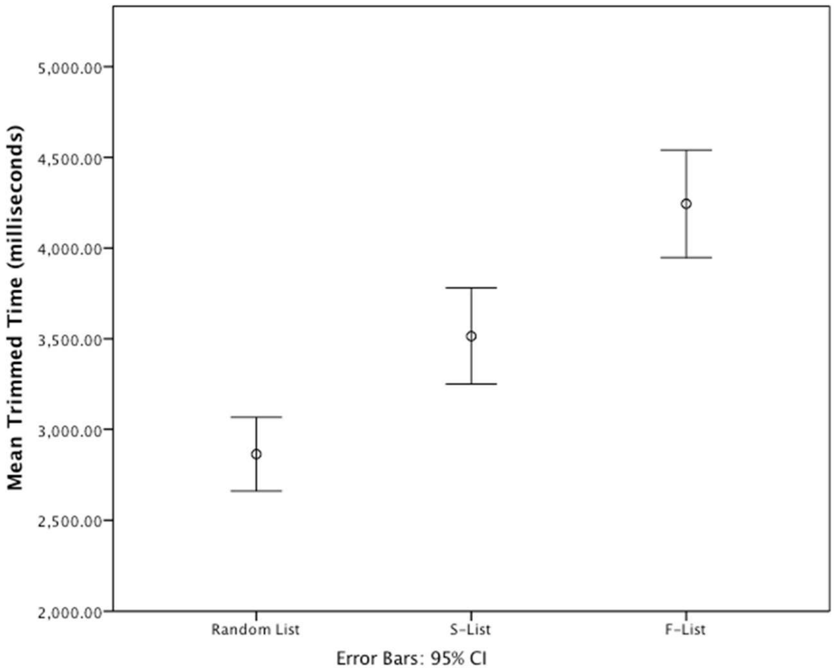


Figure 2.
Experiment 2A. HF → LF. Means and 95% confidence intervals for synonym production response times as a function of list type (S = Semantic; F = Form).

There was also a significant main effect of Concreteness: F_1 (1, 29) = 49.32; p <.001 (η_p^2 = .630) and F_2 (1, 69) = 5.89; p = .018 (η_p^2 = .079), with responses to abstract words (M = 3757 ms, SE = 131) being slower than to concrete ones (M = 3254 ms, SE = 116). An interaction of Concreteness and List Type was significant by-subject: F_1 (2, 58) = 19.81, p < .001 (η_p^2 = .406), but not by-item F_2 (2, 69) = 1.75, p = .181. Comparisons of concrete and abstract RT means (at α = 0.016) were performed in each List Type by-subject and showed that concrete words were processed faster than abstract words in the R-List: t (29) = 7.92; p < .001 and in the S-List: t(29) = 3.64; p <.001. There was no significant difference between Abstract and Concrete RTs in the F-List: t(29) = .970; p >.250.

Discussion

The semantically-blocked nouns were converted into their LF synonyms more slowly than the random nouns, evident in the by-subject analysis. The by-item effect approached significance, but did not survive Bonferroni correction in the post-hoc comparison. The greater sensitivity of the F_1 analyses may result from the repeated measures design, in which List Type was a within-subjects factor. The by-subject finding, however, is consistent with the claim that LF forms are vulnerable to semantic interference and mirrors semantic blocking effects in picture naming and bilingual translation (Kroll & Stewart, 1994). Form blocking produced an even stronger interference. This result indicates that blocking interference reported in L1→L2 translations and in the monolingual equivalent task may not be uniquely semantic in nature, but a manifestation of sensitivity of LF items to various types of interference. It is also of note, that a small, but significant word length effect present in the F-Lists compared to the Random Lists might also contribute to slower processing.

Experiment 2B: **Synonym production in the LF→HF frequency contour**

The design was identical to Experiment 2A, except that the frequency contour was reversed to LF→HF.

Stimuli

Three sets of stimuli included an F-List, which was constructed from words sharing onsets of *con-; pro -; car-; la-;* an S-list, which was constructed from words denoting *emotions, vehicles* and *professions;* and a Random list of nouns. Each list consisted of 25 (15 abstract and 10 concrete) items. The stimuli were of lower frequency of their anticipated twins (see Table 4).

	Stimuli (LF words)			Targets (HF words)			ANOVA results		
	F-List	S-List	R-List	F-List	S-List	R-List	List Type (F/S/R-Lists)	Item Function (Stimulus/ Target)	List Type x Item Function
Frequency (ipm)	16 (5)	12 (3)	14 (3)	71 (13)	71 (14)	73 (12)	F (2, 144) = .03; p > .250	F (1, 144) = 52.21; p < .001	F (2, 144) = .04; p > .250
Word length (number of letters)	7 (.5)	6 (.5)	6 (.4)	6 (.5)	6 (.4)	6 (.3)	F (2, 144) = .57; p > .250	F (1, 144) = 2.19; p = .141	F (2, 144) = .68; p > .250

Table 4. Word frequency (ipm) means, Word Length means and ANOVA results for Experiment 2 stimuli. Standard Errors (SE) are in brackets. LF = Low Frequency; HF = High Frequency; F = form; S = Semantic; R = Random.

ANOVA conducted with List Type (Form vs. Semantic vs. Random) and Item Function (Stimulus-LF vs. Target-HF), as independent measures and word frequency as the dependent variable, showed a significant main effect of Item Function indicating a clear frequency contrast within stimulus-target synonym pairs. There was no effect of List Type and no interaction between List Type and Item Function, indicating that the frequency contrast for synonyms and targets was consistent across the three lists. The stimuli and targets were also roughly matched for word length. ANOVA revealed no effect of List Type, Item Function or interaction of List type and Item Function indicating that letter count was comparable for Stimulus-Target pairs across the three lists.

Participants

15 male and 14 female monolingual British English native speakers were recruited (mean age M = 24.59, Range = 19 – 43 years). Participants had not taken part in Experiments 1 and 2A.

Results

161 (7.4%) out of 2175 cases were removed. Of these, 116 responses (32 in F-List; 65 in S-List and 19 in R-List) were errors, and the remaining 45 cases were due to non-target noise triggering the timer. Data trimming affected 107 cases (4.9%). The analyses were performed on trimmed data. ANOVAs were performed by-subject (F_1) with List Type (F-List/S-List/R-List) and Concreteness (Abstract/Concrete) as within-subject factors and Trimmed Time as the dependent variable, and by-item (F_2) with List Type and Concreteness as fixed factors and the Trimmed Time as the dependent variable (Table 5).

Measure	R-List		S-List		F-List	
	Abstract	Concrete	Abstract	Concrete	Abstract	Concrete
Mean (SE)	1970 (70)	1758 (79)	2181 (85)	1687 (73)	3842 (145)	3686 (189)

Table 5. Synonym conversion response times (ms) and SEs as a function of concreteness and list type (F = Form; S = Semantic; R = Random) in the LF→HF direction.

Both analyses yielded a highly significant effect of List Type: F_1 (2, 56) = 218.59; p < .001 (η_p^2 = .886) and F_2 (2, 69) = 99.81; p < .001 (η_p^2 = .743) (Figure 3). Bonferroni-corrected post-hoc comparisons were performed (at α = 0.016). The R-List and S-List showed no significant difference: F_1 (1, 28) = 3.61; p = .068; F_2 (1, 48) = .79, p > .250. R-List RTs were significantly faster than F-List RTs: F_1 (1, 28) = 246.47; p < .001 (η_p^2 = .898); F_2 (1, 48) =

133.41, p < .001 (η_p^2 = .735); S-List RTs were also significantly faster than F-List RTs: F_1 (1, 28) = 243.61; p < .001 (η_p^2 = .897); F_2 (1, 48) = 105.92, p < .001 (η_p^2 = .688).

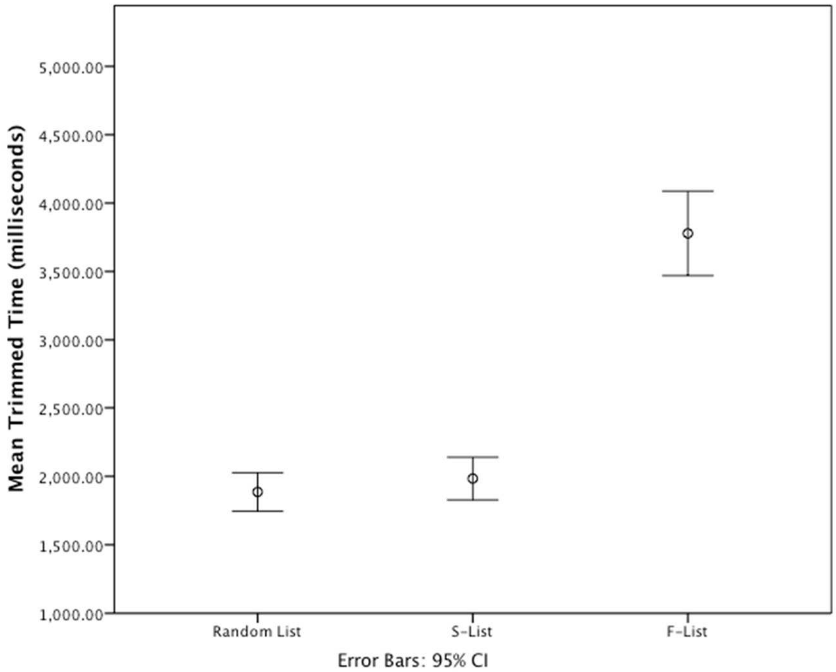


Figure 3.

Experiment 2B. LF → HF Means and 95% confidence intervals for synonym production RTs as a function of list type (S = Semantic; F = Form)

There was also a significant effect of Concreteness: F_1 (1, 28) = 24.57; p <.001 (η_p^2 = .467); F_2 (1, 69) = 5.6, p = .020 (η_p^2 = .076). Responses to concrete words (M = 2435 ms; SE = 111) were faster than to abstract words (M = 2711 ms; SE = 97). An interaction of List Type and Concreteness was significant by-subject: F_1 (2, 56) = 4.88, p = .011 (η_p^2 = .148), but not by-item: F_2 (1, 69) = .953, p > .250. Bonferroni-corrected post-hoc comparisons of concrete and abstract means were performed (at α = 0.016) by-subject in each list and revealed that concrete words were processed faster than abstract words in the R-List: F (1, 28) = 17.05, p < .001 and in the S-List: F (1, 28) = 79.81, p < .001, but not the F-List: F (1, 28) = 1.37, p > .250.

Discussion Experiment 2 (A and B)

Synonym translations were sensitive to semantic blocking in the HF→LF, but not in the reversed direction (LF→HF). These results support the primary hypothesis that, in comparison to HF words, access to LF items is more sensitive to interference. Taken together with Experiment 1, the results parallel bilingual translation asymmetry (Kroll & Stewart, 1994) and challenge the account that such response patterns are due to structural and processing differences for L1 and L2 words. Within a single lexicon, it is unlikely that distinct processing mechanisms are employed in the retrieval of HF and LF words.

The form-blocking condition resulted in interference effects in synonym generation for both HF → LF and LF → HF, as predicted by BIA+ (Dijkstra & Van Heuven, 2002). By contrast to the asymmetric semantic blocking effect, there was no difference between HF and LF words in relation to form blocking. The repeated presentation of form-similar stimuli may lead to sustained activation of multiple representations in the word recognition system, which significantly slows stimulus discrimination (Davis & Lupker, 2006; Grainger & Van Heuven, 2003). A further possibility is that the form-level interference extends beyond word recognition and impacts upon response retrieval. In Experiment 2B, significant form blocking effects were found without the potential confound of word length, as in Experiment 2A.

Experiment 3

In Experiments 1 and 2 within-language synonym tasks were used to determine the influence of frequency and stimulus list blocking on word retrieval times. Experiment 3 directly considers the bilingual case. Previous research has demonstrated that patterns of language dominance can change over the lifespan, which might modulate lexical frequency weightings and impact upon behavioural indices such as reaction times (Basnight-Brown & Altarriba, 2007). Two groups of Russian(native)-English bilinguals were recruited. One group was predominant speakers of Russian and the second group predominantly spoke English. It was predicted that their patterns of language use would modulate frequency weightings of lexical items and impact upon response times. In these two groups of bilinguals we examined speed of word retrieval across the two languages and also the effects of semantic and form blocking on the two translation directions. In order to explore the effect of form-based interference beyond the level of word recognition (Experiment 2), in the form-blocked condition the stimuli were chosen so that their predicted responses were phonologically similar.

Stimuli

Three stimulus lists were constructed in both translation directions (English → Russian and Russian → English). Form-related lists (F-Lists) consisted of nouns whose translation equivalents shared onsets. In the English → Russian direction the F-List consisted of English nouns whose Russian translation equivalents shared onsets of: *ob-; pri -; do- (e.g., Obman (deceit); Obmen (exchange); Obschestovo (society)).* In Russian → English translation, the F-List consisted of nouns whose translation equivalents shared onsets of *he-; de-; be- (Head (golova); Hell (ad); Health (zdorovie)).* The semantic list (S-list) in English → Russian translation consisted of words denoting: *time; clothes; literature.* The S-List in Russian → English translation consisted of words denoting *emotions; jobs; weather.* Categorized items were blocked together within the list. Words in the Random lists (R-Lists) were unrelated in form and meaning. Each list consisted of 24 (15 abstract and 9 concrete) words. Words in the Russian lists did not appear as their translations in the English stimulus lists, and vice versa. The lists were matched on corpus frequency within and across languages (Sharoff, 2006) (Table 6).

		Stimuli			Targets			ANOVA results		
		F-List	S-List	R-List	F-List	S-List	R-List	List Type (F/S/R-Lists)	Item Function (Stimulus/Target)	List Type x Item Function
Russian → English	Frequency (ipm)	83 (26)	88 (13)	82 (16)	91 (23)	81 (17)	90 (13)	F (2, 138) = .008; p > .250	F (1, 138) = .04; p > .250	F (2, 138) = .99; p > .250
	Word length (number of letters)	6 (.3)	6 (.3)	6 (.3)	6 (.3)	6 (.4)	6 (.4)	F (2, 138) = 1.08; p > .250	F (1, 138) = .45; p > .250	F (2, 138) = .02; p > .250
English → Russian	Frequency (ipm)	88 (20)	89 (18)	82 (19)	85 (19)	87 (17)	89 (15)	F (2, 138) = .01; p > .250,	F (1, 138) = .00; p > .250	F (2, 138) = .06; p > .250
	Word length (number of letters)	6 (.4)	6 (.4)	6 (.3)	6 (.4)	6 (.4)	6 (.3)	F (2, 138) = .85; p >.250	F (1, 138) = .01; p > .250	F (2, 138) = .10, p > .250

Table 6. Word frequency (ipm) means, Word Length means and ANOVA results for Experiment 3 stimuli. Standard Errors (SE) are in brackets. F = form; S = Semantic; R = Random.

ANOVAs were performed for the stimulus and target lists used in translations in both directions with Frequency count as the dependent variable and List Type (F-List/S-List/R-List) and Item Function (Stimulus/Target) as independent variables (Table 6). Analyses revealed no effect of List Type, Item Function or interaction of List type and Item Function, indicating that Frequency across the three list types was comparable for Stimuli and Targets in both directions.

Identical ANOVAs were also performed to test stimulus matching for word length (Table 6). For both Russian→English and English→Russian lists the analyses showed no effect of List Type, Item Function or interaction of List type and Item Function, indicating that Letter Count across the three list types was comparable for Stimuli and Targets in both directions.

Participants

8 male and 32 female Russian(native) – English bilinguals were recruited. All participants were highly proficient speakers of British English, who reported no history of speech and language disorders, and normal or corrected to normal vision. They had started learning

English as a foreign language at the age of 10 in secondary education. At the time of testing, all had resided in the UK for at least 5 years and used English professionally (public service interpreting and university lecturing). All participants used Russian as a primary language until their immigration to the UK. Based on a self-assessment of language use[4], participants were assigned to either a Russian-Dominant group (RusDom) or an English-Dominant group (EngDom). The RusDom group consisted of frequent users of Russian (predominantly using Russian socially, at work and at home); although they stated that they also used English at work and were fully proficient in it. The EngDom group consisted of more frequent users of English (at work, socially and at home). These participants also reported that they still used Russian regularly and were fluent in it.

The RusDom group consisted of 4 males and 16 females (mean age M = 35.40, range = 21 – 47 years). The EngDom group also consisted of 4 males and 16 females (mean age M = 35.55; range = 23 – 46 years).

Procedure

The design of the task, stimulus presentation procedure, response time measurement and data trimming methods were identical to those used in Experiment 2. The experiment consisted of two parts: English → Russian and Russian → English translations. The order of presentation of both parts and lists within each part was counterbalanced across participants. Subsequent data checks revealed a program error where responses produced in the time window of 1750 – 2500 ms. were recorded as time-outs and assigned an automatic 2500 ms. measurement. As a result, all time-out responses were re-measured using Praat from the audio record within DMDX (Forster & Forster, 2003). RT was measured from the offset of the stimulus word to

[4] Santello (2014) reports a significant correlation of self-reported language dominance and results of standardized scoring of language use based on linguistic background/history, attrition and phonological interference. The overall results of the standardized tests were consistent with self-reported language dominance.

the onset of the initial phone of the response. There were 282 mistimed responses and manual timings were extracted from Praat for these items.

Results

473 (8.2%) out of 5760 cases were discarded. Out of these 473 datum points, 207 (3.6%) responses were errors. The RusDom Group produced 119 errors, of which 44 were made in the Russian → English direction and 75 errors were made in English → Russian direction. The EngDom Group produced 88 errors, of which 36 were from Russian → English and 52 were from English → Russian. The remaining 266 (4.6%) cases were due to non-target noise. The trimming affected 320 cases (6.1 % of all valid data). Statistical analyses were performed on trimmed data. ANOVAs were performed by-subject (F_1) with Direction (RusEng/EngRus), List Type (F-List/S-List/R-List) and Concreteness (Concrete/Abstract) as within-subject factors, Group as a between-subject factor and Trimmed Time as the dependent variable. Analyses were also performed by-item (F_2) with Group (RusDom/EngDom), Direction, List Type and Concreteness as fixed factors and Trimmed Time as the dependent variable (Table 7)

Group/Direction			Random		S-List		F-List	
			Abstract	Concrete	Abstract	Concrete	Abstract	Concrete
RusDom Group	Rus-Eng	Mean (SE)	1197 (39)	1059 (30)	1449 (67)	1150 (34)	1464 (62)	1410 (84)
	Eng-Rus	Mean (SE)	998 (22)	970 (23)	1041 (28)	1060 (40)	1466 (73)	1091 (34)
EngDom Group	Rus-Eng	Mean (SE)	1136 (42)	1087 (41)	1165 (40)	1123 (36)	1221 (37)	1246 (39)
	Eng-Rus	Mean (SE)	1049 (42)	1007 (35)	1110 (38)	1180 (38)	1475 (74)	1099 (31)

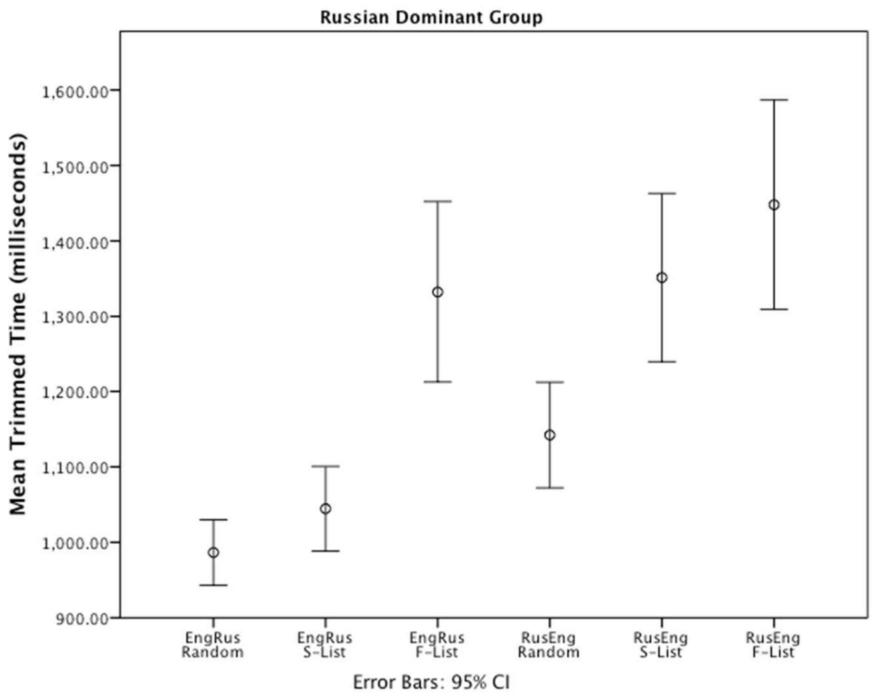
Table 7. Russian → English and English → Russian translation mean RTs (ms) and SEs as a function of list type and Concreteness. RusDom and EngDom Groups. (F = Form; S = Semantic).

The analyses showed a significant main effect of Direction: F_1 (1, 38) = 35.63; p < .001 (η_p^2 = .484) and F_2 (1, 264) = 13.79, p < .001(η_p^2 = .050) with English → Russian translations (M = 1148 ms; SE = 26) being faster than Russian → English (M = 1240 ms; SE = 203) (see

Figure 4). List Type was also significant: F_1 (2, 76) = 92.45; $p < .001$ ($\eta_p^2 = .709$) and F_2 (2, 264) = 38.22; $p < .001$ ($\eta_p^2 = .225$), with the R-Lists (M = 1071 ms; SE = 22) being translated faster than S-Lists (M = 1174 ms; SE =25): F_1 (1, 39) = 57.66; $p < .001$; F_2 (1, 190) = 13.28; $p < .001$, and F-Lists (M = 1343 ms; SE =38): F_1 (1, 39) = 118.07; $p < .001$; F_2 (1, 190) = 66.62; $p < .001$. The S-Lists were translated significantly faster than F-Lists: F_1 (1, 39) = 63.34; $p < .001$; F_2 (1, 190) = 22.63; $p < .001$ (Bonferroni corrected).

There was also a significant effect of Concreteness: F_1 (1, 38) = 63.76, $p < .001$ ($\eta_p^2 = .627$); F_2 (1, 264) = 17.18, $p < .001$ ($\eta_p^2 = .061$) with concrete items translated faster (M = 1126 ms, SE = 23) than abstract items (M = 1236 ms, SE = 31). There was no significant main effect of Group in any of the analyses: F_1 (1, 38) = .60; $p > .250$; F_2 (1, 264) = 3.47; $p = .063$ indicating that Groups were translating at comparable speeds and were balanced on proficiency. There was a significant interaction of Group, Direction and List Type by-subject (Figure 4): F_1 (2, 76) = 6.85; $p = .002$ ($\eta_p^2 = .153$), but not by-item F_2 (2, 264) = 1.48; $p = .230$. Similar to Experiment 2A, significance in the by-subjects but not the by-items analysis may be explained in part by the repeated measures analysis used for the F_1 comparisons, in which Direction and List Type were within-subject factors. The full ANOVA results are available in the online Supplementary Material.

a.



b.

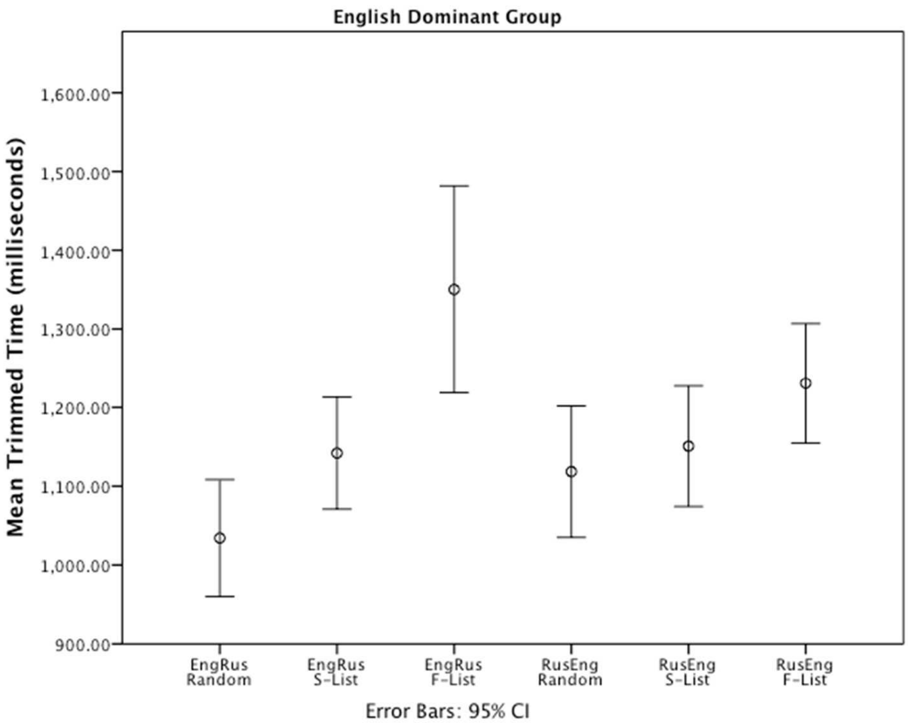


Figure 4.

Means and 95% confidence intervals of the Russian Dominant Group (a) and English Dominant Group (b) in both directions (English→Russian and Russian→English) as a function of list type (S = Semantic; F = Form).

Post hoc analyses were performed by-subject to explore the three-way interaction of Group, Direction and List Type and to determine if blocking effects were minimised in translation into the dominant language. The data were split by Group. Trimmed Time was used as the dependent variable and Direction and List Type as within-subject factors.

RusDom Group analyses revealed a significant effect of Direction: $F(1, 19) = 45.92$; $p < .001$ ($\eta_p^2 = .707$) with English→Russian translations (M = 1121 ms; SE = 33) being faster than Russian→English translations (M = 1315 ms; SE = 48). There was also a significant effect of List Type: $F(2, 38) = 55.96$; $p < .001$ ($\eta_p^2 = .747$), and an interaction of List Type and Direction: $F(2, 38) = 9.79$; $p < .001$($\eta_p^2 = .340$).

Bonferroni-corrected post-hoc comparisons (α=.016) for List Type effects were performed for the Russian→English direction. All mean RTs were significantly different. The R-List RTs were faster than the S-List RTs: $F(1, 19) = 32.12$; $p < .001$ ($\eta_p^2 = .628$); Both, R-List and S-List RTs were faster than the F-List RTs: $F(1, 19) = 41.91$; $p < .001$ ($\eta_p^2 = .688$) and $F(1, 19) = 9.83$; $p = .005$ ($\eta_p^2 = .341$), respectively.

In the English→Russian direction, the R-List and S-List RTs were also significantly different: $F(1, 19) = 9.35$; $p = .006$ ($\eta_p^2 = .330$), but to a lesser extent than in the Russian → English direction. R-List and S-List were translated faster than the F-List: $F(1, 19) = 51.95$; $p < .001$ ($\eta_p^2 = .732$) and $F(1, 19) = 49.67$; $p < .001$($\eta_p^2 = .723$).

EngDom Group showed no significant effect of Direction: $F(1, 19) = .21$; $p > .250$ ($M_{(Eng-Rus)}$ = 1175 ms; SE = 40; $M_{(Rus-Eng)}$ = 1164 ms; SE = 36). There was, however, a significant effect of List Type: $F(2, 38) = 38.73$; $p < .001$ ($\eta_p^2 = .671$), and an interaction of List Type and Direction: $F(2, 38) = 10.84$; $p = .002$ ($\eta_p^2 = .363$).

Bonferroni-corrected comparisons were performed for all three lists in the Russian→English direction. R-List and S-List RTs showed no significant difference: F (1, 19) = 2.88; p = .106. The R-List and S-List were translated faster than the F-List: F (1, 19) = 24.98; p < .001 (η_p^2 = .568), and F (1, 19) = 16.73; p < .001 (η_p^2 = .468).

In the English→Russian direction, the R-List was translated faster than the S-List: F (1, 19) = 29.76; p < .001 (η_p^2 = .610), and F-List: F (1, 19) = 43.08; p < .001 (η_p^2 = .694). The S-List was translated faster than the F-List: F (1, 19) = 16.26; p < .001 (η_p^2 = .461).

Translation RTs in the English-Dominant Group demonstrated a reversed pattern of semantic blocking interference to that of the Russian-Dominant group, with stronger effects in English→Russian translations compared to Russian→English. Therefore, in both groups the semantic blocking effect was present when translating into the language of less frequent use and minimized when translating into the language of more frequent use. Form blocking slowed RTs in both translation directions and in both groups.

Discussion

Russian-dominant bilinguals translated faster into their L1 (Russian). Translations in Russian→English were more sensitive to semantic interference than in English→Russian, which is consistent with the RHM predictions (Kroll & Stewart, 1994). The results, however, parallel those of the monolingual experiments (1 and 2) of this study. As such, they are also consistent with the prediction of processing advantage of HF items over LF ones in terms of speed of access (Howes & Solomon, 1951; Oldfield & Wingfield, 1965; Paap et al., 1987) and resistance to processing interference (Bangert et al., 2012; Camarazza & Hillis, 1990; Michael & Gollan, 2005). In English-dominant bilinguals, translation speeds in both directions were comparable. However, semantic interference affected only English→Russian translations. This result might reflect a shift of language dominance and suggests that more frequent use of English had modulated translation asymmetry.

While semantic interference had asymmetric effects, form-based interference exerted a powerful effect irrespective of language dominance or translation direction. This finding replicates results of Experiment 2, where words were blocked at the stimulus presentation stage. In Experiment 3, responses were blocked. Despite this difference, form-based blocking again evoked strong interference.

Finally, bilingual participants performed the translation task faster than monolinguals (Experiments 1 and 2). This might suggest that different processing mechanisms may be recruited in the monolingual synonym translation task compared to its bilingual equivalent. However, this difference in processing speed is more likely due to bilingual participants being more familiar with the nature of the translation task.

General discussion

The RHM of bilingual lexical processing is based upon observations that L1 forms are produced faster than their L2 equivalents and that L2 forms are susceptible to semantic interference from blocking of stimuli, while L1 words are resilient to it (Kroll & Stewart, 1994). We replicated these results in a within-language synonym 'translation' task where there was a clear frequency contrast between the synonyms so that one member of the pair was a HF and its twin, a LF form. Experiment 1 and 2 findings supported a frequency-based account. Asymmetric effects modulated by frequency were observed under conditions where there is no question of separate lexical systems.

In Experiment 3 we explored the frequency-mediated hypothesis in two groups of Russian(native)-English bilinguals. One group used their native language frequently, while the second reported a shift to more frequent use of English. These different patterns of language use appeared to modulate frequency weightings within the lexicon. We observed different patterns of sensitivity to semantic interference across the groups. L1-dominant participants displayed asymmetries similar to those described by Kroll and Stewart (1994) (slower and more semantically-sensitive L1→L2 translations). L2-dominant translators showed reversed semantic categorisation effects, with translation to Russian slowed by semantic blocking. An important practical outcome of this finding is that measuring changes in patterns of sensitivity to semantic blocking may be a way to probe shifting language dominance.

Basnight-Brown and Altarriba (2007) report similar modulations of cross-language asymmetries in a semantic priming task with increasing experience of the L2. Malt, Li, Pavlenko, Zhu, and Emeel (2015) also suggest plasticity of language behaviour as a function of frequency of language use. In a series of picture naming tasks, they compared performance of Mandarin(native)-English bilinguals immersed in L2 (English) with those of Mandarin and English monolinguals. They observed that the L2-immersed bilinguals developed native-like response times when naming in L2, while diverging from the native patterns when naming in L1. They also state that the higher the L2 usage, the greater such divergence becomes. Converging evidence of frequency-modulated dynamics of lexical access also comes from eye-tracking studies. Whitford and Titone (2012; 2015) compared eye movements of two groups of L1-dominant Canadian English-French bilinguals. The groups differed in the amount of L2 exposure (high vs. low) reported in their daily lives. Participants were asked to read simple sentences in both languages. Whitford and Titone (2015) found that the high L2 exposure group displayed faster L2 reading and shorter forward fixation times compared to the low L2 exposure group. They also report that the high L2 exposure group exhibited slower L1 reading and longer forward fixation times as compared to the low exposure group.

The above findings point towards dynamic nature of lexical access, governed by frequency of language use and exposure.

In our Experiment 3, L2-dominant bilinguals did not show an overall speed advantage in translating into English. It is more likely that in these participants the change in frequency may not have been sufficiently large to result in a full reversal of translation asymmetries. Residual advantage of age of acquisition might also contribute to this result, with early-acquired forms producing long-lasting effects on the organisation of the lexical system (Belke, Brysbaert, Meyer, & Ghyselinck, 2005; Hirsh & Funnell, 1995). Belke et al. (2005) further report that age of acquisition exerts a powerful influence over the speed of lexical access independently of word frequency.

We also explored the effects of blocking items by form on translation asymmetries and observed strong interference effects of form blocking on both stimuli (monolingual) and responses (bilingual) with no modulation by frequency contour. Similar form-based effects are reported in word recognition (Davis & Lupker, 2006; Grainger & Van Heuven, 2003), production (Dell, 1986, 1988; Wheeldon, 2003) as well as in bilingual translation recognition studies (Sunderman & Kroll, 2006; Sunderman & Priya, 2012). With regard to the more selective effect of semantic interference (stronger on LF retrieval), one possibility is that some degree of semantic overlap is typical in natural communication as speakers/listeners talk around a topic, resulting in repeated access to semantically-related words. By contrast, the repeated use of form-similar words is unusual. As a result, form blocking may lead to multiple activations of competing input/output representations and slows lexical recognition/access, irrespective of word frequency. Wheeldon (2003) reports a similar result in word and picture naming with powerful inhibitory form-relatedness effects independent of word frequency.

The evidence of common patterns of performance, modulated by frequency of word use, in monolingual and bilingual speakers provides insights into bilingual lexical organisation. While a number of models propose autonomous lexicons with distinct processing routes, our results are consistent with the notion of a single integrated lexicon, in which common principles determine accessibility of information. It is also supported by observations of common priming effects across languages, with the different priming strengths more likely related to word frequency effects (Basnight-Brown & Altarriba, 2007; Jiang, 1999). Recent eye-tracking investigations of bilingual and monolingual reading behaviour also present evidence of an integrated lexicon, in which amount of exposure to a particular item (either L1 or L2) determines its accessibility within a language as well as across languages (Brysbaert, Lagrou, & Stevens, in press; Cop, Keuleers, Drieghe, & Duyck, 2015; Diependaele, Lemhöfer, & Brysbaert, 2013). Perea et al. (2008) report a similar finding indicating common processing principles of L1 and L2 words obtained in a paradigm of masked semantic priming in lexical decision. Further, neuroimaging evidence also supports the position of an integrated lexicon. Where variations are observed in neural activations during processing of different languages, these involve neurocognitive systems linked to attention, inhibitory control and error detection, rather than language systems per se. Indefrey (2006) identified differences in activation of the anterior cingulate cortex and left posterior inferior frontal gyrus, linked to attention and inhibitory control as well as error-detection, which are required when a less practiced skill is used.

The notion of a single integrated lexicon, where ease of access to word forms is determined by general processing principles such as frequency of use, is of value in developing accounts of a range of bilingual phenomena. For example, in the case of code switching, easily available forms (i.e., of higher frequency) from one language are inserted into the constructions of another language (Heredia & Altarriba, 2001; Kheder & Kaan, 2016).

Furthermore, our results have implications for debates regarding general cognitive advantages bestowed by bilingualism. In particular, claims that bilinguals have enhanced executive function (EF) are built upon assumptions of continuous rapid switching between autonomous mechanisms and associated demands for rapid activation/inhibition of cognitive sub-systems (Green, 1998). Results suggestive of bilingualism-related advantages in EF have been reported across a range of populations (e.g., Bialystok, Craik, Binns, Ossher, & Freedman, 2014; Bialystok, Craik, Klein, & Viswanathan, 2004; Prior & MacWhinney, 2010). However, the notion of an integrated bilingual lexicon reduces the need for overt switching. Paap and Greenberg (2013) argue that, while bilinguals face L1/L2 lexical choices, monolinguals face similar challenges in terms of synonymy, hyponymy, choices over language registers. In an integrated bilingual lexicon such selections occur on the basis of system-internal modulation through factors such as word frequency and do not require the intervention of domain-general control mechanisms. The integrated lexicon model, supported by considerable evidence on frequency effects, represents a powerful reconceptualization of bilingualism which will drive the next phase of research.

Author contributions

A. Ibrahim and R. A. Varley developed the study concept and designed Experiment 1 and 2A. A. Ibrahim, R. A. Varley and P. E. Cowell contributed to the design of Experiments 2B and 3. Testing, data collection, analysis and interpretation of results were performed by A. Ibrahim, under the supervision of P. E. Cowell and R. A. Varley. P. E. Cowell provided statistical advice for all three experiments. A. Ibrahim drafted the manuscript, and R. A. Varley and P. E. Cowell provided critical revisions and editing. All authors approved the final version of the manuscript for submission. The study was funded by A. Ibrahim as a part of a PhD.

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Appendix A.

Stimuli and expected targets for Experiments 1 – 3.

Experiment 1.

HF stimuli	**Frequency**	**Length**	**Concreteness**	**LF Stimuli**	**Frequency**	**Length**
Cemetery	8	8	abstract	Graveyard	4	9
Film	101	4	abstract	Movie	18	5
Purchase	11	7	abstract	Buy	2	3
Help	110	4	abstract	Assistance	49	10
Story	184	5	abstract	Tale	34	4
Smile	69	5	abstract	Grin	12	4
Hunger	11	6	abstract	Starvation	0.4	10
Murder	23	6	abstract	Killing	16	7
Centre	282	6	abstract	Middle	60	6
Answer	93	6	abstract	Reply	36	5
Weather	58	7	abstract	Climate	31	7

Bill	121	4	abstract	Invoice	4.6	7
Enemy	40	5	abstract	Foe	4	3
Football	67	8	abstract	Soccer	13	6
Poison	10	6	abstract	Venom	2.5	5
Freedom	64	7	abstract	Liberty	19	7
Biscuit	16	7	concrete	Cookie	0.3	6
Child	710	5	concrete	Kid	60	3
Engine	69	6	concrete	Motor	48	5
Boy	213	3	concrete	Lad	35	3
Glasses	25	7	concrete	Spectacles	6	10
Girl	254	4	concrete	Lass	0.1	4
Taxi	22	4	concrete	Cab	17	3
Prison	74	6	concrete	Jail	12	4
Policeman	34	9	concrete	Cop	18	3
Animal	153	6	concrete	Spud	0.3	4
Potato	25	6	concrete	Beast	14	5
Forest	90	6	concrete	Woods	15	5
Pillow	11	6	concrete	Cushion	4	7
Money	371	5	concrete	Cash	86	4

Experiment 2A

List Type	**Stimuli (HF)**	**Freque ncy**	**Leng th**	**Concreten ess**	**Targets (LF)**	**Frequen cy**	**Length**
F-List	Contempt	12.41	8	abstract	Disrespect	1.19	10
F-List	Consent	40	7	abstract	Permission	32	10
F-List	Conflict	59.53	8	abstract	Dispute	32.73	7
F-List	Confusion	28.49	9	abstract	Mix-up	0.8	5
F-List	Problem	290.33	7	abstract	Difficulty	63.24	10
F-List	Progress	82.16	8	abstract	Improvement	42	7
F-List	Promise	38.67	7	abstract	Assurance	18.4	9
F-List	Process	228.47	7	abstract	Continuation	8.1	12
F-List	Product	112.18	7	concrete	Item	37	5
F-List	Profit	59.84	6	abstract	Gain	52	4
F-List	Programme	186.79	9	abstract	Schedule	25.01	8
F-List	Fortune	20.08	7	abstract	Riches	3.47	6
F-List	Forecast	15.56	8	abstract	Prediction	7.67	10
F-List	Format	23.21	6	abstract	Layout	12.52	6
F-List	Forest	72	6	concrete	Woods	21	5
F-List	Forehead	12	8	concrete	Brow	7.35	4
F-List	Page	105.37	4	concrete	Sheet	41.83	5
F-List	Paint	34.97	5	concrete	Dye	4.4	3
F-List	Paper	171.89	5	concrete	Parchment	2.5	9
F-List	Patient	83.08	7	concrete	Sufferer	6.04	8
F-List	Pagan	4.94	5	concrete	Heathen	1.13	7
F-List	Pavement	12.85	8	concrete	Sidewalk	0.8	8

F-List	Patience	11.71	8	abstract	Tolerance	7.27	9
F-List	Pain	71.22	4	abstract	Ache	3.94	4
F-List	Pay	220.38	3	abstract	Salary	19.22	6
S-List	Depression	23	10	abstract	Sadness	7.64	7
S-List	Joy	29	3	abstract	Happiness	16	9
S-List	Fear	91.25	4	abstract	Terror	14.45	6
S-List	Surprise	60	8	abstract	Shock	42	5
S-List	Love	227	4	abstract	Affection	13.48	9
S-List	Anger	37.26	5	abstract	Rage	12.3	4
S-List	Aircraft	63	8	concrete	Plane	32.32	5
S-List	Train	80	5	concrete	Locomotive	7.64	10
S-List	Ship	48	4	concrete	Boat	53.53	4
S-List	Car	271.5	3	concrete	Automobile	2.41	10
S-List	Lift	42.34	4	concrete	Elevator	1.94	8
S-List	Taxi	18.2	4	concrete	Cab	14.54	3
S-List	Bus	53.98	3	concrete	Coach	34.52	5
S-List	Helicopter	11.17	10	concrete	Chopper	1.15	7
S-List	Crime	70.32	5	abstract	Offence	37.2	7
S-List	Theft	17.13	5	abstract	Stealing	9.2	8
S-List	Lies	52	4	abstract	Deceit	2.1	6
S-List	Violence	56	8	abstract	Aggression	12.69	10
S-List	Danger	59	6	abstract	Threat	56	6
S-List	Criminal	50	8	abstract	Con	8.96	3
S-List	Job	225	3	abstract	Occupation	22.47	10
S-List	Doctor	103	6	concrete	Medic	0.6	5
S-List	Teacher	90	7	abstract	Tutor	11.32	5
S-List	Driver	52	6	abstract	Chauffeur	2.66	9
S-List	Solicitor	32	9	abstract	Lawyer	21	6
Random	Freedom	64	7	abstract	Liberty	13.9	7
Random	Poison	10	6	abstract	Venom	2.5	5
Random	Football	67	8	abstract	Soccer	13.4	6
Random	Bill	121	4	abstract	Invoice	4.6	7
Random	Weather	58	7	abstract	Climate	28.26	7
Random	Answer	93	6	abstract	Reply	42.9	5
Random	Film	101	4	abstract	Movie	18.1	5
Random	Smile	69	5	abstract	Grin	11.2	4
Random	Enemy	49	5	abstract	Foe	3.8	3
Random	Story	134.24	5	abstract	Tale	20.86	4
Random	Woman	223	5	concrete	Female	79.6	6
Random	Potato	25	6	concrete	Spud	0.4	4
Random	Boy	213	3	concrete	Lad	35	3
Random	Glasses	25	7	concrete	Spectacles	5.5	10
Random	Engine	69	6	concrete	Motor	47.4	5
Random	Biscuit	16	7	concrete	Cookie	0.8	6

Random	Prison	74	6	concrete	Jail	12.6	4
Random	Animal	153	6	concrete	Beast	8.9	5
Random	Pillow	11	6	concrete	Cushion	5.2	7
Random	Purchase	11	8	abstract	Buy	2	3
Random	Help	110	4	abstract	Assistance	49	10
Random	Illness	32.6	7	abstract	Sickness	12	8
Random	Hunger	11.1	6	abstract	Starvation	4.6	10
Random	Smell	35	5	abstract	Odour	6.8	5
Random	Murder	56.6	6	abstract	Killing	30.3	7

Experiment 2B

List Type	**Stimuli (LF)**	**Frequency**	**Length**	**Concreteness**	**Targets (HF)**	**Frequency**	**Length**
F-List	Conversation	52	12	abstract	Talk	164	4
F-List	Con	8	3	abstract	Trick	15.3	5
F-List	Conduct	42	7	abstract	Behaviour	123	9
F-List	Confession	6.3	10	abstract	Admission	22.9	9
F-List	Concept	64.4	7	abstract	Idea	214.2	4
F-List	Condiment	0.2	9	concrete	Dressing	14	5
F-List	Contest	17	7	abstract	Competition	95	11
F-List	Convict	2.5	7	concrete	Prisoner	17	8
F-List	Prom	0.9	4	abstract	Ball	75	4
F-List	Province	22.7	8	abstract	Region	100	6
F-List	Probability	15.7	11	abstract	Chance	130	6
F-List	Proverb	1	7	abstract	Saying	182	6
F-List	Prohibition	6	11	abstract	Ban	32	3
F-List	Carton	1.5	6	concrete	Box	87.3	3
F-List	Cargo	8.7	5	abstract	Goods	36	4
F-List	Carol	11.7	5	abstract	Song	38	4
F-List	Cartel	2.85	6	abstract	Gang	15.3	4
F-List	Carnival	3.4	8	concrete	Festival	31	8
F-List	Carousel	0.8	8	concrete	Roundabout	5	10
F-List	Lament	1.7	6	abstract	Grief	31	3
F-List	Ladle	0.6	5	concrete	Spoon	8	5
F-List	Lame	2.5	4	concrete	Disabled	33	8
F-List	Lady	94	4	concrete	Woman	223	5
F-List	Latex	1	5	concrete	Rubber	16	6
F-List	Lane	45	4	concrete	Path	60	4
S-List	Sorrow	5.5	6	abstract	Sadness	7.64	7
S-List	Rage	12.3	4	abstract	Anger	37.26	5
S-List	Affection	13.48	9	abstract	Love	227	4
S-List	Fright	4.8	6	abstract	Fear	91.2	4
S-List	Thrill	4.8	6	abstract	Excitement	25	10
S-List	Worry	53	5	abstract	Concern	104	7
S-List	Shock	43	5	abstract	Surprise	50.9	8

S-List	Ache	3.9	4	abstract	Pain	71	4
S-List	Tutor	11.3	5	abstract	Teacher	87.9	7
S-List	Medic	0.6	5	concrete	Doctor	103	6
S-List	Chef	6.5	4	concrete	Cook	38.7	4
S-List	Occupation	22.5	10	abstract	Job	225.5	3
S-List	Constructor	0.3	11	abstract	Builder	9.5	7
S-List	Cop	4.6	3	concrete	Policeman	20.6	9
S-List	Pupil	23.5	5	abstract	Student	77.4	7
S-List	Creator	5.3	7	abstract	Maker	10	5
S-List	Novelist	6.5	8	abstract	Writer	37.43	6
S-List	Lawyer	21	6	abstract	Solicitor	31	9
S-List	Locomotive	7.64	10	concrete	Train	80	5
S-List	Jet	13.54	3	concrete	Plane	34	8
S-List	Ferry	13.3	5	concrete	Ship	53.5	4
S-List	Cab	14.54	3	concrete	Taxi	18.2	4
S-List	Motorcycle	2.89	10	concrete	Bike	18	4
S-List	Automobile	2.4	10	concrete	Car	271	3
S-List	Elevator	1.94	8	concrete	Lift	42	4
Random	Halt	2.9	4	abstract	Stop	147.9	4
Random	Liberty	19	7	abstract	Freedom	64	7
Random	Venom	2.5	5	abstract	Poison	10	6
Random	Soccer	13	6	abstract	Football	67	8
Random	Invoice	4.6	7	abstract	Bill	121	4
Random	Climate	28	7	abstract	Weather	58	7
Random	Reply	36	5	abstract	Answer	93	6
Random	Grin	12	4	abstract	Smile	69	5
Random	Foe	4	3	abstract	Enemy	49	5
Random	Tale	20	4	abstract	Story	134.24	5
Random	Spud	0.3	4	concrete	Potato	25	6
Random	Lad	19	3	concrete	Boy	213	3
Random	Spectacles	6	10	concrete	Glasses	25	7
Random	Motor	47.5	5	concrete	Engine	69	6
Random	Cookie	0.3	6	concrete	Biscuit	16	7
Random	Jail	12	4	concrete	Prison	74	6
Random	Cushion	4	7	concrete	Pillow	11	6
Random	Buy	2	3	abstract	Purchase	11	8
Random	Assistance	49	10	abstract	Help	110	4
Random	Sickness	12	8	abstract	Illness	32.6	7
Random	Odour	6.8	5	concrete	Smell	35	5
Random	Starvation	0.4	10	abstract	Hunger	11.1	6
Random	Killing	16	7	abstract	Murder	56.6	6
Random	Infant	17	6	concrete	Child	240	5
Random	Woods	15	5	concrete	Forest	72	6

Experiment 3

Direct ion	List Type	Stimuli	Freq.	Length	Targets	Freq.	Length	Concrete ness
EngRus	Random	Poison	10	6	Яд	16	2	abstract
EngRus	Random	Middle	120	6	Середина	58	8	abstract
EngRus	Random	Faith	74	5	Вера	117	4	abstract
EngRus	Random	Murder	46	6	Убийство	80	8	abstract
EngRus	Random	Answer	238	6	Ответ	355	5	abstract
EngRus	Random	Currency	33	8	Валюта	19	6	abstract
EngRus	Random	Smile	41	5	Улыбка	81	6	abstract
EngRus	Random	Enemy	57	5	Враг	117	4	abstract
EngRus	Random	Boy	113	3	Мальчик	129	7	concrete
EngRus	Random	Hair	73	4	Волосы	99	6	concrete
EngRus	Random	Glasses	101	7	Очки	46	4	concrete
EngRus	Random	Engine	76	6	Мотор	32	5	concrete
EngRus	Random	Policeman	10	9	Полицейский	53	11	concrete
EngRus	Random	Prison	46	6	Тюрьма	64	6	concrete
EngRus	Random	Money	295	5	Деньги	115	6	concrete
EngRus	Random	Pig	13	3	Свинья	18	6	concrete
EngRus	Random	Pillow	10	6	Подушка	25	7	concrete
EngRus	Random	Shop	80	4	Магазин	130	7	abstract
EngRus	Random	Play	371	4	Игра	210	4	abstract
EngRus	Random	Mistake	58	7	Ошибка	113	6	abstract
EngRus	Random	illness	38	7	Болезнь	99	7	abstract
EngRus	Random	Childhood	27	9	Детство	69	7	abstract
EngRus	Random	Hunger	12	6	Голод	35	5	abstract
EngRus	Random	Smell	21	5	Запах	65	5	abstract
EngRus	SList	Midday	10	6	Полдень	23	7	abstract
EngRus	SList	Midnight	10	8	Полночь	10	7	abstract
EngRus	SList	Month	323	5	Месяц	281	5	abstract
EngRus	SList	Autumn	10	6	Осень	47	5	abstract
EngRus	SList	Summer	99	6	Лето	95	4	abstract
EngRus	SList	Spring	81	6	Весна	57	5	abstract
EngRus	SList	Winter	175	6	Зима	73	4	abstract
EngRus	SList	Hour	285	4	Час	262	3	abstract
EngRus	SList	Generation	84	10	Поколение	73	9	abstract
EngRus	SList	Century	140	7	Век	187	3	abstract
EngRus	SList	Clothes	30	7	Одежда	91	6	concrete
EngRus	SList	Shirt	31	5	Рубашка	31	7	concrete
EngRus	SList	Boots	21	5	Сапоги	40	6	concrete
EngRus	SList	Coat	16	4	Пальто	20	6	concrete
EngRus	SList	Skirt	10	5	Юбка	17	4	concrete
EngRus	SList	Jacket	12	6	Куртка	23	6	concrete
EngRus	SList	Hat	29	3	Шапка	22	5	concrete

EngRus	SList	Suit	54	4	Костюм	45	6	concrete
EngRus	SList	Reader	131	6	Читатель	85	8	abstract
EngRus	SList	Writer	85	6	Писатель	85	8	abstract
EngRus	SList	Poem	28	4	Стихотворение	25	13	abstract
EngRus	SList	Chapter	212	7	Глава	212	5	abstract
EngRus	SList	Letter	171	6	Письмо	243	6	concrete
EngRus	SList	Descript	99	11	Описание	49	8	abstract
EngRus	F-List	Promise	74	7	Обещание	24	8	abstract
EngRus	F-List	Communication	133	13	Общение	68	7	abstract
EngRus	F-List	Exchange	100	8	Обмен	42	5	abstract
EngRus	F-List	Deceit	10	6	Обман	18	5	abstract
EngRus	F-List	Society	247	5	Общество	277	7	abstract
EngRus	F-List	Monkey	14	6	Обезьяна	16	8	concrete
EngRus	F-List	Dinner	37	6	Обед	59	4	concrete
EngRus	F-List	Sample	94	6	Образец	36	7	abstract
EngRus	F-List	Cloud	26	5	Облако	43	6	concrete
EngRus	F-List	Nature	166	6	Природа	131	7	concrete
EngRus	F-List	Acceptance	27	10	Принятие	43	8	abstract
EngRus	F-List	Profit	70	6	Прибыль	18	7	abstract
EngRus	F-List	Excuse	25	6	Причина	242	7	abstract
EngRus	F-List	Habit	34	5	Привычка	40	8	abstract
EngRus	F-List	Hairdo	10	6	Прическа	10	8	concrete
EngRus	F-List	Example	443	7	Пример	183	6	abstract
EngRus	F-List	Income	139	6	Доход	60	5	abstract
EngRus	F-List	Debt	56	4	Долг	82	4	abstract
EngRus	F-List	Kindness	10	8	Добро	10	5	abstract
EngRus	F-List	Trust	110	5	Доверие	41	7	abstract
EngRus	F-List	Road	167	4	Дорога	356	6	concrete
EngRus	F-List	Daughter	67	8	Дочь	112	4	concrete
EngRus	F-List	Rain	35	4	Дождь	77	5	concrete
EngRus	F-List	Boards	28	6	Доски	43	5	concrete
RusEng	Random	Туфли	15	5	Shoes	33	5	concrete
RusEng	Random	Мясо	47	4	Meat	32	4	concrete
RusEng	Random	Крыша	62	5	Roof	22	4	concrete
RusEng	Random	Повар	15	5	Cook	35	4	concrete
RusEng	Random	Платье	39	6	Dress	47	5	concrete
RusEng	Random	Собака	101	6	Dog	139	3	concrete
RusEng	Random	Еда	66	6	Food	270	4	concrete
RusEng	Random	Девочка	120	7	Girl	136	4	concrete
RusEng	Random	Дружба	37	6	Friendship	18	10	abstract
RusEng	Random	Память	135	6	Memory	94	6	abstract
RusEng	Random	Голос	357	5	Voice	118	7	abstract
RusEng	Random	Удача	36	5	Luck	26	4	abstract

RusEng	Random	Половина	126	8	Half	145	4	abstract
RusEng	Random	Лекарство	32	9	medicine	81	8	abstract
RusEng	Random	Речь	200	4	Speech	96	6	abstract
RusEng	Random	Свобода	162	7	Freedom	107	7	abstract
RusEng	Random	Напиток	24	7	Drink	77	5	concrete
RusEng	Random	Кухня	79	5	Kitchen	35	6	abstract
RusEng	Random	Ссора	15	5	Argument	114	8	abstract
RusEng	Random	Урок	60	4	Lesson	81	6	abstract
RusEng	Random	Перерыв	15	7	Break	174	5	abstract
RusEng	Random	Свадьба	33	7	Wedding	25	7	abstract
RusEng	Random	Звук	118	4	Sound	183	5	abstract
RusEng	Random	Деревня	86	7	Village	79	7	abstract
RusEng	SList	Счастье	118	7	Happiness	20	9	abstract
RusEng	SList	Ненависть	35	9	Hatred	49	6	abstract
RusEng	SList	Удивление	50	9	Surprise	70	8	abstract
RusEng	SList	Страх	133	5	fear	111	4	abstract
RusEng	SList	Чувство	205	7	feeling	86	8	abstract
RusEng	SList	Гордость	29	8	pride	21	5	abstract
RusEng	SList	Любовь	255	6	love	304	4	abstract
RusEng	SList	Рабочий	180	7	Worker	173	7	abstract
RusEng	SList	Учитель	102	7	Teacher	246	7	abstract
RusEng	SList	Адвокат	50	7	Solicitor	10	9	abstract
RusEng	SList	Ученый	121	6	Scientist	81	9	abstract
RusEng	SList	Водитель	63	8	Driver	62	6	concrete
RusEng	SList	Медсестра	15	8	Nurse	45	5	abstract
RusEng	SList	Погода	55	6	Weather	60	7	abstract
RusEng	SList	Воздух	156	6	Air	201	3	abstract
RusEng	SList	Туман	40	5	Fog	10	3	concrete
RusEng	SList	Снег	89	4	Snow	32	4	concrete
RusEng	SList	Ветер	119	5	Wind	86	4	concrete
RusEng	SList	Мороз	40	5	Frost	10	5	abstract
RusEng	SList	Лёд	45	3	Ice	43	3	concrete
RusEng	SList	Дым	44	3	Smoke	33	5	concrete
RusEng	SList	Гром	18	4	Thunder	10	7	concrete
RusEng	SList	Молния	21	6	Lightning	12	9	concrete
RusEng	SList	Огонь	128	5	Fire	175	4	concrete
RusEng	F-List	Голова	561	6	Head	241	4	concrete
RusEng	F-List	Здоровье	105	8	Health	443	6	abstract
RusEng	F-List	Ад	10	2	Hell	39	4	abstract
RusEng	F-List	Привет	40	6	Hello	16	5	abstract
RusEng	F-List	Вертолёт	27	8	Helicopter	13	10	concrete
RusEng	F-List	Небеса	24	6	Heaven	30	6	abstract
RusEng	F-List	Ёж	10	2	Hedgehog	10	8	concrete

RusEng	F-List	Шлем	10	4	Helmet	10	6	concrete
RusEng	F-List	Задержка	10	8	Delay	54	5	abstract
RusEng	F-List	Доставка	22	7	Delivery	67	8	abstract
RusEng	F-List	Решение	334	7	Decision	240	8	abstract
RusEng	F-List	Оборона	57	7	Defence	34	7	abstract
RusEng	F-List	Декабрь	91	7	December	142	8	abstract
RusEng	F-List	Степень	111	7	Degree	152	6	abstract
RusEng	F-List	Отдел	78	5	Department	255	10	abstract
RusEng	F-List	Смерть	265	6	Death	188	5	abstract
RusEng	F-List	Глубина	72	7	Depth	35	5	abstract
RusEng	F-List	Пустыня	19	7	Desert	24	6	concrete
RusEng	F-List	Колокол	10	7	Bell	31	4	concrete
RusEng	F-List	Ремень	21	6	Belt	21	4	concrete
RusEng	F-List	Скамья	16	6	Bench	10	5	concrete
RusEng	F-List	Кровать	67	7	Bed	72	3	concrete
RusEng	F-List	Спальня	25	7	Bedroom	35	7	abstract
RusEng	F-List	Верующий	10	8	Believer	13	8	abstract