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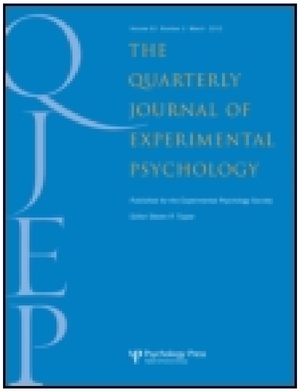

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Semantic size does *not* matter: “Bigger” words are not recognized faster

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Rapid communication

Semantic size does *not* matter: "Bigger" words are not recognized faster

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Sereno, O'Donnell, and Sereno (2009) reported that words are recognized faster in a lexical decision task when their referents are physically large than when they are small, suggesting that "semantic size" might be an important variable that should be considered in visual word recognition research and modelling. We sought to replicate their size effect, but failed to find a significant latency advantage in lexical decision for "big" words (cf. "small" words), even though we used the same word stimuli as Sereno et al. and had almost three times as many subjects. We also examined existing data from visual word recognition megastudies (e.g., English Lexicon Project) and found that semantic size is not a significant predictor of lexical decision performance after controlling for the standard lexical variables. In summary, the null results from our lab experiment—despite a much larger subject sample size than Sereno et al.—converged with our analysis of megastudy lexical decision performance, leading us to conclude that semantic size does not matter for word recognition. Discussion focuses on why semantic size (unlike some other semantic variables) is unlikely to play a role in lexical decision.

Keywords: Lexical decision task; Visual word recognition; Semantic size.

Sereno, O'Donnell, and Sereno (2009) reported that words that refer to large objects (e.g., *cathedral*) were recognized faster in a lexical decision task (LDT) than words that refer to small objects (e.g., *cigarette*). Their results suggest that when a subject is deciding whether or not a letter string is a real word, there is obligatory access to the semantic size of the word (i.e., the size of the word's referent) and that a larger semantic size facilitates processing of the word, resulting in quicker responding. The authors speculate that this *semantic size effect* may be related to the faster speed with which one can access the visual representation of a large (cf. small) object.

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However, the a priori theoretical reasons offered by Sereno et al. (2009) for expecting larger semantic size to facilitate visual word recognition (e.g., bigness is the unmarked or dominant form in the English language; larger objects attract more attention; a larger size often confers a reproductive advantage) seem equivocal. One could easily point to studies that would suggest the opposite prediction. For instance, in a property verification task (e.g., Is *face* a property of *gorilla*?), it has been shown that the larger the semantic size of the property, the *slower* it takes to respond (Solomon & Barsalou, 2004). Nonetheless, Sereno et al.'s findings are intriguing and appear to be congruent with the broader idea of embodied cognition—that is, the notion that our lexical representations are not amodal, but are instead grounded in the environment, situations, the body, and simulations in the brain's modal systems (e.g., Barsalou, 1999). In addition, the findings introduce an important new semantic variable that informs and constrains theories and models of word recognition (Balota, Ferraro, & Connor, 1991).

Given the ramifications of Sereno et al.'s (2009) results for both theories of grounded cognition and visual word recognition, the aim of the present study was to definitively establish whether semantic size has a robust effect on lexical decision performance. We used a two-pronged approach: (a) a behavioural experiment modelled after Sereno et al., and (b) analyses of megastudy lexical decision data. To preview, we conclusively failed to replicate Sereno et al.'s results, and data from two independent megastudies provided no evidence that semantic size affects lexical decision. In our general discussion, we offer an explanation as to why semantic size (in contrast to some other semantic variables) is unlikely to play a role in lexical decision.

BEHAVIOURAL EXPERIMENT

Method

Subjects

Eighty undergraduates from the University of California, San Diego, Psychology Subject Pool participated in exchange for course credit. All subjects were native speakers of English with normal or corrected-to-normal vision.

Stimuli

Ninety words and 90 pseudowords (pronounceable nonwords) were selected as items for the LDT. The words were identical to those used in Sereno et al. (2009) and consisted of 45 "big" (e.g., *jungle*) and 45 "small" (e.g., *needle*) words. The criterion used to designate a word as "big" or "small" depended on whether the referent was larger or smaller than a human body. Overall, the "big" and "small" words were matched on length, frequency (SUBTL-CD; Brysbaert & New, 2009), number of syllables, concreteness (Nelson, McEvoy, & Schreiber, 2004), and orthographic neighbourhood density (Coltheart, Davelaar, Jonasson, & Besner, 1977).[1] The nonwords were selected from the English Lexicon Project (ELP; Balota et al., 2007) such that they matched the words in terms of number of letters, number of syllables, and orthographic neighbourhood density. Descriptive statistics for word and nonword characteristics are listed in Table 1.

Procedure

Subjects were tested in individual cubicles. They were informed that letter strings would appear one at a time on the computer screen, and their task was to decide whether or not each letter string formed a real word via a button press ("L" for word and "A" for nonword). They were

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[1] Boris New suggested we analyse the parts of speech (POS) for the Sereno et al. (2009) stimuli. For the "small" words, 27 were exclusively nouns, and 18 were associated with >1 POS. For the "big" words, 33 were exclusively nouns, and 12 were associated with >1 POS. We are not aware of any prior research on the effects of POS on the LDT. However, intuitively it seems that the number of POS a word is associated might be related to the number of senses a word evokes, and there is evidence that words with more senses are typically recognized faster in LDT (e.g., Yap, Tan, Pexman, & Hargreaves, in press). To rule out this potential confound, we obtained the number of senses for the "big" and "small" words, using Miller's (1990) WordNet database, and found that number of senses did not differ significantly between the conditions, $p = .43$.

Table 1. *Lexical characteristics of items in the lexical decision experiment*

	n	*Length*	*Frequency (Log SUBTL-CD)*	*Concreteness*	*Orthographic neighbourhood size*	*No. of syllables*	*No. of morphemes*
"Small" words	45	6.20 (2.13)	2.47 (0.63)	6.06 (0.44)	3.00 (4.75)	1.98 (0.84)	1.22 (0.47)
"Big" words	45	6.20 (2.13)	2.46 (0.62)	5.95 (0.65)	4.53 (6.09)	1.98 (0.94)	1.27 (0.50)
p-value		*1.00*	*.96*	*.45*	*.19*	*1.00*	*.66*
Nonwords	90	6.20 (2.12)	—		3.56 (4.09)	1.84 (.83)	—

Note: Standard deviations in parentheses; word stimuli were taken from Sereno et al. (2009); statistics for concreteness were based on available ratings for 33 of the "small" and 35 of the "big" words; *p* values are from independent *t* tests comparing the "small" and "big" words.

instructed to respond as quickly as possible, but not at the expense of accuracy. The sequence of events for each trial was as follows: a blank screen for 1,000 ms, followed by a central fixation cross ("+") for 200 ms, another blank screen for 500 ms, and finally the letter string would appear and remain on the screen until the subject made his or her response. The presentation of the 90 words and 90 nonwords was randomly intermixed in a single block, with the order of items was randomized for each subject. To familiarize subjects with the task, they were given 20 practice trials (using a different set of 10 words and 10 nonwords) prior to the start of the experimental trials. After completing the experiment, subjects were debriefed and thanked for their participation.

Results and discussion

Prior to analysis, the data were first trimmed using the same criteria as those used by Sereno et al. (2009): Error responses (3.8% of trials) and responses that were <250 ms or >1,500 ms or more than 2 standard deviations below or above each subject's overall mean (an additional 6.3% of trials) were disregarded.[2] The α-level for all analyses was set at .05. Mean lexical decision latencies and error rates are listed in Table 2.

Although mean response latency for "big" words was numerically faster than that for "small" words, the difference was very small (5 ms) and was not statistically reliable at the level of subjects, $t(79) = 1.22$, $p > .20$, or at the level of items, $t(88) < 1$. Similarly, the mean error percentage for "big" and "small" words did not differ significantly at the level of subjects, $t(79) < 1$, or items, $t(88) < 1$.

In short, we failed to replicate Sereno et al.'s (2009) finding that "big" words were recognized faster than "small" words, despite using their word stimuli. It is unlikely that our failure to detect an effect was due to a lack of power—we had almost three times the number of subjects in Sereno et al.'s main experiment. Based on Sereno et al.'s reported Cohen's *d* of 0.32, the present experiment (with 80 subjects) had a power of .81 to detect an expected effect of that size.

ANALYSIS OF LEXICAL DECISION MEGASTUDY DATA

Factorial experiments, in which researchers manipulate a variable of interest (e.g., semantic size), while holding other factors constant, have been the mainstay of research in visual word recognition. More recently, however, an alternative, complementary approach has been advocated: the analysis of existing data from megastudies (Balota, Cortese, Sergent-Marshall, Spieler, & Yap, 2004). In a megastudy, subjects perform lexical decision (or some other word-processing task) on a very large set of words. In this approach, the language defines the stimuli, rather than an experimenter relying on a limited set of criteria. Analysing data

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[2] The results were the same when the data were untrimmed.

Table 2. *Mean lexical decision performance in the behavioural experiment*

	RT	*% Error*
"Small" words	654 (77)	2.19 (3.7)
"Big" words	649 (76)	2.51 (3.7)
Difference	5	−0.32

Note: RT = response latency in ms; standard deviations in parentheses.

Table 3. *English Lexicon Project lexical decision latencies for Sereno et al.'s (2009) word stimuli*

	Mean RT	*Mean z*[a]
"Small" words	649	−0.504
"Big" words	654	−0.468
Difference	−5	−0.036

Note: RT = response latency in ms.
[a] More negative *z* scores reflect faster latencies.

from megastudies offers noteworthy advantages over traditional factorial experiments: (a) One can investigate the effects of continuously (as opposed to categorically) defined variables in a large, unselected set of stimuli, (b) regression analyses can be used to better control for extraneous variables, and (c) it mitigates potential list context effects.

We analysed data from two independent megastudies to assess whether there was any evidence for an influence of semantic size on lexical decision performance. First, we looked at lexical decision latencies from the ELP (Balota et al., 2007) for the Sereno et al. (2009) word stimuli. Next, we examined lexical decision performance from two megastudies (ELP and Balota et al., 2004) for a substantially larger set of words.

ELP lexical decision latencies for Sereno et al. (2009) word stimuli

Table 3 lists the lexical decision latency means from the ELP for the "big" and "small" words used in Sereno et al. (2009). The results from this analysis replicate that of our behavioural experiment—that is, semantic size did not have a significant effect on lexical decision latency (and in fact the trend was in the opposite direction to what Sereno et al. found), *t*s < 1 for both raw response latencies and *z* scores. Of course, analyses of megastudy data for only a small set of items (as if the data were from an independent experiment) are susceptible to null results due to Type II error (Sibley, Kello, & Seidenberg, 2009). Therefore, it is important to examine data for a larger set of items.

Regression analysis of megastudy data for a larger set of words

To select a larger set of words, we referred to the Balota et al. (2004) megastudy of 2,428 monosyllabic words. We shortlisted 354 words that were concrete nouns and then obtained size ratings of the referents from 30 subjects (from the University of California, San Diego Psychology Subject Pool). Subjects were asked to rate the size of the referent using the same criterion as that of Sereno et al. (2009): Objects that were larger than the human body were to be classified as large, and those that were smaller than the human body were to be classified as small. Of the 354 words, 333 achieved high agreement (i.e., $\geq$70%) in size ratings, yielding 95 "big" and 238 "small" words. Lexical decision data from the ELP and the Balota et al. (2004) megastudy for these words were submitted to a hierarchical multiple regression analysis to determine whether semantic size exerts any influence after the standard variables are accounted for.

Table 4 summarizes the results of the regression analysis for 324 words that possessed values for the relevant predictors and dependent measures. We controlled for onset characteristics in Step 1, standard lexical variables (word frequency, familiarity, length, orthographic neighbourhood size, orthographic Levenshtein distance, feedforward and feedback onset, and rime consistency; see Balota et al., 2004; Brysbaert & New, 2009;[3] and Yarkoni, Balota, & Yap, 2008, for more information) in Step 2, and semantic variables (imageability, age of acquisition) in Step 3. The results of

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[3] We also ran the analyses with different word frequency norms—that is, Zeno, Ivens, Millard, and Duvvuri (1995)—and the main finding did not change: Semantic size did not predict LDT performance after controlling for the standard variables.

Table 4. *Results from regression analyses using lexical decision data from Balota et al. (2007) and Balota et al. (2004) megastudies*

		ELP lexical decision (Balota et al., 2007)		*Lexical decision (Balota et al., 2004)*	
	Predictor variable	*RT*	*Accuracy*	*RT*	*Accuracy*
Step 1: Onsets	Adjusted R^2	.02	.01	.01	.00
Step 2: Lexical variables	Adjusted R^2	.53	.31	.44	.25
Step 3: Semantic variables	Imageability	−.193**	.482***	−.280***	.551***
	Age of acquisition	.124†	.031	.159*	.130
	Adjusted R^2	.58	.45	.53	.39
Step 4	Semantic size	.003	.052	.022	.005
	Adjusted R^2	.58	.45	.53	.39

Note: ELP = English Lexicon Project. RT = response time. Regression coefficients are standardized βs.
$^\dagger p < .10$. $^* p < .05$. $^{**} p < .01$. $^{***} p < .001$.

the analyses are straightforward. Semantic size clearly fails to account for any unique variance in lexical decision performance after correlated lexical variables are controlled for.

GENERAL DISCUSSION

A new semantic variable—the size of a word's referent—was recently claimed to exert an effect on word processing. Sereno et al. (2009) reported data from two experiments demonstrating that words that referred to large objects received faster response latencies in a LDT than words that referred to relatively small objects. Due to the potential implications of this finding for theories of knowledge representation and visual word recognition, we sought to replicate their results and find additional evidence for the role of semantic size using existing megastudy data. Our behavioural replication of Sereno et al.'s experiments did not find a processing advantage of "big" over "small" words. Our analyses of existing data from two independent megastudies converged on the same finding that semantic size does not influence lexical decision performance.

One might ask why Sereno et al. (2009) found a significant effect of semantic size, in contrast to the present study, which did not. It is especially puzzling given that our behavioural experiment was closely modelled after Sereno et al.'s, in terms of the experiment parameters and the word stimuli used. Since the present experiment had a subject sample size that was almost three times that of Sereno et al., it is implausible that our experiment was underpowered. Perhaps a closer examination of the standard deviations reported in Table 2 of Sereno et al. can shed some light. The standard deviations of their lexical decision latencies were extremely small, which could explain why a 15-ms difference (between "big" and "small" words) was statistically significant with 28 subjects. In a supplementary experiment, they also managed to detect a 13-ms effect with only 14 subjects. The standard deviations in the present experiment are more consistent with those reported in other lexical decision studies. The overall response times (RTs; ~650 ms) in the present experiment were slower than in Sereno et al. (~520 ms), and one could perhaps argue that the slower processing speed might have masked the effect (even though it is usually the case that effects are magnified in slower subjects). To rule this out, we did a median split of our subjects based on mean RTs and ran an analysis of variance (ANOVA) with processing speed and semantic size as factors. There was neither a main effect of semantic size (as expected) nor an interaction between semantic size and processing speed.

Our failure to replicate Sereno et al. (2009) is buttressed by the results of our analyses of lexical decision data for a larger set of words from two separate megastudies. We found that semantic size did not predict lexical decision performance once other well-established variables in visual word recognition research had been accounted for. Aside from being able to examine a much larger set of items (increasing the generalizability of the results), another benefit of megastudies (cf. factorial experiments) is that one does not need to select a small set of stimuli that, except for the variable of interest, is controlled on all other relevant variables (something that is very hard to achieve; Cutler, 1981). For instance, the "big" and "small" words used by Sereno et al. may have been equated on several important dimensions (i.e., any difference did not reach statistical significance), but as can be seen in Table 1, there was a trend for the "big" words to have more orthographic neighbours than the "small" words. Hence, faster responses for "big" words may simply reflect the facilitative influence of denser neighbourhoods (see Andrews, 1997).

To be clear, we are not arguing that semantic size has no impact on all cognitive tasks. There is ample evidence that semantic size affects response latencies on tasks that explicitly require semantic judgements (e.g., Rubinsten & Henik, 2002; Solomon & Barsalou, 2004). Nor are we claiming that semantic variables have no effect on word processing. For example, word properties such as imageability, age of acquisition, semantic richness (Pexman, Hargreaves, Siakaluk, Bodner, & Pope, 2008; Yap et al., in press) robustly benefit word recognition performance, even after correlated variables are controlled for (see Balota et al., 1991, for a review). Other semantic factors that have been shown to exert an influence include the consistency of mapping between semantics and orthography/phonology (i.e., whether a particular meaning can be represented by only a single word or multiple synonyms; Pecher, 2001) and the degree of sensory and perceptual experience a word evokes (Juhasz, Taylor, & Gullick, 2008).

Why do some semantic factors (e.g., imageability) play a role and others (e.g., semantic size) not? Broadly speaking, meaning-level influences could emerge as a result of semantics → orthography feedback (Balota et al., 1991) or semantics → phonology feedback (Siakaluk, Pexman, Aguilera, Owen, & Sears, 2008) from highly activated semantic representations. However, semantic effects are also modulated by the specific demands of the task. In lexical decision, one goal of the lexical processing system is to attend to evidence that is useful for discriminating between words and nonwords. Therefore, the critical determinant is whether the variable in question helps distinguish a word from a nonword. Within this framework, the facilitative effects of imageability or degree of sensory experience are entirely expected: Any activation of an image or sensory experience upon processing of a letter string is useful evidence that the letter string is likely to be a word. Semantic size, on the other hand, would not appear to be a useful dimension on which to distinguish words from nonwords—since both "big" and "small" words have the same degree of "wordness"—and therefore should not be expected to influence lexical decision performance. In other words, the size of a word's referent is not diagnostic of its status as a word.

In case anyone might be tempted to interpret the null findings as evidence against theories of grounded cognition, we would like to emphasize that such a conclusion is unwarranted. Indeed, a rapidly growing body of research has demonstrated that sensory-motor variables do exert influence over a diverse range of cognitive tasks (for a review, see Barsalou, 2008), providing evidence that our cognitive systems are subserved by multimodal representations that are common to perception, action, and introspection. However, in a LDT, we failed to find any evidence that the size of a word's referent reliably affects performance. In conclusion, semantic size does not matter for lexical decision, and this finding is consistent with how semantic dimensions may be selectively and adaptively modulated by the specific demands of the task.

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REFERENCES

Andrews, S. (1997). The effect of orthographic similarity on lexical retrieval: Resolving neighborhood conflicts. *Psychonomic Bulletin & Review*, *4,* 439–461.

Balota, D. A., Cortese, M. J., Sergent-Marshall, S., Spieler, D. H., & Yap, M. J. (2004). Visual word recognition of single syllable words. *Journal of Experimental Psychology: General*, *133,* 336–345.

Balota, D. A., Ferraro, R. F., & Connor, L. T. (1991). On the early influence of meaning in word recognition: A review of the literature. In P.J. Schwanenflugel (Ed.), *The psychology of word meanings* (pp. 187–222). Hillsdale, NJ: Lawrence Erlbaum Associates.

Balota, D. A., Yap, M. J., Cortese, M. J., Hutchison, K. A., Kessler, B., Loftis, B., et al. (2007). The English Lexicon Project. *Behavior Research Methods*, *39,* 445–459.

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences*, *22,* 577–660.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, *59,* 617–645.

Brysbaert, M., & New, B. (2009). Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods*, *41,* 977–990.

Coltheart, M., Davelaar, E., Jonasson, J. T., & Besner, D. (1977). Access to the internal lexicon. In S. Dornic (Ed.), *Attention and Performance VI* (pp. 535–555). New York, NY: Academic Press.

Cutler, A. (1981). Making up materials is a confounded nuisance, or: Will we be able to run any psycholinguistic experiments at all in 1990? *Cognition*, *10,* 65–70.

Juhasz, B. J., Taylor, S., & Gullick, M. M. (2008, November). *Sensory experience ratings: A new word recognition variable*, Poster presented at the 49th Annual Meeting of the Psychonomic Society, Chicago, IL.

Miller, G. A. (1990). WordNet: An on-line lexical database. *International Journal of Lexicography*, *3,* 235–312.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (2004). The University of South Florida free association, rhyme, and word fragment norms. *Behavior Research Methods*, *36,* 402–407.

Pecher, D. (2001). Perception is a two-way junction: Feedback semantics in word recognition. *Psychonomic Bulletin & Review*, *8,* 545–551.

Pexman, P. M., Hargreaves, I. S., Siakaluk, P., Bodner, G., & Pope, J. (2008). There are many ways to be rich: Effects of three measures of semantic richness on word recognition. *Psychonomic Bulletin and Review*, *15,* 161–167.

Rubinsten, O., & Henik, A. (2002). Is an ant larger than a lion? *Acta Psychologica*, *111,* 141–154.

Sereno, S. C., O'Donnell, P. J., & Sereno, M. E. (2009). Size matters: Bigger is faster. *The Quarterly Journal of Experimental Psychology*, *62,* 1115–1122.

Siakaluk, P. D., Pexman, P. M., Aguilera, L., Owen, W. J., & Sears, C. R. (2008). Evidence for the activation of sensorimotor information during visual word recognition: The body-object interaction effect. *Cognition*, *106,* 433–443.

Sibley, D. E., Kello, C. T., & Seidenberg, M. S. (2009). Error, error everywhere: A look at megastudies of word reading. In N. Taatgen & H. van Rijn (Eds.), *Proceedings of the 2009 Meeting of the Cognitive Science Society* (pp. 1036–1041). Austin, TX: Cognitive Science Society.

Solomon, K. O., & Barsalou, L. W. (2004). Perceptual simulation in property verification. *Memory & Cognition*, *32,* 244–259.

Yap, M. J., Tan, S. E., Pexman, P. M., & Hargreaves, I. S. (in press). Is more always better? Effects of semantic richness on lexical decision, speeded pronunciation, and semantic classification. *Psychonomic Bulletin & Review*.

Yarkoni, T., Balota, D. A., & Yap, M. J. (2008). Beyond Coltheart's *N*: A new measure of orthographic similarity. *Psychonomic Bulletin & Review*, *15,* 971–979.

Zeno, S. M., Ivens, S. H., Millard, R. T., & Duvvuri, R. (1995). *The educator's word frequency guide*. Brewster, NY: Touchstone Applied Science.