Semantic influences on morphological facilitation: Concreteness and family size

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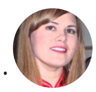

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Semantic Influences on Morphological Facilitation:

Concreteness and Family Size

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We examined the influence of two semantic variables, concreteness and morphological family size in a single word and a primed lexical decision task where related primes shared a base morpheme. The effect of concreteness emerged only in small morphological families. Stated alternatively, single word recognition latencies were faster for concrete relative to abstract targets only when morphological family size was small. In a priming task, the magnitude of morphological facilitation for primes related by inflection was greater than by derivation although both revealed a very similar interaction of concreteness and family size. Moreover, while small family concrete targets appeared to undergo greater facilitation from a morphologically related prime than did small family abstract targets or large family concrete targets, the differences for derivationally related pairs appeared to originate with anomalies in the unrelated baseline condition. In summary, concreteness influenced morphological processing so as to produce slower decision latencies for small family abstract words both in a single word and in a morphologically primed context. However, magnitudes of facilitation in isolation from baselines provided an incomplete account of morphological processing.

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1 Introduction.

Meanings of words can be related along a variety of criteria many of which have been investigated in experimental tasks of reading. Perhaps most studied is semantic association, the degree to which words co-occur in text or elicit one another in a free association task (for a review see Neely, 1991). Some words have more semantic associates than do others and therefore differ in their semantic richness (Nelson, McEnvoy & Schreiber, 1998). A second semantic variable, more frequently examined in the domain of disordered reading than in normal word recognition is concreteness, or the potential to imagine the meaning of a word (Bleasdale, 1987; Collins & Coney, 1998; de Groot, 1989; James, 1975; Kroll & Merves, 1986; Schwanenflugel, Akin, & Luh, 1992; Strain, Patterson, & Seidenberg, 1995; 2002; Tyler, Moss, Galpin, & Voice, 2002). Finally, there is the similarity that tends to arise when two words are formed from the same base morpheme so that they are morphologically related (for reviews on Spanish, German and English data see Domínguez, Cuetos, & Segui (2000); Dohmes, Zwitserlood & Bolte, 2004; Baayen, Feldman, & Schreuder, R. (submitted) and Feldman (2000), respectively).

One morphological property that has emerged as an important factor in word recognition is family size (Schreuder and Baayen 1997). A morphological family consists of the derived and compound words formed from a base morpheme. A facilitatory effect of large family size has been documented in a range of languages (Baayen, Dijkstra, & Schreuder, 1997; Ford, Marslen-Wilson, & Davis, 2003; Ludeling, & De Jong, 2002; Moscoso del Prado Martıín, 2003; Moscoso del Prado Martıín, Bertram, Haikio, Schreuder, & Baayen, in press). Evidence that family size effects are grounded in semantics derives in part from correlations between decision latencies and family size as they tend to strengthen when word forms that share the letter string but are devoid of semantic similarity are eliminated from the family size count (DeJong, Schreuder & Baayen 2000; Moscoso del Prado Mart ´ın, Kosti ´c, and Baayen, 2004). From our perspective, family size reflects the manner in which morphological regularities structure the mappings between form and meaning: The presence of a morpheme shared by members of a morphological family determines the relation between form and meaning producing greater systematicity as family size increases. A stronger mapping allows for the more rapid activation of a word's meaning, and hence faster responses in word recognition tasks. One implication is that when effects of family size are weak and the mapping is less systematic, the contribution of other semantic variables that influence word recognition can be more salient.

Within a morphological family, individual family members may vary in semantic transparency, the extent to which their meaning is related to the meaning of the base morpheme from which they are formed. For example, the meaning of *allow* is more transparent in the meaning of *allowable* than in the meaning of *allowance*. In recent years, the effect of semantic transparency on morphological facilitation has been a focus of interest (Feldman & Pastizzo, 2003; Feldman & Soltano, 1999; Feldman, Soltano, Pastizzo, & Francis, 2004). In large part, meaning similarity among morphological relatives is a function of semantic transparency, the degree to which words composed from a common base morpheme (e.g. *allow*) retain the meaning of the base despite differing affixes (e.g. *allowance* and *allowabl*e). In addition to semantic transparency, the extent to which base morphemes contribute to the meaning of their morphological relatives, and morphological family size, the number of different words formed from a base morpheme, words also vary with respect to concreteness. Although all are semantic variables, transparency appears to differ from the others with respect to grain size, whole word as contrasted with base morpheme. The goal of the current set of experiments was to probe the interaction of two semantic properties, family size and concreteness. We investigated semantic aspects of morphological processing with a focus on single word recognition and on patterns of morphological facilitation in the lexical decision task.

1.1 Concreteness effects

Results have demonstrated repeatedly that people take longer to respond to abstract words than to concrete words in lexical decision and pronunciation tasks (Bleasdale, 1987; de Groot, 1989; James, 1975; Kroll & Merves, 1987; Strain et al., 1995). It has been suggested that the difference between these word types arises because concrete words are easier to image than abstract words or because they benefit from both sensory and motor properties (Paivio, 1991). However, demonstration of a concreteness effect can depend on subtle manipulations such as presentation order. For example, Kroll and Merves (1987) reported that responses to abstract words were significantly longer than those to concrete words when abstract blocks followed concrete blocks in an unprimed lexical decision task, whereas the reverse order of presentation (i.e., concrete blocks appearing after abstract blocks) produced no difference between the two word types.

It also has been suggested that a word's context availability plays a role in the different processing that has been observed for the two word types (Schwanenflugel et al., 1992). Support derives from evidence that it is easier for individuals to generate an appropriate context for concrete than for abstract words (Schwanenflugel & Shoben, 1983). However, when additional contextual support (i.e., supplemental semantic information) is provided for abstract words, the differences between the two word types diminish (Schwanenflugel, Harnishfeger, & Stowe, 1988).

Concreteness effects have also been observed in tasks that require more explicit semantic processing. De Groot (1989) observed that individuals produced more associates to concrete words than to abstract words in a free association task. Therefore, it may be easier to access semantic information about concrete words, implying that a difference in semantic richness may characterize the two word types.

High-imageability words, which include almost all concrete words, can produce a phonological advantage as well. Strain, Patterson, and Seidenberg (1995, 2002) observed an interaction between spelling-sound typicality and word imageability when participants performed an unprimed naming task. These studies revealed faster naming times for regular words (i.e., words where spelling and pronunciation corresponded) than for exception words (i.e., those words where the pronunciation was inconsistent with the spelling), as well as faster response times for high-imageability words than for low-imageability words. Of particular interest was that imageability significantly facilitated the processing of low-frequency exceptions words as compared to low frequency regular words. Other recent findings posit a negative correlation between age of acquisition and imageability. Nonetheless, the interaction between imageability and low frequency exception words remained when age of acquisition was partialled for, suggesting that age of acquisition cannot account for effects of imageability (Shibahara, Zorzi, Hill, Wydell, & Butterworth, 2003).

Although most of the studies that have contrasted concrete and abstract words have done so in unprimed single word recognition tasks, a limited number of studies have used primed paradigms to contrast the two word types. Bleasdale (1987) had participants pronounce concrete and abstract target words that were preceded by primes that either matched or mismatched on concreteness of the prime. The results revealed significant priming for both words types only when both the primes and targets were matched- either concrete or abstract. Tyler et al. (2002) examined concrete and abstract words in a cross-modal semantic priming task at three different prime durations. They observed significant semantic priming for both word types, and the magnitude of these effects did not change depending on the prime type or duration. The authors concluded that semantic information about concrete and abstract words is available very early in the course of speech recognition.

In brief, effects of concreteness and imageability have been observed in many studies, under unprimed but also under primed conditions across various tasks. Although this semantic effect appears to be reliable, some types of words (viz., low frequency irregular) are more amenable to manipulations of concreteness than are others (e.g. Strain et al., 1995; 2002).

1.2 Semantic Effects among Morphological Relatives

Interactions of morphological facilitation with semantic variables have been revealing about the underpinnings of morphological processing. In particular, they challenge a general account whereby morphemes are represented in a manner that is independent from semantics. From the perspective of models of classical word recognition, they challenge an account whereby lexical access is an all or nothing process that depends on lexical frequency and arguably word length and other orthographic variables but remains insensitive to semantic variables. Consistent with the emerging literature on graded effects due to semantic transparency (Feldman & Pastizzo, 2004; Feldman & Prostko, 2002; Feldman, et al., 2004), an interaction of morphological facilitation with the semantic variables of concreteness and family size would support a characterization of word recognition as a process that is sensitive to degree of similarity, encompassing dimensions of meaning as well as form (Feldman, Rueckl, Pastizzo, Diliberto, & Vellutino, 2002; Gonnerman & Seidenberg 2000; Pastizzo, 2003; Rueckl, Mikolinski, Raveh, Miner, & Mars, 1997).

Adding either an inflectional (e.g., *s, ed, ing*) or a derivational (e.g., *able, ance, ful, less*) affix to the base morpheme or stem forms a morphological relative of the stem. As a rule, inflections tend to preserve the word class of the base and to be more faithful to aspects of base meaning than are derivations (Anderson, 1982, 1992; Aronoff, 1994. 1976). Not surprisingly, with controls for form similarity, inflectionally related primes tend to produce greater facilitation than do derivationally related primes in lexical decision and in other word recognition tasks (Feldman, 1994; Raveh & Rueckl, 1999; Feldman & Prostko, 2001; Feldman & Raveh, 2003). Analogously, despite a shared morpheme and depending on the particular affix, derived morphological relatives tend to vary substantially in their semantic similarity to the target. Depending on the task, the magnitude of morphological facilitation among derivations can be sensitive to the degree of overlap in meaning between prime and target (Feldman & Pastizzo, 2004; Feldman et al. 2004). Importantly, as family size increases, morphological relatives that share meaning as well as form and words that share form with minimal semantic overlap tended to become progressively more distinct. In the same study, for partially transparent pairs (e.g., *allowance-allow*) the correlation between family size and facilitation tended to be negative indicating that targets from large families tend to show smaller partially transparent facilitation whereas targets from smaller families tend to show greater facilitation (Feldman & Pastizzo, 2004). In essence, while latencies are faster overall for base morphemes with a large morphological family, facilitation is more likely to arise when primes are partially transparent (e.g., *allowance-allow*) if morphological family is small. Effects of transparency that vary with family size suggests that the magnitude of facilitation depends on a property of the base morpheme shared by *all* family members and cannot be restricted to the degree of relatedness between a particular prime and target (see also Feldman & Soltano, 1999). Facilitation arises against a backdrop of activation; it encompasses a family of words that share form and meaning that includes, but is not limited to, prime and target.

Research that has examined both transparency and family size effects in priming tasks indicates that the locus of morphological facilitation cannot be confined to the overlapping meaning of a prime and its target and the current work is designed to expand on these findings. Consistent with earlier work, the goal of the present study was to probe how gradations in concreteness and family size between morphologically related primes and targets influence performance in a lexical decision task. The study contrasts with earlier work in English on semantic contributions to morphological processing (e.g., Feldman, Pastizzo & Janack, submitted; Feldman & Pastizzo, 2004; Feldman et al., 2004) because we manipulated the semantic variable of concreteness in conjunction with family size. Like semantic transparency, and unlike morphological family size, the grain size of concreteness extends to the whole word and cannot be restricted to the base morpheme alone.

Analogous with our earlier work using the lexical decision task, we looked for gradations in the magnitude of morphological facilitation as a function of family size although here we manipulated family size directly. Further, we asked whether a similar pattern arises for concrete and abstract targets. Concreteness is a semantic variable and our working assumption is that this property is inherited to varying degrees by all words formed from the base morpheme. Toward this end, we matched average semantic similarity between prime and target. Morphologically simple forms appeared as targets without primes in experiment 1. Simple forms (e.g., *harm*) appeared as targets after complex primes in experiment 2 at an SOA (stimulus onset asynchrony) of 250 ms (milliseconds). In experiment 2a primes were related by derivation (e.g., *harmless-harm*) and in experiment 2b they were related by inflection (e.g., *harmed-harm*).

2. Experiment 1

The goal in experiment 1 was to replicate within one experiment both faster decision latencies with increasing family size and faster decision latencies for concrete relative to abstract targets when effects of both semantic variables were manipulated factorially. Targets were morphologically simple words and across target type surface frequency and word length were matched.

2.1 Participants. A total of 40 undergraduate students from the University at Albany, State University of New York, participated in experiment 1 in partial fulfillment of introductory psychology course requirements. Participants were monolingual in English with normal or corrected-to-normal vision and they had no known reading disorders.

2.2 Materials. Targets came from large (mean = 17.6, SD = 9.1; mean = 16.9, SD = 8.1) or small (mean = 4.9, SD = 29; mean = 5.2 SD = 2.1) families. In addition, targets were also either concrete (mean = 566.1, SD = 34.1) or abstract (mean = 383.7, SD = 75.8) based on the Paivio (1998), Coltheart (1981) and Gilhooly and Logie (1980) norms. Accordingly there were four types of items: large family/abstract, large family/concrete, small family/abstract, and small family/concrete with 18 items in each. Concrete and abstract items differed on the concreteness measure. A higher number on this measure indicates a more concrete item. Across types, targets were matched for family frequency, surface frequency, base frequency (includes inflections), and letter-length (see Table 1). All targets were selected to be phonologically regular (no homophones or homographs). Abstract large and small family sets did not differ on the measure of concreteness, nor did concrete large and small family items. (see Table 1). Seventy-two simple nonwords were also created and were matched on length to the word targets.

Insert Table 1 about here.

2.3 Design. All participants were randomly assigned to one list. Both concreteness (abstract/ concrete) and family size (small/large) were manipulated within participants but between items.

2.4 Procedure. Items were presented in a different random order for each participant using PsyScope experimental software on a Power Macintosh 7300/200 computer. All stimuli were left justified in the center of the screen and were presented in black lowercase 18 point Courier font on a white screen. Each experimental trial began with a fixation (+) for 450 milliseconds (ms) and then a blank screen for 50 ms. Immediately afterwards, the target appeared and remained on the screen for 3000 ms or until the participant responded. The intertrial interval was 1000 ms. Participants were instructed to decide whether or not the target was a correctly spelled English word. They indicated their lexical decision for each target on a PsyScope button box by pressing the right button (green) for words and the left button (red) for nonwords. Response latencies were measured from the onset of the target until button press or until a time-out (3000 ms).

3. Results.

Simple targets. With controls for frequency and letter length, concrete targets tended to produce faster decision latencies than did abstract targets. With controls for surface frequency and for cumulative frequency based on all morphological relatives formed form the base, targets from large families tended to produce faster decision latencies than targets from smaller families. Results are summarized in Table 2.

Insert Table 2 about here.

Results of an analysis of variance (ANOVA) on the decision latency data supported this pattern. Reaction times more extreme than 3 SD from the subjects or items mean (1.9 % and 1.8 % respectively) were treated as errors. The main effects of concreteness: [F_1 (1,24) = 11.75, $p = 0.002$; F_2 (1,68) = 5.77, $p = 0.02$] and of family size were significant [F_1 (1,24) = 7.42, $p = 0.01$, F_2 (1,68) = 5.65, $p = 0.02$]. In addition, the interaction of family size and concreteness was significant [F_1 (1,24) = 6.10, $p = 0.02$; F_2 (1,68) = 3.30, p 0.07]. With the accuracy measure, there were no significant main effects of family size or concreteness (all $F_s < 1$). Also, the interaction between family size and concreteness was not significant ($F_s < 1$).

Planned comparisons confirmed that decision latencies for targets from small and large families differed [F_1 (1,24) = 11.49, $p = 0.002$; F_2 (1,68) = 8.80, $p = 0.004$] when they had abstract meanings (605 vs. 573) but that there was no effect of family size ($F_s < 1$) when target meanings were concrete (571 vs. 572). Stated alternatively, abstract and concrete target latencies differed when they had small families while latencies for targets from large families showed no effect of concreteness.

4. Discussion.

When targets were morphologically simple, we replicated within one experiment both the effect of family size and the effect of concreteness and determined in fact that concreteness effects emerged only in small families. Most relevant to the focus of the present study was this interaction. Recognition latencies were faster for targets from large relative to small families only when targets were relatively abstract. In essence, abstract targets with small families were slowed relative to concrete targets of the same family size and surface frequency as well as relative to abstract targets with large families. Because both family size and concreteness capture aspects of word meaning, we interpret our findings as demonstrating semantic influences on single word recognition.

Crucially, the effects of concreteness and family size appear to modulate recognition latencies in a manner that cannot be predicted by summing their independent contributions. It was the conjunction of small family size and attenuated concreteness that produced slowed decision latencies.

5. Experiment 2 a and b.

In single word recognition, latencies tended to be faster for words whose meanings were concrete relative to those that are abstract and faster for words from large families than from small. Both concreteness and family size entail semantic analysis. Morphological family size encompasses a *cluster* of words that share a base morpheme with the target and typically base morphemes are units of meaning as well as of form. Family size influences decision latencies for morphologically complex as well as simple words not only when words appear in isolation (Baayen, et al. 1997; Baayen, & Schreuder, 1997; Bertram, Laine, Baayen, Schreuder, and Hyona, 1999; Ford et al. 2003; Ludeling, & De Jong, 2002; Moscoso del Prado Martıín, 2003; Moscoso del Prado Martıín, et al, in press). Effects on the magnitude of facilitation also have been documented with correlational analyses (Feldman & Pastizzo, 2003: Feldman et al., 2004).

Magnitudes of morphological facilitation also tend to be sensitive to the type of morphological relation so that inflectionally related primes (e.g., *harmed-harm*) tend to produce greater facilitation than do derivationally related primes (e.g., *harmless-harm*) when prime and target appear in immediate succession (Feldman 1994; Feldman, Barac-Cikoja, Pastizzo & Kostic, 2002; Raveh, 2002; Raveh & Rueckl 1999). Similarly, the magnitude of morphological facilitation for derived primes (e.g., *allowance*) that are partially transparent with respect to their base morpheme (e.g., *allow*) is less than for transparent primes (e.g., *allowable*).

The addition of a derivational affix tends to alter the meaning of the base morpheme in a manner in which the addition of an inflectional affix tends not to. Therefore typically, prime-target pairs related by inflection tend to be semantically more similar than are pairs related by derivation. Stated in terms of transparency we know that all words formed by derivation from a base morpheme do not retain semantic transparency of base morpheme to the same degree. Compare for example, *competitive* and *compete* with *competent* and *compete* as evidence that semantic transparency is not uniform within a morphological family. Similarly, we cannot be certain that all derivationally related word forms and all senses of each form inherit the concreteness or abstractness of a base morpheme uniformly. For example *swim* is abstract but *swimmer* seems relatively concrete; by contrast *dog* and *doghouse* are concrete but *dogged* seems relatively more abstract.

Depending on the affix or the particular stem-affix combination, morphological relatives of the stem may, but may not, be faithful to the semantics of the stem. Likewise the extent to which different morphological relatives formed from the base morpheme are faithful to its concreteness is likely to vary. Accordingly, types of prime-target pairs were matched on a measure of semantic similarity, Nonetheless, an interaction of concreteness and morphological facilitation with morphologically simple targets and derivationally related primes might still reflect the degree of similarity between targets and their particular morphologically related prime. An account of facilitation based on reduced prime-target similarity due to failures to inherit concreteness or any other aspect of semantics becomes less plausible if morphological facilitation interacts with concreteness *and* family size. In that case, it becomes unlikely that the concreteness-altering suffixes were restricted to targets of one (viz., large or small) family size. Crucially, suffixes that attenuate similarity becomes even less plausible as an account for differing magnitudes of facilitation if the pattern persists when affixes are changed. Accordingly, we examined the pattern of morphological facilitation and the interaction of concreteness and family size with morphological facilitation when primes were related by derivation and by inflection to the same set of targets.

5.1 **Participants.** We recruited 80 students from the University at Albany, State University of New York. Nineteen students were paid $5 for their participation and the remaining 61 students received partial course credit toward the research requirement in Introduction to Psychology. The eighty participants were divided into two groups so that forty participated in Experiment 2a where the morphologically related primes were derivational in relation to the target (250 SOA), and 40 participated in Experiment 2b, where primes were related by inflection to the target (250 SOA).

5.2 Materials. Eighty simple words were selected for targets. Almost all had been presented in experiment 1. Targets could be nouns or verbs and were divided into four types: (1) abstract - small family size, (2) concrete – small family size, (3) abstract – large family size, and (4) concrete – large family size. Each target (*harm*) was paired with two primes such that the morphological relation varied across experiments. In Experiment 2a primes were derivations of the target and in Experiment 2b primes were inflections of the target. For each target in each experiment there was (1) a suffixed morphological relative (*harmless or harmed*), and (2) a suffixed unrelated word with the same derived suffix or with an inflectional suffix (*needless* or *flowed*). Related and unrelated primes were matched for concreteness of the stem, suffix, surface frequency, base frequency, letter-length, suffix, and (when possible) number of syllables. Primes were also matched across target type for surface frequency, base frequency, and letter-length. Finally, we matched average semantic similarity between prime and target based on Latent Semantic Analysis

(LSA) values. This is a vector-based measure of semantics that captures the degree to which prime and target tend to appear in similar contexts (Landauer, Foltz, & Laham 1998).

To reduce the relatedness proportion to 33%, 40 filler simple targets (equally representative of the 4 target categories) were included and were paired with a derivationally suffixed unrelated prime that was matched in letter-length and surface frequency to critical primes. Additionally, filler targets were matched to critical targets for surface frequency, base frequency, and letter-length.

We created 120 nonword targets (*oint*) by removing the final syllable (which mimicked a derivational suffix, i.e., *ment*) from a multi-syllabic simplex form (*ointment*). Nonword targets were formed from words in the same frequency range as word targets. Eighty nonword targets were paired with two prime types: (1) form similar (*ointment*), and (2) form dissimilar (*flagrant*). Nonword primes were matched for surface frequency, letter-length, morphological complexity, and number of syllables. Both related and unrelated nonword prime types contained pseudo-suffixes. The remaining 40 nonword targets were always only paired with a form dissimilar prime that was dissimilar in form.

5.3 Design. We created two lists such that each target appeared once per list and across lists each target followed both prime types. Moreover, within a list each type of prime occurred equally often with each type of target, and target types appeared equally often. As a result of counterbalancing, each list contained 10 items in each of two priming conditions for each of the four target types. This required a total of 80 critical word targets. A set of 40 unrelated prime-target filler pairs recurred in both lists.

Nonword targets only appeared once per list but across lists, the 80 nonword targets followed both prime types. Another set of 40 nonword targets always followed the same unrelated prime (to mimic the filler word-word pairs). In a list, only 33% of the word-nonword pairs were similar in form. This represents the same relatedness proportion as for word-word pairs.

5.4 Procedure. Two hundred forty trials were presented in a different random order for each participant on a Power Macintosh 6100/60AV computer. A fixation "+" appeared in the center of the screen for 450 ms (milliseconds), and was immediately followed by a 50 ms blank. After a prime that appeared for 250 (Exp. 2) ms, the target word was presented and remained visible until participants responded or 3000 ms had elapsed. Trials were separated by an inter-trial interval of 1000 ms. All stimuli were left justified at the same location in the center of the screen. Stimuli were presented in black lowercase, 18 point Courier font on a white screen. There was no reaction time or accuracy feedback. Participants had a pause after the first 120 trials.

6. Results.

6.1 Experiment 2a. Overall, at a 250 ms SOA when morphological relatives were related by derivation, decision latencies were faster when stems recurred in prime and target than when they appeared only in the target. Although this is a replication of the classic effect of morphological facilitation, it is useful because related and unrelated primes were matched on frequency, length and morphological affix. In addition, with controls for frequency, concrete targets tended to produce faster decision latencies than did abstract targets. Finally with controls for surface frequency and for cumulative frequency based on all morphological relatives, targets from large families tended to produce faster decision latencies than targets from smaller families. Results are summarized in Table 3a.

Insert Tables 3 a and b about here.

Results of ANOVAs on the decision latency data supported this pattern. Reaction times more extreme than 3 SD from the subjects or items mean (1.7 % and 1.8 % respectively) were treated as errors. The main effect of morphological relatedness was significant [F_1 (1,83) = 117.86, $p < 0.0001$; F_2 (1,75) = 104.3, $p < 0.0001$] as were the main effects of concreteness [F_1 (1,83) = 31.62, $p < 0.0001$; F_2 (1,75) < 8.00, $p < 0.006$] and family size [F_1 (1,83) = 22.32, $p < 0.0001$; F_2 (1,75) = 6.07, $p < 0.02$]. The interaction of family size and concreteness was significant [F_1 (1,83) = 9.30, $p < 0.003$; F_2 (1,75) = 4.60, $p < 0.04$]. Most important, the interaction of relatedness by family size and concreteness was significant [F_1 (1,83) = 4.45, $p < 0.04$; F_2 (1,75) = 2.98, $p <$ 0.09]. Accordingly, targets from small concrete families produced greater facilitation than either concrete targets from large families or abstract targets from small families. With the accuracy measure, there was a significant effect of family size [F_1 (1,83) = 7.27, p = 0.009; F_2 (1,75) = 1.50, p = 0.2], a significant main effect of concreteness [F_1 (1,83) = 35.96, p = 0.0001; F_2 (1,75) = 5.99, p = 0.02] and a marginally significant family by concreteness interaction [F_1 (1,83) = 9.44, p = 0.003; F_2 (1,75) = 1.59. p = 0.2]. No other effects or interactions were significant.

Planned comparisons confirmed that facilitation was not uniform in magnitude across all targets. Facilitation tended to be greater when targets were concrete than when they were abstract (65 ms vs. 46 ms) as long as targets came from small families [F_1

(1,83) = 2.88, p = 0.09; F_2 (1,75) = 2.90, p = 0.09]. For targets from large families, facilitation did not vary significantly with concreteness. Moreover, the trend was in the opposite direction (53 ms vs. 39 ms). To summarize, at an SOA of 250 ms, in the primed lexical decision task the magnitude of facilitation for abstract small family targets such as *harm* (after *harmless* as compared to *needless*) was *less* than for concrete small family targets such as *lodge* (after *lodger* as compared with *rafter*). By contrast, facilitation was significant but did not vary in magnitude with concreteness when targets were from larger families.

6.2 Experiment 2b.

When morphological primes were related by inflection and the SOA was 250 ms, decision latencies were faster when stems recurred in prime and target than when they appeared only in the target. As with derived primes, morphological facilitation was greater for concrete than for abstract targets when targets came from small families but not when they came from large families (see Table 3b).

Results of an ANOVA on the decision latency data supported this pattern when reaction time outliers (1.6 % and 1.9%) and errors were treated as in the previous experiment. The main effect of relatedness was significant [F_1 (1,47) = 150.15, $p < 0.0001$; F_2 (1,68) = 264.79, $p < 0.0001$] and the main effect of family size was significant by participants [F_1 (1,47) = 5.77, $p < 0.02$; F_2 (1,68) = 2.02, $p < 0.2$]. The interaction of family size and concreteness was also significant by participants [F_1 (1,47) = 4.16, $p < 0.05$; F_2 (1,68) = 1.08, $p < 0.3$]. Similar to the pattern of morphological facilitation following derivations, the interaction of family size by concreteness and relatedness was (marginally) significant [F_1 (1,47) = 3.70, p = 0.06; F_2 (1,68) = 2.78, p = 0.09]. With the accuracy measure, only the effect of relatedness was significant. [F_1 (1,47) = 8.22, p = 0.006; F_2 (1,68) = 7.11, p = 0.01].

Planned comparisons replicated greater facilitation when targets were concrete than when they were abstract (90 ms vs. 58 ms) as long as targets came from small families [F_1 (1,47) = 8.37, p = 0.006; F_2 (1,68) = 3.45, p = 0.07]. By contrast, when targets came from large families, there was no suggestion that facilitation varied with concreteness (63 ms vs. 62 ms).

Most striking was the finding that related latencies as well as magnitudes of facilitation (unrelated minus related latencies) among derived and among inflected prime-target pairs was not uniform in magnitude despite careful matching of target frequency and other relevant properties. More specifically, latencies in the related condition to targets from small morphological families varied depending on the concreteness or abstractness of the target whereas latencies to targets from large families did not. Collectively, in the priming domain with controls for target frequency and across manipulations of the type of morphological relation (derivation vs. inflection) between prime and target, all targets did not benefit comparably from the prior presentation of a morphological relative. Targets with smaller morphological families were more vulnerable to effects of a second variable, specifically concreteness.

It is useful to point out that the benefit to targets that accrued from a morphologically related prime context cannot be understood by focusing on the magnitudes of facilitation alone. In the unprimed presentation conditions of Experiment 1, concrete small family targets that were morphologically simple in structure were comparable to both (abstract and concrete) large family target while it was latencies to small abstract targets that were slow. In experiment 2, related decision latencies showed a very similar pattern and yet difference scores computed relative to the unrelated baseline would lead one to conclude that it was abstract small family targets that seem to deviate.

It is well documented that magnitudes of semantic and morphological facilitation are sensitive to the degree of similarity between related primes and targets. Therefore one obvious possibility was that the interaction of concreteness, family size and relatedness that we observed might reflect disparities in the extent of semantic similarity between prime – target pairs. Thus, significant differences in the magnitude of facilitation across levels of concreteness and family size in Experiment 2a might reflect systematic variation in the degree of relatedness between the morphological relatives of the stem formed by derivation and the stem itself. For that reason, in Experiment 2b, we examined the pattern of latencies and magnitudes of morphological facilitation when relatives were related by inflection to the target. Overall, facilitation was numerically greater for inflections than for derivations- as one would expect given that prime target pairs related by inflection tend to be more semantically similar and than pairs related by derivation. When primes were related by inflection as well as by derivation, results revealed a very similar pattern of family size and abstractness, however. Stated generally, small abstract targets were slowest in the related condition. Greater differences between related and unrelated decision latencies (facilitation) for derived small morphological family targets was influenced by slower unrelated latencies for abstract than for concrete targets (648 ms vs. 625 ms) suggesting an anomaly. However, analogous inflected latencies differed only minimally (584 ms vs. 587 ms) and both experiments produced a similar pattern of facilitation.

7. General Discussion.

In the present study we contrasted two semantic variables whose grain size or locus differed and observed an interaction. Unlike morphological family size that, by definition, reflects the past productivity of the base morpheme, degree of concreteness is a semantic property of the whole. We examined unprimed and primed (morphologically related) decision latencies for targets that differed on the two dimensions. Interactions of morphological family size and concreteness provide new empirical evidence that morphological processing of a word is influenced by its semantic properties.

Morphological family size is a property of the base morpheme whose influence is fundamentally semantic. Effects of family size have been documented in single word recognition tasks in many languages. We are aware of no earlier published reports where factorial manipulations revealed differences in the magnitude of morphological facilitation as a function of morphological family size. To reiterate in the present study, overall facilitation was reduced for targets with large relative to small morphological families when targets were related by derivation. Effects were less reliable (evident in the analysis by participants only) when pairs were related by inflection. Latencies to targets with large morphological families tend to change less in the context of a related word form.

Concreteness is a property of the word that has been represented in multiple ways that include richness of semantic representations (Allport 1985: Breeding, Saffron, & Colette, 1994), autonomy from context (Schwanenflugel, Akin & Luh, 1992) or as capturing a link between sensory and motor properties in memory (Paivio 1991). In one way or another each of these accounts posit richer and more stable semantic representations for words with concrete referents and this benefits performance in single word recognition tasks. Concreteness values are available for morphologically simple words that served as our targets and the extent to which different morphologically complex relatives formed from the base morpheme are faithful to its semantics may vary. Therefore we used an LSA metric to match overall similarity of prime and target across combinations of family size and concreteness. Although effects of matched concreteness between prime and target have been documented previously in a priming task, to our knowledge, we are the first to report that effects of concreteness interact with morphological family size in a morphological priming task as well as in single word recognition. When targets were not primed, effects of concreteness were more salient for targets from small than from large morphological families.

Our unprimed as well as our primed findings suggest that word recognition is not accurately captured as all or none activation of a target. Effects are graded systematically even when lexical variables such as surface frequency and word length have been matched. Specifically, recognition seems to depend on the strength of the form-meaning relation where multiple instances as exist for targets from a large morphological family render the mapping more stable. Conversely, fewer instances render a target more amenable to influences of a short-term (prime) context. Results of the present study are consistent with the claim that patterns for smaller families tend to be weaker, to require more time to become stable and to benefit more from the introduction of a related prime. Target recognition can benefit more from a greater degree of relatedness with the prime. Nonetheless, even when frequency, length and degree of prime-target relatedness are matched, it is still the case that some targets have faster decision latencies than do others. We discuss semantic and morphological influences on unprimed and primed decision latencies and then on the magnitudes of facilitation (relative to the unprimed baseline) in turn.

For unprimed targets we have replicated in English the effect of morphological family size documented first in Dutch and later replicated in several other languages. Likewise, we have replicated the effect of concreteness for our small family targets. The restriction on concreteness effects that we observed has implications for other studies that have not universally replicated the effect (e.g., Kroll, & Merves, 1986). Stated most broadly, we observed effects of concreteness only for targets from small morphological families (and effects of family size were restricted to words that were low in concreteness). This pattern is consistent with other observations that semantic effects are more evident when recognition processes are prolonged. Seidenberg and his colleagues model such effects in terms of settling rate for form-meaning weights in a connectionist network (Strain et al., 1995). For example, in an English naming task, the dimension of concreteness was more salient for low frequency exception words whose latencies tend to be prolonged relative to regular words (Strain et al., 1995). Similarly, concreteness was more important for low frequency Japanese words written in Kanji so that the requisite character pronunciation was (phonemically underspecified or) inconsistent (Shibahara, Zorzi, Hill, Wydell & Butterworth, 2003). Like weak orthographic to phonological systematicity, weak form to meaning systematicity, as exists for small morphological families relative to large in the present study, allowed concreteness effects to be more prevalent.

The patterns of facilitation with derivationally and inflectionally related primes differed in overall magnitude but were strikingly similar in topology. For primed target words, the semantic similarity of a derivationally related prime to its base morpheme (e.g., *harmless harm*) tends to be less systematic than that of an inflectionally related prime (*harmed harm*). Accordingly, we replicated differences in the magnitude of facilitation as a function of type of morphological relation (Raveh 2002; Raveh & Rueckl 1999). Of more interest in the present study was the interaction of family size and concreteness after inflected as well as derived primes that we observed. Most obvious was that when targets were matched on relevant lexical variables, the decision latencies in the related condition were not uniform across regularly inflected target conditions. As when targets appeared in isolation, target decision latencies after derived and inflected morphological relatives were most deviant in the small abstract condition. In the presence of a morphological prime, as in isolation, decision latencies to abstract targets with small morphological families tend to be slowest.

Curiously, conclusions deviated somewhat when we focused on the magnitude of facilitation, the difference between related and unrelated decision latencies rather than on each alone. Unprimed decision latencies and latencies after morphologically related primes indicated that abstract targets with small morphological families were slowest to recognize whereas magnitudes of facilitation indicated that small concrete targets benefited most from the prior presentation of a morphologically related prime. When the magnitude of facilitation varies among derivationally related prime target pairs that are otherwise matched, typically differences are attributed to the degree of semantic relatedness between a particular prime and target. For this reason, correlational analyses of facilitation and its variation with family size often partial for the variability due to semantic relatedness between prime and target (Feldman et al., 2004; Feldman & Pastizzo 2004). We consider and dismiss three reasons why magnitudes of facilitation may have been greater for small concrete targets. The most obvious account would have been that targets in the critical cell were slower to recognize overall and then benefited disproportionally more from a related prime. Examination of unprimed cell means indicated that small abstract targets tended to be slowest to recognize yet they were not the type to produce the greatest facilitation. A second possibility was that prime target pairs in one particular condition happened to be more closely related than the pairs in the other three conditions. In our estimation, this account has little appeal as we observed a very similar pattern in experiments 2a and 2b; although targets were identical in each experiment, primes were related by derivation in the former but by inflection in the latter. Thus, different relatives of the target appeared in each experiment and yet the pattern of facilitation was the same.

In the semantic domain, Nelson, McEvoy, and Schreiber (1998) have examined the relation between decision latencies and semantic richness based on properties of the associates of a target as well as on the interconnection between those associates. Similar to the Nelson measure based on temporal co-occurrence, there are other measures that define semantic richness between words in terms of their tendency to appear in similar contexts. Measures of relatedness are based on statistical co-occurrence properties of words. The assumption is that pairs of words that words that appear in similar contests tend to be similar in meaning. Typically, they capture both semantic and grammatical information associated with a context (see Burgess & Lund, 1997). One co-occurrence measure is Semantic Neighborhood (SN). It reflects the semantic richness of a word and successfully predicts latencies in single word recognition tasks (e.g., Buchanan, Westbury, & Burgess 2001). A second metric is, LSA or Latent Semantic Analysis. LSA also predicts magnitudes of facilitation in a priming task (Analysis (Landauer, et al., 1998)). The average Latent Semantic Analysis co-occurrence indices (LSA) and standard deviations (SD) for (derived) prime-target pairs in experiment 2a were .37 (.23), .37 (.23), .34 (.23) and .33 (.24) for small abstract, small concrete, large abstract and large concrete target conditions respectively. By the LSA measure computed between prime and target, there was nothing unique about the interrelation of small concrete morphologically related primes with their targets. In essence, the degree of semantic similarity between prime and target did not differ across concreteness.

Evidently the semantic relatedness between a specific target and its prime is not adequate to predict magnitudes of facilitation. Therefore we considered properties of the ensemble of words that cluster to form a morphological family. We asked whether facilitation varied as a function of the semantic heterogeneity within the set of morphologically related words that formed the family. We emphasize that semantic heterogeneity within a morphological family is a measure distinct from prime-target relatedness because it encompasses words that are presented in an experiment (viz., prime and target) as well as words that are not (viz., other family members). In this respect we were seeking a semantic analog of orthographic neighborhood size (Coltheart, 1981). We applied the LSA co-occurrence metric to each pair of family members to develop a measure of semantic homogeneity between a base morpheme and *all* of its morphological relatives. Our hypothesis was that large and small families might be characterizable by differing degrees of co-occurrence between *all* combinations of morphologically related words. Toward this end, we computed the average LSA for each pair of morphologically related words within a morphological family. For example, for the target COAST, we included the LSA value for COAST-COASTAL .65; COAST-COASTER .05; COAST-COASTLINE .60, COAST-COAST GUARD .95; COASTAL-COAST GUARD .62 as well as the other combinations.

As summarized in Table 1, means (SD) for small versus large morphological family x low versus high concreteness ranged between .28 (.17) and .37 (.12).

Importantly, small families averaged numerically lower average LSAs than did larger families (.29 vs. .35) and the small abstract condition, which showed the slowest unprimed decision latencies, averaged the lowest average LSA. Interestingly, based on average LSA among members of a morphological family, it appears that morphological relatives that reside in a large family tend to behave more similarly (are more likely to appear in similar contexts) than do morphological relatives with a smaller family. (We proceed cautiously here because LSA values tend to be sensitive to frequency. Although we did match the average family frequencies as well as target surface frequencies.) In summary, the average LSAs within the family varied in a manner that was consistent with the unprimed decision latencies in experiment 1, and with related latencies in experiment 2. Average LSA within a morphological family did not provide a good account of the magnitude of morphological facilitation, however.

At this point, it appears that while the magnitude of morphological facilitation was greater for small concrete pairs than for other target types, differences cannot be attributed to the degree of relatedness between prime and target or to the overall semantic similarity between members of a morphological family. In addition, following Blaesdale (1987), unrelated primes were matched to related primes with respect to degree of concreteness so that a potential confound between prime concreteness and relatedness could not be responsible for differences in facilitation. Finally, if the magnitude of facilitation were greater for small concrete targets only when primes were related by derivation then we might attribute it to an anomaly in the unrelated baseline condition but there were suggestions of a similar pattern after inflected primes where there was no variation across concrete and abstract unrelated baselines. Collectively, we have documented that morphological and semantic dimensions of similarity interact, but further empirical work is necessary to determine why latencies and differences in latencies lead one to designate differing cells as deviant. Further, we have demonstrated is that in priming studies, magnitudes of facilitation in the absence of baseline latencies provide an incomplete account of processing.

In summary, a concreteness effect among morphological relatives was impossible to detect when family size was large but was easier to detect as family size decreased and latencies became more variable. Differences in decision latencies due to semantics, specifically concreteness, are consistent with an account of recognition based on the strength of form-meaning mappings. Because form-meaning mappings are less systematic in small families than in large they tend to take more time to reach a stable state of activation and are more influenced by a prime word context than are targets from larger families. Like the differing pattern of morphological facilitation after primes with partial as contrasted with more complete semantic transparency, effects of concreteness tend to be more characteristic of words with small than with large morphological families.

References

Anderson, Stephen R. 1982. 'Where's Morphology?' *Linguistic Inquiry* 13.571-612.

Anderson, Stephen R. 1992. *A-Morphous Morphology.* Cambridge: Cambridge University Press.

Aronoff, Mark 1976. *Word Formation in Generative Grammar.* Cambridge, MA: MIT Press.

Aronoff, Mark 1994. *Morphology by Itself.* Cambridge, MA: MIT Press.

Baayen, R. H., Piepenbrock, R. & Gulikers, L. (1995). The CELEX lexical database (CD-ROM). Philadelphia: Linguistic Data Consortium, University of Pennsylvania.

Baayen, R.H., Dijkstra, T., & Schreuder, R. (1997). Singulars and plurals in Dutch: Evidence for a parallel dual route model. *Journal of Memory and Language, 37,* 94-117.

Baayen, R. H., Feldman, L. B., and Schreuder, R. (submitted). Morphological influences on the processing of monosyllabic monomorphemic words.

Baayen, R. H., Tweedie, F. J. & Schreuder, R. (2002). The subjects as a simple random effect fallacy: Subject variability and morphological family effects in the mental lexicon, *Brain and Language 81,* 55–65.

Bertram, R., Laine, M., Baayen, R. H., Schreuder, R. and Hyona, J. (1999) Affixal homonymy triggers full-form storage even with inflected words, even in a morphologically rich language, Cognition 74, B13–B25.

Bleasdale, F.A. (1987). Concreteness dependent associative priming: Separate lexical organization for concrete and abstract words. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 582-594.

Buchanan, L., Westbury, C., & Burgess, C. (2001). Characterizing semantic space: Neighborhood effects in word recognition. *Psychonomic Bulletin & Review, 8*, 531-544.

Collins, M., & Coney, J. (1998). Interhemispheric communication is via direct connections. *Brain and Language, 64,* 28-52.

Coltheart, M. (1981). The MRC Psycholinguistic Database, Quarterly Journal of Experimental Psychology, 33A, 497-505.

De Groot, A.M.B. (1989). Representational aspects of word imageability and word frequency as assessed through word association. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 824-845.

Dohmes, P., Zwitserlood, P., & Bolte, J. (2004). The impact of semantic transparency of morphologically complex words on picture naming. *Brain and Language, 90,* 203-212.

Dominguez, A., Cuetos, F., & Segui, J. (2000). Morphological processing in word recognition: A review with particular reference to Spanish data. *Psicológica, 21,* 375-401.

de Jong, N. H., Schreuder, & Baayen, R. H. (2000). The morphological family size effect and morphology. *Language and Cognitive Processes, 15*, 329-365.

Feldman, L.B. (2000). Are morphological effects distinguishable from the effects of shared meaning and shared form? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 1431-1444.

Feldman, L. B. (1994). Beyond orthography and phonology: Differences between inflections and derivations. *Journal of Memory and Language, 33,* 442-470.

Feldman, L. B., Barac-Cikja, D., & Kostic, A. (2002). Semantic aspects of morphological processing: Transparency effects in Serbian. *Memory and Cognition, 30(*4), 629-636.

Feldman, L. B. & Pastizzo, M. J. (2003). Morphological facilitation: The role of semantic transparency and family size. In R. H. Baayen and R. Schreuder (Eds.). *Morphological Structure in Language Processing.* (pp. 233-258). Berlin, Germany: Mouton de Gruyter.

Feldman, L. B., Pastizzo, M. J. & Janack, T. (2004). Interactions of surface frequency and morphological family size in a morphological segmentation task typify the interdependence of whole word and sublexical processes. (ms submitted for review)

Feldman, L. B., & Prostko, B. (2001). Graded aspects of morphological processing: Task and processing time. *Brain and Language, 81,* 1-16. doi:10.1006/ brln.2001.2503

Feldman, L. B., and Raveh, M. (2003). When degree of semantic similarity influences morphological processing: cross language and cross task comparisons. In J. Shimron (ed.) *Language Processing and Language Acquisition in Languages with Root-based morphology.* (pp. 187-200). Amsterdam, The Netherlands: John Benjamins.

Feldman, L. B., Rueckl, J., Pastizzo, M. Diliberto, K., & Vellutino, F. (2002). Morphological analysis in beginning readers as revealed by the fragment completion task. *Psychological Bulletin and Review, 77*, 529-535.

Feldman, L.B., & Soltano, E.G. (1999). Morphological priming: The role of prime duration, semantic transparency, and affix position. *Brain and Language, 68*, 33-39.

Feldman, L. B., Soltano, E.G., Pastizzo, M., & Francis, S. E. (2004). What do graded effects of semantic transparency reveal about morphological processing? *Brain and Language, 90,* 17-30. doi:10.1016/S0093-X934(03)00416-4.

Ford, M., Marslen-Wilson, W. D. & Davis, M. H. (2003). Morphology and frequency: contrasting methodologies. In Baayen, R. H. & Schreuder R. (Eds) *Morphological Structure in Language Processing*. (pp. 89-124). Berlin, Germany: Mouton de Gruyter.

Hino, Y., Lupker, S.J., & Pexman, P.M. (2002). Ambiguity and synonymy effects in lexical decision, naming, and semantic categorization tasks: Interactions between orthography, phonology, and semantics. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 686-713.

James, C.T. (1975). The role of semantic information in lexical decisions. *Journal of Experimental Psychology: Human Perception and Performance, 104,* 130-136.

Kroll, J.F., & Merves, J.S. (1986). Lexical access for concrete and abstract words. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*, 92-107.

Landauer, T.K., Foltz, P.W., & Laham, D. (1998). Introduction to latent semantic analysis. *Discourse Processes, 25*, 259-284. http://lsa.colorado.edu/.

Lupker, S.J., & Pexman, P.M. (1999). Ambiguity and visual word recognition: Can feedback explain both homophone and polysemy effects? *Canadian Journal of Experimental Psychology, 53*, 323-334.

Meunier, F., & Segui, J. (1999). Morphological Priming Effect: The role of surface frequency. *Brain and Language, 68*, 54-60. brln.199. 2098.

Moscoso del Prado Martín, F., Bertram, R., Häikiö, T., Schreuder, R., & Baayen, R. H. (in press). Morphologically family size in a morphologically rich language: the case of Finnish compared to Dutch and Hebrew. *Journal of Experimental Psychology: Learning, Memory, and Cognition.*

Moscoso del Prado Martín, F., Kostić, A., and Baayen, R.H. (2004) Putting the bits together: An information theoretical perspective on morphological processing. Cognition 94, 1–18.

Neely, J. H. (1991). Semantic priming effects in visual word recognition: selective review of current findings and theories. In D. Besner & G. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 264-336). Hillsdale, NJ: Erlbaum.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). The University of South Florida word association, rhyme, and word fragment norms. http://www.usf.edu/FreeAssociation/.

Pastizzo, M. J., and Feldman, L. B. (2002). Does prime modality influence morphological processing? *Brain and Language, 81*. pp 28-41. doi: 10.1006/brln.2001.2504.

Raveh, M. (2002). The contribution of frequency and semantic similarity to morphological processing. *Brain and Language, 312-325.* Doi:10.1006/brln.2001.2527.

Rueckl, J.G., & Raveh, M. (1999). The influence of morphological regularities on the dynamics of a connectionist network. *Brain and Language, 68*, 110-117.

Rueckl, J.G., Mikolinski, M., Raveh, M., Miner, C.S., & Mars, F. (1997). Morphological priming, fragment completion, and connectionist networks. *Journal of Memory and Language, 36*, 382-405.

Seidenberg, M.S., & Gonnerman, L.M. (2000). Explaining derivational morphology as the convergence of codes. *Trends in Cognitive Science, 4*, 353-361.

Schreuder, R., & Baayen, R. H. (1997). How complex simplex words can be. *Journal of Memory and Language, 37*, 118-139.

Schwanenflugel, P.J., Akin, C.E., & Luh, W.M. (1992). Context availability and the recall of abstract and concrete words. *Memory and Cognition, 29,* 96-104.

Schwanenfluge, P.J., Harnishfeger, K.K., & Stowe, R.W. (1988). Context availability and lexical decisions for abstract and concrete words. *Journal of Memory and Language, 27,* 499-520.

Schwanenflugel, P.J., & Shoben, E.J. (1983). Differential context effects in the comprehension of abstract and concrete verbal materials. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 82-102.

Shibahara, N., Zorzi, M., Hill, M.P., Wydell, T., & Butterworth, B. (2003). Semantic effects in word naming: Evidence from English and Japanese Kanji. *Quarterly Journal of Experimental Psychology, 56A,* 262-286.

Strain, E., Patterson, K., & Seidenberg, M. S. (1995). Semantic effects in single word naming. *Journal of Experimental Psychology: Learning, Memory and Cognition, 21*, 1146-1154.

Strain, E., Patterson, K., & Seidenberg, M. S. (2002). Theories of word naming interact with spelling--sound consistency. *Journal of Experimental Psychology: Learning, Memory and Cognition, 28*, 207-214.

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Table 1. Properties of critical stimuli.

		Prime		
Small Family		Related	Unrelated	Target
Abstract		**harmless**	**needless**	**harm**
	Surface Frequency	4.8 (5.9)	3.5 (5.1)	28.0 (27.9)
	Letter-length	7.5 (1.7)	7.5 (1.6)	4.7 (1.1)
	Base Frequency			50.4 (55.2)
	Family Frequency			10.2 (6.9)
	Family Size			5.2 (2.1)
	Concreteness stem	360.8 (77)	433.7 (110)	360.8 (77)
	Family LSA			.28(.17)
Concrete		**lodger**	**rafter**	**lodge**
	Surface Frequency	5.3 (10.4)	3.6 (3.8)	25.2 (29.3)
	Letter-length	7.5 (1.7)	7.5 (1.6)	5.0 (1.0)
	Base Frequency			39.7 (41.6)
	Family Frequency			8.7 (13.6)
	Family Size			4.9 (2.0)
	Concreteness	555.7 (36)	510.5 (86)	555.7 (36)
	Family LSA			.31 (.16)
Large Family				
Abstract		**shameful**	**blissful**	**shame**
	Surface Frequency	3.3 (4.7)	3.7 (4.1)	30.8 (21.9)
	Letter-length	7.3 (1.6)	7.3 (1.5)	4.5 (0.9)
	Base Frequency			58.0 (39.9)
	Family Frequency			13.6 (12.1)
	Family Size			16.9 (8.1)
	Concreteness Stem	406.3 (70)	421.2 (102)	406.3 (70)
	Family LSA			.34 (.16)
Concrete		**stormy**	**faulty**	**storm**
	Surface Frequency	3.0 (4.8)	2.8 (3.9)	30.2 (22.2)
	Letter-length	7.1 (1.0)	7.1 (1.6)	4.6 (0.9)
	Base Frequency			45.3 (31.4)
	Family Frequency			9.2 (7.3)
	Family Size			17.6 (9.1)

Concreteness Stem	575.6 (29)	501.9 109)	575.6 (29)
Family LSA			.37 (.12)

Note. Properties of critical stimuli [frequency counts are based on CELEX lexical database, and are expressed per million; concreteness ratings were obtained from M. Coltheart (1981), The MRC Psycholinguistic Database, Quarterly Journal of Experimental Psychology, 33A, 497-505 (and are derived from Pavio, A., Yuille, J.C. and Madigan, S.A. (1968*). Concreteness, imagery and meaningfulness values for 925 words*. Journal of Experimental Psychology Monograph Supplement, 76 (3, part 2), and Gilhooly, K.J. and Logie, R.H. (1980). *Age of acquisition, imagery, concreteness, familiarity and ambiguity measures for 1944 words*. Behaviour Research Methods and Instrumentation, 12, 395-427.)]

Table 2. Decision latencies and accuracy (in parentheses) for unprimed targets (accuracy in parentheses).

Family	Concreteness	Simple
Small		harm
	Abstract	605 (98)
		lodge
	Concrete	571 (97)
Large		shame
	Abstract	573 (98)
		storm
	Concrete	572 (98)

Table 3a. Decision latencies and accuracy for targets as a function of derived prime at SOA 250 ms (accuracy in parentheses).

			Prime		
SOA	Family	Concreteness	Related	Unrelated	Facilitation
250der					
	Small		harmless	needless	
			harm	harm	
		Abstract	602 (95)	648 (95)	46* (0)
			lodger	rafter	
			lodge	lodge	
		Concrete	560 (99)	625 (98)	65* (1)
	Large		shameful	blissful	
			shame	shame	
		Abstract	565 (98)	619 (97)	53* (1)
			stormy	faulty	
			storm	storm	
		Concrete	569 (99)	608 (98)	39* (1)

Table 3b. Decision latencies and accuracy for targets as a function of inflected prime at SOA 250 ms (accuracy in parentheses).

			Prime		
SOA	Family	Concreteness	Related	Unrelated	Facilitation
250inf					
	Small		harmed	flowed	
			harm	harm	
		Abstract	526 (98)	584 (96)	58* (2)
			lodged	slimed	
			lodge	lodge	
		Concrete	497 (99)	587 (97)	90* (2)
	Large		shamed	braved	
			shame	shame	
		Abstract	504 (98)	566 (96)	62* (2)
			storming	charting	
			storm	storm	
		Concrete	508 (98)	571 (96)	63* (2)