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## FEATURE ARTICLE

# *Contexts That Pack a Punch: Lexical Class Priming of Picture Naming*

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Vol. 11, No. 1, February, 1997

# Contexts That Pack a Punch: Lexical Class Priming of Picture Naming

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## Abstract

This study examined the effect of semantically-impoverished, lexical-class predicting contexts on reaction times to name line drawings of objects and actions. Using the same sets of noun-predicting, neutral, and verb-predicting contexts, Liu (1996) found lexical class priming effects on both written and spoken word naming times. We extended this result to picture naming. The naming of objects was facilitated in noun-predicting contexts and inhibited in verb-predicting contexts, relative to naming times in neutral contexts. Similarly, the naming of actions was facilitated in verb-predicting contexts and marginally inhibited in noun-predicting contexts, relative to neutral. Although all three experiments (written word naming, spoken word naming, and picture naming) showed effects of syntactic primes, the exact pattern of results differed in each case. These differences suggest a complex interaction between modality and language context that no current model of lexical access adequately predicts.

## Introduction

On the surface, language is essentially just another perceptual stimulus. It may be an auditory stimulus -- the sound of someone pronouncing the word “punch”, for example. Or, it may be the visual features that make up a written word, a signed word, or a picture that represents a word. It may even be the tactile stimulus a blind individual receives when reading in Braille. What is amazing is that the language user is able to convert these perceptual stimuli -- in some cases, from any of three completely different modalities -- into a representation which can include semantic, syntactic, and morphological properties of the word, as well as access to the motor programs which would allow the individual to pronounce, sign, or write that word. How this process, which we will broadly define as “lexical access”, occurs remains one of the fundamental questions of psycholinguistics. One approach to answering this question has been to determine what kinds of stimuli and processes -- that is, what kinds of cognitive and linguistic contexts -- can affect lexical access.

The fact that languages contain words with multiple meanings is an argument for the importance of linguistic context in language processing. In isolation, a word like "punch" is ambiguous -- one cannot even determine its part of speech ("she wanted to punch" vs. "she wanted the punch") let alone its meaning (a drink? an instrument for making holes?). However, ambiguous words are readily used and understood in everyday language because they nearly always appear in the context of other words, and a word that is ambiguous alone is rarely ambiguous in context -- in fact, it may even be quite predictable.

The argument that context is important for language processing has a lot of punch, but determining exactly how has not proven straightforward. One means of studying context effects in their simplest form is to examine the response to a word when it is preceded by one or more associated or unassociated words. In this "semantic priming" paradigm one typically observes that individuals are faster to respond to target words when they are in the context of an associated or semantically-related word (e.g., Meyer and Schvaneveldt, 1971). This seems to be true whether one measures reaction time to make a word/non-word judgment (lexical decision), to identify a briefly-presented or visually-degraded word (threshold identification), or to read or repeat a target (naming) (for review, see Balota, 1994). Thus, the effect of context on the processing of a particular word may arise in part because words in the context have partially overlapping meaning with that target word (cat - lion) and/or tend to co-occur with it (bread - butter).

However, in everyday language words do not typically occur in the kind of pairs or triplets used in semantic priming experiments; rather, they occur in sentences. The presence of a sentence context, like that of an associated word, has been shown in several studies to speed a word’s processing regardless of the measure (Stanovich and West, 1983; Fischler and Bloom, 1985). Of course, sentence contexts are likely to contain at least one -- and often many -- words associated with a particular target word. Thus, some have suggested that sentence context effects derive from the kind of word-association effects already described (e.g., Stanovich and West, 1983). However, while word associations likely play a role in sentence context effects, the processing advantage gained from the presence of a sentence context is not reducible to word-relatedness alone. Ratcliff (1987), for instance, has shown that the priming effect of a sentence context can be significantly reduced by changing the order of the words; in this case, even though the same content words precede the target, the removal or alteration of syntactic cues causes the priming to dissipate. Other behavioral studies have come to similar conclusions (O'Seaghdha, 1989; Simpson et al., 1989), as have studies using event-

related potentials (ERPs). ERP studies have shown that, while both word primes and sentence contexts cause a reduction in the amplitude of the same component, the N400[1], to the target word this effect seems to occur slightly earlier (Kutas, 1993) and to last longer (Van Petten, 1993) for words in sentence contexts as compared with words preceded by associated word primes. Thus, while word-association is likely an important component of the processing benefit derived from sentence contexts, it is not the **only** factor responsible for the observed context effects.

That sentence context effects are not simply word-relatedness effects should perhaps not be surprising. For one thing, word association priming seems to decay fairly rapidly. Often the presence of only one intervening word can eliminate any facilitative effects of the prime on word naming or lexical decision times for the target (Neely, 1991). In sentence contexts, associated words are often separated by at least one word. More importantly, however, sentence contexts contain information beyond word-associations -- information derived from the structure of the words in the sentence. This syntactic information can have considerable predictive value, and it would be perhaps surprising if language users were not sensitive to it above and beyond their sensitivity to word associations.

In fact, results from studies of "syntactic priming" are converging to suggest that language users **can** make use of the predictive value of syntactic cues during language processing. Robust influences of syntactically congruent and incongruent sentence contexts (Wright and Garrett, 1984; West and Stanovich, 1986) and morpho-syntactically congruent and incongruent single word primes (Cole and Segui, 1994; Grosjean et al., 1994) have been observed in lexical decision tasks. Influences of these kinds of contexts have also been observed in word naming tasks in some studies (e.g., West and Stanovich, 1986, and Cowart and Cairns, 1987, who find effects on naming in English; but see also Carello, Lukatela, and Turvey, 1988, who find no effect on naming in Serbo-Croatian). Many of the results from both kinds of tasks have indicated primarily inhibitory influences of incongruent contexts (e.g., Wright and Garrett, 1984; Cole and Segui, 1994; Cowart and Cairns, 1987), but facilitative effects have also been reported (e.g., Grosjean et al., 1994).

The influence of syntactic cues on lexical access has remained controversial because these cues seem to affect some tasks (lexical decision) more than others (word naming) and because the effects have tended to be inhibitory, unlike semantic priming effects which are often (although not always) facilitative (for review, see Balota, 1994). Studies in this literature are difficult to compare directly because of the variety of context types, stimulus types, languages, and tasks used to examine the influence of syntax on lexical access. Nevertheless, some studies have shown results that seem similar to those obtained with semantic primes. For example, in her dissertation work, Liu (1996) paired semantically-deprived, lexical class predicting contexts (e.g., "I want to . . . ", "Look at the . . .") with noun and verb targets and found effects on word naming in both the visual and auditory modalities. These effects were only inhibitory in the visual modality; however, in the auditory modality (where the target to be named was signaled with a voice switch), she observed facilitative effects of syntactically congruent contexts relative to a neutral baseline (e.g., "Now please say . . . "). Thus, at least certain kinds of syntactic cues seem to influence lexical access in a manner similar to that observed for semantic cues.

In general, therefore, a variety of different contextual cues -- including semantic and syntactic -- seem to influence the ease with which individuals process a given word. These results have been found primarily in investigations using written words, though a few have used spoken words. It is important to ask whether these semantic and syntactic cues similarly affect the processing of other types of representations, such as pictures (or line drawings). The visual features of a picture seem to allow the viewer to eventually gain much of the same kind of information s/he would gain by viewing or hearing a word and seem to lead to the same kinds of behavioral responses. For example, an individual can name a picture just as s/he can read or repeat a word, and pictures and words can seemingly represent the same concept and similarly provide information about gender, lexical class, etc. However, picture naming tasks differ in several ways from other kinds of measures used to examine context effects. A critical difference is that picture naming is a lexical retrieval task. In word naming, word identification, or lexical decision tasks, phonological or orthographic word-form cues are present. In contrast, pictures provide no word-form cues; a naming response must be generated solely from the **conceptual** information invoked by the picture. Thus, by contrast to other behavioral measures typically used to study context effects, picture naming is more similar to word production than word

[1] The N400 is a negative-going potential that peaks about 400 milliseconds after the presentation of a word. Although N400 responses are observed to any word stimulus, the size of the N400 varies as a function of the word's "cloze probability" in a given context -- that is, the proportion of individuals who would choose to use that particular word in that context. The N400 is larger to the extent that words have a low cloze probability (are less predicted in the context). The N400 thus seems to be related to the semantic integration of a particular word with context.

recognition. Overall, while pictures and words can lead to similar overt behaviors, the type of information **most readily** gained from the two representations are different -- phonological or orthographic in the case of written or spoken words and conceptual in the case of pictures[2].

Despite these differences, however, the presence of a semantic prime -- either an associated word or an associated picture -- has been shown in several studies to facilitate picture naming times in a manner similar to semantic priming effects on words (e.g., Sperber et al., 1979 and Bajo, 1988; but see Durso and Johnson, 1979, for an example of a case in which semantic priming was not observed). Sentence contexts have also been shown to influence picture processing. For example, Kroll (1990) found that congruous sentence frames facilitated performance on a reality decision task, a task using pictures that is similar to a lexical decision task for words. In sum, behavioral studies suggest that a semantic context, either a single word or picture or a sentence, seems to influence the processing of words and pictures similarly.

These results -- especially the fact that words and pictures seem to be able to prime one another -- have been taken to support the idea that words and pictures access a common semantic system (e.g., Theios and Amrhein, 1989; Snodgrass, 1984; Potter, 1979) rather than two independent semantic systems (e.g., Pylyshyn, 1980). However, types of information other than semantic can be accessed from a picture or word stimulus, and, as we have seen, non-semantic aspects of context do seem to affect the processing of words. To our knowledge, no one has yet examined the influence of **syntactic** primes on picture naming. Therefore, in this study we aimed to extend Liu's (1996) results by examining lexical class priming of picture naming of actions and objects using her contexts.

On the whole, theories of lexical access via pictures have not made explicit predictions about the influence of syntactic contextual information on picture naming. However, it is possible to examine the nature of the cognitive systems postulated by these theories to determine what their predictions might be. Those theories that postulate that pictures and words converge upon a common, abstract, and amodal store (diagrammed in Figure 1a) would most likely suggest that syntactic cues exert their influence after modality information has been discarded. If so, these theories predict that syntactic cues should affect picture naming in the same manner as they affect word naming. Other theories (e.g., Levelt, 1989; Glaser and Glaser, 1989), diagrammed in Figure 1b, have postulated that, while pictures converge directly on an abstract semantic store, written and spoken words converge first on a verbal lexicon which has pointers to entries in the semantic store as well as to associated grammatical, phonological, and orthographic information. To be named, picture stimuli would have to be processed in the semantic store and then the verbal lexicon. Written or spoken words could theoretically be named without ever accessing the semantic store; however, since semantic priming is often observed in word reading or word repetition studies, it seems likely that in most cases words which are read or heard are processed semantically. If the naming of both words and pictures involves processing in the semantic store **and** the lexicon, then these theories should also not predict any differences in syntactic priming between words and pictures, regardless of whether the syntactic primes are believed to exert their influence via the semantic store or the verbal lexicon. One might expect a main effect of modality on reaction times, since words would access the lexicon first while pictures converge directly on the semantic store. However, no interactions between modality and the influence of syntactic contexts would be expected. Only if syntactic cues were believed to operate within the semantic store (or in other cognitive processors accessed after semantic processing) and if written and spoken words were believed to be processed without accessing semantic information would an interaction be expected. However, the fact that words **are** influenced by syntactic primes (e.g., Liu (1996)) seems to rule out this possibility.

Note that, in general, predictions regarding the influence of syntactic cues on picture naming times made by current theories are not well-delineated. Neither type of theory explicitly states which part of the cognitive system would be affected by syntactic cues nor exactly how contextual cues change processing. By examining lexical class priming of action and object picture naming, therefore, we hope to provide new data regarding the similarities and differences between picture and word processing and the influence of syntactic contexts on lexical access via conceptual information. Furthermore, since few picture naming studies with brain intact individuals have used action pictures, this experiment will also provide new data about the differences and/or similarities between the processing of actions and objects in general. In other words, with this experiment we hope to generate data that will help us come closer to understanding how language users can comprehend sentences like: "Furious that it had spilled on her new dress, Francis wanted to punch the punch!"

[2] Note that, in most cases, the picture stimuli used in experiments are line drawings and not actual photos.

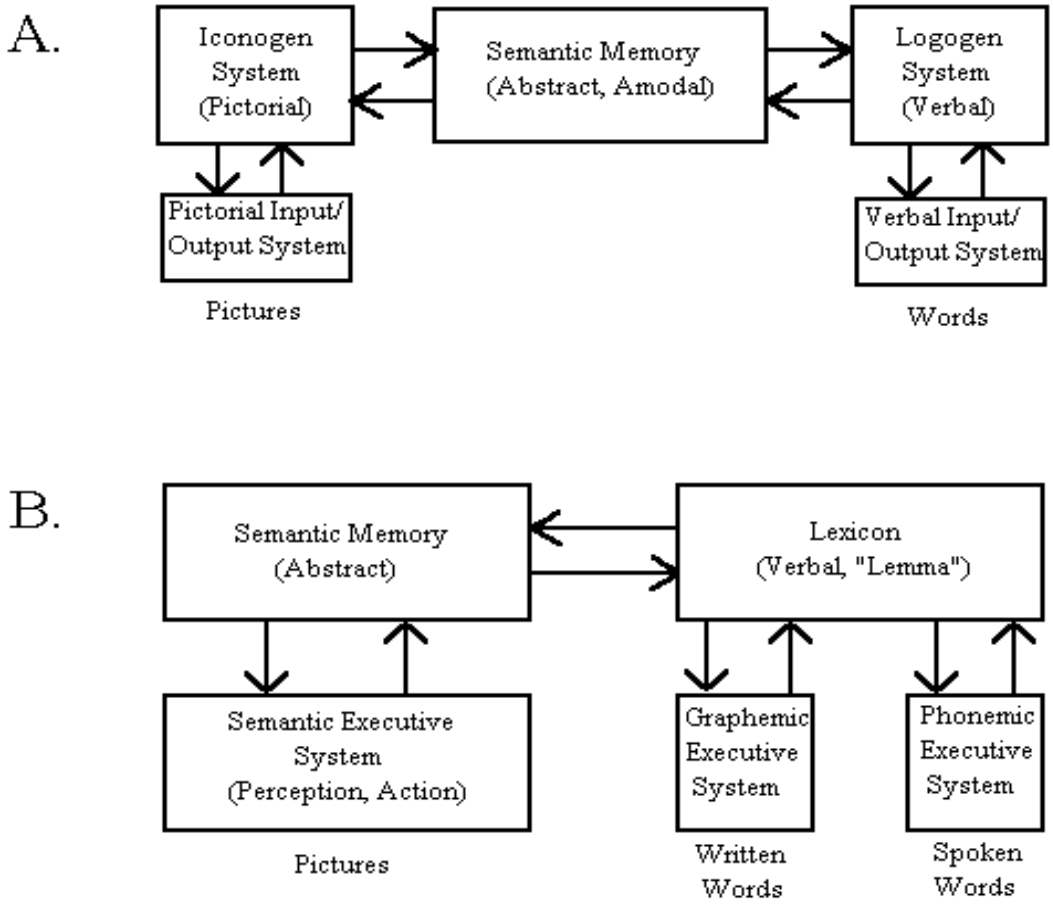


**Figure 1:** Diagrams illustrating current models of picture and word processing, taken from Glaser (1992). Part A illustrates an example of a model postulating a central, abstract, semantic code accessed equally by pictures and words. Part B illustrates an example of a model that postulates a verbal lexicon, accessed more directly by words, and an abstract semantic store, accessed more directly by pictures.

## Methods

Participants: Twenty-eight UCSD undergraduate volunteers (12 men, 16 women; mean age 20) participated in this experiment for course credit. All were right-handed, monolingual English speakers with no early second language exposure.

Stimulus Materials: The pictures used in this experiment consisted of line drawings of 46 common objects, drawn from the Snodgrass-Vanderwart picture set (Snodgrass and Vanderwart, 1980), and 46 common actions, drawn from the Obler and Albert "Action Naming Test". Appendix A gives a list of the stimuli. Objects and actions were matched for word frequency, number of syllables, and number of letters in the printed word (word length). Pictures were preceded by nine different auditory sentence fragments, spoken by a male voice. Three of these sentence fragments were predictive of nouns ("Here is the . . .", "This is the . . .", "Look at this . . ."), three were predictive of verbs ("I started to . . .", "He wants to . . .", "When will you . . ."), and three were neutral with respect to lexical class ("And now say . . .", "I want you to say . . .", "Next, please say . . .").

Procedures: Participants wore headphones with a microphone and were seated approximately 60 cm away from the screen of a Macintosh computer. The Psy-scope Experimental Shell (Cohen et al., 1993) was used to present stimuli and record voice-onset times. Participants were instructed to name the picture on the screen as quickly and accurately as possible, regardless of the picture's fit to the preceding auditory context. They were also instructed to name actions in the uninflected "imperative" form (e.g., "jump"). Participants were first given off-line practice (using printed examples

not included in the experimental trials) in distinguishing objects from actions and in naming under contextual conflict. They were then given an on-line practice containing six items (again, not used in the experimental trials) encompassing all possible combinations of lexical class and context. Participants were only run on the experimental trials after demonstrating success with the practice items. Actions and objects were presented in random order and were randomly paired with contexts across participants. Each trial began with presentation of the picture, which remained on the screen until the participant responded or for a maximum of 5 seconds. The picture was followed by a blank screen for one second. The participant's responses were tape-recorded, and errors (false starts (e.g., "umm . . ."), extraneous noise (e.g., coughs), technical problems, and lexical class errors (i.e., when the name of an object is given in response to a picture of an action or visa-versa) were noted by the experimenter on-line and reconfirmed off-line.

## Results

Reaction times:

After removal of error trials (7.6% on average, from all error sources), the reaction time data were subjected to an omnibus ANOVA on two levels of Picture Type (action and object) and three levels of Auditory Context (noun-predicting, verb-predicting, and neutral). Results showed a main effect of Picture Type ($F = 162.3$, $p < 0.05$) with actions significantly slower to name than objects overall (see Figure 2). There was no main effect of Auditory Context ($F=0.6$; $p=0.5$). The Picture Type by Auditory Context interaction was significant ($F = 11.8$, $p < 0.05$). The same analysis done over items yielded the same pattern of results: a main effect of Picture Type ($F=12.4$, $p < 0.05$), no main effect of Auditory Context ($F=0.9$; $p=0.409$), and a Picture Type by Auditory Context interaction ($F=10.5$; $p < 0.05$). Planned comparisons revealed that, relative to naming times in neutral contexts, naming times for both actions and objects were significantly ($p < 0.05$) **facilitated** (i.e., faster RTs) in predictive contexts -- objects were fastest in noun-predicting contexts and actions were fastest in verb-predicting contexts. Additionally, objects were significantly ($p < 0.05$) **inhibited** in conflicting (i.e., verb-predicting) contexts. A trend for actions to be inhibited in noun-predicting contexts was only marginally significant ($p < 0.1$).

Lexical class errors:

On average, participants made only 2.5 (range 0 to 6) lexical class errors out of 92 responses (i.e., on average less than 3% of the responses were lexical class errors). However, the number of these errors varied with the nature of relationship between the picture's lexical class and the lexical class predicted by the context. In cases where the lexical class of the picture was congruent with that predicted by the preceding context, the average number of lexical class errors (+/- SE) was 0.18 (+/- 0.07). In neutral contexts, the average number of lexical class errors was 0.75 (+/- 0.19). And in cases where the lexical class of the picture was incongruent with that predicted by the preceding context, the average number of lexical class errors was 1.61 (+/- 0.21). A one way ANOVA on the factor Match to Context (three levels: congruent, neutral, incongruent) revealed a significant effect of Match to Context on the number of lexical class errors ($F=19.044$, $p < 0.001$). Planned comparisons showed that, relative to cases where the context was neutral with respect to lexical class, participants were significantly ($p < 0.05$) more likely to make lexical class errors when contexts conflicted with the lexical class of the picture and were significantly ($p < 0.05$) less likely to do so when contexts were congruent with the lexical class of the picture. These results are almost entirely accounted for by lexical class errors made when naming actions, as the 28 participants committed a total of only 6 lexical class errors naming objects (5 in incongruent contexts and 1 in a congruent context). Generally, the error involved naming an object involved in the action rather than the action itself (e.g., saying "tears" instead of "cry").

## Discussion

While Liu (1996) found no baseline differences in naming times for nouns and verbs, a significant main effect was found for the naming of actions and objects in this experiment, with actions significantly slower to name than objects. More lexical class errors were made to action pictures as well. While it remains unclear exactly why action pictures are harder to name, there are two differences between action and object pictures that are likely to contribute to the slower naming of actions. First, pictures of actions are more complex than those of objects; while object pictures generally contain one item, action pictures often have one or more participants interacting with some item. Action pictures are thus more scene-like and likely require more complex analysis. Additionally, while the principle distinguishing features of an object are typically easy to depict in a line drawing, movement, which is an important distinguishing feature for actions, is more difficult to depict in a line drawing. Action pictures are thus at once more complex and yet less complete than object pictures, probably making them more difficult to identify.

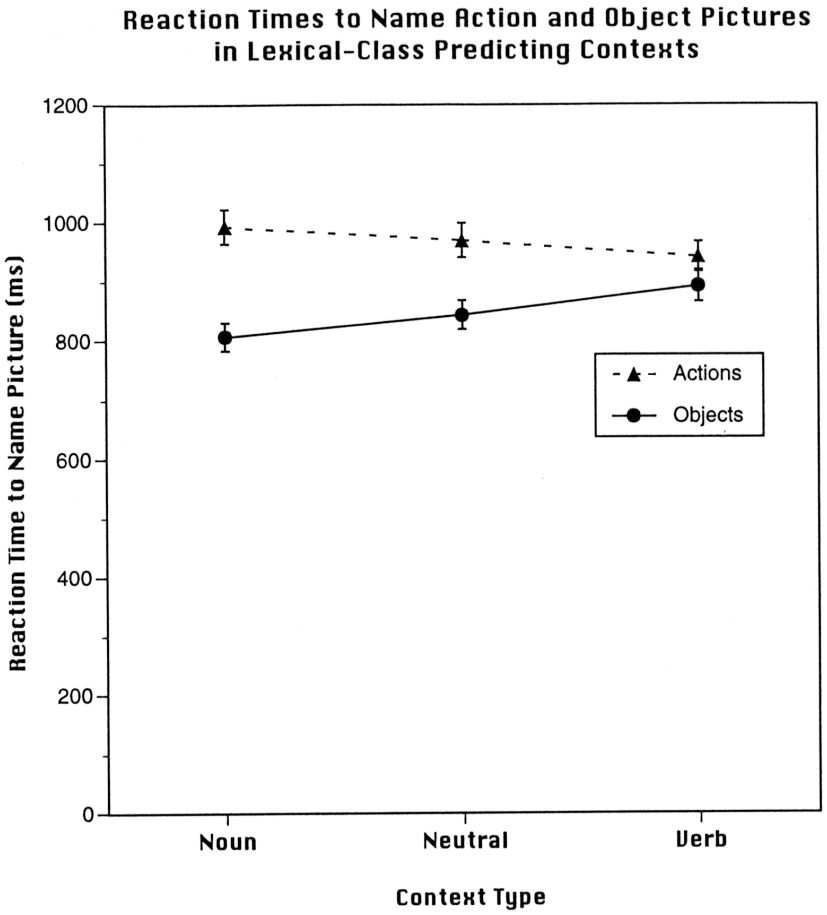


**Figure 2:** Mean reaction times (in milliseconds) to name action and object pictures in the three types of auditory contexts (noun-predicting, neutral, verb-predicting). While actions were slower to name overall, both actions and objects were faster to name in congruent contexts and slower to name in incongruent contexts relative to reaction times in neutral contexts.

While there was no main effect of context, there was a significant context by picture type interaction. The naming of object pictures was significantly facilitated in noun-predicting contexts relative to neutral contexts and was significantly inhibited by verb-predicting contexts relative to neutral contexts. Similarly, the naming of action pictures was significantly facilitated by verb-predicting contexts relative to neutral contexts. There was also a trend for actions to be slower to name in noun-predicting relative to neutral contexts. Error patterns were similar: relative to the number of errors in neutral contexts, we observed more lexical class errors to pictures whose lexical class was incongruent with that predicted by the context and fewer lexical class errors to pictures whose class was congruent with that predicted by the context. (Thus there does not seem to have been a speed / accuracy trade-off). It seems clear, then, that semantically impoverished contexts predictive of lexical class can influence naming from picture stimuli (and, by inference, lexical access). Picture naming is susceptible to syntactic priming, despite the fact that it is a conceptually-driven word-retrieval task.

Are the influences of syntactic primes on pictures similar to those for words? We can address this question by comparing our results with those obtained by Liu (1996), whose contexts we used, for the auditory and visual naming tasks she employed. Her results are shown in Figure 3. For written word naming, which, because of the shared modality of input (vision), might at first pass seem the more similar of the two to the picture naming study, Liu (1996) observed only one significant effect, an inhibitory influence of verb-predicting contexts on nouns. No facilitative effects were observed. By contrast, in the picture naming task, we found that congruent contexts were facilitative for the naming of both object and action pictures. In the auditory version of her task, which was more similar to our picture naming task in the latency range of the elicited responses, Liu (1996) observed facilitative

effects of congruent contexts on the naming of both nouns and verbs. She observed no inhibitory effects of incongruent contexts in this version of the experiment. The facilitative effects of congruent contexts are similar to those observed in our picture naming experiment; however, we also obtained inhibitory effects of incongruent contexts for object naming. In other words, the results obtained in the current experiment look like a combination of the results Liu (1996) obtained in two different modalities -- facilitation similar to that observed in the auditory modality and inhibition (of objects only) similar to the inhibition observed for nouns in the visual modality.

Of course, it is important to note that objects and actions cannot be equated with nouns and verbs, as many nouns are not pictureable objects and many verbs are not actions. However, it is noteworthy that three experiments using exactly the same contexts to examine lexical class priming obtained three different patterns of results. These differences would not seem to be predicted by current theories of lexical access.

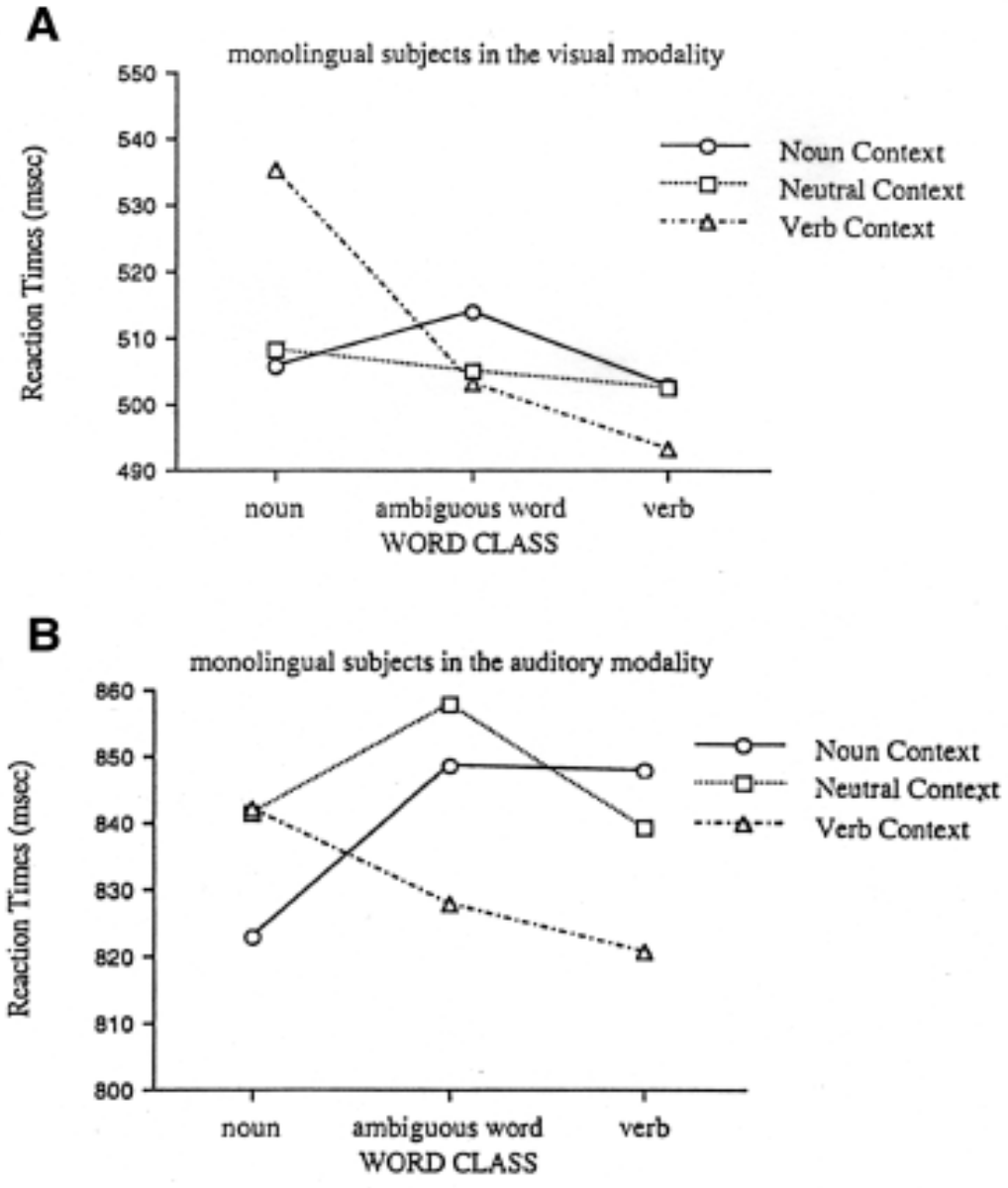


**Figure 3:** Results from Liu's (1996) written and spoken word naming tasks. Part A shows mean reaction times (in milliseconds) to name written words -- unambiguous nouns, unambiguous verbs, and ambiguous words -- in three types of auditory contexts (noun-predicting, neutral, verb-predicting). Part B shows mean reaction times (in milliseconds) to repeat the same three types of words presented auditorily in the same three context types.

Theories that describe pictures and words converging on a single, amodal, abstract store (e.g., Theios and Amrhein, 1989; Snodgrass, 1984; Potter, 1979) would seem to predict similar influences of syntactic primes in all three experiments. These theories allow for early processing differences between written words, spoken words, and pictures that could result in main effects of modality on reaction times or error rates. Assuming that syntactic processing occurs **after** conversion to an amodal representation, however, syntactic cues should facilitate and/or inhibit processing of all of these kinds of stimuli in an analogous manner. In fact, though, we did not see similar effects in the three presentation modes, suggesting that either syntactic processing does not operate on common, amodal representations or else that syntactic primes are influencing a very early stage of processing (before conversion to an amodal representation and therefore before what has traditionally been defined as lexical access).

Theories that postulate an amodal semantic store plus a verbal lexicon (e.g., Levelt, 1989; Glaser and Glaser, 1989) also seem to predict that pictures and words should be similarly affected by syntactic cues. If syntactic cues exert their influence after words and pictures have been converted to an amodal semantic representation, these theories make the same predictions as those already described. Similarly, since both words (in either modality) and pictures are processed in a common lexicon in order to be named, it is unclear why modality should interact with syntactic priming in these theories if syntactic primes are postulated to affect processing in the verbal lexicon. Because these theories do not state exactly how syntactic context might alter processing, it is difficult to know for certain whether some type of modality information might be expected to be maintained in the lexicon and to influence processing. If the effect of syntactic primes is to cause some lexical entries to become easier or harder to retrieve, however, it would seem that this facilitation or inhibition would be observed regardless of stimulus modality. Again, while main effects are accounted for by differential early processing and that fact that pictures and words initially converge upon different components of the system, interactions between modalities would not seem to be predicted to occur unless syntactic cues are having their influence at very early processing stages. In fact, however, different influences of lexical class cues were seen with all three modes of presentation.

Thus, none of these theories that postulate an amodal conceptual store seem to adequately account for the differences observed in these three experiments. However, theories that postulate modality-specific conceptual representations do not offer an explanation for how an auditory, verbal (let alone **syntactic**) context can influence the response to a pictorial stimulus. The picture of lexical access emerging from these studies thus seems too complex to be encompassed by current models. Language stimuli in different modalities seem to interact with one another (e.g., words can prime pictures and vice versa) and are influenced by similar kinds of contextual information. Yet, the modality of presentation of the language stimulus seems to continue to influence language processing at what are, at least in many accounts, conceived of as fairly advanced stages of processing, such as syntactic analyses. Similar effects have been observed in an ERP study by Ganis et al. (1996). In this study, sentence context effects on words and pictures were similar in their time course and general nature, but seemed to involve at least partially non-overlapping neural generators.

The differences observed across these three experiments also have implications for current thinking about lexical class in general. Are nouns and verbs (or objects and actions) processed differently? Recently, neuropsychological studies have suggested that impairments with noun and verb processing can be doubly dissociated. Damasio and Tranel (1993) described two cases of patients with damage to left anterior and middle temporal lobe regions who seemed to have selective difficulty naming pictures of nouns (common and proper); they performed in the normal range on the naming of verbs. In contrast, a third patient with damage to left premotor cortex showed a selective difficulty naming verbs but performed in the normal range on naming pictures of common and proper nouns. While Damasio and Tranel's (1993) results actually only support a dissociation between the processing of actions and objects, recent papers (Daniele et al., 1994; Berndt et al., 1997) describe patients with selective noun or verb impairments that were observed in picture naming but also in auditory and visual lexical decision tasks, sentence completion tasks, oral reading tasks, and naming from definition tasks, all of which used non-action verbs and abstract nouns. All three sets of authors suggest that nouns and verbs are processed by at least partially non-overlapping neural systems.

Neither Liu's (1996) nor our results showed significant differences between the way that nouns and verbs (or actions and objects) were influenced by syntactic contexts, although verbs seemed slightly less susceptible to inhibition in the current picture naming study and in Liu's (1996) visual task. What is striking, however, is the fact that both nouns and verbs behaved differently overall in the three tasks, as described previously. While the differences between the two classes within a given modality were small, the differences themselves **differed** depending on whether participants were naming pictures, reading visually-presented words, or naming auditorily

presented ones, and we observed no overarching processing difference signature of nouns or verbs. Thus, if nouns and verbs are represented in different areas of the brain, the influence of syntactic context on both seems to be similar and is stimulus-modality-dependent in both cases.

Overall, then, the picture of language processing emerging from this study and the studies that came before it is a complicated one. Language processing does seem to be influenced by syntactic, as well as semantic, information contained in context -- even if that information only coarsely constrains the search space, as does lexical class. Apparently, knowing whether an upcoming word is likely to be a noun or a verb is an important cue for language users. In fact, there seems to be something of a processing "boundary" between the two lexical classes; few lexical class errors were observed even in this experiment where cues conflicted, and language production errors in general rarely cross lexical class lines (e.g., Bock, 1990). On the other hand, the precise manner in which this predictive information impacts language processing (i.e., whether congruence facilitates and/or incongruence inhibits) seems to depend upon the nature of the stimulus -- whether picture or word, auditory or visual presentation. It is important to know whether a word is a noun or a verb -- but what *is* a noun or a verb? Again, the answer seems to depend; no indication of modality-independent "characteristic processing" was observed for either nouns or verbs. Language users seem to combine the cues that context can provide -- whether cues to meaning or to form -- with current sensory input -- edges of objects, letters, sounds -- to process language in a way that depends in a complex fashion on the nature of both kinds of cues. In order to understand this process, one must explore both different kinds of contexts and different kinds of tasks in ways that will enlighten both the similarities and the differences that emerge. There is much work yet to be done -- and it is time to punch in!

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## Appendix A: List of Stimuli Used

**Objects**

axe
ball
bird
book
bow
box
bread
butterfly
car
cat
chain
coat
comb
corn
desk
doll
dress
drum
duck
fence
fish
fly
frog
heart
horse
iron
leaf
mitten
moon
nut
pear
pepper
piano
pig
ring
rooster
saw
sheep
snake
sock
spider
stove
swing
train
wagon
wheel

**Actions**
bow
bowl
box
brush
climb
conduct
cry
cut
dig
dive
drink
eat
fence
fish
float
iron
juggle
kneel
knit
lasso
milk
operate
paint
parachute
peel
pet
pour
propose
rake
read
row
run
salute
saw
sit
ski
sleep
smoke
surf
sweep
swim
swing
throw
type
win
write

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