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Examining Long-Term Priming Across Modalities: Looking for Semantic Antipriming

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Examining Long-Term Priming Across Modalities: Looking for Semantic Antipriming

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Abstract

Traditional localist theories of semantic memory use spreading activation to explain short-term priming. Rival distributed accounts use incremental learning to explain both short and long-term priming. This experiment examined the possibility of a long-term negative priming mechanism in semantic memory. The results supported the existence of long-term priming. The results did not support the existence of any negative priming mechanism, but did lead to a follow up experiment that will investigate a possible role for negative priming in semantic memory.

Examining Long-Term Priming Across Modalities: Looking for Semantic Antipriming

Philosophers, cognitive scientists, and neuroscientists have puzzled over the question of how human knowledge is organized. For humans to understand a simple sentence like "Gail wanted to give Roger a birthday present, so she went to her room and shook her piggy bank." one must quickly and efficiently access a large and diverse range of knowledge. In addition to knowledge of word meanings and syntax, in order to understand that Gail probably is shaking the piggy bank to see if she has money to buy Roger a present, one would need to access a wide variety of knowledge. The variety may include: knowledge about birthday presents (they usually are purchased; previously owned objects, like the piggy bank, are not typical birthday presents), and knowledge about piggy banks (they contain money; they are opaque; they are made of hard material; they usually contain coins, not paper money). This simple sentence illustrates the ability of our cognitive system to access large amounts of knowledge instantaneously and with little apparent effort. Psychologists and computer scientists have been trying to model this ability for more than 40 years. A focus of this enterprise has been on the organization of semantic memory, our vast storehouse of world knowledge. The present research tested two leading hypotheses about the organization of knowledge.

Much of the research in this area has relied on the priming effect to study how we process semantic information. The repetition priming effect demonstrates, for example, that identifying a concept once briefly facilitates the next identification of the same concept, or a closely related one. Early attempts to understand the organization of semantic memory (Collins & Quillian, 1972; Collins & Loftus, 1975) explain information processing in terms of a short-term (lasting for a matter of seconds) activation spreading within a network of concepts that are distinct yet connected. More recent accounts (Rumelhart, 1990) have explained information processing as longer lasting incremental weight changes in connections between or among units, units that are activated in patterns to represent individual concepts. The purpose of the current study was to collect data to help understand the nature of information representation and to consider the results with respect to the existing major theories mentioned above.

One original model of information representation is Collins and Quillan's (1972) hierarchical model. The model arranged knowledge based on category membership; the broadest categories formed the upper levels and then branched down into subordinate categories and specific instances. Each category and instance was stored as a separate node in its respective level, and was connected to appropriate nodes via connections. For instance, the representation of robin could be represented by nested connections between the following categories, from top to bottom: LIVING THING, ANIMAL, BIRD, ROBIN. Properties common to members of each level were stored at that node from each concept; "has a heart" was connected to ANIMAL, since all animals have hearts, "has wings" was connected to BIRD, and "lays blue eggs" was connected to ROBIN. Exceptions were noted locally. For example, a property attached directly to "penguin" is "does not fly". This model was effective because it was efficient and because it seemed to explain how we learn new concepts quickly. It was efficient because each concept is only represented once and all of its features are accounted for via connections. The nested storage and connected features also helped explain how we quickly learn features of new concepts. For example, when we were told that a dax is a bird we can infer that daxes have two wings, a beak, a heart, etc.

One weakness of this localist model is that category membership was considered all-or-none, not mediated by psychological factors such as typicality. Behavioral experiments highlighted this weakness and demonstrated that the hierarchy was not psychologically valid. For example, in sentence verification tasks participants routinely verify phrases such as: “A robin is a bird” faster than “A chicken is a bird” (Smith, Shoben & Rips; 1974). In the hierarchical model both chicken and robin are stored equidistant from BIRD, and therefore the two sentences above should be verified at approximately the same rate. Collins and Loftus (1975) expanded on the new results and developed a model of knowledge representation based on semantic distance instead of hierarchy. In this system, features that are more typical of an item are stored closer to that item. This model lost some of the cognitive economy, because features could be stored multiple times and an item did not automatically inherit all of the characteristics attributed to its category; however, it was more true to the data. The storage mechanisms of the original model were still maintained; each concept was represented in its own node and concepts and features were linked by connections of varying lengths. In addition to semantic distance, Collins and Loftus added the processing concept of spreading activation. As a person processed a word, his or her representation of that concept was briefly activated, as were all concepts that were closely connected to that concept. This mechanism explained how semantic priming might occur. Semantic priming is an effect quite similar to repetition priming. In semantic priming, the activation of one concept leads to facilitated identification of a highly related concept. Spreading activation is a plausible mechanism of semantic priming because the activation of one concept, for example ROBIN, also activates the highly related concept BIRD. Thus, if BIRD is processed after ROBIN has been identified, then BIRD is residually activated (primed).

As described above, these accounts have some differences but also share much in common. Specifically, both models envision concepts that are stored individually in nodes, linked together in semantic representation by connections of varying lengths. These models together with the research they inspired are called *localist* models (Ober & Shenaut, 2006). They are localist because the models represent concepts in discrete, local units.

One well-supported alternative to localist semantic theory is the distributed account. The distributed account holds that meaning is not psychologically localized to specific nodes. Instead, meaning is represented by a pattern of activated units, a system that is quite amenable to comparisons with neurons that fire in groups.

Distributed accounts of information representation often are developed for use in neural networks in computer simulations (Rumelhart, 1990; Ober & Shenaut, 2006). Generally, distributed accounts of semantic memory represent word meaning in layers of units that are linked by weighted connections. The units in the input layer represent the concept and the units in the output layer represent the characteristics and features of that concept. The network reaches a state where it represents a person's semantic memory through training. The connections between units start at arbitrary values; when input units are selected and the appropriate output units are active, the connections between the active units are strengthened. Then the input is repeated and, with the appropriate output activation, the connections are strengthened again. The model is trained to the designer's specifications. Variations of these distributed models can simulate most of the results from localist literature.

In distributed accounts, priming effects are explained by the strengthened connections between units. After the network processes a concept once, the connections between appropriate units are left stronger than before, and processing of that concept is facilitated at the time of the next encounter. Unlike the idea of temporary residual activation, this incremental strengthening is long-term. Consequently, the adjustments of connection weights are long lasting. Supporters of distributed models point out that this long-term change may account for more than just a priming effect. These relatively permanent changes could also provide a mechanism for the system to learn words, or add them to its long-term semantic memory.

One advantage of the distributed models is that they are more biologically plausible than localist. The idea of one discrete unit representing one concept was never meant to be, and consequently is not, supported by neurobiological evidence. By contrast, distributed models have been designed with the role of the neuron in mind. As a consequence, each concept is represented by the activation of a pattern of multiple units; a system that is quite comparable to neurons firing together in the brain.

Distributed accounts also excel at modeling neuropsychological results. Patients with semantic dementia gradually lose their memory for concepts, starting with the idiosyncratic information first. For example a person with semantic dementia will forget that a penguin swims before he or she forgets that the penguin has two wings. When one destroys units from a simulated neural network, the system's representation loses idiosyncratic information before essential information. This shared pattern of degradation is a significant similarity between distributed and biological accounts of semantic representation.

Distributed accounts have been used to examine both positive and negative priming. Negative priming is an effect in which the processing of one concept leads to an inhibition of the processing of another concept. Marsolek, Schnyer, Deason, Ritchey, and Verfaiellie (2006) used a distributed account of information representation to understand the mechanisms of long-term priming. The research demonstrated that the process of priming one set of pictorial objects lead to antipriming (an example of negative priming) of a different set of objects. The Marsolek et al. (2006) results fit well within a distributed model. Each concept is represented by the activation of multiple units; due to the distributed nature of the system, units are activated for more than one concept. Therefore, there is overlap between items, (i.e., some of the units that fire for concept *a* also fire for concept *b*). In the Marsolek et al. (2006) account, the process of strengthening the connections between appropriate units (to represent *a*) leads to the weakening of overlapping connections not required for the current item (those that also connect to *b*). The purpose of the current experiment is to replicate the antipriming mechanism observed by Marsolek et al. (2006) with lexical stimuli.

If the antipriming demonstrated with pictorial stimuli can be replicated with lexical stimuli then the generalizability of the model will increase in important ways. Such results would support a conclusion that antipriming functions when knowledge is accessed via pictorial and lexical representations. If antipriming cannot be replicated with lexical stimuli, it could be argued that the effect is not a true mechanism of information representation generally, but that the modality of input plays an important role in the effect.

The Marsolek et al. (2006) experiment was comprised of four phases (see Figure 1). In the first part of the experiment, participants stared at a fixation point while listening to and judging the names of a set of common objects such as: HOUSE, KEY, DESK, and PIANO. Next they saw and identified a set of new objects (none were repeated from the first phase); this was used to establish a baseline of accuracy for object identification. In the third phase the participants again stared at a blank screen while listening to and judging another new set of object names, which strengthened each object's representation in memory. This phase primed and antiprimed the objects to be presented in the last phase. The phase primed all of the words included in the phase and antiprimed objects whose representations overlapped with the objects being primed. In the final phase, participants repeated the object identification from the second phase. Half of the objects were repeated from the previous auditory section and therefore were primed. The remaining antiprimed objects were new (not repeated from any of the previous three phases). The priming effect and antipriming effect were both measured against the baseline condition.

The current study used the Marsolek et al. (2006) paradigm; with the key difference that the object identification was replaced by a lexical decision task (see Figure 2). In the present study, the first phase is an evaluation of a set of tone. The second phase consists of lexical decisions used to measure the baseline rate of response time. Then participants evaluate how much they like or dislike a set of new words. The process of evaluation primes these words for the final step, another set of lexical decision tasks. In this last step, participants will evaluate some words repeated from the like/dislike task and some new words.

The predictions of this experiment are simple. First, if the response times for repeated words in the final phase are faster than the response times to words in the baseline, then we can conclude that these words were semantically primed. This result would support both a localist and a distributed account of semantic representation. Second, if the response times for new words in the final phase are slower than responses in the baseline, the data demonstrate antipriming. Such a data set would only support a distributed account of semantic representation.

Method

Participants

Twenty-six undergraduates from the University of Minnesota and 18 undergraduates from Macalester College participated for course credit. All participants were native English speakers and had normal or corrected vision.

Materials

The visual stimuli were 200 words and 200 non words, plus 9 practice words and 9 practice non words (see Appendix). The words were selected from the MRC Psycholinguistic Database (http://www.psy.uwa.edu.au/mrcdatabase/uwa_mrc.htm) and fit the following parameters: each word was 4 to 9 letters long, rated between 5 and 250 on the Kucera-Francis written frequency scale (as determined by http://www.psy.uwa.edu.au/mrcdatabase/uwa_mrc.htm), and rated between 100-300 on the concreteness scale. The non-words were selected by starting with 200 words within the same length and frequency ranges listed above and adjusting one letter to create a pronounceable non-word. The auditory stimuli were 55 different tones and each of the 200 words used as visual stimuli, plus 5 practice words. Three raters ensured that none of the words were closely related to one another. The presentation of the stimuli was controlled by a computer and was counterbalanced with pseudorandomized lists.

Procedure

The experiment consisted of four phases. In the first phase, participants stared at a fixation point while rating how much they liked or disliked 55 tones presented over headphones. The rating system ranged from 1 (dislike) to 4 (very much like). In the second phase, participants evaluated 100 words and 100 non-words in a lexical decision task. Letter strings were presented for 183 ms and followed the presentation of a fixation point (500 ms). Participants responded with their right index finger to signal "word" and right middle finger to signal "non-word". In the third phase, participants listened to 50 experimental words and 5 practice words presented at the beginning over headphones. Participants performed the same like-dislike rating as in the first phase. Every word presented in this phase was different from the words presented in the preceding phase. The procedure for the fourth phase was the same as the second. 50 of the words in this phase were repeated from the third phase and 50 of the words were new. The experimenter remained present for each experimental session, which lasted approximately 30 minutes.

Results

Data Treatment

The data consisted of response times and accuracy measures to the lexical decision tasks. These responses are split into three conditions. One set of responses was collected before priming occurred (baseline words) and two sets came after priming. Of these two, one set was repeated (primed words) and the other was not (potentially antiprimed words). Error rates were analyzed by participant and by condition. Each participant was accurate in over 90% of trials. A repeated measures ANOVA confirmed that there were no differences in accuracy rates across conditions: $F(1,37) = .922$, $MSE = .0202$, $p = .343$. All further analyses described were performed only on correct responses to words. The author calculated the mean response times and standard deviations for each participant. Then a filter was applied which removed any case that exceed three times the standard deviation in either direction from that participant's mean. This resulted in a loss of 1.5% of the data. The author made a box plot of mean response time by participant by condition. Three participants were eliminated for exceeding the extremes of the plot in one or more conditions. An alpha of .05 was used for all statistical tests and all reported differences were significant at that level.

Data Analysis

Once treated, the response times were examined for the predicted effects. The mean response times were examined by participant by condition and are presented in Table 1. The mean baseline response time was the slowest, followed by the mean antiprimed response time, followed by the mean primed response time. A repeated measures ANOVA determined a significant main effect of condition: $F(1,37) = 10.84$, $MSE = 1205$, $p = .002$. Pairwise comparisons confirmed that the response times in the primed condition were significantly faster than response times in the other two conditions. Pairwise comparisons also confirmed that the response times in the potentially antiprimed condition were significantly faster than response times in the baseline condition. Therefore, the results supported the first prediction of long-term priming but did not support the predicted antipriming; the antiprimed response times were predicted to be slower than baseline response times but were significantly faster.

The demonstrated priming effect was consistent with all of the literature mentioned above. The antiprimed effect that was faster than baseline was unexpected and not consistent with any of the literature. Therefore the author sought an alternative interpretation of the results to examine the possibility that the faster antiprimed condition was an anomaly. The order of condition was not counterbalanced, that is the baseline condition was always presented before the primed and antiprimed, which were interleaved. Therefore it is possible that the mean response times in the baseline condition were slower than response times in the other two conditions because of a practice effect. There were only four practice lexical decision trials before the baseline condition; it is possible that participants needed more trials than four to reach a consistent and minimum rate of response. One hundred words were presented in the baseline condition. To search for a practice effect, the author split the 1^{st} 50 baseline condition trials from the 2^{nd} 50, and examined mean latency for correct responses. The mean response times in the first half (614 ms) were slower than those in the 2^{nd} half (586 ms). A t test confirmed that the difference was statistically significant: $t(37)= 2.923, p =.006$. Therefore, participants were indeed improving with performance. As a result, responses to the 2^{nd} 50 trials represent a more pure baseline performance.

Table 2 displays the means across conditions with the 2nd half of the baseline condition. The primed condition was still faster than the other two conditions and the antiprimed condition was still faster than the baseline condition. A t-test confirmed that the response times in the primed condition were still faster than the response times in the corrected baseline: $t(37) = 2.051, p = .047$. The difference between the antiprimed and baseline conditions, however, was no longer significant when the corrected baseline was used: $t(37)= .709, p = .482$ Now consider the two predictions of the experiment with refined results in mind.

The first prediction stated that the response times of the primed condition should demonstrate priming. The results support this conclusion and add to existing literature describing long-term priming (e.g., Becker, Moscovitch, Behrmann, & Joordens; 1997).

The second prediction stated that if the mean response time in the antiprimed condition was slower than the mean response time in the baseline condition then the results would support the existence of a negative priming mechanism in long-term semantic representation. The response times in the antiprimed condition were not statistically different from the response times in the second half of the baseline condition and the mean was in the opposite direction from the prediction. The results, therefore, do not demonstrate the existence of a negative priming mechanism in long-term semantic representation. This experiment was exploratory in nature; these results do not come as a full surprise.

Concepts can be primed in a number of ways: identifying pictures, naming words, deciding whether a letter string is a word or not (lexical decision), deciding whether an object is animate or not (animacy task), all function as priming tasks. Becker et al.

(1997) found that using a lexical decision task did not demonstrate any long-term priming. However, an animacy task did demonstrate long-term priming. The authors explained this result in terms of levels of semantic processing. According to their account, the lexical decision task only primed the words on a short-term scale because the task did not require enough semantic processing to be primed on a long-term scale. The animacy task, however, did require enough semantic processing for long-term priming. The like-dislike judgment used in the current research is a purely subjective rating that does not necessarily require the same degree of semantic processing as the Becker et al. (1997) model. These varying task demands should be considered as more specific models of long-term priming are developed.

If antipriming can be observed with both pictorial and lexical stimuli, it is most likely to be observed under similar task demands. Keeping the same paradigm while switching to a naming task might increase the likelihood of finding a negative priming effect because it is a task more similar to the object identification task used by Marsolek et al. (2006) to establish antipriming with pictorial stimuli. The experiment design is already being updated to reflect this point; the data for the naming paradigm will be collected by Fall 2008.

In summary, the purpose of the current study was to use lexical stimuli in an attempt to extend the antipriming results found by Marolek et al. (2006). The results of the experiment replicated the existence of long-term priming, which is consistent with both localist and distributed theories, but did not demonstrate antipriming. The author will follow up the current experiment by measuring priming with a naming task; this change will make the experiment more similar to the original conditions under which antipriming was demonstrated.

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Appendix

Words	Concrete	Kucera-Francis Frequency	Number of Letters	Non-Words
ABILITY	273	74	7	ABUNDALT
ABRUPT	266	18	6	ADUNT
ABUNDANCE	267	13	9	AKERT
ACCORD	299	9	6	AMPLITUDO
ACTUALITY	247	8	9	ANYMODY
ADHERENCE	265	9	9	ARPLIANCE
ADMIRE	296	10	6	AUTUME
ADVANTAGE	282	73	9	AWKWALD
ADVICE	291	51	6	AXPANSE
AFFECTION	280	18	9	BANT
ALLOW	268	72	5	BERNY
AMAZEMENT	277	10	9	BINEAPPLE
AMBITION	281	19	8	BIRECTION
ANALOGY	247	13	7	BOONLIGHT
ANXIETY	241	42	7	BOST
APPEAR	271	118	6	BREKE
APPROVAL	267	51	8	BRETALITY
ATTITUDE	265	107	8	BRIEM
ATTRIBUTE	266	6	9	BRIMARY
AUTHENTIC	276	20	9	BUILNER
BECAME	273	246	6	BULE
BELIEF	270	64	6	BUSHOP
BETRAYAL	258	6	8	CANDITION
BLAME	293	34	5	CARBOW
BLESSING	277	10	8	CARDIZAL
BOAST	295	8	5	CATHEGRAL
BOREDOM	262	11	7	CHAIB
BOTHER	267	22	6	CHALLINGE
CAPACITY	293	83	8	CHEEST
CAUSE	287	130	5	CHEMILTRY
CHANCE	254	131	6	CIGARENNE
CONCERT	252	39	7	CLANNEL
CONFUSION	282	44	9	CLATH
COURAGE	277	32	7	CLITHES
CRITERION	261	11	9	CLUMSE
CUNNING	265	5	7	COMODY
DARE	291	21	4	CONTELT

DECISION	297	119	8	COTTANDER
DEFIANCE	275	7	8	COUL
DEMOCRACY	298	24	9	CRAUD
DENIAL	272	18	6	CREATMENT
DEVIL	274	25	5	CREATURN
DIGNITY	280	35	7	CRILD
DIMENSION	274	15	9	CRITIFISM
DISMISSAL	300	7	9	CUST
DISTINCT	247	42	8	DEAK
DISTRESS	282	15	8	DEEY
DIVERSITY	268	13	9	DEGREP
DRAB	281	5	4	DEME
DREAD	267	9	5	DENEIVER
EASY	288	125	4	DENUCTION
ECONOMY	284	79	7	DEPOSUT
EFFECT	295	213	6	DIVISIOT
EFFORT	296	145	6	DOCTIR
ELSE	222	176	4	DOIK
EMOTION	260	34	7	DONEN
ENVY	265	7	4	DOSK
ESSENCE	243	15	7	DWYLLING
ESTIMATE	293	39	8	ELEPHALT
ETERNAL	214	29	7	EMCRACE
EXCEPTION	260	40	9	EMIDENCE
EXTENT	267	110	6	ENTERTAIG
EXTRA	262	50	5	EPISONE
EXTREME	265	62	7	ERPOSURE
FACILITY	279	11	8	ESTRONOMY
FAILURE	282	89	7	FARL
FANTASY	295	14	7	FIRT
FATE	255	33	4	FLANCHISE
FOOLISH	244	16	7	FLAURISH
FORE	300	7	4	FLYTH
FREEDOM	277	128	7	FOLM
GAIETY	275	8	6	FOREHOAD
GALLANT	240	5	7	FORG
GENEROUS	260	25	8	FUBMARINE
GOODNESS	275	16	8	GALLOC
GRATITUDE	239	9	9	GESTUXE
GUESS	247	56	5	GLAY
HARDLY	223	106	6	GOAV
HARM	244	25	4	GOUNGER
HASTY	290	5	5	GRABE

HOPE	261	178	4	GROTHER
HOSTILITY	277	6	9	HETEL
HUMBLE	231	18	6	HIEVARCHY
IDEAL	253	61	5	HOMICIVE
IGNORANCE	249	16	9	HONTEX
ILLUSION	249	37	8	IDUCATOR
IMPULSE	271	20	7	ILFECTION
INACTION	297	6	8	IMBULANCE
INFLUENCE	280	132	9	INCATABLE
INNOCENCE	247	28	9	INVENTIOK
INSIGHT	270	22	7	JAGAZINE
INSOLENCE	248	6	9	JEAR
INSTANCE	284	82	8	JOLF
INTEGRITY	247	10	9	JUSTIPE
INTELLECT	254	5	9	KEOGRAPHY
INTENTION	285	36	9	KESULT
INTIMATE	281	21	8	KINSDOM
IRONY	243	12	5	KLIGHT
JOIN	292	65	4	LAUGHTEX
JUSTIFY	289	26	7	LEADUR
KEPT	264	186	4	LECKER
KINDNESS	261	5	8	LERTER
KNOWN	226	245	5	LIVY
LATE	262	179	4	LOMBY
LEGENDARY	272	6	9	MAGNITUKE
LESSEN	287	5	6	MAKIR
LITERAL	295	15	7	MATHOD
LOGIC	250	17	5	MESSENTER
LOSE	299	58	4	METOL
LOYALTY	261	22	7	MOFUMENT
LUCK	275	47	4	MOLECULT
MAGIC	257	37	5	MOMEST
MANNER	297	124	6	MOTIR
MARVEL	293	6	6	MUAN
MASTERY	279	10	7	MYNTH
MEANT	226	100	5	NERM
MEEK	299	10	4	NIBRARY
MEMORY	284	76	6	NIREPLACE
MERCY	239	20	5	ONGINEER
MIRACLE	282	16	7	ONSURANCE
MOOD	234	37	4	OPENINT
MORAL	220	142	5	OPPONECT
MOTIVE	255	22	6	OVEAN

MYSTERY	256	39	7	PAPITOL
NECESSITY	273	40	9	PAQS
NEGLECT	282	12	7	PARDOB
NICE	279	75	4	PEFRAIN
NONE	288	108	4	PERMANEND
NONSENSE	256	13	8	PERSAN
NOWHERE	222	29	7	PESSAGE
OBEDIENCE	238	9	9	PESSAGE
OBSESSION	243	5	9	PHYSOCS
OKAY	245	20	4	PINDOW
OPINION	285	96	7	PLID
OPTIMISM	240	15	8	PLUB
ORIGINATE	285	6	9	POHETRY
PASSION	300	28	7	POLICEMAF
PATHETIC	256	8	8	POLLYTRON
PATIENCE	266	22	8	POURTEOUS
PIOUS	288	10	5	POZZLE
PREDICT	288	8	7	PRODUCH
PRESTIGE	248	29	8	PUNSE
PREVALENT	255	5	9	QAMMER
PRIDE	270	42	5	REACK
PURPOSE	280	149	7	RECALP
QUALITY	274	114	7	REGIOX
QUICKLY	292	89	7	RELIGIEN
REALITY	296	79	7	RIDICULN
RECOMMEN D	278	25	9	ROLT
REGRET	260	9	6	ROMATION
RELUCTANT	263	15	9	RONT
RESPECT	280	125	7	ROUSEHOLD
RESTORE	275	9	7	RUTCHER
RETENTION	280	12	9	SAFT
RISK	290	54	4	SALL
RULE	286	73	4	SAMAGE
SALVATION	269	32	9	SANCTUAVY
SANE	290	8	4	SCHALAR
SATIRE	287	9	6	SELLEN
SCARCE	297	6	6	SERVAPT
SECURITY	290	91	8	SHAOTIC
SEEM	226	229	4	SHILLY
SENSATION	265	14	9	SILVEH
SENT	292	145	4	SIWER
SEVERE	286	39	6	SKEN

SHAME	287	21	5	SNUDENT
SLOW	293	60	4	SONDIER
SOON	261	199	4	STANX
SORROW	282	9	6	STEOM
SOUL	289	47	4	SUARTER
SPITE	262	56	5	SUNSHINT
SUCCESS	295	93	7	SURPRYSE
SUFFRAGE	283	5	8	SWEAK
SUSPICION	265	27	9	SWEMMING
SYMBOLISM	273	8	9	THROAG
TALENT	290	40	6	THUNCER
THEORY	287	129	6	TOBEN
THEREFORE	199	205	9	TUNNING
TOLERANT	265	9	8	ULDER
TRADITION	291	94	9	UNIQUT
TRUST	300	52	5	UNTERANCE
TRUTH	261	126	5	URBUN
UNANIMITY	250	5	9	VEGETAPLE
UNIQUE	300	58	6	VEREMONY
UNKNOWN	222	47	7	VIGN
UNLIMITED	263	13	9	VOIN
UPKEEP	299	6	6	VOOL
UPSET	282	14	5	WARK
USUAL	235	96	5	WELLOW
VAGUE	272	25	5	WENNY
VANITY	250	7	6	WHEEC
VARY	258	34	4	WIKE
VENTURE	295	19	7	WILEAGE
VIRTUE	243	30	6	WITNENN
WEAKNESS	257	46	8	WRATE
WEIRD	253	10	5	WRENG
WHOM	243	146	4	WUIT
WISE	268	36	4	YACATION
WISH	270	110	4	ZAINT
WORTH	257	94	5	ZAYLIGHT

Table 1

Means, Standard Deviations, and Accuracy for Three Conditions

Condition	Mean (ms)	Standard Deviation	% Error
Baseline	598	94.3	8.0
Primed	571	77.0	5.1
Antiprimed	580	76.7	7.6

Table 2

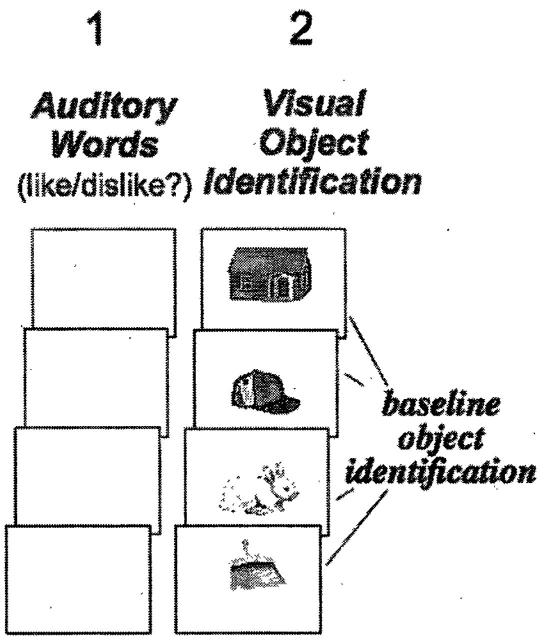
Means, Standard Deviations, and Accuracy with Modified Baseline

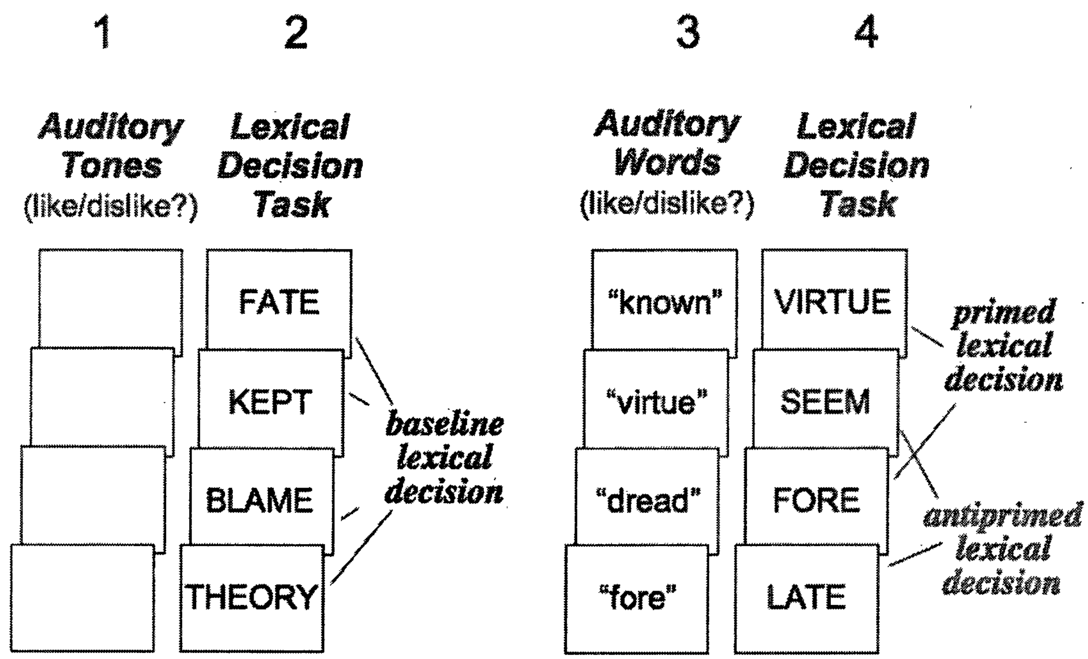
Condition	Mean (ms)	Standard Deviation	% Error
2nd half of Baseline	586	96.7	8.0
Primed	571	77.0	5.1
Antiprimed	580	76.7	7.6

Figure Captions

Figure 1. A diagram of the procedure for the Marsolek et al. (2006) experiment. In phase 1, participants listen to object names and perform a like/dislike judgment. Phase 2 is an object identification task that measures baseline accuracy. Phase 3 repeats the task from phrase 1 with participants listening to words, which serves to prime them. Phase 4 is an object identification task with half of the objects repeated from phase 3 and half of the words new. The accuracy of the primed objects measures any priming and the accuracy of the new objects measures any antipriming.

Figure 2. A diagram of the procedure for the experiment. In phase 1, participants listen to tones and perform a like/dislike judgment. Phase 2 is a lexical decision task that measures baseline response time. Phase 3 repeats the task from phrase one with participants listening to words, which serves to prime them. Phase 4 is a lexical decision task with half of the words repeated from phase 3 and half of the words new. The response times for the primed words are to measure any priming and the response times for the new words are to measure any antipriming.


1
2
3
4
Auditory Words
(like/dislike?)
Visual Object Identification
Visual Objects
(like/dislike?)
Visual Object Identification
baseline object identification
primed object identification
antiprimed object identification


1
2
3
4
Auditory Tones (like/dislike?)
Lexical Decision Task
Auditory Words (like/dislike?)
Lexical Decision Task
FATE
KEPT
BLAME
THEORY
baseline lexical decision
"known"
"virtue"
"dread"
"fore"
VIRTUE
SEEM
FORE
LATE
primed lexical decision
antiprimed lexical decision