ANALYTIC LIMITATIONS OF UNCONSCIOUS LANGUAGE PROCESSING

by

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Abstract

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Cognitive theorists have assumed that unconscious cognition, due to inherent analytic limitations, plays a minor role in language comprehension relative to conscious systems. The following research tested this assumption by examining whether the analytic powers of unconscious cognition include the ability to process the meanings morphologically complex words and simple grammatical constructions. Four experiments used variations of a two-choice, subliminal priming paradigm (Greenwald, Draine, & Abrams, 1996) to assess unconscious processing of (1) grammatically uncombinable word pairs, (2) two-word grammatical negations, (3) one-word lexical negations, (4) compound words, (5) and noun phrases. Experiments 1 demonstrated unconscious semantic processing of multiple, uncombinable words. Experiment 2 demonstrated unconscious sensitivity to the meanings of the constituents of two-word phrases, but not to phrase-level meanings. Results of Experiment 3 showed weak evidence for unconscious processing of lexical negation. In Experiment 4, priming effects were obtained for supraliminal noun phrases and compound words, but subliminal conditions showed no evidence for unconscious processing of the primes. The findings indicate that unconscious linguistic analyses are limited to activation of stored lexical representations of morphologically simple words. Semantic representations of unstored linguistic constructions such as phrases and morphologically complex words, in contrast, are constructed on line by conscious cognitive systems.

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Glossary

Subliminal. Marginally perceptible

List of Abbreviations

SPA. Subliminal Psychodynamic Activation

SSA. Subliminal Semantic Activation

SOA. Stimulus Onset Asynchrony

EV. Effective Valence

EG. Effective Gender

Preface

[Click and type preface]

Acknowledgments

The author wishes to [Click and type acknowledgments]

Dedication

The author wishes to dedicate this dissertation to Zeke, Axl, Karen, and Anders.

Introduction

Conscious cognition has been implicated by various language processing theories as playing an important role in the cognitive analysis of grammatical constructions such as phrases and sentences. In particular, much of psycholinguistic theory has focused on the role of working memory in syntactic processing. The exact role played by working memory in syntactic analysis has varied from one theoretical account to the next depending upon the theory's assumptions about the functional architecture of the language processing system. For example, some theorists have maintained that syntactic processing involves a distinct, language-specific form of working memory, while others have proposed, more generalized, highly integrated working memory systems. Whatever the architectural bias, parsing theories have generally agreed on two important claims; a) syntactic processing involves the expenditure of some form of conscious working memory resources, and b) the working memory resources required to process syntax are finite in capacity.

Evidence linking working memory to syntactic processing has largely consisted of demonstrations that individual differences in working memory capacity predict the speed and accuracy of sentence comprehension. King and Just (1991), for example, have shown that readers with high working memory capacity, as measured by the *Reading Span* task (Daneman & Carpenter, 1980), comprehend complex embedded sentences faster than low capacity readers. Furthermore, high capacity readers are better able to use context information in order to construct the meaning of unfamiliar words (Daneman & Green, 1986), and are better able to resolve apparent semantic inconsistencies within and between sentences (Daneman & Carpenter, 1983). Finally, age-related working memory deficits have been shown to impair ability to repeat syntactically complex sentences (Kemper, 1986).

That working memory is a finite resource, whereas the processing demands imposed by language are potentially limitless, poses an important problem to theories of sentence comprehension. Most theorists have addressed the limited capacity issue by assuming that working memory is equipped with a number of mechanisms that ensure efficient allocation and de-allocation of its resources. For example, in their Sausage Machine model, Frazier and Fodor (1978) addressed the limited capacity issue by supposing sentence parsing to occur in two stages. The first stage packages incoming streams of words into discrete, grammatically structured phrase representations (i.e., “sausage links”) whose maintenance requires less working memory than do representations of the initial raw input stream. Once the high-level representations have been constructed, the low-level information can then be flushed from memory. This packaging process is comparable to chunking in that information stored in long term memory (in this case, syntactic knowledge) is used to organize the contents of working memory into a more memory-efficient form. The chunks (i.e., phrase representations) are then analyzed by a second processing stage that builds high-level sentence and thematic representations.

In their *Capacity Constrained READER* (CC READER) model of sentence comprehension, Just and Carpenter (1992) instantiated several memory management techniques that have been established in the sentence comprehension literature as likely mechanisms for preventing working memory overload. For example, CC READER selectively allocates more memory towards maintaining representations of the most recent sentences and the most central clauses (Glanzer, Fischer, & Dorfman, 1984). The model also uses stored context information in order to facilitate interpretation of incoming information (Sanford & Garrod, 1981). In a manner similar to Frazier and Fodor’s Sausage Machine, CC READER discards low-level information as soon as more efficient, high-level representations of that information have been constructed.

In summary, most psycholinguistic research has addressed the limited capacity issue by examining whether working memory is equipped with various memory management schemes. In this paper, I explore an alternative, complementary theoretical strategy for addressing the limited capacity issue — that of abandoning the assumption that *all* forms of syntactic parsing necessarily consume limited working memory resources. More specifically, I will evaluate a theory of syntactic processing that makes the following three assumptions. First, syntactic processing is to some extent *modular* in the sense defined by Fodor (1983). Second, different kinds of grammatical constructions and syntactic operations are processed by different modules. Third, and most controversially, the computational activities of modules that process the most elementary grammatical constructions are *unconscious* in the sense that they are the automatic, inevitable result of exposure to linguistic stimuli. To the extent that grammatical operations are stimulus-driven, they need not be fueled by limited conscious cognitive resources such as working memory or attention.

Chapter 1: Background

Is Syntactic Processing Modular?

Fodor (1983) described cognitive modules, or *input systems*, as having several defining properties. The operations of input systems are domain specific, handling only information relevant to a particular sensory modality, stimulus type, or processing stage. Input systems are functionally encapsulated, autonomous neural ensembles whose internal workings are impenetrable to conscious introspection. Finally, the computations performed by input systems are fast and mandatory. Importantly, Fodor left open the question of whether input systems require focal attention in order to function. According to Fodor, input systems may completely shut down if unattended, or they may continue to operate but their output is no longer transferred to more persistent, consciously accessible memory buffers such as working memory.

Fodor and others (Posner & Snyder, 1975; Schneider & Shiffrin, 1977) have suggested that the more frequently encountered a stimulus domain, the more plausible it should be that the domain is processed by automatic input systems as opposed to slow, more generalized, controlled systems. This suggestion follows from the intuitions that a) the brain's functional architecture is shaped to some extent by pressures towards efficiency, and b) processing efficiency would be increased if fast, specialized cognitive structures were dedicated to processing the most frequently encountered stimulus domains. A modular brain architecture may have evolved through natural selection at the genetic level, as nativists such as Chomsky (1968) have argued with respect to language processing, and others have argued with respect to face perception (Farah, Wilson, Drain, Tanaka, 1995; Nachson, 1993). Conceivably, modularity could also be the result of Darwinian-like selection of neural circuits throughout the developmental course of a given individual. That is, modularity could be the result of learning (Shiffrin & Schneider, 1977).

Although the details of Fodor’s modularity hypothesis have been much disputed, most psycholinguists agree that syntactic processing is handled to some extent by cognitive components that are separable from central, superlinguistic forms of cognition. The most compelling evidence for modular syntactic processing comes from research on Broca’s aphasics, who tend to show functional deficits specific to the analysis of syntax. The speech output of Broca’s aphasics is typically limited to simple declarative forms and rarely includes articles or inflected verbs (Goodglass & Kaplan, 1972). Broca’s aphasics also have deficits in the comprehension of syntactic but not semantic information as demonstrated by Caramazza and Zurif (1976) in their well-known study. Caramazza and Zurif compared comprehension of center embedded sentences whose relational structure could be determined through both syntactic and semantic constraints (e.g., “The apple that the boy is eating is red.”) or through syntactic analysis alone (e.g., “The boy that the girl is chasing is tall.”). The relational structure of the former sentence could be assigned from the nongrammatical knowledge apples are red, boys eat but apples do not, and so on. The relational structure of the latter sentence, however, can only be recovered through syntactic analysis because both boys and girls can be tall. The experiment showed that Broca’s aphasics comprehended the former type of sentence almost as well as nonaphasic subjects but showed marked deficits in comprehending the latter. These findings have been widely interpreted as showing that syntax and semantics are processed by functionally and anatomically distinct systems and that Broca’s aphasia entails damage to the syntactic system (Berndt & Caramazza, 1980; Caplan, 1985; Grodzinsky, 1986; Linebarger, 1995).

Although the theoretical landscape surrounding Broca’s aphasia has been dominated by modular accounts syntactic processing, some nonmodular explanations of syntactic deficits have recently been proposed (e.g., Frazier and Friederici, 1991; Miyake, Carpenter, & Just, 1994). Nonmodular accounts have suggested that the lesions associated with Broca's and other types of aphasia result in a reduction of working memory resources that are used in the processing of both syntactic and semantic information. Aphasics may show syntax-specific deficits, however, because syntactic processing is especially resource intensive.

Although working memory accounts of syntactic processing can explain syntactic deficits in Broca's aphasia, such accounts are more difficult to reconcile with the findings of other aphasia research. For example, McCarthy and Warrington (1987) studied 2 conduction aphasic patients with impaired working memory spans (measured by a digit recall task) and 1 transcortical sensory aphasic whose memory span was intact. McCarthy and Warrington measured the patients' abilities to repeat a) sentences consisting of up to 7 words, and b) lists consisting of 3 words. They found that the span-impaired patients were better at repeating sentences than word lists, but that the span-preserved patient was better at repeating word lists than sentences. Syntactic processing was thus intact for the patients with impaired working memory and impaired for the patient with intact working memory. This pattern of results is clearly problematic for comprehension models that attempt to explain syntactic processing solely in terms of working memory. In summary, nonmodular, working memory accounts of syntactic processing remain controversial and have not been widely embraced.

Do Language Systems Include Syntax-Specific Modules?

The second assumption to be examined in this paper is that different grammatical constructions may be processed by different cognitive modules. Most theories of parsing acknowledge that some grammatical constructions are more difficult to comprehend than others. For example, sentences with a center-embedded, object relative clause (e.g., "The reporter that the senator attacked admitted the error.") are notoriously difficult to process, and subjects asked to paraphrase such sentences make errors approximately 15% of the time (Larkin & Burns, 1976). In contrast, sentences containing subject-relative clauses (e.g., "The reporter that attacked the senator admitted the error.") are comparatively easy to process (Holmes & O'Regan, 1981). As another example, active sentence constructions have been shown to be more easily comprehended than passive constructions (Gough, 1966). These differences in processing difficulty are commonly explained in terms of working memory demands — some grammatical constructions are difficult to comprehend because they require more memory resources. When the resource demands of a grammatical construction actually exceed memory capacity, comprehension errors may occur (King & Just, 1991).

Some researchers have argued in favor of the stronger claim that some grammatical constructions are processed by entirely different cognitive systems than others. The most compelling evidence that cognitive structures may be dedicated to specific grammatical constructions consists of demonstrations of ‘double dissociations’ in aphasia research. A double dissociation occurs when one class of aphasics is able to process grammatical construction X but not construction Y, whereas another class of aphasics is able to process construction Y but not construction X. Double dissociations are difficult to explain solely in terms of global working memory deficits, because working memory deficits should not selectively impact different grammatical constructions across different patients. If construction X requires more memory resources to process than construction Y, then all patients with global working memory deficits should have more difficulty with X than Y.

Caplan, Baker, and Dehaut (1985) examined syntactic comprehension deficits in patients with a variety of different language aphasias and found a double dissociation between aphasia classification and syntactic processing. Specifically, Caplan et al found that one group of aphasics was able to process conjoined sentences (e.g., “The elephant hit the monkey and hugged the rabbit.”) quite well, but had difficulty with subject-relative sentences (e.g., “The elephant hit the monkey that hugged the rabbit.”). A second group, in contrast, found the subject-relative sentences easy to process but the conjoined sentences difficult. Druks and Marshall (1995) found a double dissociation in comprehension of active and passive sentences. Specifically, they examined comprehension skills of two Broca’s aphasics and found that one could comprehend active but not passive sentences, whereas the other could comprehend passive but not active sentences. Caplan et al (1985) have argued on the basis of such findings that brain lesions cause deficits associated with comprehension of specific kinds of syntactic structures. These syntax-specific deficits, in turn, indicate that different kinds of syntactic operations are processed by functionally and anatomically distinct parsing mechanisms. The findings are thus inconsistent with claims that aggramatical aphasics suffer from deficits of a global parsing mechanism (Berndt & Caramazza, 1982) or general working memory resources (Miyake et al, 1985).

Is Syntactic Processing Unconscious?

The third assumption examined in this paper is whether processing of some syntactic constructions is handled by unconscious cognitive systems. That is, given the assumption that different modules process different syntactic constructions, is it possible that some of these modules operate unconsciously? The term ‘unconscious’ has at least two different uses in psycholinguistic theory. First, a given linguistic analysis may be considered unconscious insofar the computations and mechanisms underlying it are not subject to conscious introspection. Syntactic processing is widely considered to be unconscious in the this sense (Chomsky, 1968). A linguistic analysis may be unconscious in a second, stronger sense if a) its underlying computations and mechanisms can not be introspected, and b) it can be carried out upon linguistic input that is not consciously perceived. Whether some forms of syntactic analysis are unconscious in this second, stronger sense is the main concern of this paper. The intended meaning of the term ‘unconscious’ as used in this paper is given by the second definition.

Claims that certain linguistic operations are performed unconsciously have typically rested upon demonstrations of *subliminal semantic activation*[1] (SSA). SSA is

[1]The term ‘subliminal’ has fallen out of favor among cognitive psychologists because of its association with now discredited theories of a perceptual threshold. The term is nevertheless used in this paper as shorthand for ‘marginally perceptible’ because of its accessibility to nontechnical audiences.

operationally defined as evidence for indirect effects of the semantic content of word stimuli (e.g., semantic priming effects) that are presented under conditions in which performance on direct measures of the perceptibility of those stimuli is at chance (Greenwald, Klinger, & Schuh, 1995). Following Marcel's (1983) controversial report of subliminal semantic priming effects obtained with single word stimuli, SSA phenomena became the focus of much attention and controversy among psychologists. Despite numerous claimed demonstrations of SSA effects[2], the validity of SSA remained in question throughout the 80's. One reason for the skepticism was Holender's (1986) well-known and well justified methodological critique of procedures used to establish that stimuli were not in fact consciously perceptible. A second reason was that whenever SSA effects *were* obtained, they were difficult to reproduce and were usually associated with very small effect sizes.

The decade-long empirical controversy surrounding SSA gave birth to a number of important theoretical and methodological advances in the study of unconscious perception (e.g., Reingold & Merikle, 1988; Greenwald, Klinger, & Schuh, 1995; Greenwald & Draine, 1996). Recently, Greenwald, Draine, and Abrams (1996; see also Draine and Greenwald, in press) introduced a methodological paradigm designed to remedy the problems of past SSA research. Greenwald et al (1995) introduced a regression method for comparing indirect and direct effects of subliminal text in order to address the problems of previous attempts to establish stimuli as consciously imperceptible. In addition, Greenwald et al. 1996) introduced a response window procedure that constrained latencies to fall within a narrow time band, thereby concentrating subliminal priming effects onto accuracy measures. The response window procedure produced SSA effects that were much larger than had previously been obtained. With the regression method and response window procedure, Greenwald et al.

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[2] See, for example, Avant & Thieman, 1985; Balota, 1983; Brown & Hagoort; Dagenbach, Carr, and Wilhelmsen, 1989; Doyle and Leach, 1988; Fowler, Wolford, Slade, & Tassinary, 1981; Greenwald, Klinger, and Liu, 1989; Groeger, 1988; Hirshman and Durante, 1992; Kostandov, 1985; Shevrin, 1988

(1996) were able to produce and consistently reproduce robust subliminal semantic priming effects. These findings indicated that unconscious systems are capable of extracting semantic information from single, morphologically simple words.

Perhaps because of the controversy that has surrounded research on SSA with single words, few investigators have attempted to demonstrate what Greenwald (1992) labeled the “the two-word challenge” — the task of demonstrating SSA effects of multiword grammatical constructions. Greenwald outlined two essential methodological ingredients for any attempt to meet the challenge. First, critical stimuli should be presented using masking procedures in order to ensure that any measurable behavioral influences of the stimuli are indeed unconscious. Second, two-word stimuli should be chosen so that the meaning of the two-word sequence is not communicated by either word individually.

Findings that successfully meet the two-word challenge could be explained using either of two theoretical approaches. First, it could be argued that unconscious cognitive systems are ‘smarter’ than most contemporary psychologists have allowed. According to this view, unconscious systems are equipped with resources for deriving higher order semantic information from combinations of multiple words. The capabilities of unconscious linguistic analyses thus extend beyond simple lexical processing. This view challenges the prevailing view of unconscious linguistic processing as being analytically mundane. A second interpretation, however, is that the language processing system may be designed such that some forms of linguistic input that appear to be complex are actually processed in mundane ways. For example, some complex linguistic constructions such as phrases may become represented in lexical memory as independent lexical units, thus achieving the psycholinguistic status of a single word. The language processing system could then process these constructions in the same way that it processes single words. Swinney & Cutler (1979) have argued that common idiomatic expressions such as “chew the fat” or “break the ice” may be given single lexical representations. Possibly, other kinds of phrases may also become lexicalized if they are encountered with sufficient frequency.

A Summary of Research on Unconscious Processing of Multiword Strings.

To date, the cognitive literature contains only one published attempt to meet the two-word challenge. Greenwald and Liu (1985) attempted unsuccessfully to demonstrate two-word SSA effects using an evaluative priming task. Prime stimuli were two-word sentences, the meanings of which were uncorrelated with the meanings of the individual constituent words (e.g., “enemy loses”, “friend wins”). Although significant subliminal priming effects were obtained, the direction of the effects was determined by the meanings of constituent words rather than sentences-level meanings. For example, sentences like “enemy loses” (whose sentence-level meaning is pleasant and constituent word meaning is unpleasant) functioned as evaluatively negative primes.

Some evidence for unconscious processing of multiword strings has been obtained in clinical research. Using a method called *subliminal psychodynamic activation* (SPA), Lloyd Silverman and others have found that repeated subliminal exposures to the sentence “MOMMY AND I ARE ONE” (as compared to a control stimulus such as “PEOPLE ARE THINKING”) reduced pathology in schizophrenics (Silverman, Spiro, Weisberg, and Candell, 1969), improved academic performance (Ariam & Siller, 1982), and improved success rates of people trying quit smoking (Palmatier & Bornstein, 1980). According to Silverman and Weinberger (1985), SPA effects result from the unconscious gratification of “powerful, wishes for a state of oneness with ‘the good mother of early childhood’.” Although Silverman’s psychodynamic conjectures have not been widely embraced, the effectiveness of the subliminal psychodynamic method seems to be empirically reliable. Weinberger and Hardaway (1990; see also Hardaway, 1990) tallied the results of 87 journal reports and unpublished doctoral dissertations that tested SPA, concluding that 59 of the reports were clearly supportive of the phenomenon, 17 were mixed, and 11 were clearly unsupportive.

Silverman's interpretation of SPA implies that the unconscious is capable of parsing complete sentences. Do the results in fact meet (or surpass) the criteria of the two-word challenge? Several commentators (Balay & Shevrin, 1988; Fudin, 1986; Greenwald, 1992) have suggested that the ameliorative effects of the critical sentence observed in Silverman's experiments could possibly have resulted from activation triggered by any of the individual constituent words (e.g., MOMMY, I, or ONE). Remarkably, this hypothesis seems not to have occurred to Silverman — neither he nor his colleagues conducted experiments in order to confirm or disconfirm the single word interpretation. However, several experiments (Bronstein & Rodin, 1983; Kaplan, Thornton, and Silverman, 1985) did test close variations of the standard sentence (e.g., MOMMY AND I ARE THE SAME). In those studies, ameliorative effects were significantly larger for the standard sentence than for the alternative sentences, providing some support for Silverman's claim that the standard sentence is unconsciously processed in full. The results, however, do not permit any strong conclusion to be drawn.

The lack of conclusive evidence for or against unconscious processing of complex stimuli has left room for other extravagant claims regarding the processing of subliminal input. Marketers of subliminal self-help audio-tapes, for example, have claimed that subliminal stimulation may have a range of beneficial effects including improved memory, higher self-esteem, and weight loss. These tapes are alleged to contain spoken messages recorded at volumes too low to be consciously heard. The messages are usually affirmative sentences such as "I have high self-worth and high self-esteem" and "My ability to remember and recall is increasing daily". Evidence that these sentences work as claimed would suggest that the meanings of sentences were unconsciously comprehended. Several double-blind experiments have been conducted in order to evaluative these claims (e.g., Greenwald, Spangenberg, & Eskenazi, 1991; Merikle & Skanes, 1992; Russel, Rowe, & Smouse, 1991). Without exception, the results of these studies have shown no beneficial effects of subliminal content. These results clearly show that the subliminal messages do not have ameliorative effects. They do not, however, rule out the possibility that the semantic content of the messages is nevertheless unconsciously registered.

In summary of the evidence for unconscious processing of multiword strings, only one experiment (Greenwald & Liu, 1985) has used methods that were rigorous enough to directly test whether some syntactic constructions can be processed unconsciously. Although several experiments have examined the potentially beneficial effects of subliminal exposure to grammatical constructions, the results of these studies have been inconclusive with respect to whether unconscious cognitive systems are capable of performing syntactic operations. The present research is intended to fill this empirical void by examining subliminal priming effects of a variety of linguistic constructions including morphologically complex words and 2-word phrases. These experiments employed methods that have been successfully used to demonstrate SSA effects with single words.

Chapter 2: Grammatically Uncombinable Words - Experiment 1

Possibly, there are constraints on amount of lexical information that can be processed and stored by unconscious systems at a given time. Such constraints would limit the range of multiword grammatical constructions that could be unconsciously processed. If the capacity of unconscious lexical processing were limited, for example, to a single word at a time, unconscious syntactic combinations of two or more words would be impossible because at no point would more than one word be available for analysis. Experiment 1 sought to establish whether the semantic capacity of unconscious cognition is limited to a single word at a time, or whether meaning can be unconsciously extracted and stored from multiple words in parallel. Unconscious semantic capacity was tested using a variation of the evaluative priming task in combination with the response window procedure (Draine & Greenwald; in press). Prime stimuli on a given trial consisted of a single evaluative word, or two grammatically uncombinable evaluative words. If magnitude of subliminal priming effects is larger on trials with 2 prime words than on those with just 1, it could be concluded that the meanings of both primes had been unconsciously processed in parallel.

Method

Subjects

Subjects were 34 undergraduate students at the University of Washington who volunteered to participate in exchange for extra credit in an introductory psychology course. All were fluent in English and had normal or corrected-to-normal vision. One subject's data showed unusually short response latencies (100 - 200 ms) and excessively high error rates and consequently was omitted from the reported analyses.

Materials

Stimuli consisted of 50 evaluatively polarized words, half of which were pleasant in meaning and half of which were unpleasant. Stimuli were drawn from the list of Bellezza, Greenwald, and Banaji (1985) by selecting 25 unpleasant words from the low end of the distribution of normative pleasantness ratings and 25 pleasant words from the high end. Selected words were from 4 to 8 letters long and were pronounceable in one or two syllables. The complete list of word stimuli is given in Appendix A. A final set of 25 non-word stimuli was constructed from the set of unpleasant stimuli by replacing each character in those words alternately with an X or a G (e.g., the replacement for EVIL could be GXGX or XGXG).

Apparatus

Up to three subjects participated concurrently, each in a separate cubicle with a 33-cm (diagonal) color monitor and keyboard controlled by an IBM/AT-type (80486) computer. A fan motor in each cubicle produced background white noise to mask extraneous sounds. Subjects viewed a color SVGA display (640 by 480 pixel resolution) from a chin-rest positioned 65 cm away from the display. Subjects responded on all experimental tasks by pressing either the standard keyboard's "A" key with the left forefinger or the "5" key (on the numeric keypad) with the right forefinger.

Procedure

Stimulus Sequence: Subliminal and Supraliminal Trials. All stimuli were presented in fixed-width black, upper-case letters on a strip of light gray background (1 character space tall and 21 character spaces wide) centered on the otherwise dark gray screen. Subliminal trials began with simultaneous presentation of two non-overlapping strings of 13 consonant letters (e.g., KQHYTPDQFPBYL), one positioned just above the other such that the mid-line between the two stimuli was also the mid-line of the screen. These stimuli marked the beginning of a trial and also served as forward masks. The forward masks remained on the screen for 150 ms and were then replaced, respectively, by 2 non-identical prime stimuli drawn from the sets of pleasant words, unpleasant words, and non-words. Both prime stimuli remained on the screen for 50 ms, after which they were each replaced by 2 backward masks. The backward masks remained on the screen for 17 ms and were then immediately replaced by a blank. Exactly 83 ms after the onset of the prime stimuli, a single, clearly visible target word was presented that was drawn from the sets of pleasant and unpleasant words (but not from nonwords). The target word was replaced after 333 ms by an exclamation point that defined the response window. The window center was initially 400 ms following target onset and the window width was 133 ms. (The exclamation point was thus on screen from 333 to 317 ms after the target word onset.) The next trial started 600 ms after the subject pressed a response key.

The display sequence for supraliminal trials was identical to that of subliminal trials except that centered fixation points (*) were presented in place of the forward masks in order to indicate the beginning of the next trial, and blanks were presented in place of the backward masks. Supraliminal presentations were included in the experiment in order to examine semantic priming in conditions in which subjects could consciously perceive the primes but were unable to attend to them due to the heavy processing demands of their task.

The Response Window Procedure. Subjects were instructed to ignore the mask and prime stimuli and to classify the target words as either unpleasant or pleasant by pressing the left or right response key, respectively. For trials using the response window, subjects were instructed to respond while the black exclamation point was on the screen. Feedback for success in responding during the window interval was provided by the exclamation point's behavior. If the response occurred before the window, the exclamation point never appeared on the screen. If the response occurred during the window interval, the exclamation point changed from black to red and remained on the screen for the remaining 300 ms of the trial. If the response occurred after the window, the exclamation point disappeared from the screen without changing color.

For all subjects, the response window was initially centered at 400 ms after onset of the target word. The response window thus obliged most subjects to respond more quickly and to make more errors than they normally would under standard reaction time instructions to respond as quickly possible while keeping errors to a minimum. At the end of each block, the window center could be made shorter by 33 ms, longer by 33 ms, or could remain unchanged, depending upon the subject's performance in that block. The window center was made shorter if the subject's error percentage was less than or equal to 20% *and* the subject's mean response latency for that block was no more than 100 ms greater than the current window center. The window center was made longer if the subject's error percentage was greater than or equal to 45% *and* the subject's mean response latency was more than 100 ms longer than the current window center. If neither of these sets of conditions was met, the window center was not changed.

Evaluative classification task: Practice and data collection. Each subject initially performed 200 practice trials at the evaluative classification task. The first block of 50 practice trials presented only target words (no masks or primes). Subjects then performed a block of 25 trials in which supraliminal primes were presented, and a second block of 25 trials with subliminally presented primes. On all of these trials, subjects received immediate feedback in the form of the displayed word ERROR if they incorrectly classified the target word. At the end of each of these blocks, subjects were informed of their percentage of correct responses for that block.

The next block of 50 practice trials introduced the response window procedure in conjunction with supraliminal primes, and a final block of 50 practice trials with the response window procedure in conjunction with subliminal primes. After each response, subjects were given feedback (described above) about success in responding during the window interval. On all response window trials, the ERROR message no longer appeared after incorrect responses. At the end of all practice and test blocks involving the response window, however, subjects learned their percentage success in responding within the window, and were encouraged to keep this percentage at 70% or higher. Additionally, they learned their percentage of correct classifications and were advised that, although relatively high error rates could normally occur, they should nevertheless try to respond as accurately as possible. After completion of practice, subjects performed 16 blocks of 50 trials (800 trials total) of the evaluative classification task during which data was collected. Presentation of primes alternated between subliminal and supraliminal conditions after each block.

Prime Stimulus Conditions. The critical independent variable of Experiment 1 was the stimulus set (pleasant words, unpleasant words, or nonwords) from which the two primes were drawn. Five combinations of stimulus sets were used: pleasant-pleasant, pleasant-nonword, pleasant-unpleasant, unpleasant-nonword, and unpleasant-unpleasant. Prime condition was varied within-blocks, randomly from trial to trial among the 5 conditions above. Each prime condition occurred equally often in conjunction with pleasant and unpleasant target words. For those conditions with primes from different stimulus sets (e.g., pleasant-nonword, pleasant-unpleasant, unpleasant-nonword), position was randomly varied so that both stimulus types were displayed equally often in the upper or lower position. Target words were randomly selected (from the same sets of pleasant and unpleasant words used for the primes) so that (a) each word appeared exactly once as the target within each block of 50 trials, and (b) the same word did not appear as a prime and target on the same trial.

Results

Computation of priming effects: Effective valence. Data from the evaluative classification task were analyzed using a measure referred to as *effective valence* (EV). A virtue of EV is that for each class of prime, it provides a single index of priming that uses information from both pleasant and unpleasant target trials. EV was computed, separately for the trials of each of the 5 prime conditions, as the proportion of trials on which unpleasant targets were incorrectly classified as pleasant minus the proportion of trial on which pleasant targets were incorrectly classified as unpleasant. The computation of effective valence is expressed in the following formula:

$$EV = P\left(Error \mid T_U\right) - P\left(Error \mid T_P\right),$$

where T_U are unpleasant target trials and T_P are pleasant target trials. To the extent that a class of prime stimuli increases error rates for unpleasant targets and/or decreases error rates for pleasant targets, EV for those primes increases. Conversely, to the extent that a class of primes increases error rates for pleasant targets and/or decreases error rates for unpleasant targets, EV for those primes decreases. Thus, EV provides an indirect measure of the valence of a class of prime stimuli. Given that baseline error rates for pleasant and unpleasant targets may differ, EV has no rational zero point. The measure can, however, be used to assess the relative effective valence of different classes of prime stimuli.

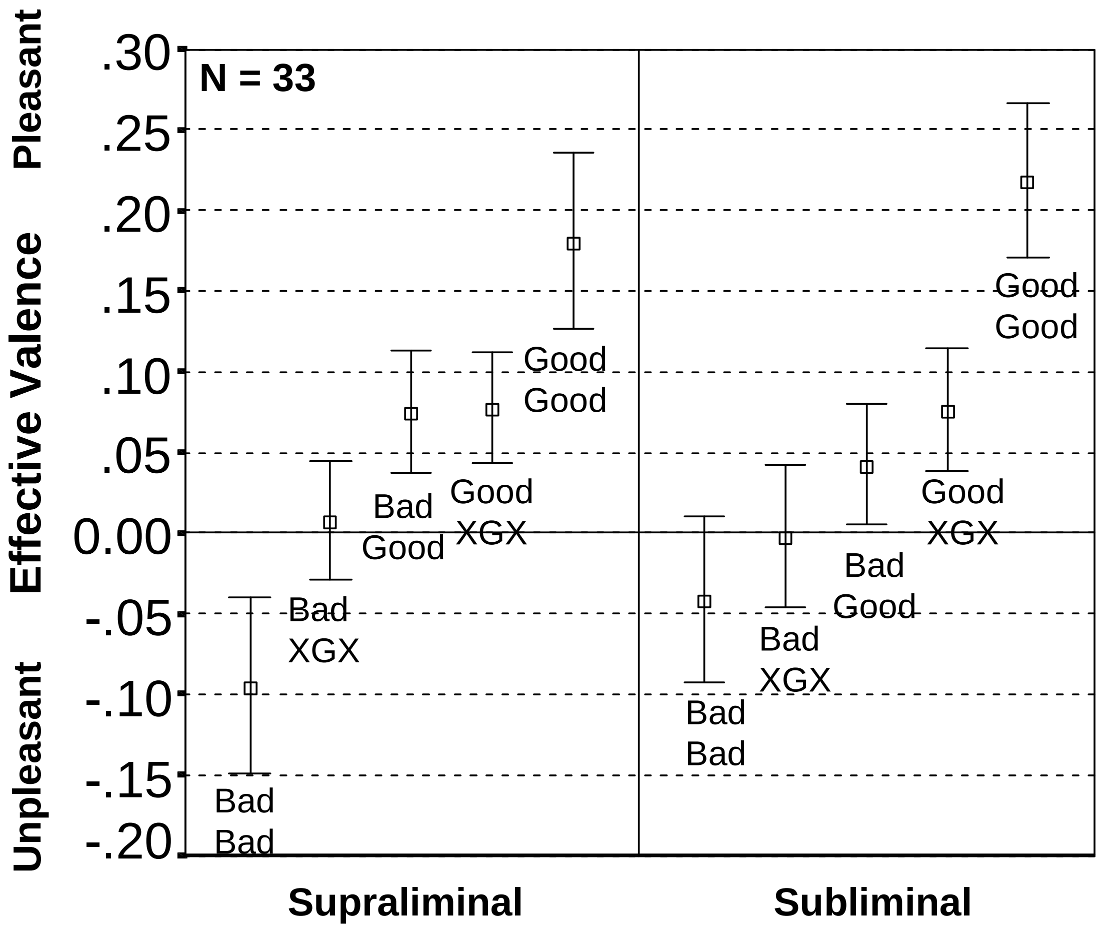

Figure 1. Effective valence for the 5 priming conditions of Experiment 1, separately for subliminal (left) and supraliminal (right) presentations (see text for definition of effective valence). Labels below the error bars indicate the categories of the prime stimuli — 'good' indicates pleasant words, 'bad' indicates unpleasant words, and 'XGX' indicates nonword stimuli. Error bars are 95% confidence intervals.

Significance Tests. Figure 1 shows the EV for each of the 5 prime conditions, in both supra- and subliminal presentation conditions. The figure shows that combinations of pleasant primes were higher in EV than combinations of unpleasant primes, and that this effect was larger for conditions involving two words than for those involving just one. This pattern was equally apparent in supra- and subliminal presentation conditions. Statistical strength of subliminal effects was tested using a 2X2 repeated measures ANOVA that examined the influence of the two factors — (1) *prime pole* (pleasant vs. unpleasant), and (2) *number of words* (1 vs. 2) — on the EV of subliminally presented primes (the PU priming condition was not included in this analysis). The analysis yielded a significant main effect of prime pole (F = 40.16, df = 32, p < .001), and a significant interaction between prime pole and number of words (F = 21.02, df = 32, p < .001). Significance tests for supraliminal priming yielded similar results — a strong main effect of prime pole (F = 43.64, df = 32, p < .001) that was significantly moderated by the number of words (F = 21.29, df = 32, p < .001). These tests indicated that in both supra- and subliminal conditions, pleasant primes were significantly higher in EV than unpleasant primes, and that this effect was significantly larger when two evaluatively polarized words were presented as opposed to just one.

Discussion

Experiment 1 demonstrated that magnitude of subliminal (and supraliminal) priming effects was larger for conditions involving 2 prime words than for those involving 1. The results indicate that unconscious processing of lexical information occurs in parallel and has a capacity greater than one word. These findings suggest that presentation of multiple word stimuli simultaneously activates the lexical representation of each word, producing a sum of activation greater than that of a single word stimulus. To the extent that priming magnitude reflects strength or quantity of activation, greater numbers of prime stimuli would therefore produce larger priming effects.

An alternative explanation of the findings is that subjects were able to consciously perceive more prime information on two-word than one-word trials. This seems plausible given the expectation that the probability of perceiving any single stimulus should increase with the total of number of stimuli presented. Comparison of subliminal and supraliminal priming effects, however, indicated that increased contributions from conscious cognition did not influence priming magnitude. Although visibility of the primes was much higher under supraliminal presentation conditions, the size of the one- and two-word priming effects did not differ between supra- and subliminal conditions.

In summary of the results of Experiment 1, unconscious cognition appears to have met a preliminary, minimal requirement for processing two-word grammatical constructions — the capacity to simultaneously process the meanings of two words.

Chapter 3: Grammatical Negations - Experiment 2

Experiment 1 provided evidence for unconscious semantic processing of pairs of words that could *not* be combined to form a meaningful phrase. Experiment 2, in contrast, was a direct attempt to meet the two-word challenge. Specifically, Experiment 2 sought evidence for unconscious processing of phrase-level meaning for grammatically combinable word pairs. Experiment 2 used a variation of the evaluative priming task in which prime stimuli were evaluatively polarized adjectives or two-word, grammatical negations of those adjectives. Grammatical negations were thus pleasant or unpleasant adjectives preceded by the word 'not' (e.g., `NOT STUPID`; `NOT CLEAN`; `NOT PRETTY`). A critical property of these stimuli was that their phrase-level meanings were evaluatively opposite to their component word meanings. Thus, phrases involving the negation of an unpleasant adjective (e.g., `NOT DIRTY`) were pleasant in meaning although the adjective components were themselves unpleasant. Similarly, phrases involving the negation of a pleasant adjective (e.g., `NOT NICE`) were unpleasant although the adjective components were pleasant.

This dissociation between phrase-level and component-level meaning allowed phrase-level priming effects to be easily distinguishable from component-level priming effects. Specifically, to the extent that phrase-level meaning is unconsciously processed, pleasant prime phrases should be relatively high in EV compared to unpleasant prime phrases. However, if component words are processed individually but not in combination, pleasant prime phrases (whose component words are unpleasant) should be relatively lower in EV than unpleasant prime phrases (whose component words are pleasant). In subliminal presentation conditions, evidence for unconscious phrase-level processing could thus take any of the following 3 forms: (a) higher EV for pleasant than unpleasant prime phrases, (b) higher EV for pleasant phrases than unpleasant adjectives presented alone, or (c) lower EV for unpleasant phrases than pleasant adjectives presented alone.

Method

Subjects

Subjects were 30 undergraduate students at the University of Washington who volunteered to participate in the experiment in exchange for extra credit in an introductory psychology course. All were self-described as fluent in English and as having normal or corrected-to-normal vision.

Materials

Stimuli consisted of a set of 50 adjectives, half of which were unpleasant in meaning and the other half of which were pleasant. A second set of 50 two-word phrases was generated from these adjectives by preceding each adjective with the word “NOT” (for example, “NOT CLEAN” was generated from “CLEAN”, “NOT DIRTY” was generated from “DIRTY”). The complete list of stimuli is given in Appendix B.

Procedure

Stimulus Sequence: Supraliminal and Subliminal Trials. With several important exceptions, the presentation procedure for Experiment 2 was identical to that of Experiment 1. In Experiment 2, a *single* string of 13 consonant letters (e.g., KQHYTPDQFPBYL) marked the beginning of subliminal trials and also served as a forward mask. The forward mask remained on the screen for 150 ms and was immediately replaced by an evaluatively polarized prime stimulus that remained on the screen for 50 ms. Prime stimuli were single adjectives or the grammatical negation of those adjectives with the word “NOT” appearing left of the adjective separated by one character space. Primes were replaced by a different string of 13 consonant letters that served as a backward mask and was displayed for 17 ms.

Next, a clearly visible, evaluatively polarized target word was presented. The onset of the target words occurred either 67 or 150 ms following the onset of the prime word and remained on the screen for 183 ms. This interval between prime and target onsets defined the stimulus onset asynchrony (SOA) of the priming task. SOA was manipulated in order to vary the amount of time available for analysis of prime stimuli before the to-be-classified target words appeared. At short SOAs, priming effects are expected to be mediated exclusively by fast, automatic cognitive systems. As SOAs become longer, however, contributions from slower, more sophisticated conscious cognitive systems should increase. Although Greenwald et al. (1996) found that short SOAs of about 67 ms were optimal for measuring SSA effects with single word primes, it is plausible that SSA effects of two-word stimuli might unfold according to a slower time course. Thus, the present experiment examined priming at SOAs of 67 and 150 ms. Importantly, even the larger of these SOA values was shorter than the 250 ms value that has commonly been used to operationalize *automatic* priming effects (e.g., Neely, 1979; Onifer & Swinney, 1981).

Presentation of the target word was followed by the response window procedure. The target was replaced after 333 ms by the exclamation point defining the response window. The window center was initially 400 ms following target onset and the window width was 133 ms. The display sequence for supraliminal trials was identical to that of subliminal trials except that a fixation point (*) was presented in place of a forward mask, and a blank was presented in place of the backward mask.

<u>Evaluative classification task: Practice</u>. Each subject performed initially a minimum of 170 practice trials at the evaluative classification task. The first block of 20 practice trials contained only target words (no masks or primes). Subjects then performed a block of 50 trials in which supraliminal primes were presented before the targets, and a second block of 50 trials involving subliminal (masked) primes. On all of these trials, the word ERROR was presented immediately after incorrect target classifications. At the end of each of these blocks, subjects were informed of their percentage of correct responses

for that block and were given the option to repeat the block or proceed to the next phase of the experiment. The next block of 20 practice trials introduced the response window procedure. Subjects had the option of repeating these 20 practice trials multiple times if desired before performing a final block of 50 practice trials with the response window. On all practice blocks involving both prime and target stimuli, SOA was fixed at 67 ms.

Evaluative classification task: Data collection. After completion of practice, subjects began the data collection phase of the experiment, which consisted of 24 blocks of 50 trials (1200 trials total). SOA was varied between 67 and 150 ms according to an ABBABAABABBA ordering scheme with A and B representing 100 trial (2-block) intervals. Assignment of the two SOA conditions to the A and B positions alternated every other subject. Experiment 1 also varied whether primes were presented supra- or subliminally according to an AABBBBAAAABB ordering scheme, also based on 100 trial intervals. Assignment of supra- and subliminal conditions to the A and B positions alternated after every second subject. The third critical variable was whether the prime stimulus consisted of a word (an evaluatively polarized adjective) or a phrase (an evaluatively polarized adjective preceded by the word "NOT"). The word and phrase conditions varied according to a ABABABABABAB ordering scheme, with assignment of conditions to the A and B positions alternating after the first and third of every 4 subjects. The counterbalancing scheme ensured that the 3 factors, (a) SOA, (b) supra- vs. subliminal, and (c) word vs. phrase, were not confounded.

A randomly selected 50% of the trials in each block consisted of congruent prime-target pairs (i.e., prime and target were both pleasant or both unpleasant), and the remaining trials consisted of incongruent pairs (one of the prime-target pair was pleasant and the other unpleasant). Stimuli were randomly selected so that (a) each appeared exactly once as the target and once as the prime within each block of 50 trials and (b) the same adjective did not appear as the prime and target on the same trial. (During practice blocks, primes and targets were always congruent.)

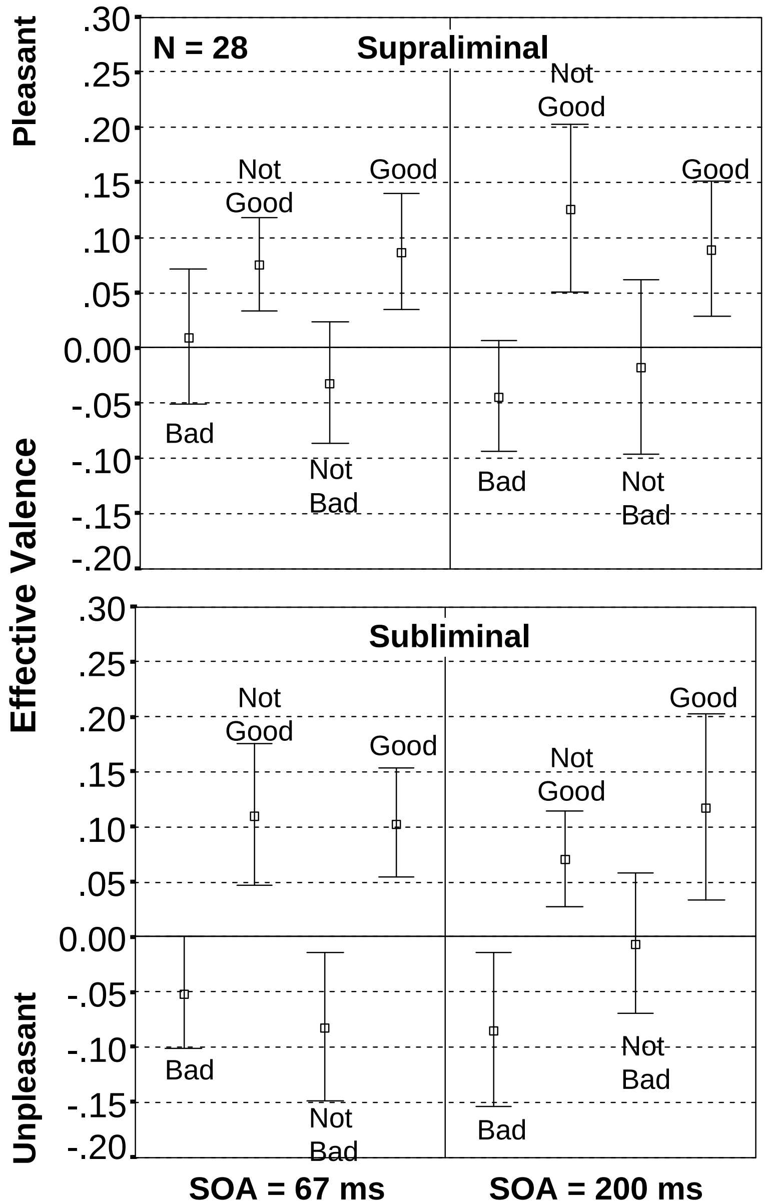

Figure 2. Effective valence for each of the 4 prime stimulus conditions, shown separately for supraliminal (top) and subliminal (bottom) presentation conditions, and for 67 ms (left) and 150 ms (right) SOA conditions. Labels above and below the bars indicate the prime stimulus category: Bad = unpleasant word, Not Good = NOT + pleasant word, Not Bad = NOT + unpleasant word, Good = pleasant word.

Results

Significance Tests. Figure 2 shows the EV of each of the 4 categories of prime stimulus broken down by presentation and SOA conditions. Data were analyzed using a 2X2X2X2 repeated measures ANOVA that examined the influence of four factors — (1) *presentation procedure* (supra- vs. subliminal), (2) *SOA* (67 vs. 150 ms) (3) *adjective pole* (pleasant vs. unpleasant word), and (4) *negation* (presence vs. absence) — on EV. The data showed a single, consistent pattern indicating that EV was strongly influenced by the primes' unpleasant or pleasant adjective components, but was not influenced by the presence or absence of the word "NOT". The ANOVA confirmed the statistical strength of this pattern, yielding a strong main effect of adjective pole ($F = 50.29$, $df = 27$, $p < .001$) that was not significantly moderated by negation ($F = .02$, $df = 27$, $p = .89$). Additional statistical tests indicated that the effect of adjective pole was not significantly moderated by SOA ($F = 2.43$, $df = 27$, $p = .13$) or presentation procedure ($F = .04$, $df = 27$, $p = .84$).

Of the 3 data patterns that would provide evidence for unconscious processing of the phrases, none are apparent in Figure 2. Specifically, Not Bad stimuli were in all conditions lower in EV than Not Good stimuli. In some conditions, Not Bad stimuli were slightly higher in EV than Bad stimuli, and Not Good were slightly lower than Good stimuli. These effects, however, did not appear consistently across SOA or presentation conditions, and they were not statistically significant.

Discussion

Experiment 2 showed a pattern of supra- and subliminal priming that was driven by the meanings of single words but not by the meanings of phrases. The results of subliminal conditions demonstrated that the operation of negation, in the form of a grammatical combination of two words, falls beyond the analytic powers of unconscious cognition. This conclusion is reinforced by failure to obtain phrase-level priming effects even with visible (supraliminal) primes using relatively long (150 ms) prime-target SOAs. The absence of phrase-level priming in supraliminal conditions indicated that grammatical negation also falls outside the capabilities of conscious but attentionless cognition.

That grammatical negation requires slow, conscious cognitive resources is consistent with an abundance of research showing that processing grammatical negations in the context of a sentence is especially demanding (Wason, 1959; Gough, 1965; Slobin, 1966). Why are grammatical negations too difficult to be processed by unconscious systems? Possibly, the semantics of negation are too complex to be processed automatically or unconsciously. On the other hand, it is conceivable that the semantics of negation do fall within the processing capabilities of unconscious systems, but the syntactic operation of combining the word “NOT” with an adjective does not.

In English, negation occurs in a number of linguistic forms, including as a grammatical operation involving the word ‘NOT’ and as a lexical operation involving prefixes such as ‘UN’, ‘DIS’, and ‘NON’. Although grammatical and lexical negations are semantically equivalent, only the former construction involves syntactic processing. Thus, if unconscious systems are capable of semantically processing negation but are incapable of processing multiword syntactic constructions, it should be possible to obtain subliminal priming effects using single words containing negating prefixes. Research by Sherman (1973) suggests that lexical negations may in fact be more rapidly processed than grammatical negations. Sherman measured verification times for sentences involving lexical or grammatical negations, and found that grammatical negations increased verification times more so than lexical negations. Possibly, the shorter verification times for lexical negations reflected increased contributions from fast, unconscious systems.

Chapter 4: Lexical Negations - Experiment 3

Experiment 3 examined whether the meanings of lexical negations — single words with a negating prefix — can be unconsciously registered. Experiment 3 used a variation of the evaluative classification task in which prime stimuli were pleasant and unpleasant adjectives, presented either alone or in conjunction with a negating prefix. As with Experiment 2, prime-target SOA was varied between 67 and 150 ms. Primes were presented supraliminally in order to test conscious, attentionless processing, and subliminally in order to test unconscious processing. For subliminal conditions, three data patterns would indicate unconscious processing of negation: (a) higher EV for negated unpleasant adjectives than negated pleasant adjectives, (b) higher EV for negated unpleasant adjectives than unpleasant adjectives presented alone, and (c) higher EV for pleasant adjectives presented alone than negated pleasant adjectives.

Method

Subjects

Subjects were 42 undergraduate students at the University of Washington who volunteered to participate in exchange for extra credit in an introductory psychology course. All were fluent in English and had normal or corrected-to-normal vision.

Materials

Stimuli consisted of a set of 50 adjectives, half of which were unpleasant in meaning and the other half of which were pleasant. A second set of 50 words were generated from the first set by adding a negating prefix such as "`UN`", "`DIS`", or "`NON`" to each adjective (e.g., "`UNCLEAN`" was derived from "`CLEAN`", and "`NONVIOLENT`" was derived from "`VIOLENT`"). The complete list of stimuli is given in Appendix C.

Procedure

The procedure used in Experiment 3 was nearly identical to that of Experiment 2 with the exception that the number of data collection trials task was decreased to a total of 800 (16 blocks of 50 trials). The reduction in trials made it easier for subjects to complete the experiment in the 1-hour allotted time slot.

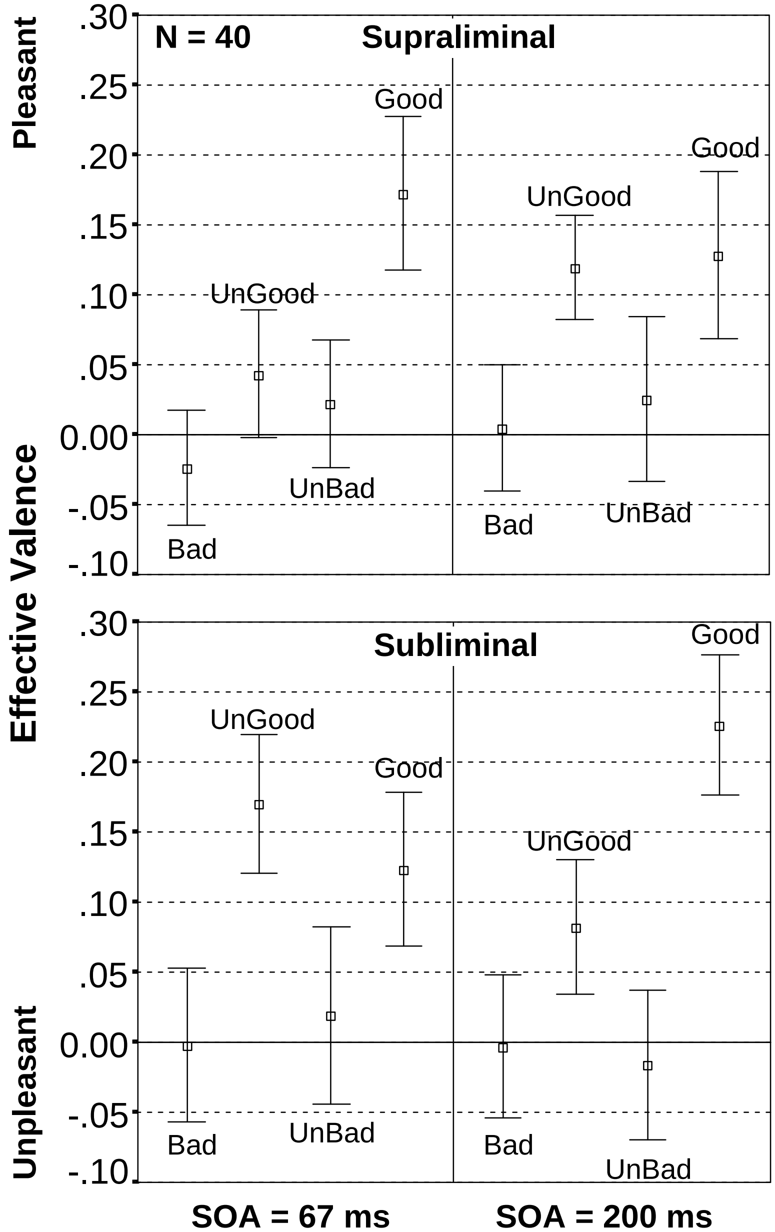
N = 40
Supraliminal
Subliminal
Pleasant
Effective Valence
Unpleasant
.30
.25
.20
.15
.10
.05
0.00
-.05
-.10
Good
UnGood
UnBad
Bad
SOA = 67 ms
SOA = 200 ms

Figure 3. Effective valence for each of the 4 prime stimulus conditions, shown separately for supraliminal (top) and subliminal (bottom) presentation conditions, and for 67 ms (left) and 150 ms (right) SOA conditions. Labels above and below the bars indicate the prime stimulus category: Bad = unpleasant root, UnGood = negating prefix + pleasant root, UnBad = negating prefix + unpleasant root, Good = pleasant root. Error bars indicated 95% confidence intervals.

Results

Significance Tests. Figure 3 shows the EV for each of the 4 categories of prime stimulus broken down by presentation and SOA conditions. The data were analyzed using a 2X2X2X2 repeated measures ANOVA that included four factors — (1) *presentation procedure* (supra- vs. subliminal), (2) *SOA* (67 vs. 150 ms) (3) *adjective pole* (pleasant vs. unpleasant adjective), and (4) *negation* (presence vs. absence). Figure 3 shows that the direction of priming effects was influenced predominantly by the valence of the root words, and the influence of the adjective roots was attenuated, but not reversed, by the negating prefixes. This pattern was evident in the ANOVA as a strong main effect of adjective pole ($F = 67.67$, $df = 39$, $p < .001$) that was significantly moderated by the presence or absence of a negating prefix ($F = 13.21$, $df = 39$, $p = .001$). The main effect of adjective pole did not significantly vary as a function of SOA ($F = 3.80$, $df = 39$, $p = .06$) or presentation procedure ($F = .71$, $df = 39$, $p = .41$). The interaction between adjective pole and negation also did not significantly vary as a function of SOA ($F = 1.58$, $df = 39$, $p = .22$) or presentation procedure ($F = .01$, $df = 39$, $p = .92$).

Figure 3 shows that in no conditions were UnGood primes lower in EV than UnBad primes — a pattern that would clearly indicate processing of negation. In some conditions, however, UnGood primes were lower in EV than Good primes, and UnBad primes were higher in EV than Bad primes. Planned contrasts revealed only two of these results to be statistically significant. Specifically, UnGood primes were significantly lower in EV than Good primes in the conditions involving supraliminal priming with an SOA of 67 ms (difference = .13, t = 3.64, $df = 39$, $p = .001$) and subliminal priming with an SOA of 150 ms (difference = .14, t = 4.14, $df = 39$, $p < .001$). In no conditions were UnBad primes significantly different in EV than Bad primes.

Discussion

Experiment 3 showed that the EV of evaluatively polarized adjectives (in supra- and subliminal conditions) was somewhat influenced by the presence of a negating prefix. This effect, however, was limited in magnitude and did not appear consistently throughout all conditions of the experiment. Possibly, effects of the negating prefixes were weakly obtained because only a subset of the negation words were processed *in toto*, and only the adjective roots of the rest of the stimuli were processed. To the extent that processing lexical items becomes automated through repeated exposure to those items, it seems plausible that the meanings of frequently encountered, highly familiar words would be subject to fast, unconscious semantic analysis. The delineation of processed and unprocessed lexical negations could therefore rest upon the frequency of those words in the language. This account is in keeping with Fodor's (1983) above-mentioned hypothesis that frequently encountered stimulus domains are more likely to be processed by input systems.

The finding that unconscious prefix negation occurs on an item by item basis would further suggest that this operation is not performed by some generic morphological parsing mechanism that combines prefixes with root words. Rather, effects of item frequency would indicate that individual instances of the lexical negation operation enter the domain of unconscious cognition by becoming lexicalized. That is, frequently encountered, morphologically complex words may achieving the same psycholinguistic status as morphologically simple words by becoming explicitly represented in lexical memory. Lexical representations of complex words, like those of simple words, may then become unconsciously activated through subliminal stimulation.

Effects of word frequency on SSA were examined by separating the prefixed primes into high and low frequency groups[3] and comparing their EV. The 12 items with

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[3] Word frequencies were obtained using COBUILDDirect™, an online corpus of over 50,000,000 written and spoken words obtained from a number of sources including the London Times, National Public Radio, the British Broadcasting Company, US

the lowest frequency from each of the pleasant and unpleasant sets made up the low frequency groups. The remaining items made up the high frequency groups. The results, shown in Table 1, provided no evidence that frequency of the lexical negations affected whether they were unconsciously processed. For UnGood primes, high frequency items were actually higher in EV than low frequency items in most conditions. Similarly, for UnBad primes, high frequency items were typically lower in EV than low frequency items. The pattern of the results was thus inconsistent with the hypothesis that prefix negation is more likely to be processed for high than low frequency items.

Prime Category	**Frequency (N per million)**	**Subliminal**		**Supraliminal**	
		SOA= 67ms	**SOA=150ms**	**SOA=67ms**	**SOA=150ms**
Good					
high	59.01	.12	.24	.17	.13
UnGood					
high	6.58	.19	.12	.06	.10
low frequency	0.61	.14	.04	.03	.15
Bad					
high	14.26	.00	.00	-.02	.00
UnBad					
high	1.66	.04	-.03	.00	-.01
low frequency	0.16	.00	.02	.05	.07

Table 1. Effective Valence (EV) for high and low frequency prime items. The first column shows the mean occurrence rate (number of occurrences per million) for each item group. Numbers in subsequent columns represent mean EV.

published books, and various ephemera (e.g., informal conversations, junk mail, lectures) produced between 1989 and 1996.

Chapter 5: Compound Words and Noun Phrases - Experiment 4

To date, attempts to meet the two-word challenge have examined only two grammatical operations — combination of subjects and predicates (Greenwald & Liu, 1985) and grammatical negations (Experiment 2). Possibly, these attempts failed, not because processing two-word sequences in general requires conscious cognition, but because the grammatical operations tested in those experiments were particularly complex. Success in meeting the two-word challenge might therefore depend on testing relatively easy grammatical constructions. Experiment 4 examined unconscious processing of two-word grammatical constructions that seem intuitively easier to process than subject-predicate constructions or negations. The constructions tested in Experiment 4 were compound words and two-word noun phrases (hereafter referred to as *compounds* and *noun phrases*). Compounds typically consist of noun-noun or adjective-noun pairs that by convention have been combined into a single word (for example, “LIPSTICK”, “SIDEBURNS”). The noun phrases tested in Experiment 4 were, like the compounds, noun-noun or adjective-noun pairs. Although these pairs could in theory be combined into a single compound word, in practice they typically are not (e.g., “NAIL POLISH”, “FACIAL HAIR”).

Are compounds and noun phrases, in fact, relatively easy to comprehend? Some language development research suggests that compound words enjoy the same psycholinguistic status as morphologically simple words in that they are stored as a single lexical entry. For example, Derwing (1979) has shown that compounding is one of the earliest derivational processes used by children. Silvestri & Silvestri (1977) (see also Berko, 1958) asked children in the first through fourth grades to define a series compound words. For each word that they correctly defined, the children were asked “Why is ______ called a _______?” Children’s responses were coded according to whether they made reference to the either of the compounds’ constituent words. The results showed a direct relation between age and awareness of the semantic connection between compound words and their constituent morphemes. Furthermore, the youngest children were often unaware of the relation between compound words and their constituents, although they understood what the compound words meant. The results suggest that children begin with a unitary conception of compounds and only later become aware of the relation between the meaning of the compound and its constituents.

Some psycholinguists, however, have argued in favor of decomposed lexical representations of compounds (Taft & Forster, 1976; Lima & Pollatsek, 1983; Inhoff, 1987). In this view, compound words are processed via representations of their constituent words. Taft and Forster (1976), for example, measure lexical decision times to compound words and nonwords. They found that reaction times were longer for compound nonwords whose first constituent was a word (e.g., “dustforth”, “footmilge”) compared to compound nonwords whose first constituent was not a word (e.g., “trowbreak”, “mowdflisk”). Whether or not the second constituent was a word had no effect on reaction time, however. Taft and Forster concluded from these results that compounds are accessed via their first constituent. The issue is by no means resolved, however, as other theorists have proposed single lexical entry interpretations of Taft and Forster’s data. (Sandra, 1990; Andrews, 1986; Monsell, 1985).

Experiment 4 examined subliminal priming effects of compounds and noun phrases using a two-choice gender classification task (structurally similar to the evaluative classification task) in which subjects classified common first names as male or female. Prime stimuli were compound words and compound phrases that had connotatively feminine or masculine meanings but whose constituents were comparatively gender-neutral. Control primes were constructed from the compounds and noun phrases by reversing the order of their constituent words. The constituent words of the compounds and noun phrases were thus identical to the constituent words of their reversed counterparts. However, whereas the two-word sequence of the compounds and noun phrases formed a distinct, meaningful concept, the order-reversed two-word sequences did not.

Experiment 4 addressed the following questions. First, can the meanings of compounds and noun phrases be unconsciously processed? If the answer is yes, then the feminine compounds and noun phrase should appear as more effectively feminine than masculine compounds and noun phrases. Furthermore, the differentiation between feminine and masculine primes should be greater for the compounds and noun phrases than for their order-reversed counterparts. This pattern of results would meet the two-word challenge. Second, are compounds stored and accessed as single lexical entries (like morphologically simple words) or must their representations be constructed from representations of their morphological elements? The finding of subliminal priming effects for compound words would be consistent with the unitary representation hypothesis, whereas the lack of subliminal priming effects would suggest that compounds are stored and processed on the basis of their constituents. Finally, although noun phrases and compound words are given different linguistic classifications, are they stored and processed the same way? If compounds and noun phrases are cognitively equivalent, they should produce comparable subliminal priming effects.

Method

Subjects

Subjects were 51 undergraduate students at the University of Washington who volunteered to participate in exchange for extra credit in an introductory psychology course. All were fluent in English and had normal or corrected-to-normal vision. Data from 8 subjects were discarded because preliminary data analyses indicated that they did not follow task instructions.

Materials

Target stimuli consisted of 24 male and 24 female first names drawn from lists of the names most frequently given to newborns in the United States in 1982 and 1983 (Dunkling & Gosling, 1984). All names were from 3 to 8 letters in length and were pronounceable in one or two syllables. Prime stimuli consisted of 12 compounds and 12 noun phrases, half of which were stereotypically feminine in meaning and the other half stereotypically masculine. These items were selected from a larger set of items that had been rated by 46 subjects on a 5-point gender-bias scale (a rating of 1 indicated the item was “very feminine” and 5 indicated “very masculine”). The 6 most feminine and the 6 most masculine items were chosen for both the compound word and noun phrase sets. A second set of 24 control primes was generated by reversing the order of the constituent words of each of the compounds and noun phrases. All stimuli are listed in Appendix D with mean gender bias ratings.

Procedure

Stimulus Sequence: Subliminal and Supraliminal Trials. The presentation procedure for Experiment 4 was similar to that of Experiments 1-3. Subliminal trials begin with forward and backward masked prime stimuli. Prime duration was 50 ms. A clearly visible target word, drawn from the sets of male and female first names, was then presented 67 ms after the onset of the prime stimulus. If subjects did not respond within 333 ms following target onset, the target was replaced by an exclamation point, 133 ms in duration, indicating the occurrence of the response window. Supraliminal trials were identical to subliminal trials except that a centered fixation point (*) was presented in place of the forward mask, and a blank was presented in place of the backward mask. On supraliminal trials, the onset of the target names occurred 133 ms following onset of the prime stimuli.

Gender classification task: Practice and data collection. Each subject performed 192 practice trials at the gender classification task. The first block of 32 practice trials presented only target words (no masks or primes). Subjects then performed 2 blocks of 32 trials each in which supra- and then subliminal primes were presented. On all of these trials, subjects received immediate feedback in the form of the displayed word ERROR if they incorrectly classified the target word. At the end of each of these blocks, subjects were informed of their percentage of correct responses for that block. The next two blocks of 32 practice trials introduced the response window procedure in conjunction with supraliminal and then subliminal primes.

After completion of practice, subjects performed 20 blocks of 48 data collection trials (960 trials total) of the gender classification task. Presentation of primes alternated between subliminal and supraliminal conditions with each block. The response window procedure was used on all data collection trials. After each block, subjects were informed of their average response time, their percent of correct responses, and the percent of responses that occurred during the response window.

Prime Stimulus Conditions. The main independent variable of Experiment 4 was the set from which prime stimuli were drawn. There were 8 sets of prime stimuli: 1) masculine noun phrases, 2) feminine noun phrases, 3) masculine compound words, 4) feminine compound words, 5) order-reversed masculine phrases, 6) order-reversed feminine phrases, 7) order-reversed masculine compounds, and 8) order-reversed feminine compounds. Prime condition was varied within-blocks, randomly from trial to trial among the 8 conditions above. Prime stimuli were selected such that (a) every prime item from the 8 sets was presented once within each 48-trial block, and (b) each prime item was equally likely to occur on the same trial as a male or female target name. Targets were randomly selected from the sets of male and female names such that each name appeared once within each block.

Computation of Priming Effect: Effective Gender. Data from the gender priming task were analyzed using the measure *effective gender* (EG) which was mathematically isomorphic to the effective valence measure used in the previous 3 experiments. Effective gender was computed by substituting the proportions involving pleasant target trials with those involving female-name trials, and the proportions involving unpleasant target trials with those involving male-name trials.

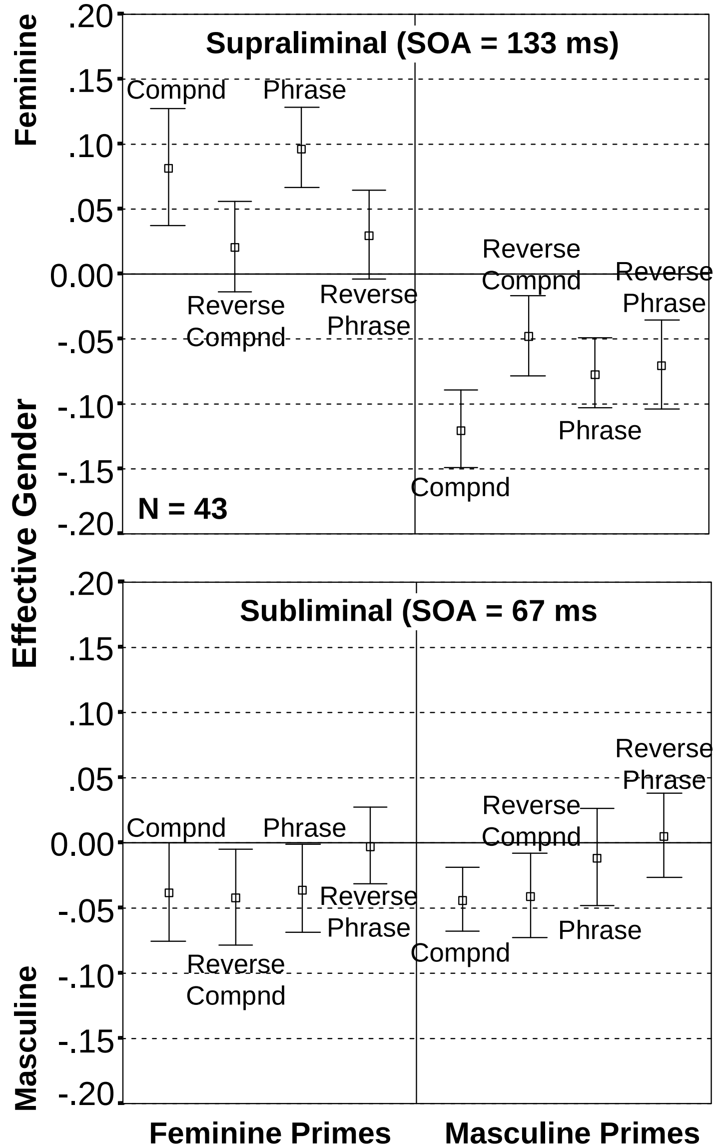

Figure 4. Effective gender for each of the 8 prime stimulus categories, shown separately for supraliminal (top) and subliminal (bottom) presentation conditions. Feminine primes are shown on the left side of the graphs and masculine primes on the right. Labels above and below the bars indicate the prime stimulus category.

Results

Significance Tests. Figure 4 shows the EG for each of the 8 categories of prime stimulus, separately for supraliminal (top panel) and subliminal (bottom panel) presentation conditions. As can be seen in the top panel of Figure 4, the EG scores of supraliminally presented compounds and phrases show more gender polarization than their order-reversed counterparts. Statistical significance of these supraliminal priming effects were tested using a 2X2X2 repeated measures ANOVA that examined the influence of 3 factors — (1) *prime gender,* (2) *prime type* (noun phrase vs. compound word), and (3) *prime constituent order* (regular vs. reversed) — on the dependent variable EG. The analysis yielded a strong main effect of prime gender (F = 113.58, df = 42, p < .001), indicating that feminine primes, regardless of type or constituent order, were more effectively feminine than masculine primes. The analysis also yielded a significant interaction between prime gender and constituent order (F = 13.32, df = 42, p = .001), indicating that the compound words and noun phrases were more gender-biased than the order-reversed counterparts.

As is shown in the bottom panel of Figure 4, subliminal presentation conditions yielded no difference in EG across the different categories of primes. A 2X2X2 repeated measures ANOVA was conducted to test effects of prime gender, prime type, and consituent order on EG for subliminally presented primes. The analysis yielded no main effects of prime gender (F =.27, df = 42, p = .61) on EG, nor was there any interaction between prime gender and constituent order (F = .04, df = 42, p = .85). Finally, no interaction was found between prime type, prime gender, and constituent order (F = .25, df = 42, p = .62).

Discussion

Experiment 4 yielded compound- and phrase-level priming effects for supraliminal but not subliminal primes. The supraliminal priming effects indicated that the meanings of compound words and noun phrases are registered under conditions in which focal attention is limited (recall that the priming task demanded that subjects attend to targets rather than primes). That priming effects were obtained using a relatively short SOA (133 ms) suggests that the meanings of the compounds and noun phrases were processed by fast, automatic cognitive systems. The absence of *sub*liminal compound- and phrase-level priming effects indicated, however, that the linguistic operations entailed by these structures exceed the analytic capabilities of unconscious cognition. The process of combining nouns and (noun or adjective) modifiers into a single lexical or grammatical unit apparently requires conscious cognitive resources.

A second finding of Experiment 4 was that order-reversed feminine primes were higher in effective femininity than order-reversed masculine primes. This result is consistent with two interpretations. First, the constituent words of the compounds and noun phrases may themselves have been gender biased. That is, the constituent words of the feminine compounds and phrases may have been more effectively feminine than the constituent words of the masculine compounds and phrases. This account of the data seems unlikely for two reasons, however. First, careful inspection of the constituents of the items reveals no obvious gender bias. Second, no difference in effective gender was found between the order-reversed feminine and masculine primes in subliminal presentation conditions. Given that the subliminal priming task was shown to be sensitive to semantic processing of single words in Experiments 1-3 (see also Draine and Greenwald, in press), the absence of subliminal priming effects in Experiment 4 suggest that the single-word constituents were not themselves gender biased.

A second more plausible explanation is that order-reversed items produced priming effects by activating their counterpart items from the sets of compounds and noun phrases. For example, the stimulus “HEEL HIGH” may have automatically activated “HIGH HEEL”, which in turn would have facilitated classification of female targets. This form of priming, referred to as *mediated* priming, has been reported by a number of investigators using supraliminal prime presentations (Balota & Lorch, 1986; McKoon & Ratcliff, 1992; McNamara & Altarriba, 1988; Shelton & Martin, 1992) Experiment 4 seems especially conducive to mediated priming effects given that in supraliminal (and subliminal) conditions, subjects were repeatedly exposed to both the regular and order-reversed versions of the prime items. Interestingly, no evidence of mediated priming was obtained with subliminally presented primes. The results indicate that the processes underlying mediated semantic priming, namely activation of indirectly associated representations, are themselves mediated by conscious cognitive resources. The findings thus reveal another form of cognition that apparently exceeds unconscious processing capabilities.

Chapter 6: General Discussion

The present research examined what roles are played by unconscious cognition in performing linguistic analyses that have generally been assumed to require conscious cognitive resources. In four experiments, unconscious linguistic processing was operationalized using variations of the two-choice subliminal semantic priming task of Greenwald et al. (1996) and Draine and Greenwald (in press). The experiments tested four different classes of verbal constructions as prime stimuli. Those constructions were 1) grammatically uncombinable word pairs, 2) grammatical negations, 3) lexical negations, 4) compound words, and 5) noun phrases. Unconscious performance of the linguistic operations entailed by those constructions could thus be measured as statistically significant subliminal semantic priming effects. The experiments also included supraliminal prime presentation conditions that measured conscious but attentionless processing of prime stimuli.

The results of Experiments 1 - 4 indicated that unconscious cognitive systems play an important but limited role in language processing. The capabilities of unconscious cognition include the ability to extract the separate meanings of multiple, simultaneously presented words with simple morphological forms (Experiment 1). Unconscious systems may also be able to process some instances of words involving negating prefixes (Experiment 2). Although meanings of compound words and two-word noun phrases could be processed by conscious, attentionless cognition, the meanings of these items could not be processed by unconscious cognitive systems alone (Experiment 4). Finally, the meanings of grammatical negations could not be processed under conditions that prevented allocation of conscious or attentional resources (Experiment 3).

Two Words are Too Challenging.

Conditions in two of the present experiments — subliminally presented grammatical negations in Experiment 2 and noun phrases in Experiment 4 — satisfied the methodological criteria of Greenwald's (1992) two-word challenge. Both attempts to meet the challenge failed. Is it possible that the two-word challenge could be met with two-word grammatical constructions other than those tested here? Although this possibility can not be ruled out, it seems unlikely given the following considerations. Intuition suggests that noun phrases are processed more rapidly and with less cognitive effort than most other types of two-word grammatical constructions.[4] Second, the present investigation indicated that even some lexical constructions could not be unconsciously processed under subliminal presentation conditions. Given the failure to find clear evidence of SSA effects for morphologically complex words, it seems unlikely that SSA effects could be found for multiword grammatical constructions.

Although unconscious cognitive systems may not be sophisticated enough to parse multi-word syntactic constructions, they may nevertheless play a key role in extracting syntactic information contained in single words. For example, unconscious systems may register information about a verb (e.g., "runs") such as its tense or whether it is singular or plural. Single-word syntactic information is presumably easier to process than multi-word grammatical constructions because representations of the latter are necessarily derived from information provided by the former. Investigations of unconscious processing of single-word syntactic information may therefore be more likely to yield positive results. Negative results, on the other hand, would only reinforce the conclusion of the present research that syntactic processing requires conscious resources.

[4] Two-word proper nouns (e.g., Sigmund Freud, New York) may be a good candidate phrase type for future attempts at the two-challenge.

Stored Versus Constructed Linguistic Representations.

The findings of the present research suggest that unconscious linguistic analyses, operationalized as SSA, are limited to activation of relatively fixed representations in long term memory store. Specifically, brief exposure to the subliminal prime stimuli produces rapid, automatic activation of corresponding representations in lexical memory. Any semantic (and possibly syntactic) information that is associated with those lexical representations may also be activated. Linguistic structures that are not explicitly represented in long term store, however, remain ‘unrecognized’ during this unconscious stage of analysis. According the results of the present experiments, some kinds of morphologically complex words (lexical negations, compound words) and two-word phrases (grammatical negations, compound words) are among these unrecognized structures.

How, then, are linguistic structures that are not represented in long term store processed? Presumably, cognitive representations of unstored structures must be actively constructed on the fly. The present research suggests that this kind of constructive linguistic processing can not be carried out by fast unconscious cognitive systems alone. Rather, processing of unstored linguistic constructions requires that linguistic input be entered into working memory where it can be sustained long enough for more sophisticated language processing systems to construct whatever representations are needed for comprehension. If the transfer of linguistic input to working memory is interrupted (for instance, by the appearance of a backward mask), constructive linguistic processing does not occur.

Importantly, evidence that constructive language processing requires conscious cognitive resources does not necessarily imply that such processing is nonmodular. The present findings suggest only that linguistic input needs to be buffered in working memory in order for constructive processing to take place. The constructive language processing systems that analyze this buffered input may nevertheless be domain specific in that they respond only to linguistic input. They may also be functionally encapsulated in that their operations are mandatory and are unaffected by top-down information. Finally, although the present findings suggest that constructive systems operate more slowly than the rapid systems that mediate unconscious semantic activation, they may nevertheless be faster than most forms of controlled processing.

To the extent that subliminal semantic priming effects reflect activation of representations in lexical memory, the methods of the present research may be used to resolve current debates about what level of linguistic constructions are stored in lexical memory. Some theorists (e.g., Hankamer, 1992; Taft & Forster, 1976) have maintained that the basic unit of information in lexical memory are actually morphemes. According to these views, representations of multimorphemic words must be constructed from morphemic representations. Others (Sandra, 1990; Monsell, 1985) have suggested that multimorphemic words are represented in lexical memory independently of their constituent morphemes. Still others have argued that even multiple word constructions may in some cases become lexicalized (Swinney and Cutler; 1979). Assuming that subliminal semantic priming effects are mediated by activation of representations in lexical memory, it should in theory be possible to obtain subliminal priming for any lexicalized construction. Conversely, constructions that are not independently stored in lexical memory should not produce subliminal priming effects. Subliminal semantic priming effects may thus provide a means of operationalizing what kinds of linguistic constructions are contained in long term lexical store.

Subliminal Persuasion: Is it Compelling?

Subliminal perception has captured the public's imagination ever since James Vicary claimed in 1957 to have increased Coca-Cola and popcorn sales at a movie theater using a subliminal advertising technique (Rogers, 1992). Vicary's claims spawned a number of other suggested applications of subliminal techniques, including political and commercial advertising in mass media (Cousins, 1957; Key, 1973), subliminal self-help audio recordings, and subliminal psychodynamic activation therapy (Silverman, 1985). The possibility of subliminal influence has also been given serious consideration within the legal domain (Vance vs. Judas Priest, 1991). Despite a lack of scientific support for subliminal influence, much of the public continues to believe in the phenomenon. Rogers and Smith (1993) surveyed 400 households in the area of Toledo, Ohio, in order to assess public beliefs about subliminal advertising. Their results showed that of those who had heard of subliminal advertising, 49% percent (36% of the entire sample) believed that the technique was practiced by advertisers and was actually effective.

In all of the suggested applications of subliminal techniques, the possibility of subliminal influence of behavior rests upon the assumption that unconscious linguistic systems are capable of receiving and comprehending multi-word grammatical constructions. The present research directly examined this assumption using a procedure that has been established as sensitive to unconscious semantic processing of subliminally presented words (Draine & Greenwald, in press). The investigation found evidence of unconscious sensitivity to single word meanings, but *no* evidence of unconscious sensitivity to phrase-level meanings. The present findings support the results of previous research showing that subliminal self-help audio-tapes (Greenwald, et al., 1991) and subliminal advertising (Moore, 1982) are ineffective. The findings further indicate that these subliminal techniques could not possibly work as claimed because the subliminal messages involved are too complex for their meanings to be unconsciously registered.

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Appendix A

Unpleasant	Pleasant
EVIL	HONOR
CANCER	LUCKY
SICKNESS	DIAMOND
DISASTER	LOYAL
POVERTY	FREEDOM
VOMIT	RAINBOW
BOMB	LOVE
ROTTEN	HONEST
ABUSE	PEACE
MURDER	HEAVEN
ASSAULT	PLEASURE
SLIME	FAMILY
DIVORCE	DIPLOMA
POISON	KISS
KILL	CHEER
DEATH	HEALTH
HATRED	FRIEND
SCUM	CARESS
ACCIDENT	SUNSET
JAIL	HAPPY
STINK	MIRACLE
TORTURE	SUNRISE
CRASH	PARADISE
FILTH	VACATION
POLLUTE	TREASURE

Table 2. Prime and target stimuli from Experiment 1.

Appendix B

Good	Not Good	Bad	Not Bad
CLEAN	NOT CLEAN	DIRTY	NOT DIRTY
HAPPY	NOT HAPPY	ANGRY	NOT ANGRY
DECENT	NOT DECENT	OBSCENE	NOT OBSCENE
CORRECT	NOT CORRECT	WRONG	NOT WRONG
GOOD	NOT GOOD	EVIL	NOT EVIL
HEALTHY	NOT HEALTHY	SICK	NOT SICK
PRETTY	NOT PRETTY	UGLY	NOT UGLY
HONEST	NOT HONEST	WICKED	NOT WICKED
PURE	NOT PURE	ROTTEN	NOT ROTTEN
GENTLE	NOT GENTLE	VIOLENT	NOT VIOLENT
BRAVE	NOT BRAVE	AFRAID	NOT AFRAID
PROUD	NOT PROUD	ASHAMED	NOT ASHAMED
CHEERY	NOT CHEERY	GLOOMY	NOT GLOOMY
POLITE	NOT POLITE	VULGAR	NOT VULGAR
SMART	NOT SMART	STUPID	NOT STUPID
NICE	NOT NICE	CRUEL	NOT CRUEL
FRIENDLY	NOT FRIENDLY	BRUTAL	NOT BRUTAL
CUDDLY	NOT CUDDLY	HARSH	NOT HARSH
CUTE	NOT CUTE	RUDE	NOT RUDE
CHARMING	NOT CHARMING	VICIOUS	NOT VICIOUS
LOYAL	NOT LOYAL	NASTY	NOT NASTY
LUCKY	NOT LUCKY	FILTHY	NOT FILTHY
KIND	NOT KIND	HURT	NOT HURT
FUNNY	NOT FUNNY	TOXIC	NOT TOXIC
PLEASANT	NOT PLEASANT	SCUMMY	NOT SCUMMY

Table 3. Prime and target stimuli from Experiment 2.

Appendix C: Stimuli for Experiment 3

Good	UnGood	Bad	UnBad
CLEAN	UNCLEAN	STRESSFUL	NONSTRESSFUL
HAPPY	UNHAPPY	POLLUTED	UNPOLLUTED
DECENT	INDECENT	SELFISH	UNSELFISH
CORRECT	INCORRECT	INFECT	DISINFECT
HELPFUL	UNHELPFUL	INJURED	UNINJURED
HEALTHY	UNHEALTHY	SPOILED	UNSPOILED
CARING	UNCARING	HURT	UNHURT
HONEST	DISHONEST	BIASED	UNBIASED
PURE	IMPURE	OFFENSIVE	INOFFENSIVE
FAIR	UNFAIR	VIOLENT	NONVIOLENT
LOVING	UNLOVING	AFRAID	UNAFRAID
PROUD	UNPROUD	ASHAMED	UNASHAMED
NOBLE	IGNOBLE	FLAWED	UNFLAWED
POLITE	IMPOLITE	TAINTED	UNTAINTED
COMFORT	DISCOMFORT	HARMED	UNHARMED
HONOR	DISHONOR	DAMAGED	UNDAMAGED
FRIENDLY	UNFRIENDLY	BEATEN	UNBEATEN
TRUST	MISTRUST	SOILED	UNSOILED
WISE	UNWISE	TARNISHED	UNTARNISHED
NATURAL	UNNATURAL	TOXIC	NONTOXIC
LOYAL	DISLOYAL	SCATHING	UNSCATHING
LUCKY	UNLUCKY	DISTURBED	UNDISTURBED
KIND	UNKIND	TORMENTED	UNTORMENTED
AGREE	DISAGREE	TROUBLED	UNTROUBLED
PLEASANT	UNPLEASANT	SNOBBISH	UNSNOBBISH

Table 4. Prime and target stimuli from Experiment 3.

Appendix D: Stimuli for Experiment 4

Male Names	Female Names	Female Compounds	Female Noun Phrases
MIKE	JILL	LIP STICK (1.07)	HIGH HEEL (1.07)
DAVID	SARAH	EYE LINER (1.09)	HAIR RIBBON (1.09
JEFF	BECKY	MAKE UP (1.19)	EYE SHADOW (1.12)
JOHN	KATE	HAIR PIN (1.31)	NAIL POLISH (1.17)
MARK	LISA	CHEER LEADER (1.44)	SILK STOCKING (1.23)
BOB	AMY	HOME MAKER (1.57)	POWDER ROOM (1.38)
BILL	JANE		
BRAD	JULIE	**Male**	**Male**
TOM	ANN	**Compounds**	**Noun Phrases**
MATT	ALICE	SIDE BURNS (4.74)	CHEST HAIR (4.87)
ERIC	MARY	FOOT BALL (4.61)	TIE CLIP (4.63)
STEVE	SALLY	NECK TIE (4.61)	DRAG RACE (4.61)
BRIAN	JENNY	SKIN HEAD (4.54)	FACE HAIR (4.49)
JOE	PAM	OLD TIMER (4.50)	BIG LEAGUE (4.48)
SCOTT	TAMMY	CUFF LINK (4.49)	DRUG DEALER (4.47)
PAUL	LAURA		
JASON	EVE		
KEVIN	JOAN		
KARL	APRIL		
ADAM	VICKI		
BRIAN	EMILY		
HARRY	TARA		
BART	HOLLY		
ALAN	JANE		

Table 5. Prime and target stimuli from Experiment 4.

Vita

[Click and type Your Name]

University of Washington

[Click and type Year]

[Click and type vita]