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The Effect Of Word Sociality On Word Recognition

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To my family.

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CHAPTER 1 INTRODUCTION

Overview

The goal of this study was to investigate a new type of semantic influence in word recognition – specifically, whether there is a behavioral difference in the recognition of spoken social words when compared to non-social words, in speed of recognition and accuracy. Semantics is a topic of growing interest in psycholinguistics overall (e.g., Forster, & Hector, 2002; Landauer, & Dumais, 1997), and in the study of spoken word recognition. Research has shown that some semantic characteristics of words can influence word recognition. For example, concreteness and imageability have been shown to influence response times in tasks considered to be measures of online lexical retrieval (for a review see Tyler, Moss, Galpin, & Voice, 2002). The presence of semantic effects in word recognition supports the notion that recognition is an interactive process in which higher level cognition can influence lower level perception. The current study is an investigation into a new semantic effect in word recognition – social bias – and whether word recognition shows some dependency upon the sociality of a word's referent, with the goal of uncovering elements of semantic structure in the mental lexicon.

By social bias, I mean the relevance of a word’s referent in a social context. I refer to this concept as *sociality* – higher sociality means more relevance in a social context. The goal of the study was to investigate whether sociality affects visual and auditory word recognition.

A Brief Review of Semantic Effects in Word Recognition

The two most studied semantic variables in word recognition research are concreteness and imageability. Concreteness is highly correlated with imageability and both are often used interchangeably (although Paivio, Yuille, & Madigan [1968] observed that emotion words may be rated high on imageability but low on concreteness, while the opposite may be true for infrequently encountered nouns). Imageability has been shown to influence several stages of language production and comprehension (e.g., Bird, Howard, & Franklin, 2003). Concreteness effects have been primary demonstrated in visual word recognition tasks (e.g, Strain, Patterson, & Seidenberg, 1995; Strain & Herdman, 1999). There is ample evidence suggesting that language production and recognition processes confer a benefit to concrete words, especially when the process of recognition is slowed or difficult to resolve. This is one of the most striking examples of a word's semantics influencing how it is perceived; another example is polysemy, or the number of meanings associated with a word (e.g., Rodd, Gaskell & Marslen-Wilson, 2002), which, while having a more complicated relationship with recognition performance, also is frequently cited as a perceptual semantic effect.

Along these lines, Wurm and Vakoch (1996; Vakoch & Wurm, 1997) looked at three dimensions of meaning that are prevalent in several areas of psychology: Evaluation (how good or bad something is), potency (how strong or weak something is), and activity (how fast or slow something is). These scales were taken from Osgood's (1957) multidimensional scaling research and have been shown to be useful in characterizing stimuli in a number of domains. They were selected by the authors because they describe behaviorally important aspects of stimuli. Together, the authors surmised, they capture the value and threat of a stimulus, which affect both decision-making and emotional responses. Wurm and Vakoch (1996) assessed the influence of these three dimensions on lexical decision times for emotion words, and found that low evaluation, high potency, and high activity were associated with the fastest responses, suggesting that word recognition is sensitive to the adaptive motivation of avoiding danger. In a second study, Vakoch and Wurm (1997) used a more general sample of words and observed an opposite evaluation effect, with good words being responded to in a lexical decision task faster than bad words. The authors concluded that emotion words and words in general may be processed differently. A more recent study using these three dimensions (Wurm, Vakoch, & Seaman, 2004) confirmed these results using the naming task, which is seen as less contaminated by non-perceptual processes. Together, these studies show that *behaviorally-relevant* variables seem to have some role in auditory recognition processes.

Wurm and Vakoch (2000) followed up this line of research by investigating additional behaviorally-relevant semantic variables. The authors asked subjects to rate 100 common nouns on danger and usefulness. These ratings predicted reaction times in a lexical decision task, even after controlling for frequency, length, neighborhood size, concreteness, and animacy of the referent. Higher ratings on both dimensions were associated with faster lexical decisions. Additionally, an interaction between the two was observed, with the effect of usefulness depending on the value of danger; words with high danger ratings were associated with slower responses as usefulness increased. The authors concluded that useful things that are not dangerous are unambiguously desirable, and can be responded to quickly. However, things that are both dangerous and useful cause a conflict, which negates or reverses the usefulness advantage. This effect was also investigated using the naming task (Wurm et al., 2003). Again, facilitative main effects were observed for danger and usefulness. However, there was not a significant interaction. Wurm and Seaman (2008) followed this up with a series of tasks – including delayed naming and perceptual identification – designed to assess the effects of these variables under different conditions. They observed little evidence for a post-perceptual bias explanation for danger and usefulness, while seeing a strong predictive interaction between the two in both naming and perceptual identification. The authors concluded that these behaviorally-relevant variables do indeed appear to be perceptual, providing further evidence that behaviorally-relevant semantic structure can be investigated via word recognition paradigms. It is these findings that motivated the use of word recognition tools to uncover evidence for social semantic structure in the lexicon.

Theoretical Semantics and Embodied Cognition

Theoretical Semantics: Features and Multidimensional Space

Before describing the current study, I'll briefly outline several theories of semantics that have some bearing on incorporating semantics into word recognition, before tying these theories to social psychology. First, it should be noted that by "semantics" I am referring to the properties of words that are not captured by syntax or "traditional" psycholinguistic measures, such as frequency, or form-based characteristics. Many of the variables described thus far – concreteness, danger, usefulness, and the to-be-discussed sociality – may appear more pragmatic in nature, but fall under the umbrella of "semantics" when discussed in terms of word recognition.

Many treatments of semantics (e.g., Wierzbicka, 1980) propose that meaning is composed of semantic features or primitives. Features have been obtained in norming studies (e.g., Battig & Montague, 1969; McRae, de Sa, & Seidenberg, 1997), where subjects list features of things or concepts and the most frequent responses are inferred as semantic components. In a compositional model, a single lexical item is mapped onto many features or primitives which are shared for all entries in the lexicon. Semantic features represent the core of most psychological and linguistic approaches to the representation of meaning. In concepts research, features, also referred to as primitives and attributes, have historically been the basis of representation in probabilistic models of meaning. Rosch (1978) describes objects as bundles of perceptual and functional attributes, and claimed that there exist natural discontinuities where cuts in categorization can be made to define attributes. For cognitive economy, all objects share a common pool of attributes. In Rumelhart and Norman's (1975) Active Structural Network model of semantic representation, features are nodes that are accessed via a natural language vocabulary. This is concordant with many linguistic natural language approaches to semantics (e.g., Wierzbicka, 1980) that posit the meaning of a word as a constellation of primitive words. The feature norming task, where subjects are asked to provide lists of features of category concepts, creates natural language schemata that are probabilistically weighted by frequency of feature endorsement.

McRae et al. (1997) showed that subjects were sensitive to these feature frequencies in rating tasks where stimuli were primed by words whose semantic relatedness was measured in feature overlap. Subjects were asked to rate the animacy, concreteness, artificiality, and growth of nouns after being presented a prime noun that had a variable degree of relatedness to the target. Greater feature overlap facilitated responding, which was taken as evidence for a network model of semantics where features are shared among lexical entries and access to features is dependent upon resting activation levels. In such a model, sociality would not necessarily represent a single primitive, but aspects of sociality may.

A modern approach to semantics involves conceptualizing meaning in high-dimensional co-occurrence spaces. Associationist models, based heavily on research in connectionist representations, posit meaning primarily as a matrix of recorded word co-occurrences. Landauer and Dumais' (1997) seminal Latent Semantic Analysis (LSA) model of knowledge representation describes relationships among words through multidimensional analysis of word co-occurrences in a very large text corpus into a high dimensional space. Although the dimensions are chosen mathematically, the authors contend that LSA's hyperspace could be isomorphic to a model of semantic features, such as models described above; however, it is also possible that features only reflect an underlying system driven by estimates of semantic distance taken from word co-occurrences. For the present study, a discussion of the underlying nature of semantic representation will be postponed; instead, the LSA co-occurrence model will be used primarily to generate a surrogate measure of sociality for the preliminary study. With this in mind, it is important to note that LSA uses the aggregate of the entire context of a word – in sentence or paragraph units – as a measure of its distance to other words; thus, words that rarely co-occur (synonyms, for example) will be semantic neighbors due to the similarity of their contexts.

Embodied Cognition

"Embodied cognition" approaches, on the other hand, bypass abstract features of meaning or agnostic connectionist networks and link representation directly to perception and action. Glenberg and Robertson's (2000) primer in embodied cognition for psychology describes the Indexical Hypothesis, which describes language comprehension as multiple processes that link words to perceptual symbols, derive affordances (responses, actions) from perceptual symbols, and mesh the affordances with the sentence syntax to create an interpretation of a scenario that reflects what probably happened or what was conveyed. Meaning is conceptualized as being stored in perceptual symbols similar to those described by Barsalou's perceptual symbols theory (1999). These are modal symbols that link words to the perceptual state initiated by the entity to which they refer. Meaning retrieval is a type of re-experiencing. This framework maps nicely onto semantic effects such as concreteness, danger, and usefulness because each of these bears a relationship to both perceptual symbols and to responses and actions, but not as neatly onto sociality. Still, I believe it is a useful framework for considering how behaviorally relevant aspects of meaning may structure the mental lexicon. I discuss its philosophical origins and the details of its framework in more detail below.

Embodied cognition represents a modern re-thinking of the nature of cognition. It is a response to the Cartesian tradition of dualism that pervades the cognitive sciences – the notion that the mind is distinctly separated from the body. While this is not often acknowledged, and while cognitive science does not frequently find itself in opposition with materialism, it is nonetheless a prevalent philosophy (Bennett, 2001). In the traditional cognitivist approach, the nature of thinking is so different from any material (physiological) properties that one cannot be understood in terms of the other. This can be seen in how representations are depicted in cognitive theories – amodal, abstract symbols. Perceptions – both the physical stimuli and physiological perceptual processes – are viewed as unreliable, messy, and ultimately unsatisfactory for the complex thought processes which operate upon our knowledge. While the nature / nurture debate has generally led psychologists to conclude that much of the world is learned through the senses, most theories of cognition posit a layer of abstraction between the deceptive senses and the mind. Beyond that layer of abstraction, representations are governed by a rational mind that is frequently (although increasingly less frequently) likened to a digital computer. The operands of the mind are not messy perceptions, but clean, abstract symbols. These function, in many ways, like the linguistic notion of words, which are signs that are arbitrarily related to what they signify. Just as the word *green* bears no similarty to the physical property green, so does the mental of representation of *green* bear no resemblance to its perceptual form. Implicit in this formulation of thought is the need for formal rules, which govern how perceptions are translated into abstract symbols (Anderson, 2003). Cognition, then, is conceptualized as a series of rules that transform one cognitive state into another.

While cognitivism has had a prolific life in psychology, philosophy, cognitive science, and linguistics, many researchers have begun to reject some of its basic tenets. Notably, embodied cognition rejects its most basic tenet: that the mind is distinct from the body. Embodied cognition has a philosophic tradition that can be traced back to the 17th century philosopher Benedictus de Spinoza. A contemporary of Rene Descartes, Spinoza rejected dualism in favor of parallelism: the cause of our behavior is ultimately physical, and can be understood physically, but it appears to be mental (Bennett, 2001). This is not simple associationism, which, to Spinoza, would resemble minimalism. Spinoza contrasts the events in a pinprick as understood through dualism and minimalism. Dualism posits three events: the mental event, pain, and a second mental event. Minimalism also posits three events: the jab, the material event, and the cry. However, minimalism is insufficient for understanding the event, according to Spinoza. Pain has its own mental causes and effects, and intervenes between the jab and the cry. These material events must be paralleled by a mental event, and vice versa. All thoughts correspond to physical events, and all physical events correspond to thoughts. The simple components of thought are not recognizable as thought, and all human behavior can be understood in materialistic terms. According to this philosophical perspective, there is no need for a layer of abstraction between the physiological processes of sensation and the mental processes of cognition: the operands of cognitive functions correspond directly to the physical world.

Embodied cognition is most frequently encountered in the theoretical perspectives of Mark Johnson and George Lakoff (Johnson & Lakoff, 2002; Lakoff, 1987, 2001; Lakoff & Johnson, 1980, 1999). As cognitive linguists, Lakoff and Johnson (1980) virtually introduced embodied cognition to linguists, philosophers and psychologists as a process of conceptual metaphor. Embodied meaning was described as perceptual meaning: meaning that was unfiltered and indistinguishable from the physiological processes (sensory and motor) that acquired it. Higher-level concepts are understood through embodied meaning by conceptual metaphor, which involves processes borrowed from linguistics and literature (e.g., metaphor, metonymy) and from cognitive psychology (e.g., radial categories, conceptual blending) which build embodied representations into more complex concepts (Johnson & Lakoff, 2002). Their early work (e.g., Lakoff & Johnson, 1980) established the theoretical plausibility of embodiment by describing complex human concepts in embodied terms. For example, *love* is often described and may largely be understood as a journey; *social organizations* can be conceptualized as plants, *knowing* is seeing, *personal preference* is taste. These simpler concepts (e.g., journeys, plants, seeing, tasting) can then be readily described in terms of their sensorimotor experience, and thus the pathway between physiology and high-level concept is complete. Later (e.g., Lakoff, 1987; Lakoff & Johnson, 1999), the two authors expanded these few examples of high-level concepts into hundreds of examples of “primary conceptual metaphors” (Johnson & Lakoff, 2002, p. 245), such as *more is up*, which results from the coactivation of verticality and quantity concepts which are conflated through a child’s experience watching a glass of orange juice be poured. There are many examples where this concept is used linguistically (e.g., *up the ante*, *raising money*), and the authors conclude that young children, and later adults, find it convenient to conceptualize *more* as the perceptual experience of *up*.

Barsalou’s theory of perceptual symbol systems (1999) is an attempt to reconcile embodied cognition with existing empirical data on attention and categorization. In it, long term memory representations are shaped like perceptual states in sensory-motor systems. Selective attention, a well documented cognitive construct, extracts a subset of each perceptual state for long term storage. Unlike cognitivisist approaches to symbols, perceptual symbols are modal and analogical. This approach has the added benefit of being physiologically efficient: instead of positing distinct neural areas and neural structures (which bring with them distinct patterns of neural growth), a single perceptual system underlies the bulk of cognition. It is important to note that Barsalou does not define perceptual symbols as a recording system, but as a conceptual system. A recording system creates an "attenuated copy" (Barsalou, 1999, p. 581) of what it records: for example, a photograph records some of the light present in a scene without making any interpretation. A true conceptual system, however, recognizes tokens within the visual scene and binds them to general types stored in memory. A conceptual system can also combine concepts (e.g., a *snow ball* can be represented by a *ball* concept and a *snow* concept).

To this end, Barsalou introduces the concept of simulators into the perceptual symbols theory. Simulators function to allow modal symbolic manipulation. They allow an individual to activate previous representations during routine recognition to fit a token into a conceptual frame (e.g., fitting a steering wheel into the frame for *car*); to imagine counterfactuals; and to anticipate the effects of manipulations on stimuli. Simulation can follow the combination of multiple, multimodal experiences into a single concept, and involves the reactivation of stored perceptual patterns guided by attention. Simulators are also key for perceptual search: the simulation of specific perceptual states associated with a target (e.g., bananas: yellow) guides the higher level interpretation of a visual scene. In this manner, individual differences in basic cognitive tasks can be explained, and demonstrated top-down effects can be modeled into perceptual symbols. Critically, Barsalou extends this theory to underlie abstract concepts. He follows in Lakoff and Johnson's footsteps by first proposing metaphor as a system of abstraction for perceptual symbols. *Anger*, for instance, can be a combination of the emotional state (affect being intimately related to the perceptual symbols theory) and the simulation of related perceptual states, such as *liquid exploding from a container*. In this manner, the association between the concept *explode* and the concept *anger* leads to a much more concrete understanding of the latter concept. Later, Barsalou proposes that many abstract concepts can be represented directly through perceptual symbols, and this appears to be a much more innovative alternative. In addition to static perceptual representations, perceptual symbols can contain temporally extended knowledge. Event sequences can be represented perceptually via simulators. Symbols can also emphasize focal parts of experience: combined with the notion that symbols can be introspective states, a wide variety of abstract concepts can be simulated directly without metaphor. *Marriage*, then, can refer to a series of events (courtship, a ceremony, etc.) and a specific interpersonal relation (the focal part of the conjunction of the simulations of the parties). Similarly, more basic abstract concepts, such as *truth*, *falsity*, and *negation* can be represented via perceptual symbols and simulators. For example, *truth* can be represented as the experience of "successfully mapping an internal simulation into a perceived scene" (Barsalou, 1999, p. 601). This takes place after several evaluations of whether a simulation is accurate or not; the perceptual experience of a successful simulation itself becomes a symbol.

Likewise, the perceptual experience of an unsuccessful simulation can also become a symbol – for falsity. Barsalou provides the following example: In trying to determine whether a balloon appears above a cloud, an individual simulates balloon, cloud, and above, and their combination. If that simulation maps onto the perceived scene, a perceptual state will arise: with enough pairings of any cognitively-driven simulation with a perceived scene and the resulting perceptual state, that perceptual state will come to be abstracted as *truth*, according to Barsalou. In that way, not only semantics, but the majority of cognitive processes (i.e., those that involve logic) are driven by perceptual symbols. Barsalou thus is presenting a comprehensive theory of cognition based on modal symbols stored in perceptual systems. It is the long-term goal of this study to lay the basic framework for a comprehensive theory of cognition based upon symbols grounded in social thought.

Empirical Evidence for Embodied Cognition

Wilson (2002) identified several observations about cognition that make an embodied framework attractive. First, cognition appears to be situated: while a task is being carried out, perception continues, and task-relevant information comes in that can affect processing. Wilson provides the examples of driving and conversing as activities that are clearly situated: task-relevant information is constantly pouring in through the sensory systems. Although Wilson describes tasks that are likely not situated (e.g., planning, remembering), and is critical of attempts to frame human evolutionary context in situated task contexts only (gathering, potentially less situated than hunting, was probably also more prevalent), conversations remain a likely situated task. This suggests, then, that language use tasks are time-pressured, and the mind, mid-conversation, may not have time to "build up a full-blown mental model of the environment, from which to derive a plan of action" (Wilson, 2002, p. 628). In this context, an embodied approach to representation would be preferable, if internal representations are employed at all. Again, while Wilson succeeds in providing many examples of non-time-pressured cognition, many examples of language use are not among them. Finally, Wilson notes that many uses of cognition are designed for action: improved perceptual skills, she notes, evolutionarily provided improved motor control. If that is the case, then representations that best permit improved motor control will be the most adaptive, and these are likely to be representations that are embodied. While Wilson rejects many of the most radical tenets of embodied cognition, she makes a case for the embodiment of working memory representations (Wilson, 2001). Certain conceptualizations (e.g., the articulatory loop) and observations (e.g., the effect of articulatory suppression) point to a working memory system that employs sensorimotor encoding.

Recently, there has been a surge in research looking specifically at the embodied cognition hypothesis. Pecher, Zeelenberg, and Barsalou (2003; 2004) investigated the existence of perceptual symbols in routine perceptual processing in a series of experiments. In a property verification task (Pecher et al., 2003), participants were presented a concept (e.g., *BLENDER*) and a property (e.g., *loud*) and asked to respond, as quickly as possible, if the property were usually true of the concept. Critically, trial order was manipulated so that sometimes two adjacent trials would present properties of the same modality (e.g., *loud* and *rustling*), while sometimes the modalities would differ (e.g., *loud* and *sour*). Based on Barsalou's (1999) perceptual symbols theory, the authors hypothesized that trials in which the modality had not changed from the previous trial would have faster reaction times than trials in which the modality had changed from the previous trial. This is due to the cost of switching from one perceptual system to another during the simulation of different modality concepts. The hypothesis was supported: the cost of switching modalities was observed to be 29 milliseconds. In order to control for the possible effects of greater semantic association between same-modality properties, a second experiment was conducted comparing semantically-associated property pairs to unassociated pairs; no effect was observed here. In a second study (Pecher et al., 2004), a similar effect was observed at longer latencies. In each block, the same concept (e.g., *apple*) was presented twice, but with two different properties. Sometimes the properties were same-modality (e.g., *green, shiny*), and sometimes they were different-modality (*green*, *tart*). When both presentations included same-modality properties, there was an RT advantage of 34-41 msec if the number of intervening trials was 12 or 18. When the number of intervening trials (the number of trials between the first presentation of *apple* and the second) was fewer, there was no RT advantage to using same-modality properties. The authors concluded that representations are componential and not holistic: relevant aspects of concepts are activated when needed, and these aspects tend to be grouped by modality. Recent experience with a modality tends to keep that modality activated. Because of the modality-specificity of these results, the authors conclude that sensorimotor systems play an important role in cognition.

In a similar study, Zwaan, Stanfield, and Yaxley (2002) presented sentences to subjects that described objects in specific locations. Then, they were asked to indicate whether a picture presented represented something that had been mentioned in the sentence. The critical manipulation here was that the picture sometimes portrayed the animal or object as it would sit in the sentence, and sometimes it did not. For example, if the animal in the sentence was *eagle*, and its location was *nest* (e.g, *The ranger saw the eagle in its nest*), then a matching picture would be of an eagle sitting, while a mismatching picture might portray an eagle flying. The authors observed that reaction times were longer for trials in which mismatching pictures were presented than matching pictures (Experiment 1), and that matching picture conditions were equivalent to a neutral condition, in which the sentence did not specific any configuration of the target object or animal (Experiment 2). The authors concluded that specific images were activated automatically during sentence comprehension, and that this is consistent with a representation of meaning that is based on perceptions. This study is particularly relevant, because it involves the perception of sentences, as opposed to single words, and requires a somewhat complex semantic interpretation on the part of the participant in order to get the observed reaction time disadvantage in the mismatch condition. In addition, the effect seems to occur during sentence parsing, not during the picture probe (at which point there would be no benefit to parsing the sentence and engaging in mental imagery for anything beyond its constituent nouns). That suggests that perceptual simulation is routine.

Additional evidence supporting the embodied cognition hypothesis comes from cognitive neuroscience. Kan, Barsalou, Solomon, Minor, and Thompson-Schill (2003) used fMRI to measure cortical activity during a property verification task. Behaviorally, the authors replicated Solomon (1997). Concepts selected from 18 superordinate categories (e.g., car, cow) were paired with physical part properties (e.g., hood, udder). Additionally, two types of false pairs were constructed: associated sets (e.g., canary-sing) and unassociated sets (canary-wine). The association strength was varied in each group, but the average strength between the true and false associated sets was equivalent. Critically, participants were assigned to associated false or unassociated false conditions. In the associated false condition, associated false pairs were presented which required a no response; these trials differed from true trials in that the property was not a physical part of the target concept. Participants in the associated condition were significantly less accurate and slower at verifying properties than participants in the unassociated condition. The concurrent fMRI was aimed at looking at a region of interest in the left fusiform gyrus, which has been associated with mental imagery. The authors hypothesized that when conceptual information was required (when the associated false trials were presented), the left fusiform gyrus should show activation if that conceptual information is grounded in the perceptual system. Because conceptual information was not required when the unassociated false trials were presented (because responses could be based on associative strength alone), the authors did not expect to see any conceptual activation. The fMRI analysis supported their hypotheses: a region of the visual association cortex was activated during the retrieval of semantic information without explicit instructions to engage in mental imagery. This provides physiological evidence that there is a relationship between imagery and semantics.

Although a good developmental theory of embodied cognition will be essential for establishing its legitimacy, this appears to be lacking in the literature. Thelen (1996; 2000), however, began the work of formulating a theory of motor development that emphasizes the unit of perception, action and cognition. Thelen (1996) describes infant motor development in a dynamic systems framework, but adopts an embodied approach in order to coordination modeling problems. For example, the multiple degrees of freedom available to an infant who is learning to crawl or reach pose a massive problem first; over time, this is somehow overcome and the infant achieves a stable motor pattern via experience. How experience helps to overcome that problem is a question that is difficult for dualists to answer; however, in an embodied approach, Thelen argues, cognition emerges as a product of learning the relation between perception and action. By viewing cognition as emergent, Thelen seems to be arguing that it is the environment and the mental states of infants that eventually give rise to higher level faculties. Later I will argue that interactions between a child and their social environment may lead to emergent thought; that this coincides with language development and developing cognitive capabilities may suggest a deep relationship between the three.

In conclusion, embodied cognition, as a framework, has several manifestations, but overall empirical evidence is growing that perceptions are routinely activated and may underlie thought in a variety of cognitive tasks. Furthermore, cognition may be uniquely tuned for interaction with the physical environment, and the success of embodied theories in specifying a relationship between the mind and the environment makes it an attractive framework for developing a theory of mind and social environment interactivity. In the following sections, I will link evidence from the social psychology and language acquisition literature with the embodied frameworks I've discussed to introduce a theory of social semantics.

A New Framework: Social Psychology, the Development of Language, and Semantics

Social Psychology and the Development of Language

Several recent theoretical developments and studies in social psychology bear on the possibility of socially-grounded semantic systems. First, the recent bourgeoning of social cognition stresses how tied social psychology and cognitive psychology really are. Social cognition is an approach to the study of social psychology and personality, which emphasizes how people process social information, especially its encoding, storage, retrieval, and application to social situations. Social cognition tends to focus on the information processing framework within cognitive psychology, but, as will be argued later, its reliance upon cognitivist notions of representation (i.e., amodal symbols) does not render the empirical work or overarching theories irrelevant within an embodied framework. Second, research in language development has demonstrated clear links between language and social behavior. Using evidence from social cognition studies and social development, the goal of this section is to show that social language acquisition parallels social development; that social representations are easily activated and nearly ubiquitous; and that the representations of others are closely linked to self-representations.

Baldwin and Moses (2001) presented child speech errors to support a hypothesis that language acquisition is informed by social understanding. In order to learn to map words onto objects, the authors argue, children need to disregard many potential links between words and things in the world; more often than not, words are spoken in the absence of their referent, but with other potentially misleading referents present. The crucial factor is interpreting the speaker's intention to talk about the objects at hand, and this likely requires the processing of social cues. Previous research by Baldwin (e.g., Baldwin et al., 1996) has demonstrated that infants 19-20 months old can resist potential but invalid links between objects and words. For example, when infants are presented a new object, and an accompanying speaker, gazing toward the object, pronounces a novel name (e.g., 'A *dawnoo*!'), children demonstrated that they successfully linked the new word to the new object during instructed reaching. However, when the speaker was seated out of the infants' view, infants appeared to resist making the link. In both cases, the acoustic cues and temporally contiguity were identical; the only difference was the appearance of the speaker. Additional studies have shown infants are sensitive to a variety of social clues when learning words, including gaze direction, body posture, voice direction, and hand position during both noun learning and verb learning. As children become more sensitive to social clues, word learning gains speed (e.g., in pre-school). The authors argue that this isn't due to fundamental cognitive processes (e.g., memory and attention), but is due to genuine social understanding. Overall, the authors note a wide variety of observations that support the notion that language learning demonstrates acute sensitivity to social cues, even in young children. This is a necessary pre-requisite to a theory that posits that semantics have a social basis: if language acquisition precedes primary social development, then one can hardly argue that language emerged from social cognition.

Outside of the realm of word learning, there is evidence for a requirement of social understanding in successful language interactions in children with peers. Smiley (2001) assessed intention understanding in peer-interactions with 19-39 month-old children during play with long-term acquaintances. The author hypothesized that understanding prior intention – representing others' intentions as goals that indicate future action – is an important part of coordinated interactions between two goal-driven individuals. Intention-understanding was assessed through interviews, in which events were shown to children, followed by questions related to the intentional behavior of the participants in the taped events. For example, during a video segment in which a child asked for, and then took, a toy, the child might be prompted *What did Adam do?* and then *Why did she take it?* The latter question directly queries for intentionality. To measure peer-interaction, children were videotaped at home with friends with minimal parent intervention. A variety of behaviors were recorded, including nonverbal gestures and speech acts. The author observed that intention understanding did predict differences in children's interactions. Children with higher levels of intention understanding (the prior intention group, who understood that intentions precede actions) were more likely to use distal means of interaction (speech) than intrusive, proximal means (taking objects) when interacting with peers. In other words, children with greater social understanding were more likely to use language than children with poorer social understanding to accomplish a goal. This study stresses the importance of social understanding for successful peer interaction and language use, but, again, it also fails to adequately control for general cognitive ability,

Beyond the understanding of peer and parent intentionality, there is evidence that understanding intentionality (theory of mind, in most cognitive developmental frameworks) plays a role in understanding group behavior (i.e., collective intentionality). Tomasello and Rakoczy (2003) describe what they believe to be a second stage in social and cognitive development: the 4 – 5 year transition where children begin to participate in cultural activities. It is at this point, the authors note, that humans really become distinct as a species. Pathological evidence (e.g., from children with autism) suggests that at this age joint attentional skills begin to show variability and can predict later social performance and intentionality understanding. At 5 years of age, cultural institutions become realities, and intentionality is viewed as potentially collective. It is important to note that a growth in intentionality understanding is associated with an understanding of higher level cultural concepts, because it is in direct opposition to the embodied theory of abstract concepts, which states that these are learned through metaphorical extension of simpler perceptual concepts, without requiring, as Tomasello and Rakoczy posit, an innate biological mechanism geared toward better comprehending the social world. While the embodied approach stresses a certain efficiency which is appealing, the latter approach that is currently being discussed is better grounded both in studies of ethology (e.g., Seyfarth, Cheney, & Bergman, 2005) and child language acquisition and cognitive development. This indicates to me that for embodied cognition to more successfully model abstract concepts, it will have to take into account alternatives to purely sensorimotor-based explanations.

While the above examples show a clear relationship between social understanding and language learning and use, they rely upon an ultimately cognitive notion to operationalize social development: comprehension. One counter-argument to any deeper claims about social development and language is that social understanding is a part of intelligence, and as such is a cognitive ability. To circumvent this problem, other conceptualizations of social development need to be explored. In one such example, Locke (2001) investigated the classic social concept of attachment and its relationship to language. The author argued that language acquisition cannot be understood through a conventional information-oriented approach. Instead, infants learn words because they appear in a social space: one which they’ve already entered, at birth, through vocalization. Instead of emphasizing the information transferring properties of speech, Locke emphasizes phatic communication - the relational function of speech. Language serves to bond individuals together, and this function is not limited to communication between an infant and its caregiver. Indeed, the author notes that much speech cannot be characterized as informational: much of it is self-regulatory, or tension-discharging, and much of the speech that does transmit information transmits shared information: information the receiving party undoubtedly knows. To this end, Locke emphasizes, phylogenetically, the social root of language, and goes on to discuss how vocal behaviors in infants (humans and animals) aid in both attachment formation and language development. The amount of visual attention shared between mothers and infants, for example, predicts both attachment and vocabulary development (Tomasello & Farrar, 1986). The author indicates that this suggests infants want to understand their mother and, the more time they spend looking at what she is looking at, the better they will be able to do so, and vocabulary acquisition is a side-effect. An alternative, however, is that the more a child wants to understand its parent, the faster it will learn language. This is supported by observations by blind children, who learn language at the same rate as sighted children without the benefit of shared visual attention. Ultimately, Locke is suggesting that a social motivation, and not a cognitive motivation, underlies language acquisition, and that only later does language become a tool of asocial thought. Importantly, this is a step towards demonstrating that language's roots are ultimately social, which is an important piece of any theory of grounding.

Given how much of language acquisition appears to be socially motivated and moderated, it is not surprising that language, as a conceptual topic, comes up frequently in social interactions. Ely, Gleason, MacGibbon, and Zaretsky (2001) observed dinner table conversations among families with young children (2 to 5.5 years of age), and found that a large percentage of utterances (around 7% on average) contained language-focused terms, such as *say*, *ask*, *tell*, and *speak*. While the percentage of use of these terms was not related to child age (4% across children observed), it was more prevalent in adults (11% in mothers, 7% in fathers). Much of this use was elicitation (*Can you tell Daddy who had supper with us last night?*), and much of it was pedagogical: parents asked their children to label objects, and corrected them if they make a mistake. This surprising result suggests that in the home social environment there is an emphasis on both communication and language itself as a cognitive skill. Because the authors do not report any other cognitive domains of related terms that frequently occur in regular discourse, it's unknown how dominant language is as a conceptual topic in family discourse, but nonetheless it appears to be a singular cognitive skill that preoccupies both parents and children. Also, this supports Locke's (2001) notion that much of speech is not about transmitting information. Sometimes people speak to prompt speech – and sometimes that prompted speech serves a non-informational function.

Additional theories of parallel and interacting social and cognitive development can be found in Tomasello's usage-based theory of language acquisition (e.g., Tomasello, 2000) and, more generally, in social cognition literature (e.g., Garfield, Peterson, & Perry, 2001; Maass, Karasawa, Politi, & Suga, 2006; Meier & Robinson, 2005; Prentice & Miller, 2006). However, of specific relevance to a theory of embodied cognition, are a diverse set of neurological findings pointing to a possible unity of the mind, the body, and the other. Recently, mirror neurons have received a lot of press: these are cortical neurons that respond both to one's own actions and to the actions of a perceived other. Williams, Whiten, Suddendorf, and Perrett (2001) proposed that these may play a large role in autism: children with deficient mirror neurons may be unable to properly imitate others. The authors explain how imitation may be an important part of developing a theory of mind. If the imitation of others is grounded in the mind in such a concrete, specialized way as neurons, this suggests that the perception of others – and perhaps intentionality – is in fact a very special type of perception. The uniqueness of person perception has been supported to an extent, perceptually, by conditions such as prosopagnosia (face blindness) and feature detectors that correspond to body parts. It has also been supported in the social cognition literature on representation. Sebanz, Knoblich, and Prinz (2003) found that participants were sensitive to the actions – and the available actions – of a cohort during a joint go-no go task. The repertoire of actions available to the second agent seemed to facilitate participant responding, suggesting they were represented alongside and in a similar form to the participants' own.

To conclude this section, there is a wealth of evidence supporting the notion that social understanding and perception play a large role in a variety of cognitive tasks, and that social behavior, as we know it, ontogenetically and phylogenetically predates much of what we consider cognition. In the next section I will attempt to briefly describe what an embodied theory of cognition might look like that recognizes language's social roots.

A New Framework

There are two ways that the social development literature can be reconciled with embodied cognition. First, social development can be likened to perceptual development, but a specific type, with its own associated neural areas. Second, mechanisms of embodied cognition can be incorporated into theories of socio-cognitive development. In the first way, the logic of embodied cognition is, by and large, preserved. Simple concepts are perceptual. Instead of a person or a relationship concept being componential, it may be, neurally, discrete and noncomponential. It would then be subject to well documented cognitive processes, like selective attention, via simulators. The ultimately rich representations of significant individuals in our lives would be multimodal, with emotional and introspective perceptual properties having a great deal of prominence.

On the other hand, social cognition and the social and language development literature could benefit from the incorporation of metaphorical extension. If language is for action, and much action is social, it makes sense to represent language concepts in social terms. Higher level concepts, then, would be grounded not in the most basic of perceptions, but in the uniquely human perceptions that accompany our social functioning. This would place a layer of phylogenetic abstraction between basic motor and perceptual systems and higher level cognition: a layer representing people, minds, and relationships. *Democracy*, for example, would be understood in noncomponential, social symbols, as opposed to noncomponential perceptual symbols. However, the basic structure of both sets of symbols would be isomorphic: they would be housed in the same perceptual systems that generated the initial experience and be subject to perceptual processes and selective attention. Importantly, social symbols would more readily map concepts onto social actions, of which language is one.

In order to investigate the social grounding of meaning, the currently popular task for investigating perceptual symbols – the property verification task – may be the most easily adapted. Social cognition research has shed light on the conceptual structure of the person and relational representation; applied to property verification, person concepts may manifest themselves as concepts while relationships act as properties. Thus, words associated with one set of relationships (e.g., kinship) may facilitate one another while another set of relationships (e.g., professional) do not. Similarly, emotional properties of individuals, relationships, and communities could easily be incorporated.

A second tactic to investigate social grounding may be a corpus linguistics approach. Just as early embodied cognition adopters identified embodied and perceptual metaphor in literature and discourse, similar trends might be found for relational thought. One example: bigger and precursor is *maternal*; smaller and successor is *child*. Surely more can be found, and these might more readily be explained through relational grounding than sensorimotor embodiment.

A third approach is more general. It remains to be shown that the simplest components of cognition (e.g., semantics) are tuned for behavior. A limited set of promising work (e.g., Wurm, 2007; Wurm & Vakoch, 2000; Wurm, et al. 2003; Wurm & Seaman, 2008) suggests that language recognition, at one of its more basic levels – spoken word perception – is sensitive to behaviorally relevant properties (e.g., danger and usefulness). This represents an important step towards demonstrating that cognition is situated and reflects the context it evolved in; however, much more work needs to be done to fully demonstrate the pervasiveness of this trend. Applied to social psychology, this fits with the language acquisition framework of Lev Vygotsky (e.g., 1997), in that language's roots are social and, in turn, it is found to be used primarily within a social behavioral context. It is this avenue that I have explored in the current study.

The current study

The current study is a visual and auditory word recognition investigation into potential social effects.

The lexical decision task is a commonly used task to investigate factors that affect word recognition speed. It has been shown to be modestly affected by semantic variables. The current study uses both visual and auditory lexical decision tasks as well as visual word naming to investigate on-line word processing.

Potential social biases will be operationalized two ways:

1. Participant ratings on a social/non-social scale (Experiment 1).
2. High-dimensional meaning representation computations (Preliminary Study).

CHAPTER 2 PRELIMINARY STUDY

Objective LSA scores and an extant data set

To investigate the possibility of a social semantic bias in word recognition, a preliminary study was conducted using data from the English Lexicon Project (ELP; Balota, Yap, Cortese, Hutchison, Kessler, Loftis, Neely, Nelson, Simpson, & Treiman, 2007). This data consists of visually presented lexical decision and naming reaction times and accuracy data for thousands of words and hundreds of participants.

Materials

The stimuli consisted of the 2,689 most frequent words in the ELP data set that were also available in the Latent Semantic Analysis (LSA) corpus. For each word, the following values were obtained:

Frequency (all items, from the British National Corpus [Leech, Rayson, & Wilson, 2001]);

Number of phonemes (all items, measured by ELP);

N (Phonological neighborhood size of all items, measured by ELP);

Concreteness (1167 items, from the MRC Psycholinguistic Database [Coltheart, 1981]);

Age of Acquisition (AoA; 531 items, from MRC);

Written / Spoken Frequency Ratio (all items, see below);

Semantic sociality (all items, see below).

Semantic sociality was estimated using the LSA corpus (Landauer & Dumais, 1997). Values were obtained as follows: First, a one-to-many LSA distance computation was made between each of the 2,689 items and a set of subject-case pronouns that anaphorically refer, generally, to human subjects: *he*, *she*, *we*, *I*, and *they*. This involves finding the semantic distance between each item in the ELP set and each of the pronouns in my small LSA set, and then taking an average for each item. The basic framework of semantic distance computation is outlined above. A second set of scores was done using a one-to-one distance computation, using each word in the ELP set and the non-person pronoun *it*. Therefore for each item two distance scores were computed: one for person pronouns (person-distance), and one for the non-person pronoun *it* (non-person-distance; note that this does not differentiate between the regular pronoun use of *it* and non-literal uses of *it*, as in "it remains to be seen," which further adds to the imprecision of this measure). Person-distance was conceptualized as measuring how semantically related a target word is to people, as used in everyday language. Non-person distance was conceptualized as measuring how semantically related a target word is to things, again as used in everyday language. Critically, the analyses described below use the ratio of person-distance to non-person-distance as a surrogate for the semantic sociality of the word. Using a ratio was essential to control for the relationship between the log of word frequency and both person-distance ($r = .43$) and non-person-distance ($r = .57$) (resulting in a bivariate correlation of $r = .11$). The resulting value can be thought of as how much more likely a word is to be used in the context of people than it is in the context of things. It was predicted that the more likely a word is to be used in the context of people, the faster it would be responded to in word recognition paradigms.

Results

Bivariate correlations between relevant measures can be seen in Table 1. Sociality has a higher bivariate correlation with naming times and an equivalent correlation with lexical decision times to the mainstay of semantic effects in word naming – concreteness. It is also comparable to the strength of the log of word frequency, one of the most studied and oft-observed lexical effects in word recognition.

However, to better estimate the effect of sociality on naming and lexical decision times, simultaneous regressions were computed using different combinations of the variables described above as continuous independent variables, and lexical decision and naming reaction times from the ELP as dependent variables. The results of these analyses can be seen in Tables 2-4. In the first analysis (Table 2), all of the items were included, and only variables for which a value was obtained for each item were used. In both lexical decision and naming RT analyses, sociality was significantly facilitative, even with significant length and frequency effects included in the model (and a significant neighborhood effect in lexical decision). In the second analysis (Table 3), less than half of the RTs were used to accommodate concreteness scores into the models. While concreteness was facilitative in both the lexical decision and naming models, sociality was only significant in the naming model (facilitating RTs). In the third analysis (Table 4), a much smaller set of RTs was analyzed to accommodate age of acquisition values. Surprisingly, AoA was quite strong in both analyses and neither concreteness nor sociality were significant in either model, and frequency was only significant in naming. To check the effect of AoA on the naming dataset at large, a fourth analysis was conducted using all of the words and only length, N, frequency, sociality, and an age of acquisition surrogate computed by taking the ratio of a word's written frequency to its spoken frequency. In the naming version of this model, sociality was marginally facilitative ($p < .06$).

Discussion

As expected, increased semantic sociality significantly facilitates reaction time in both naming and reaction time tasks. However, the strength of this facilitation varied in this data set depending upon covariates and data set size – as the data set shrunk to about 500 items, and age of acquisition and concreteness were included, the relationship was no longer significant. That said, it is worth noting that even concreteness was not significant in that analysis. This suggests that this data set may possess the peculiar property of being overly sensitive to age of acquisition – to the extent that the bivariate relationship between response latency and age of acquisition absorbs predictable variability and prevents other variables from achieving expected significance. In support, the fourth analysis suggests that, when looking at the entire data set and using an AoA surrogate, there remains an effect of sociality in naming, even if marginally.

Nonetheless, it is important to note that this objective measure is a surrogate for what will ultimately be a subjectively rated sociality measure. While AoA and concreteness scores in these models were obtained using well-conducted rating studies, sociality was assessed through a novel method of computing semantic distance scores from the LSA corpus. Still, a relationship between sociality, recognition latency, and age of acquisition seems evident. It was the goal of the following experiments to assess this relationship using subjective ratings, a more powerful within-subject analysis of lexical decision latencies, and visual and auditory lexical decision tasks.

CHAPTER 3 EXPERIMENT 1

Subjective ratings

A more traditional approach to collecting semantic information is through subjective ratings. In this experiment, subjects rated a set of words on a bipolar social – non-social dimension in an on-line study.

Method

Participants

75 Wayne State University undergraduate students in psychology were recruited to participate in this study. Participants were given extra credit in psychology courses for their voluntary participation.

Of these 75 participants, 13 did not complete the task as asked, either by failing to complete every trial (11 subjects) or by not making correct use of the rating instrument (described below), providing answers with little to no variance (2 subjects). Of the 62 remaining subjects, 223 ratings (1.5% of total trials) were removed due to having excessively long reaction times (greater than ten seconds), indicating the participants may have paused their participation in the task, which was not monitored, mid-trial.

Materials

The stimuli were 200 nouns selected to have extant values on the following dimensions:

1. Lexical decision and naming performance from the ELP (see above).

2. Age of acquisition scores (see above).

3. Concreteness values (see above).

Of the more than 500 nouns that met these criteria, 220 (200 target words and 20 practice words) were randomly selected.

Ratings were made using a computerized slider. Subjects were presented a slider bar in their Internet browser window that they were instructed to manipulate using a mouse. Moving the slider left moved it toward a label that said PEOPLE and moving the slider right moved it toward a label that read ANYTHING ELSE. A submit rating button was used to confirm their assigned rating.

Procedure

Testing was done remotely via a testing application embedded on a website hosted on a computer run by the experimenter. The application was a Java applet (Sun Microsystems), retrieved by participants' browsers and run locally on their computers. Java was selected for its robustness, technological maturity, and multiplatform compatibility. It also has commonly installed libraries for playing sound, albeit with a few caveats (see below). Keller, Gunasekharan, Mayo and Corley (2009) demonstrated that Java timing over the web over multiple platforms is sufficiently comparable to lab testing. Java applets have very flexible graphical interface options, allowing for unique graphical configurations. For example, in the current study, a slider bar was implemented to obtain ratings, as opposed to an 8 point scale. This allowed for an intuitive and simple task that was simultaneously sensitive, and also, by virtue of requiring the slider to be moved from its default position, permitted easy recognition of shirking participants.

Participants were instructed to rate visually presented words by how likely they were to use the word in a conversation about people or a conversation about anything else. They were instructed to move the slider left if they were more likely to use a word in a conversation about people, and to move the slider right if they were more likely to use a word in a conversation about anything else. During each rating, labels were presented to remind subjects of the poles of the rating axis.

Participants completed 20 practice trials before rating 200 words. Ratings were recorded on a 0 – 100 point scale. 50 indicated no preference (or no movement from the default slider position); 0 indicated the participant was extremely likely to use the word in a conversation about people; 100 indicated the participant was extremely likely to use the word in a conversation about anything else. Reaction times were also recorded, from the display of the target word to the submission of the rating (via clicking a "Submit rating" button with their mouse).

Data Analysis

After data cleaning (see above), responses were averaged over each word, and scores were reversed (by subtracting each word's mean rating from the maximum rating) so that higher values indicated more likelihood of use in a conversation about people. Ratings were then correlated with lexical values on several other dimensions, and linear models were computed to see the overall relationship between these ratings and the known set of relevant variables.

The new variables introduced at this stage were:

1. Frequency values from CELEX (Baayen, Piepenbrock, & van Rijn, 1993). These were used to better correspond to previous studies into semantics and word recognition.
2. Polysemy, as operationalized by number of synonym sets associated with each word (Miller, 1990). The number of distinct uses of a word, sometimes known as polysemy or semantic complexity, is known to affect word recognition in

complex ways, and controlling for complexity was essential to test the viability of the sociality construct.

3. Animacy – although English has few grammatical markings for semantic animacy, there is evidence that animate nouns are conferred processing benefits (e.g., Wurm, Whitman, Seaman, Hill & Ulstad, 2007). Animacy was rated as a three level factor: 0 for words with inanimate referents (e.g., article); 2 for words with animate referents (e.g., beast), and 1 for words with generally animate referents (e.g., committee).

4. Bigram frequency, the frequency of encountering two-letter combinations in the English language. While the data on whether there is any influence of bigram frequency on lexical decision and naming tasks are mixed (e.g., Andrews, 1992), it's a well-known lexical variable and is included for completeness.

5. Additional length measures – number of morphemes, number of syllables, number of phonemes – to make as strong a correction as possible for form-based influences on response timing and accuracy. Although these are largely redundant, they are not fully redundant. As such, any model which includes several length measures, while complicating the assessment of any individual length predictor, should leave unrelated variables more-or-less unaffected. This was done to make as conservative an estimate of the effect of sociality on word recognition as possible.

Results

Significant bivariate correlations between ratings ("Rated Sociality"), reaction times, and other lexical measures are shown in table 5. As expected, rated sociality correlates significantly and positively with the LSA ratio obtained in the preliminary studies ($r = 0.25$), and, as expected, this correlation was well below 1, indicating that the computationally derived surrogate, while the best lexical predictor of rated sociality, was still an imperfect surrogate. Interestingly, the variable that correlates highest with rated sociality is lexical decision accuracy obtained in the ELP, used in the preliminary studies analysis, suggesting that ELP lexical decision performance can be predicted by rated sociality. Other variables included here will be used in later regression studies to control, primarily, for form-based variability in the target words under study. Further analyses related to ELP tasks are described below.

To assess the composite contributions of lexical variables to rated sociality – in other words, the percentage of rated sociality which can be explained by known lexical variables – a linear model was computed predicting sociality using the other lexical variables shown in Table 5, as well as a factor, semantic animacy. As expected, the model significantly predicted rated sociality, with an adjusted R-Squared of .286 ($p < .001$). By contrast, a similar model was run on other rated lexical variables, and, for a conservative estimate, rated sociality was excluded. Concreteness was predicted with an adjusted R-Squared of .48; age of acquisition was predicted with an adjusted R-Squared of .682, both significant at $p < .001$. This suggests that, while rated sociality is significantly related to semantic and form-based lexical variables, this relationship is far weaker than it is in two commonly used rated variables, and that rated sociality has far more unexplained variance. Therefore, it is expected that any effect that rated sociality has on behavior is more likely to be due to unique aspects of rated sociality rather than the variance it happens to share with other variables.

Finally, to get a preliminary idea of the effect of sociality on word recognition, simultaneous regressions were computed using the all of the above referenced lexical variables, including rated sociality, and ELP task data. Results for only significant variables in the lexical decision task are shown in Table 6. Words with fewer letters and with smaller orthographic neighborhoods were responded to significantly faster than words higher on those dimensions. Aside from this, only three lexical variables showed marginal ($p < .10$) significance): more synonym sets, earlier acquisition, and higher rated sociality were associated with marginally faster response times. Only sociality predicted response accuracy: Better accuracy was associated with a higher likelihood of being used in a conversation about people ($p < .001$). Notably, across both dependent variables, the only semantic variable consistently predicting lexical decision performance in the ELP data set for these nouns was rated sociality (albeit marginally in reaction time).

The pattern was different for ELP naming data (see Table 7). While again words with fewer letters were associated with significantly faster RTs ($p < .001$), the only other significant variable was age of acquisition (showing the same effect as was seen marginally above, $p < .05$). The number of synonym sets associated with a word was marginally predictive of reaction time (showing the reverse trend as above, $p < .10$), and there was a nonsignificant facilitative trend ($p = .128$) of rated sociality. All other effects were less likely than sociality, and no variables predicted naming accuracy. This suggests that while rated sociality may predict word recognition performance, it does so far better for lexical decisions than naming, although the ELP naming data overall showed very little influence of lexical variables. However, across both tasks, rated sociality showed far more relevance than frequency, concreteness, orthographic neighborhood, and bigram frequency.

Discussion

Two major findings emerged from the rating study – first, that ELP lexical decision performance was predicted by rated sociality, independent of a host of form-based and otherwise lexical measures; second, that rated sociality, while related to other lexical variables, is related far less so than the two predominant rated variables – concreteness and age of acquisition – indicating that the effect of rated sociality in a simultaneous regression should be more distinguishable from other variables. However, due to the scarcity of significant effects, and the lack of within-subject variance, a visual lexical decision task was computed to obtain subject-level data for a better analysis of the effect of rated sociality.

CHAPTER 4 EXPERIMENT 2

Visual Lexical Decision

Social semantic effects in visual word recognition were investigated in a task that is largely considered sensitive to word recognition processes – lexical decision. Lexical decision reaction times are generally considered to be dependent upon lexical access times; variables that influence lexical decision times are therefore likely to be related to lexical access times. The goal of this experiment was to assess the influence of sociality on lexical access times using trial-level data obtained in a new experiment. It was hypothesized that lexical access times would be shorter as scores on rated sociality rise. Error analyses were also conducted, with accuracy of lexical decision performance expected to be higher for words with higher sociality; however, due to the normally low error rate of lexical decision tasks, this trend may not reach significance.

Participants

Seventy-one undergraduate students from the Wayne State University psychology subject pool were recruited to participate. All subjects were native speakers of English. Participants received extra credit in a psychology course for their participation.

Of these 71 subjects, 5 were removed for not completing the task. Of the remaining trials, 239 (~ 1.5%) were removed for having excessively long or short RTs (beyond two standard deviations from the mean). No subjects were removed due to excessive inaccuracy.

Materials

100 of the 200 words used in experiment 1 were randomly selected to serve as the real word stimuli for experiment 2. The remaining 100 were turned into nonwords by changing a single letter (randomly selected from the beginning, middle, and end of each word). The splitting of the experiment 1 stimuli was done as to maximize the equivalence of the two groups

first on length (by randomly generating a hundred combinations of two groups with equivalent mean lengths), and then by minimizing the Mahalobis distance of a set of average variables, including bigram frequency, orthographic neighborhood, and word frequency, to maximize the similarities between the groups to ensure full lexical processing. The practice items from experiment 1 were selected as practice items for experiment 2, half of which were changed to nonwords using the same procedure.

The 100 real words used in experiment 1, along with mean rated sociality, age of acquisition score, and concreteness score, can be found in Appendix C.

Procedure

As in experiment 1, experiment 2 was conducted on the web using Java applets. As in lab testing, subjects were presented instructions before testing, and were given an opportunity to practice, followed by feedback on their practice performance. Subjects were encouraged to go as quickly and as accurately as possible.

Participants were presented each word visually immediately following a fixation cross. Participants were asked to indicate words by pressing the “H” key on their keyboards using their right index fingers, and to indicate nonwords by pressing the “G” key on their keyboards using their left index fingers.

Data Analysis

Data were analyzed at the trial level using mixed-effects linear models with both subjects and items as random factors. For error analyses, models were fitted applying a binomial distribution to predict likelihood of a correct response.

Results

Analyses were restricted to real word trials. All word trials (screened as described above) were used in accuracy analyses; only correct word trials were used in reaction time analyses, with 321 (4.86%) of word trials removed due to error.

Reaction time results are shown in Table 8. Larger orthographic neighborhoods ($p < .01$), more letters ($p < .05$) and more animate referents ($p < .05$) were associated with significantly slower RTs; higher frequency ($p < .05$), more synonym sets ($p < .01$) and higher sociality ($p < .001$) were associated with significantly faster RTs (see Figure 1). Notably, the most robust effect was associated with sociality, even after controlling for several other lexical variables. More syllables and later acquisition were associated with marginally slower RTs (p < .10), and higher concreteness was associated with marginally faster RTs (p < .10).

Accuracy results are shown in Table 8 as well. More synonym sets ($p < .01$), higher frequency ($p < .01$), higher bigram frequency ($p < .05$), and higher sociality ($p < .05$) were associated with better accuracy, while animacy was associated with poorer performance ($p < .01$) (see Figure 2). Words with more morphemes and earlier acquisition were marginally associated with better performance ($p < .10$).

Discussion

For rated sociality, the story is quite consistent: Visual lexical decision speed and accuracy are better for words rated as more likely as being used in a conversation about people than anything else. This demonstrates that visual word recognition is sensitive to social information. The next experiment looks at whether this effect is unique to reading or also extends to the auditory modality.

CHAPTER 5 EXPERIMENT 3

Auditory Lexical Decision

To assess the generality of the sociality construct in word recognition, an auditory version of the lexical decision task was conducted. Wurm (e.g., Wurm, Vakoch, Strasser, Calin-Jageman, & Ross, 2001) has argued that the use of oral language as stimuli may uncover links between language processing and emotional aspects of meaning better than written words. Pinker (1994) conjectured that spoken language was used tens of thousands of years before written language in early humans, which may indicate that the processing of speech is more sensitive to evolutionarily- and behaviorally-relevant dimensions of meaning. As with written words, spoken word recognition is dependent on a variety of factors. Many of these factors are shared with written words, but a few are unique or different. Auditory stimulus length is operationalized not by number of letters, but by number of phonemes. Phonological neighborhoods are controlled for in lieu of orthographic neighborhoods. Reaction times can be measured from stimulus onset, as in visual word recognition, but to reflect the unfolding of the stimulus over time, and that in the lexical decision task responses typically require a complete stimulus to have been presented to ensure accuracy – and that in the visual analog of this task such information was available to subjects at onset – the offset of stimuli were used in reaction time models.

Participants

Seventy-seven undergraduate students from the Wayne State University psychology subject pool were recruited to participate. All were native speakers of English. Participants received extra credit in a psychology course for their participation.

Of these 77 subjects, 26 were removed for not completing the task. It is believed that this excessive number of drop-outs is due to technical difficulties involved with running an auditory Java experiment over the web. Due to the non-universality of the sound implementation in many Java clients, the amount of data necessary for transfer to a client computer in an auditory task, and complications that go along with playing sound on a computer, a large number of subjects were unable to effectively run the experiment software.

Of the 51 remaining subjects, two were removed due to excessive error rates that approached chance, leaving 49 subjects who completed the task with above-chance accuracy.
Of the remaining trials, 140 (~ 2%) were removed for having excessively long or short RTs (beyond two standard deviations from the mean).

Materials

The words and non-words used in this study were those used in experiment 2. A female speaker unfamiliar with the purpose of the experiment recorded the words at a normal speaking rate. Words were recorded as 16 bit, 44,100 Hz PCM audio files, but converted to 8,000 Hz, 64 kbps Sun AU files for Java applet compatibility. This stripped each sound file of some of the audible high frequency spectrum in speech. This yielded sub-optimal recordings; however, because of the exploratory nature of this project, and because of the general noisiness of spoken words in natural speech, I proceeded with the experiment using these stimuli.

Procedure

As in the previous two experiments, subjects were tested on-line. Instructions were the same as in experiment 2.

Data Analysis

RTs were measured from stimulus offset by subtracting stimulus duration from each response.

Results

Error rates were much higher than in experiment 2 – even after removing subjects with very poor performance, the overall error rate was 7.5%.

Reaction time results are in Table 9. Only frequency and age of acquisition predicted response latencies – more frequent words were associated with faster responses ($p < .05$) and later acquired words were associated with longer responses ($p < .01$). While rated sociality's coefficient was in the right direction (facilitative), its standard error led it to be far from significant (see Figure 3).

Accuracy results are also in Table 9. In contrast to RTs, accuracy analyses were much more fruitful. Words with more phonemes ($p < .001$), higher bigram frequency ($p < .001$), more syllables ($p < .001$), higher frequency ($p < .05$), concreteness ($p < .001$), and sociality ($p < .01$) were associated with higher accuracy, while animacy ($p < .001$) was associated with poorer accuracy (see Figure 4).

Discussion

Although auditory lexical decision times collected were not very sensitive to the effects of lexical variables, accuracy was, fitting the general nature of the variables, and fitting the pattern observed thus far for rated sociality – better performance for words rated as more likely to be used in a conversation about people as opposed to a conversation about anything else.

CHAPTER 6 GENERAL DISCUSSION

This study achieved a number of firsts – the first word recognition study to investigate sociality; the first study to explicitly compare semantic ratings and a corpus-based semantic distance measure; the first word recognition study to investigate the importance of conversational context; and the first auditory word recognition study to be deployed on-line.

The main effect of sociality

Sociality was significant or marginally significant in four out of four analyses involving visual lexical decision performance – more than any other variable in the study. Sociality showed significance in auditory lexical decision accuracy (and showed a potential trend toward facilitating visual naming latencies) in the ELP data. Only age of acquisition showed such robustness across all of these tasks. Notably, age of acquisition is primarily a composite of other known lexical variables, in that the majority of its variance can be predicted using the set of other variables used in this study. This is not true of rated sociality, most of which cannot be predicted by other known lexical variables. This means that rated sociality contributes more independent predictive power to multimodal word recognition performance models than any other rated variable examined in this study. I conclude that visual recognition is indeed sensitive to the likelihood of a word's use in a conversation about people, independent of its form or other lexico-semantic variables, and there is evidence to suggest this effect applies to auditory processing as well and is perhaps not limited to the lexical decision task.

Subject ratings, corpus-based semantic distance, and conversational context

Notably, a corpus-based semantic distance measure – the ratio between the distance between target words and a set of personal pronouns and the distance between target words and the pronoun "it" – managed to correlate significantly with subjective ratings of the likelihood of words being used in conversations about people vs. the likelihood of words being used in conversations about anything else. While the majority of variance in each variable was unexplained by the other, the fact that no other lexical variable correlated higher with either indicates a clear relationship. This may indicate that more carefully controlled or informed uses of semantic distance measures as proxies for subjective ratings (which require time to acquire and can be contaminated with subject biases unrelated to the construct of interest) may be suitable for certain semantic variables in the future. It also indicates that, as far as amorphous concepts such as "sociality" are concerned, a co-occurrence based conceptualization of semantics may not be entirely off track. Indeed, as far as isolated word recognition goes, it appears that previous associated contexts do seem to matter – the kinds of conversations we previously found words in influences how they are recognized now.

On-line Testing

All behavioral testing was done on-line, with mixed results. Ratings and visual lexical decisions appeared quite good, with many lexical variables predicting visual lexical decision latencies and accuracy exactly as expected. Auditory lexical decisions were not systematically related to the variables expected to predict performance, and this may have been due to an elevated error rate due to the low quality of the stimuli used or issues related to playing sounds remotely via the on-line client. While this leads to compelling effects using accuracy as a dependent variable, it would be interesting to evaluate on-line testing using higher quality stimuli using a different platform to see if typical reaction time effects can be observed.

Why sociality?

The next obvious question is: Why is the word recognition system sensitive to rated sociality? The effects of more apparently evolutionarily relevant constructs such as *danger* and *usefulness* are more readily interpreted: They speak to a general perceptual system that emphasizes behaviorally relevant stimuli. But does that necessarily translate to language, in which words can and often do refer to things not present, and the immediacy of on-line processing is not a matter of life or death? I turn to two foundational cognitive theorists to answer this question.

Notably, Lev Vygotsky posited the social function of language as core. Vygotsky emphasized that language, as a part of a larger set of mental functions, was modeled after real relations between people.

> Initially, the sign is always a means of social connection, a means of affecting others … The original psychology of the function of the word is a social function, and if we want to trace how the word functions in the behavior of the individual, we must consider how it functioned formerly in the social behavior of people (Vygotsky, 1997, p. 103).

This held not only for the function of language, but the level of the word itself, which carries meaning specifically because of and for social purposes. Unlike other cognitive skills in our toolbox – memory, pattern recognition, decision-making – language is generally used in a social context. When we hear words, they are (as far as current technological limits are concerned) almost always generated by people; when we read words, they are almost always generated by people. It is, in most cases, impossible to perceive extraneously-produced language and not be engaged in a discourse, whether immediate or mediated, with another human, a social being.

While Vygotsky's emphasis of the social in cognitive development has been criticized for its roots in Marxist theory, such has not been attributed to the author of noted contrasting theories of intellectual development, Jean Piaget. While Piaget emphasized the individual in cognitive growth, this was not to the exclusion of the importance of social effects.

> [T]here is no longer any need to choose between the primacy of the social or that of the intellect: collective intellect is the social equilibrium resulting from the interplay of the operations that enter into all cooperation (Piaget, 1970, p. 114).

Notably Piaget flipped the role of the social in cognitive development: Engagement with society was the end-goal of cognitive development, indicating our language and reasoning systems grew to fit a social need. To that end, language is shaped by and in turn serves social interactions.

In light of both theories, we recognize social words better because social words are of primary behavioral importance. Intuitively, it simply means that words related to the task in which language is immersed demonstrate more relevance than words related to other things. We recognize social words better because people are important whenever we are employed in language recognition.

Possible mechanisms

I won't speculate much on how this effect may be implemented in the word recognition system. A possibility may be that word recognition networks are tuned to receive feedback – for the learning of new words or adjustment of old word meanings – that is generally linked to more social semantics, and these words are conferred a processing benefit. Whether this influence is top-down or due to a preattentive filter is unknown, but given the notable independence of social effects from form-based effects, it seems that deeper semantic processing may be necessary, leading me to believe these effects are indeed top-down, from lexical semantics.

One issue with this study is that all of the sociality effects were observed in the lexical decision task. While the intent was to observe a perceptual effect, post-perceptual contamination may have occurred. By "perceptual," I am using the general definition, as applied to word recognition, described by Wurm:

> In the context of our research, perception is the involuntary, low-level process whereby a physical stimulus makes initial contact with a mental representation. From the point of view of perception researchers, the question of when variables have an influence is as important as whether they do. This leads us to the important distinction between processing that is truly perceptual (called “online” processing) and that which occurs post-perceptually. In general, an effect is considered online if the basic act of perceiving a stimulus (not interpreting it or making a judgement about it) is itself influenced … Variables that influence later decision processes (i.e. those that occur “higher up” in the system) are considered post-perceptual (Wurm et al. 2001, p. 411).

While the lexical decision is used as an approximation of perceptual latencies, and it does span the act of stimulus acquisition and representation access, there is a necessary decision stage which can be best described as an executive function. There are three possibilities: this stage adds a constant duration, more or less, to each lexical decision RT as far as sociality is concerned; sociality influences this stage of lexical decision performance and not the lexical access stage; sociality influences both. While the lexical decision task suggests that sociality is perceptual – in that it very well may influence the process of accessing a lexical representation from an external stimulus – without observing its effect in a task not dependent upon executive functioning the possibility of it instead being a post-perceptual effect cannot be eliminated. The naming task helps get around this issue, although post-perceptual biases can still be observed as delays or facilitations in initiating the speech response. The delayed naming task (e.g., Wurm & Seaman, 2008) helps get around this by checking for a response bias after delaying pronunciation of the stimulus, and indeed this type of study should be carried out to confirm that sociality’s effects on the processing of speech are perceptual.

Future directions

Clearly, more research needs to be done multimodally and using more than the lexical decision task to demonstrate the universality of rated sociality effects in word recognition. A lab-based auditory naming study that demonstrated social effects would accomplish this. Furthermore, this finding lends itself to neuroscience investigations. If social processing at the semantic level resembles the processing of social-specific stimuli in other domains, there may be clear electrotemporal and hemodynamic patterns associated with social words not associated with other words. For example, face processing in vision is associated with early (e.g., N200) evoked potential components in specific occipitotemporal regions (e.g., Allison, Puce, Spencer & McCarthy, 1999) and BOLD respond in the fusiform gyrus (e.g., Kanwisher, McDermott, & Chun, 1997) – nicknamed the face gyrus. Similarly research into the auditory cortex has revealed distinctions between the processing of human and nonhuman sounds, with speech sounds, regardless of semantic content, more likely to be processed in the left ventral temporal and temporoparietal regions (e.g., Binder, Frost, Hammeke, Bellgowan, Springer, Kaufman, & Possing, 2000). While these distinctions can be traced to differences in visual or acoustic energy, seeing such a person/non-person distinction at the level of lexical semantics would be both novel and would demonstrate a greater organizing principle of human perception and cognition.

APPENDIX A TABLES

Table 1 – Bivariate Correlations Between Lexical Measures and a Sociality Ratio

	WSRatio	Length	N	LDRT	NMGRT	P-D	NP-D	AOA	CNC	SOC	LogFreq
Written/Spoken Ratio	1										
Length	0.49	1									
N	-0.38	-0.63	1								
Lex Dec. RT	0.38	0.55	-0.32	1							
Naming RT	0.39	0.52	-0.35	0.46	1						
Person-Distance	-0.70	-0.36	0.27	-0.22	-0.26	1					
Non-Person-Distance	-0.68	-0.28	0.19	-0.19	-0.21	0.89	1				
AoA	0.68	0.59	-0.45	0.55	0.53	-0.50	-0.38	1			
Concreteness	0.22	-0.07	0.12	-0.24	-0.12	-0.37	-0.53	-0.53	1		
Sociality Ratio	-0.50	-0.38	0.31	-0.24	-0.28	0.76	0.45	-0.53	0.09	1	
Log Frequency	-0.71	-0.22	0.15	-0.25	-0.21	0.43	0.57	-0.14	-0.39	0.11	1

Table 2 – Simultaneous Regression Model Using All Items and a Sociality Ratio

	Lexical Decision RTs			Naming RTs		
	B	St. Err. *B*		*B*	St. Err. *B*	
Length	15.39	0.62	***	10.22	0.5	***
N	0.59	0.28	*	-0.36	0.22	
Log Freq.	-6.66	0.79	***	-3.58	0.64	***
Sociality Ratio	-9.01	4.25	*	-18.41	3.45	***

Adjusted R^2 = 0.32 | Adjusted R^2 = 0.28

df = 2684 | df = 2684

* < .05; ** < 0.01; *** < .001; **** < .0001

Table 3 – Regression Model Using Items with Concreteness Scores and a Sociality Ratio

	Lexical Decision RTs			Naming RTs		
	B	St. Err. *B*		*B*	St. Err. *B*	
Length	13.79	0.94	***	10.46	0.81	***
N	0.74	0.33	***	-0.37	0.23	
Log Freq.	-3.41	1.14	**	-3.05	0.98	**
Concreteness	-0.12	0.013	***	-0.05	0.01	***
Sociality Ratio	-5.05	6.09		-12.09	5.23	*

Adjusted R^2 = 0.29 | Adjusted R^2 = 0.28

df = 1161 | df = 1161

* < .05; ** < 0.01; *** < .001; **** < .0001

Table 4 – Regression Model Using Items with AoA Scores and a Sociality Ratio

	Lexical Decision RTs			Naming RTs		
	B	St. Err. *B*		*B*	St. Err. *B*	
Length	15.46	1.26	***	9.35	1.13	***
N	1.96	0.49	***	-0.25	0.45	
Log Freq.	-7.89	2.10	***	-4.60	1.89	*
Concreteness	-0.02	0.02		0.00	0.02	
AoA	0.15	0.03	***	0.14	0.03	***
Sociality Ratio	7.33	9.45		7.61	8.51	

Adjusted R^2 = 0.46 (Lexical Decision RTs); Adjusted R^2 = 0.38 (Naming RTs)

df = 524 (Lexical Decision RTs); df = 524 (Naming RTs)

* < .05; ** < 0.01; *** < .001; **** < .0001

Table 5 - Bivatiate Correlations between Rated Sociality and Lexical Measures

	Soc.	Soc. RT	L (let)	OrthoN	PhonN	Bigram	L (phn)	L (syll)	N (mor)	LD RT	LD Acc	N RT	N Acc	AoA	CNC	LSAR	Syns	Freq
Rated Sociality	1																	
Sociality RT		1							.									
Length (letters)		0.15	1															
Orthographic N.	-0.18		-0.56	1														
Phonlog. N.	-0.18		-0.57	0.82	1													
Bigram Freq.			-0.20	0.14	0.15	1												
Length (phon.)			0.91	-0.56	-0.61	-0.16	1											
Length (syll.)	0.14		0.83	-0.51	-0.55	-0.18	0.86	1										
Length (morph.)	0.16		0.71	-0.35	-0.37		0.64	0.66	1									
LD RT			0.69	-0.33	-0.36		0.67	0.62	0.50	1								
LD Acc.	0.30		0.15	-0.15							1							
Nmg. RT			0.63	-0.34	-0.35		0.61	0.50	0.51	0.55		1						
Nmg. Acc.													1					
Age of Acq.			0.62	-0.46	-0.54		0.65	0.58	0.56	0.54		0.54		1				
Concreteness			-0.46	0.33	0.43		-0.47	-0.42	-0.40	-0.35		-0.39		-0.62	1			
LSA Soc.	0.25		-0.32	0.22	0.28		-0.33	-0.29	-0.31	-0.26		-0.28		-0.58	0.40	1		
Synsets				0.15													1	
Frequency			-0.18		0.16				-0.16	-0.19		-0.20		-0.32		0.21		1

Table 6 - ELP Lexical Decision Peformance and Rated Sociality

	RTs			Accuracy		
	B	St. Err. *B*		*B*	St. Err. *B*	
Length (letters)	16.03	2.66	***	0.0018	0.0014	
Orthographic N.	2.41	1.09	*	0.0006	0.0006	
Synsets	-2.26	1.30	.	0.0009	0.0007	
AoA	0.10	0.05	.	0.0000	0.0000	
Sociality	-0.35	0.19	.	0.0005	0.0001	***

Adjusted R^2 = 0.51 | Adjusted R^2 = 0.09

df=205 | df=205

. < .10; * < .05; ** < .01; *** < .001

Table 7 - ELP Naming Peformance and Rated Sociality

	RTs		
	B	St. Err. *B*	
Length (letters)	11.45	2.38	***
Synsets	2.08	1.16	.
AoA	0.10	0.05	*
Sociality	-0.26	0.17	

Adjusted R^2 = 0.44

df=205

. < .10; * < .05; ** < .01; *** < .001

Table 8 - Lexical Decision Performance and Rated Sociality

	RTs				Accuracy			
	B	St. Err. *B*		*b*	*B*	St. Err. *B*		*b*
Length (letters)	9.05	4.35	*	0.33	0.010	0.060	.	0.01
Orthographic N.	4.01	1.53	**	0.24	-0.001	0.021		0.00
Length (morph.)	-1.26	10.40		-0.01	0.259	0.140	.	0.08
Bigram Freq.	0.00	0.01		0.00	0.0002	0.0001	*	0.06
Length (syll.)	16.94	9.35	.	0.26	-0.099	0.132		-0.05
Log Freq.	-14.77	6.12	*	-0.14	0.244	0.079	**	0.07
Age of Acq.	0.14	0.08	.	0.21	-0.002	0.001	.	-0.09
Synsets	-6.40	2.05	**	-0.27	0.090	0.029	**	0.09
Concreteness	-0.10	0.06	.	-0.16	0.000	0.001		0.00
Sociality	-1.09	0.31	***	-0.30	0.009	0.004	*	0.08
Anim. (level 1)	36.34	16.27	*		-0.608	0.212	**	
Anim. (level 2)	17.55	20.04			0.088	0.284		

. < .10; * < .05; ** < .01; *** < .001

Table 9 - Auditory Lexical Decision Performance and Rated Sociality

	RTs				Accuracy			
	B	St. Err. *B*		*b*	*B*	St. Err. *B*		*b*
Length (phon.)	13.81	1.44		0.28	0.304	0.076	***	0.17
Phonol. N.	1.53	0.98		0.13	-0.004	0.010		-0.01
Length (morph.)	-26.49	-1.31		-0.17	0.048	0.160		0.01
Bigram Freq.	0.02	1.50		0.12	0.0004	0.0001	***	0.07
Length (syll.)	-36.00	-1.72		-0.35	0.662	0.160	***	0.17
Log Freq.	-16.40	-1.87	*	-0.10	0.128	0.059	*	0.02
Age of Acq.	0.49	2.91	**	0.48	-0.001	0.001		-0.02
Synsets	-0.52	-0.13		-0.12	-0.016	0.026		-0
Concreteness	-0.06	-0.44		-0.06	0.004	0.001	***	0.11
Sociality	-0.34	-0.53		-0.06	0.011	0.004	**	0.05
Anim. (level 1)	-31.06	-0.94			-0.924	0.263	***	
Anim. (level 2)	-8.59	-0.21			0.064	0.272		

. < .10; * < .05; ** < .01; *** < .001

APPENDIX B FIGURES

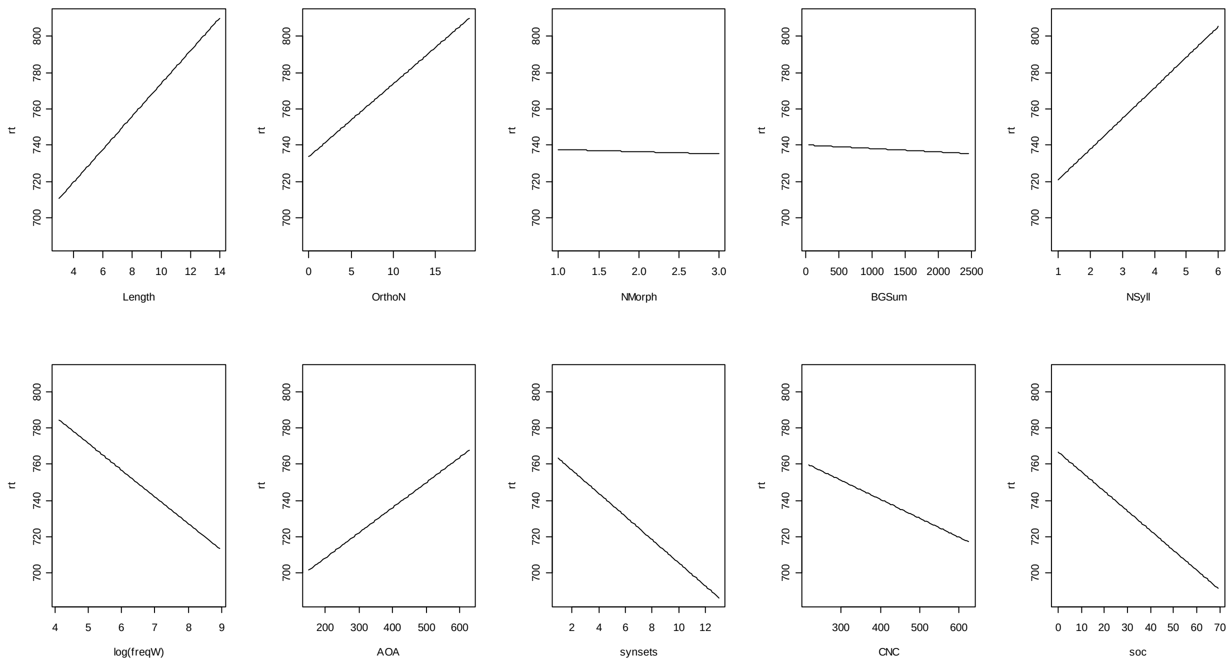

Figure 1. The effects of 10 lexico-semantic variables on visual lexical decision reaction time (ms). OrthoN = orthographic neighborhood; NMorph = number of morphemes; BGSum = bigram frequency; NSyll = number of syllables; log(freqW) = log of written frequency; AOA = age of acquisition; synsets = number of senses; CNC = concreteness; soc = sociality.

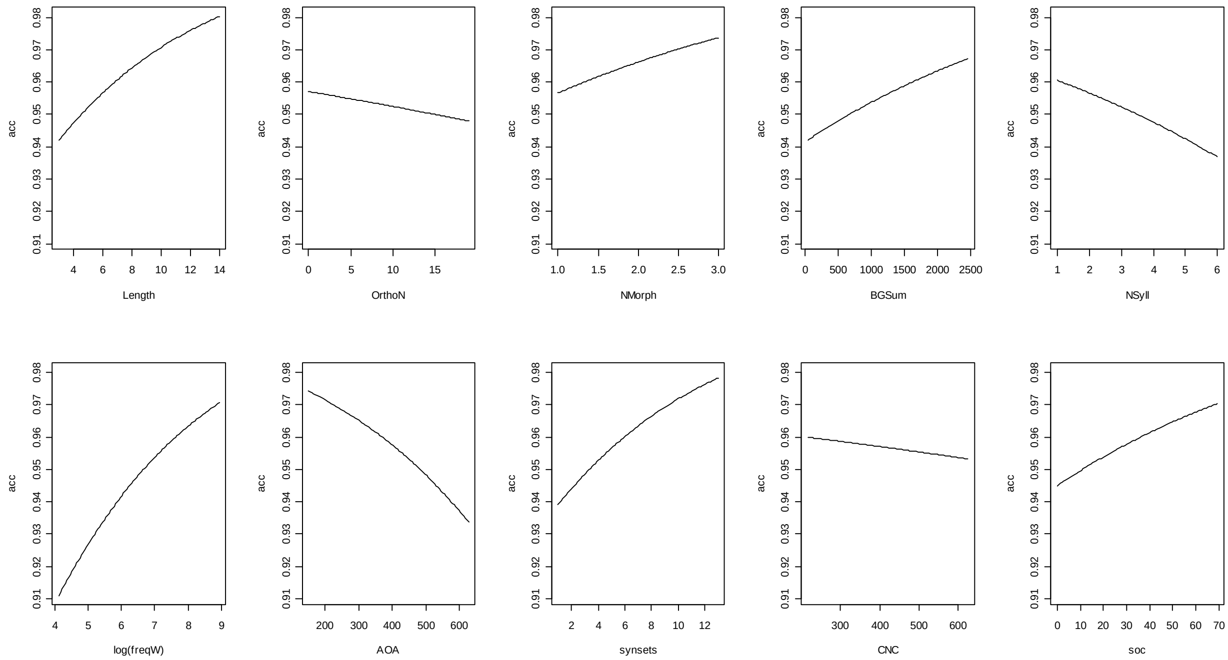

Figure 2. The effects of 10 lexico-semantic variables on visual lexical decision accuracy. OrthoN = orthographic neighborhood; NMorph = number of morphemes; BGSum = bigram frequency; NSyll = number of syllables; log(freqW) = log of written frequency; AOA = age of acquisition; synsets = number of senses; CNC = concreteness; soc = sociality.

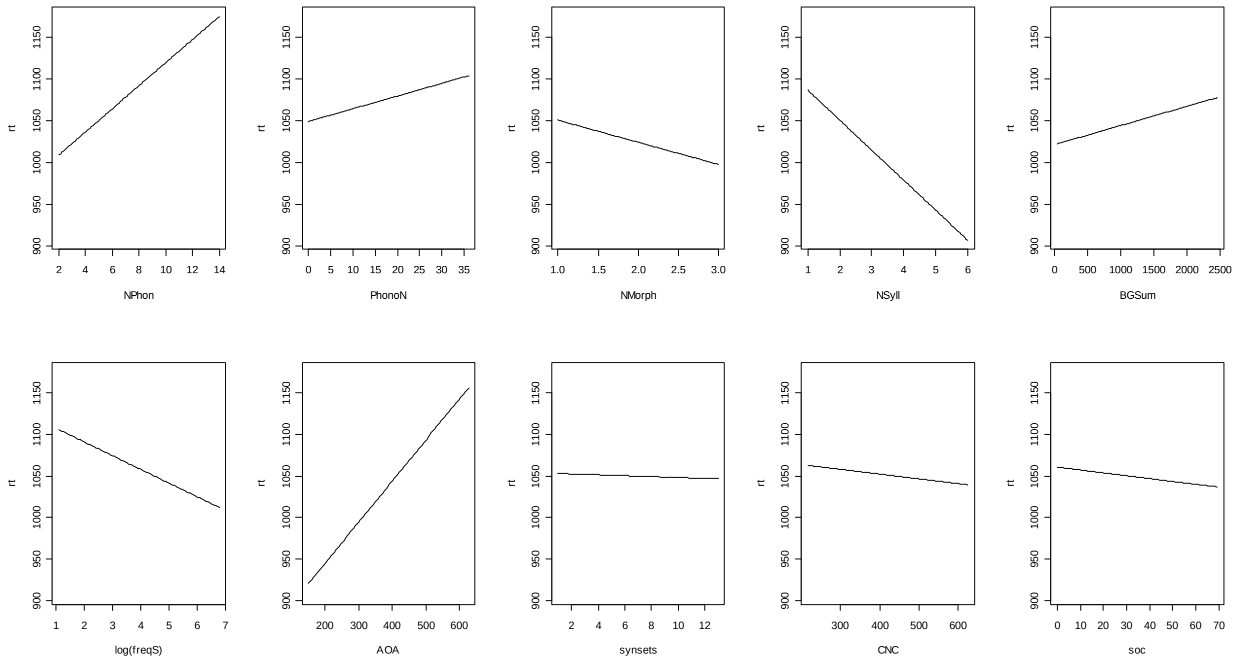

Figure 3. The effects of 10 lexico-semantic variables on auditory lexical decision reaction times (ms). NPhon = number of phonemes; PhonoN = orthographic neighborhood; NMorph = number of morphemes; BGSum = bigram frequency; NSyll = number of syllables; log(freqW) = log of spoken frequency; AOA = age of acquisition; synsets = number of senses; CNC = concreteness; soc = sociality.

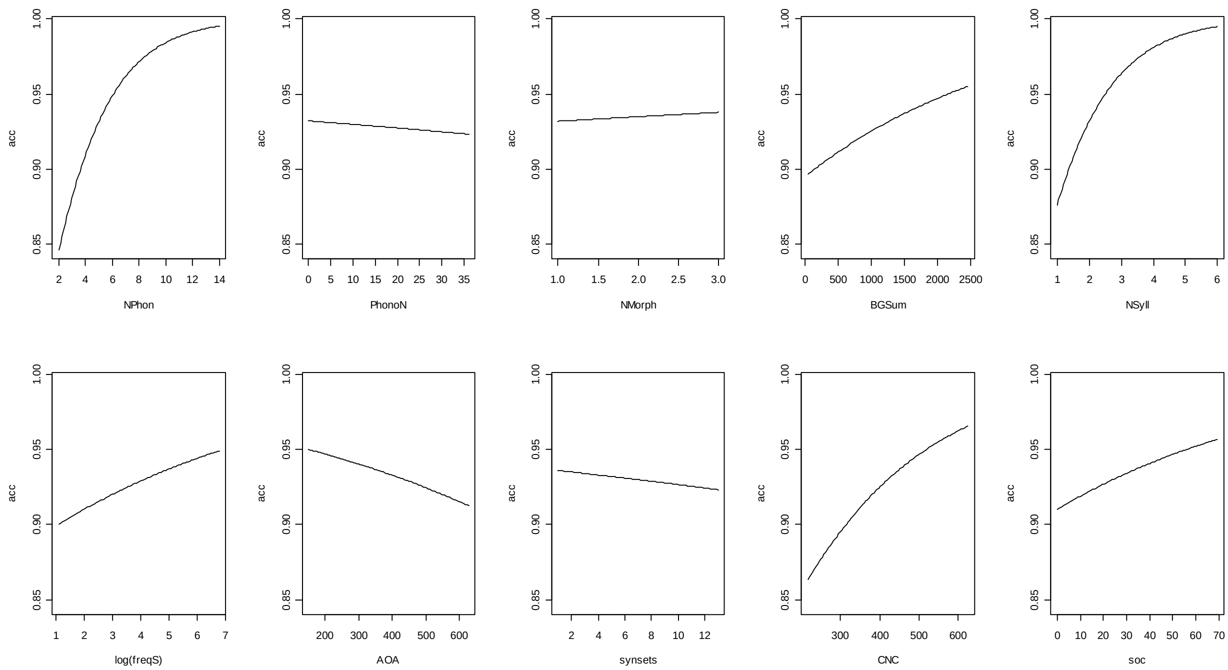

Figure 4. The effects of 10 lexico-semantic variables on auditory lexical decision accuracy. NPhon = number of phonemes; PhonoN = orthographic neighborhood; NMorph = number of morphemes; BGSum = bigram frequency; NSyll = number of syllables; log(freqW) = log of spoken frequency; AOA = age of acquisition; synsets = number of senses; CNC = concreteness; soc = sociality.

APPENDIX C WORDS

Word	*Sociality Rating*	*Age of Acq. Score*	*Cncrtness Score*	*Word*	*Sociality Rating*	*Age of Acq. Score*	*Cncrtness Score*
administration	45.1	561	331	corporation	30.1	522	361
angel	41.1	242	399	crime	47.3	383	387
anybody	60.1	306	343	customer	60.3	369	505
area	10.5	392	384	department	20.9	494	447
army	51.0	317	543	description	20.7	469	341
article	10.3	406	479	direction	18.3	381	336
aspect	14.1	547	217	door	5.2	214	606
attitude	52.2	481	265	education	45.1	408	320
avenue	4.4	372	539	effort	38.3	411	296
ball	6.9	150	615	enemy	53.0	367	434
bird	2.1	206	602	equipment	6.8	447	532
blood	44.3	253	613	evidence	19.8	480	340
brain	49.8	347	556	failure	36.0	439	282
business	26.9	436	389	fee	10.4	444	441
car	20.2	197	622	gas	13.9	339	554
century	9.8	414	346	generation	47.1	489	320
character	50.9	464	365	girl	69.5	183	607
circuit	6.8	494	493	goal	34.5	294	482
coffee	28.5	292	613	government	43.5	453	426
column	3.0	436	520	growth	36.6	378	381
committee	50.5	517	498	hall	6.6	283	565
community	53.4	522	388	income	41.8	506	429
compression	6.7	628	356	industry	18.2	492	479

Word	Sociality Rating	Age of Acq. Score	Cncrtness Score
instance	12.0	471	284
introduction	15.8	481	341
item	9.8	406	436
journal	24.0	447	563
justice	40.0	500	307
lady	68.7	231	564
length	3.8	322	365
letter	23.1	256	577
literature	29.8	494	462
liver	41.3	353	617
loss	25.6	331	313
marriage	65.4	383	398
moment	21.7	350	301
money	35.7	247	574
mountain	0.0	283	616
mouse	5.6	242	624
music	31.8	272	512
nature	14.4	342	414
organ	51.1	356	596
package	6.5	364	580
personnel	43.9	575	429
philosophy	30.3	622	257
platform	8.4	386	547
population	53.4	469	406
presence	28.5	456	326

Word	Sociality Rating	Age of Acq. Score	Cncrtness Score
president	65.6	458	526
professor	64.2	519	549
protection	37.5	461	308
ray	8.8	322	470
reaction	36.3	506	312
resolution	24.2	550	265
responsibility	49.0	514	222
road	7.3	206	583
self	65.7	328	459
series	7.2	461	373
situation	34.9	457	311
society	51.7	497	335
solution	20.5	506	388
speech	52.6	369	453
spirit	38.3	389	296
statement	22.2	481	379
suggestion	36.6	461	333
suspect	50.1	472	379
sword	8.0	342	577
teacher	61.6	247	569
text	24.4	486	498
theory	22.0	557	287
title	15.9	375	384
translation	23.5	556	366
union	37.6	503	449

Word	*Sociality Rating*	*Age of Acq. Score*	*Cncrtness Score*
unit	11.7	411	389
van	8.6	267	606
vice	21.8	517	399
weapon	12.5	375	560

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ABSTRACT

THE EFFECT OF WORD SOCIALITY ON WORD RECOGNITION

by

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Degree: Doctor of Philosophy

While research into the role of semantic structure in the recognition of written and spoken words has grown, it has not looked specifically at the role of conversational context on the recognition of isolated words. This study was a corpus-based and behavioral exploration of a new semantic variable – sociality – and used on-line behavioral testing to obtain new word recognition data using the visual and auditory lexical decision tasks. The results consistently demonstrated that sociality is one of the most robust predictors of lexical decision performance. Overall, it appears that the visual lexical decision task is quite sensitive to the likelihood of words being used in conversations about people, and there is evidence suggesting this effect is multimodal and may extend beyond lexical decision.

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SELECTED PRESENTATIONS

Seaman, S., Hsieh, L., & Young, R. (2009, April). *Effects of conversational complexity of cell phone conversations on driving: ERP lab and on-road driving studies.* Poster session presented at Annual Meeting of the Cognitive Neuroscience Society, San Francisco, CA.

Seaman, S., Young, R.A., & Hsieh, L. (2008, November). *Neuroimaging the Conversation Effect during Event Detection*. Presented at the Convention of the American Speech-Language-Hearing Association, Chicago, IL.

Seaman, S., Hsieh, L., & Young, R. (2008, April). *The effect of conversation on visual detection during simulated driving: Overt vs. covert speech.* Poster session presented at Annual Meeting of the Cognitive Neuroscience Society, San Francisco, CA.

Seaman, S. & Wurm, L.H. (2004, November). *Semantic, non-semantic, and production effects in word naming.* Poster session presented at Annual Meeting of the Psychonomic Society, Minneapolis, MN.

Seaman, S. & Wurm, L. (2004, July). *Semantic effects in auditory word naming: Production versus perception.* Poster session presented at the 4th International Conference on the Mental Lexicon, Windsor, ON, Canada.

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