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Examining Semantic Effects in Conceptual Combination

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ABSTRACT

Conceptual combination is a cognitive process that produces complex concepts (e.g., adjective-noun pairs) from simple concepts. The Selective Modification Model (SMM; Smith, Osherson, Rips, & Keane, 1988) postulates that simple adjective-noun combinations (e.g., *red apple*) are understood by the modifier *red* selecting the colour attribute of the head noun *apple*. Theories of conceptual combination have not extended to fulfill our understanding of how complex adjective-noun pairs (e.g., *empty dream*) are processed. This exploratory study had two main objectives: to determine which semantic variables best captured the processing of complex adjective-noun pairs and to examine the semantic effects of conceptual combination to extend current theories. Adjective-noun combinations were manipulated based on subjective ratings (i.e., concreteness and plausibility; see the preliminary study) or objective measures (i.e., age of acquisition and semantic distance) and compared. Two hundred and ninety-three participants were randomly assigned to complete one of three computerized tasks that differentially engaged semantic processing from shallow to deep, including the non-pronounceable double lexical decision task (Experiment 1), the pronounceable double lexical decision task (Experiment 2), and the meaningfulness task (Experiment 3). Across all tasks, the subjective model outperformed the objective model in reaction time and accuracy analyses. Adjective-noun processing was facilitated by concrete, early acquired head nouns, as well as adjective-noun pairs that were rated as plausible and situated close in semantic space. Interestingly, adjectives paired with abstract head nouns were difficult to process across tasks regardless of how plausible the pair was. In conclusion, semantic variables rated by participants are valuable and may better capture how the mental lexicon is organized and accessed, and further research should pursue innovative ways of examining how abstract head nouns are processed to incorporate into existing theories.

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CHAPTER 1

INTRODUCTION

Introduction to Conceptual Combination

Conceptual combination is an intricate and fundamental cognitive process that produces complex concepts (i.e., combinations of words) by accessing and merging basic concepts (Wisniewski, 1996). This process permits language extension, as familiar language items can be combined to form novel combinations or phrases (Wisniewski, 1996). Thus, conceptual combination recycles old concepts to form new concepts, highlighting its degree of flexibility and complexity (Thagard, 1984). Familiar and novel combinations of terms can serve to constrain and exemplify how complex concepts are represented and formed (Wisniewski, 1996). Determining the mechanism(s) and process(es) involved in conceptual combination will provide insight into conceptual representations as a whole as well as reveal the processes involved in both language comprehension and production (Maguire, Deverux, Costello, & Cater, 2007).

Wisniewski (1997) illustrates the three primary intentions of conceptual combination in communicative contexts. First, individuals produce novel combinations to label a new item (e.g., a *car boat* to describe a dual function car that can float in water) that current knowledge does not capture, differentiating it from pre-existing categories. These language extensions can be permanent or temporary, depending on the function they serve (Wisniewski, 1997). Second, combinations allow people to transmit concise information in an efficient manner. Rather than stating a full sentence to convey meaning, an individual can simply state a combination, such as *football parking*, and the entire meaning is captured within the combination (i.e., where you park during a football game; Wisniewski, 1997). Lastly, combinations can serve as an anaphora in that they can be used succinctly to refer to a previously stated referent during discourse context (e.g., saying *moon man* to describe the first man on the moon; Wisniewski, 1997). These three goals are achievable when certain constraints are placed on the production and interpretation of a novel combination (Wisniewski, 1997). Primarily to avoid ambiguity and encourage the transmission of an informative exchange, these constraints include that (a) the head noun is the main categorical item, and the combination distinguishes itself from other items within the category; (b) the distinguishing element is the modifier (i.e., lexical item preceding the head noun); and (c) the combinatory referent shares similarities with the items in the head noun category (Wisniewski, 1997). For example, in the noun-noun combination *moon man*, the head noun is *man* and the modifier is *moon*. *Moon man* shares similarities to items within the same head noun category, such as *boss man*, which also describes a type of man but is distinct due to the preceding modifier.

The above example highlights the relevance of combinations in communicative contexts and proposes one account of conceptual combination constraints to consider. Products of conceptual combination (i.e., complex concepts) can be formed from a variety of constituent components including noun-noun (N-N), adjective-noun (A-N), and verb-noun (V-N) phrases. Various theories have been proposed to explain the time-course, mechanism, and logistics of conceptual combination in these combinatory pairs.

Theoretical Perspectives of Conceptual Combination

The time-course of conceptual combination, or the order that language items are processed in combinatory pairs, has competing viewpoints. Initially, it was assumed that the head noun largely contributed to the semantic interpretation of a noun phrase (Kamp & Partee, 1995; Springer & Murphy, 1992; Wisniewski, 1996). Thus, interpretation of the modifiers may be delayed until the head noun is comprehended. More recently, another possibility is that noun phrases are interpreted sequentially upon presentation (Kennison, 2010), consistent with previous studies that support rapid integration of single concepts with compatible preceding contexts (Kennison, 2005).

Another aspect to consider is the mechanism of conceptual combination, or how neural representations are stored, activated, and retrieved. As with schema models of simple concepts (Rumelhart, 1980), it is unlikely that complex concepts have prototype representations stored for all conceivable combinations (Medin & Shoben, 1988). The infinite number of combinations renders this notion impractical, as does its inflexibility and inability to account for the activation of novel combinations (Medin & Shoben, 1988).

Potter and Faulconer (1979) examined adjective modification of nouns and determined that there are two activation processes that may occur depending on the A-N. For familiar or related A-Ns (e.g., *furry animal*), presentation of the adjective followed by the noun leads to the subsequent activation of overlapping conceptual structures. This activation instantaneously facilitates a semantic interpretation, contributed to by both constituents of the pair (Potter & Faulconer, 1979). Meaning is derived from the pattern of activation of the interactive conceptual systems (Potter & Faulconer, 1979). This rapid process is akin to a model of spreading activation (Collins & Loftus, 1975), in which activation of one knowledge structure results in the activation of nearby, or related, knowledge structures to facilitate interpretation. Spreading activation models typically fall short when considering novel complex concepts with no apparent connection to each other (e.g., *obtuse fog*), in which case Potter and Faulconer (1979) postulate the use of a slower, more controlled processing to deduce an appropriate semantic interpretation of unusual or novel A-N combinations.

In addition to the mechanism(s) involved storage and activation, another consideration of conceptual combination is the retrieval mechanism; that is, whether the interpretation of the noun is retrieved context-dependent or context-free (Potter & Faulconer, 1979). On the one hand, the compositionality view is similar to schema models in that it proposes that word semantics are statically stored in default schematic representations, and the same pattern of activation is achieved when encountering a word, regardless of context (McElree, Murphy, & Ochoa 2006; Swinny, Love, Walenski, & Smith. 2007). This view assumes that conceptual schemas form the building blocks of language, and to accurately interpret a noun phrase, all corresponding constituent units must be activated independently before being combined and pruned to focus on relevant features (Maguire & Maguire, 2011). However, noncompositionality of conceptual combination is demonstrated in cases where participants are asked to verify attributes that are true of the conjunction but not true of the head noun constituent (i.e., emergent attributes; Costello & Keane, 2000; Springer & Murphy, 1992). For example, *green* is a feature of both *celery* and *boiled celery*; however, *soft* is only a property of *boiled celery*. This latter example is an emergent attribute, and Springer and Murphy (1992) found that participants were faster to verify phrase features compared to noun features. They concluded that this finding is supportive of context-dependent retrieval (Springer & Murphy, 1992).

Theorists in support of the contextuality view do not assume that word meaning is subsumed by a fixed schema but rather includes crucial information about the interplay between words in context (Barsalou, 1982; Potter & Faulconer, 1979; Springer & Murphy, 1992). With this view, contextual factors contribute as inputs to produce a more accurate referent. For example, consider the homonym *table.* A table can refer to a piece of furniture or a data-organizing tool. When presented with the noun phrase *wooden table* it seems likely that the preceding modifier of the noun would influence the retrieval of table as meaning a piece of furniture, rather than its alternative interpretation. Thus, it is more realistic to assume that retrieval is context dependent (Potter & Faulconer, 1979).

Relatedly, the logistics of conceptual combination, or how meaning is derived from the constituents to create a holistic interpretation, is a third aspect to consider. One set of theories proposes that a complex concept (XY) is simply a derivation of its constituents (X and Y; Wisneiwski, 1996). The set intersection model is one such theory (Osherson & Smith, 1981) that proposes *metal spoon* is the intersection of the nouns *metal* and *spoon*. Although this reasoning can be applied in some instances, it is not universally applicable to all cases (e.g., *dog sled*; Wisniewski, 1996). Along with non-intersective examples, another drawback of this model is that it does not specify how a novel complex concept is formed (Murphy, 1988).

A second class of models, formulated extensively in the study of N-N combinations, proposes that meaning is derived from complex concepts by forming a relationship between the constituents (Wisniewski, 1996). These theories include various conceptualizations of what constitutes a relation between constituents. One theory proposes sixteen types of abstract relationships between N-N combinations, such as a CAUSE relation (e.g., *electric shock*) and an IN relation (e.g., *mountain stream*; Levi, 1978; Wisneiski, 1996). Relatedly, Gagné and Shoben (1997) introduced a theory that proposes a similar underlying concept, called the competition among relations in nominal (CARIN). In this model, N-Ns use one of sixteen potential thematic relation types. For example, one relation type is LOCATED such as "*chair* LOCATED *kitchen*" for the compound *kitchen chair* (Gagné & Shoben, 1997). As the title suggests, the CARIN assumes that there is selection competition amongst the thematic types. Competition is resolved by the relative availability of the appropriate relation, which determines the ease of interpreting the conjunctive pair (Gagné & Shoben, 1997). The ease of interpretation is dependent on how noun constituents are used in other combinatory pairs, as some nouns have certain relational preference. For example, *mountain goat* is easier to interpret than *mountain range* as it relies on the LOCATED relation in comparison to the MADE OF relation (Gagné & Shoben, 1997; Maguire et al., 2007). In contrast to most theories that assume an interaction between constituents, the CARIN model assumes independence of the constituents and that relation availability is solely dependent on the modifier constituent (Gagné & Shoben, 1997).

Other models that suggest a relational role in conceptual combination include slot-filling approaches, which extend the notion of schematic representations of concepts (Rumelhart, 1980). In these models, nouns are characterized as frames (i.e., a knowledge structure representing a concept such as a situation or object) with slots and fillers. Slots are dimensions of the concepts, and fillers are values that are exemplars of the dimensions (Wisniewski, 1996). For example, a frame for *giraffe* would include colour, size, and habitat as slots with orange, large, and the safari as typical fillers, respectively. To interpret a complex concept, a filler occupies the slot of a head concept and acts as a modifying concept. To illustrate, a combination such as *alley cat* is interpreted by the value *alley* occupying a habitat slot of the head concept *cat*. In contrast to equally valued constituents that were proposed in the set intersection model (Osherson & Smith, 1981), these models suggest that conceptual formations are asymmetric structures; that is, the second concept acts as the head concept and the preceding concept modifies it (e.g., concept specialization model; Murphy, 1988). Slot-filling models share a few key assumptions including (a) the noun phrase will be easier to comprehend if the modifier selects a clear slot in the noun frame, (b) the interactive process between the modifier and noun is highly context-dependent, (c) and noun phrases will be evaluated as nonsensical if an appropriate slot is not found (Murphy, 1990).

Property-mapping approaches are a third class of models with inherent differences from slot-filling models. Rather than asserting a relation between the constituents to synthesize a conceptual formation, property attribution proposes that a property of one constituent is applied to the second constituent (Wisniewski, 1996). For example, for the phrase *box clock*, a relational theorist would propose that the head noun clock has a location slot that is occupied by box as a filler; thus, proposing a relation between a box and a clock (i.e., a clock sitting on a box). On the other hand, a property-mapping theorist would propose that the clock is represented by a property of box (i.e., a square clock; Wisniewski, 1996). An extreme form of this amalgamation is reminiscent of the set intersection model (Osherson & Smith, 1981) in which the two constituents are completed conjoined (e.g., a *human horse* is a creature featuring properties of both a human and a horse; Wisniewski, 1996).

Although the majority of theories have focused extensively on the conceptual combination of N-N phrases, some have extended to A-N phrases. For instance, the feature addition model proposes that the features of the adjective are combined with the features of the noun to produce a rich, complex concept (Clark & Clark, 1977; Murphy, 1990). Thus, features of the adjective are added to the noun, and this process should be ubiquitous across nouns (e.g., *green* should modify table and chair in the same manner). A major drawback of this theory is that it does not take into account context or more general knowledge structures (Murphy, 1990).

Another model exclusive to A-Ns that evolved from slot-filling and property-mapping features is the Selective Modification Model (SMM; Smith, Osherson, Rips, & Keane, 1988). The SMM specifies how prototypes for A-N combinations can be assembled from prototypes of the constituent items. This theory extends the standard definition of a prototype as a cognitive representation of a typical instance (Rosch & Mervis, 1975) by including typical descriptive properties associated with the concept as an additional key feature (Smith et al., 1988). Similar to slot-filing approaches, the SMM presumes that these properties have attributes and values (Smith et al., 1988). For example, the concept *apple* has a colour attribute with red as a typical value. The selective modification process is also congruent with property-mapping, as it assumes that the slots of the adjective selects and modifies the analogous slots of the noun (Smith et al., 1988). For example, for *red apple*, the colour slot of the adjective selects and modifies the colour slot of the noun apple (Smith et al., 1988).

The authors propose that the selection and modification process occurs in three serial steps (Smith et al., 1988). First, the adjective selects the appropriate attribute in the noun. Once these attributes are identified, there is an increase in salience in the value that is represented by the adjective (i.e., referred to as “vote shifting”; Smith et al., 1988). Lastly, this process will increase the diagnosticity of the modified attribute (Smith et al., 1988). So for *red apple,* the colour attribute is selected and all votes are shifted to red and away from green and brown. Subsequently, the colour attribute will have enhanced diagnosticity. As such, the model is dependent upon prototype representations for noun concepts and typical instances of attributes and values. For example, the attribute modified in *red apple* is more typical than a *round apple*, so the votes inherently favour the adjective attribute that is more salient (Smith et al., 1988). To further elaborate on this notion, the model would predict that a compatible conjunction such as *red apple* would have most of the votes on the value specified by red, whereas for an incompatible conjunction such as *brown apple*, the votes would have to be shifted to designate brown as the value (Smith et al., 1988). This illustrates the contribution of the salience of the attribute and the value to the noun concept; one factor determining saliency is the relatedness between concepts (i.e., highly related concepts are more salient). Additionally, saliency is relative to the concept; for example, a *red firetruck* has more salience than a *red apple* (Smith et al., 1988). Other factors that determine saliency include the subjective frequency and perceptibility of the value to instances of the noun concept (Smith et al., 1988). In some cases, the rated typicality of the instance in an A-N combination surpasses that of the noun concept alone (e.g., *red apple* is more typical than *apple*); this is known as the conjunction effect (Smith et al., 1988).

The SMM was one of the first comprehensive models of conceptual combination of A-N phrases (Smith et al., 1988). Although it has many caveats, it also has a few crucial limitations. The model assumes that a single value directly influences a single attribute. However, this does not capture values that influence multiple related attributes (Medin & Shoben, 1988). For example, for *brown apple*, the value brown does influence the colour attribute, but it also modifies the shape, smell, and taste of the apple. The model also assumes that adjectives are represented by only a single attribute (e.g., consider the adjective ripe which may have multiple attributes associated with it including colour, texture, smell, and taste). Relatedly, the model only tested simple A-Ns, and it has not been extended to include more complex conjunctions (Springer & Murphy, 1992).

To summarize, the theoretical debates surrounding the time-course, mechanism, and logistics of conceptual combination are still controversial. Most theorists propose a relation between the constituents as a key variable to successful combination and interpretation of a complex concept. Below, empirical evidence of competing theories will be described.

Empirical Investigations of Conceptual Combination

Research has explored the order that lexical items are semantically processed in A-Ns. Kennison (2010) examined the time course of semantic processing by manipulating adjective order during sentence comprehension. Appropriate adjective order is determined by meaning (e.g., colour follows size such as *the big red balloon)* and order violations disrupt semantic processing (e.g., *the red big balloon)*. Contrary to models suggesting delayed interpretation of adjective modifiers, the results demonstrated that prior to deriving an interpretation of the head noun, the meaning of adjective modifiers were rapidly integrated (Kennison, 2010). Furthermore, sentence comprehension was hindered when an order violation was present (Kennison, 2010).

Other research has examined the retrieval mechanism of conceptual combination. Blank and Foss (1978) performed a study that investigated whether retrieval was context-free or context-dependent. They used a phoneme-monitoring task and found that when an adjective was highly related to a noun (e.g., *bloodshot eye*), participants' response to a subsequent phoneme was twenty milliseconds quicker than when a noun was paired with an unrelated adjective (e.g., *aching eye*). Their findings suggest that retrieval of the noun is dependent on context (Blank and Foss, 1978). Similarly, Potter and Falcouner (1979) found support for holistic retrieval, or that a preceding adjective does affect retrieval of a noun.

Furthermore, Maguire and Maguire (2011) explored whether context inappropriate features are considered when individuals interpret complex concepts. Participants verified a concepts' weight (i.e., whether it was above or below one kilogram) in a contextual or compositional condition. In the contextual condition, participants were required to evaluate the weight of the modified concept only, whereas in the composition condition, they evaluated the weight of the unmodified concept followed by the modified one (Maguire & Maguire, 2011). Their findings demonstrated that when the weights between unmodified and modified concepts were largely discrepant (e.g., *fork* and *compost fork*), the compositional condition was more difficult than the contextual condition (Maguire & Maguire, 2011). The results were interpreted as support for the contextual view of conceptual combination. Relative to words in isolation, words presented in combination with contextual cues avoid activation of context inappropriate features (Maguire & Maguire, 2011).

The different types of conceptual combinatory strategies employed during semantic interpretation have also been examined. Wisniewski (1996) explicitly asked participants to write down an interpretation of familiar and novel N-N pairs and rate the difficulty of the interpretation process. Results of Wisniewski's study suggested that there are three approaches to combining concepts: property mapping, relational thinking, and hybridization (1996). Of the strategies, the most common strategy employed was property mapping, and this was especially the case between highly similar nouns. For example, when presented with *tiger pony*, participants' interpretations typically attributed the viciousness of a tiger as a property of a pony. Wisniewski (1996) concluded that a competitive model of conceptual combination should be able to predict conditions regarding which strategy will be used to interpret a complex concept from its constituents; for example, the degree of similarity between constituents may encourage a property-mapping technique. This lead to Wisniewski's (1997) proposal of a dual process model, in which attributional combination (i.e., property-mapping) and relational combination are distinct mechanisms of language comprehension.

Other research has explored the explicit semantic interpretations derived from combinatory pairs. Murphy (1990) performed a set of experiments to determine which type of modified noun phrases ease semantic interpretation. Murphy (1990) did this by asking participants to provide their interpretation of various N-N and A-N phrases in an untimed task and requiring participants to respond to the meaningfulness of phrases in a reaction time task. For adjectives, there was a distinction between both typical and atypical adjectives. Typicality was determined by whether the adjective modifier attributed a common feature to the noun (e.g., *clean hospital* versus *filthy hospital*). Additionally, predicating and non-predicating adjective types further distinguished adjectives. For example, a predicating adjective is sensical regardless of the position of the adjective: the horse is vicious, the vicious horse (Murphy, 1990). On the other hand, non-predicating adjectives are nonsensical when the adjective follows the noun: the corporate building, the building is corporate (Murphy, 1990). The results demonstrated that typical features, in which the adjective modifier was proposed to be within the noun's schematic representation, were easier to process than their atypical counterparts. Further, both typical and atypical statements were processed faster with a relevant noun such as *slow* or *fast snail*, respectively, than when paired with an irrelevant noun, such as *slow* or *fast rocking chair*. Second, the level of complexity of the modifiers was evident in the ability to conceptually combine concepts. That is, predicating adjectives were the simplest in the meaningful task whereas non-predicating adjectives and nouns were more difficult. Murphy's (1990) findings supported schema-based theories as opposed to feature addition theories.

Similarly, researchers examined the semantic interpretation of A-N combinatory pairs by investigating different types of combinations. Kamp and Partee (1995) identified two types of combinations: subsective and intersective. Subsective adjectives are a subset of combinations in which adjective modification is highly specific to the noun. For example, *skillful surgeon* and *skillful guitarist* refer to two different sets of entities denoted by skillful that are dependent upon the subsequent noun (i.e., *skillful* refers to different set of skills dependent on the following noun; Kamp & Partee, 1995). In contrast, intersective adjectives contain an adjective with the ability to define a precise set of entities independent of the noun; that is, the adjective modifies nouns in a ubiquitous manner (Kamp & Partee, 1995). For example, for *carnivorous mammal* and *carnivorous plant*, the adjective refers to the same set of entities (i.e., *carnivorous* refers to meat-eating, regardless of the subsequent noun). Drašković, Pustejovsky, and Schreuder (2013) explored whether these different adjective categories influenced their semantic interpretation and referent identification in combinations with nouns. They predicted that intersective adjectives would not require successive activation and selection of the noun-related properties due to their independence, whereas subsective nouns would recruit this more elaborate processing. Using an explicit speeded semantic classification task in which participants were required to identify whether an A-N pair was meaningful or meaningless, the results supported their hypothesis; participants responded to with more speed to intersective combinations than to subsective combinations (Drašković, Pustejovsky, & Schreuder, 2013).

Some researchers targeted specific models of conceptual combination, such as the SMM, and proposed that the model be extended to include conflicting findings. Medin and Shoben (1988) performed a series of three experiments to address the shortcomings of the SMM. First, the authors examined the SMM claim that the dimension associated with the preceding adjective solely modifies noun representations; that is, adjective dimensions are uncorrelated (Medin & Shoben, 1988). Second, the authors tested the contribution of noun context on similarity judgments of A-N combinations; for example, brass, gold, and silver railing would have disparate similarity ratings compared to brass, gold, and silver coin (Medin & Shoben, 1988). Third, they examined the concept of centrality and its influence on similarity judgments of A-N pairs, regardless of frequency; for example, curved is a property of both bananas and boomerangs, but it is likely more central to boomerangs and this should be reflected in typicality judgments (Medin & Shoben, 1988). All experiments were carried out by asking participants to provide explicit judgments or ratings of various A-N combinations. The authors found clear evidence against the SMM and exemplar theories; correlated adjectival dimensions, noun contexts, and property centrality modified typicality judgments and should be considered in the interpretation of A-Ns (Medin & Shoben, 1988).

Relatedly, a second study conducted by Springer and Murphy (1992) examined how complex concepts are constructed and found that the SMM was an insufficient model. They describe the SMM as a two-step serial processing model involving spreading activation then knowledge-dependent construction. To test this model, the researchers performed a series of three experiments to determine whether the properties of the noun will be verified as true of the noun more rapidly than the verification of the entire phrase (Springer & Murphy, 1992). Participants were presented with statements (i.e., adjective, noun, and predicate) at a typical rate of presentation, a rapid rate of presentation, which separated the presentation of the adjective, noun, and predicate, and a reverse order presentation in which the predicate was presented prior to the adjective and noun. Participants were required to determine if the statements were true or false as quickly as possible. The key manipulation was within the predicate following the A-N pair; it was either true of the noun (e.g., *boiled celery is green*), false of the noun (e.g., *boiled celery is blue*), true of the phrase (e.g., *boiled celery is soft*), or false of the phrase (*boiled celery is crisp*). The last condition was labeled "canceled features", as the predicate was true of the noun but false of the phrase (Springer & Murphy, 1992). This condition was expected to be harder to reject due to requiring conscious inhibition of the automatically activated noun features (Springer & Murphy, 1992). Results did not support this, providing concrete evidence against the SMM. That is, participants quickly verified phrase attributes as true in comparison to noun attributes, and no differences were found for the false conditions. These findings suggest that, contrary to the serial model's predictions, individual features of the words were not activated and then subsequently combined prior to the activation of phrase features during language comprehension (Springer & Murphy, 1992).

Collectively, the selected research discussed has investigated numerous theoretical debates of conceptual combination through various methodological approaches. Both N-N and A-N combinations have been investigated, although the latter pairs are typically studied in a simplistic form (e.g., *green leaf)*. Few studies have manipulated the various semantic properties of complex A-Ns or measured the comprehension speed of conceptual combinatory pairs implicitly. The present study intends to address these gaps in the literature.

The Present Study and Related Research

This exploratory study takes a unique approach in determining the underlying semantic variables that facilitate comprehension of complex A-N pairs in order to extend existing conceptual combination theories. It compares and contrasts semantic variables that are obtained subjectively through participant ratings (i.e., concreteness and plausibility) to similar objective variables that are computed based on properties of the word or connection between words (i.e., age of acquisition and semantic distance) to determine which model best predicts the processing outcomes of A-Ns. Ideally, the objective model will equally or better capture the outcomes in order to circumvent cumbersome data collection of participant ratings and emphasize the utility of objective measures of semantics. The subjective and objective models were used to predict the comprehensibility of A-Ns, via accuracy and reaction time, across tasks with different engagement of semantic processing. From shallowest to deepest level of semantic processing, this study used the non-pronounceable double lexical decision task, the pronounceable double lexical decision task, and the meaningfulness task, respectively. The former double lexical decision tasks required participants to make word/non-word judgments based on paired letter strings with either non-pronounceable (e.g., BGKE) or pronounceable (e.g., SHEP) distractors. Therefore, these tasks are considered implicit because the judgment does not require interpretation of the A-N pair. In contrast, the latter meaningfulness task engages explicit processing because participants must make a judgment about whether the word pairs make conceptual sense (i.e., are meaningful) or not.

All semantic variables are unique in that none have been investigated in the context of complex A-Ns. However, concreteness of the modifier noun and plausibility of the pair have been investigated in the context of N-N pairs. To expand, Lucas, Hubbard, and Federmeier (2017) manipulated the concreteness of the first constituent of N-Ns and kept the concreteness of the second constituent constant (i.e., concrete). They used a conceptual combination task where participants were required to rate how well they could produce definitions for the novel combinations while simultaneously recording electroencephalography (EEG) measures (Lucas, Hubbard, & Federmeier, 2017). Their results demonstrated that imageability of the first constituent was positively related to the ease of inventing a definition for the pair. Moreover, participant ratings of concrete-concrete combinations evoked a N700 potential, suggesting that participants recruited imagery or visualization-based strategies to produce a definition (Lucas, Hubbard, & Federmeier, 2017). In terms of plausibility, or the degree that two constituents make conceptual sense (Cohen & Murphy, 1984; Wisniewski & Murphy, 2005), Wisniewski and Murphy (2005) used an explicit task similar to a meaningfulness task in which participants had to make sense/nonsense judgments about N-N combinations. The researchers found that implausible and unfamiliar N-Ns contributed significantly to increased reaction times relative to judgments of plausible pairs (Wisniewski & Murphy, 2005).

The examples above illustrate that concreteness and plausibility are two semantic variables that affect the comprehension of N-N combinations. One goal of this study was to explore these two variables in the context of complex A-N combinations. Concreteness and plausibility are both subjective characteristics of words in that participants must provide ratings on a Likert-type scale in order to obtain their values. For concreteness, values were obtained from Brysbaert, Warriner, and Kuperman (2014). For plausibility, a preliminary study was conducted to obtain plausibility values to use as a variable in this study (see below).

Two semantic variables that have not been investigated in the context of conceptual combination are age of acquisition and semantic distance. Age of acquisition (AoA) is a property of a word that is determined by approximating the age a word is learned at. AoA has a positive relation with reaction time, in that later acquired words typically yield slower reaction times relative to earlier acquired words (Brysbaert, Wijnendaele, & De Deyne, 2000; Morrison & Ellis, 1995). When considering the relationship between AoA and concreteness, the distribution of AoA superimposed on concreteness typically shows concrete words (e.g., *dog*) are acquired early and abstract words (e.g., *thought*) are acquired late. Therefore, AoA often captures some of the variance in concreteness. AoA values were obtained from Kuperman, Stadthagen-Gonzalez, & Brysbaert (2012). In contrast to concreteness, AoA is not obtained through a rating matrix. For the purposes of this study, AoA will be used as an objective counterpart to concreteness.

Although previous studies have used A-N combinations made up of constituents that semantically overlap (e.g., *clean-hospital*; Murphy, 1990), only one study has used an objective measure of semantic relatedness between constituents. Chan and Schunn (2015) looked at the conceptual combination distance (i.e., the degree of semantic distance between the constituents of the pair) on the production of creative combined concepts. They examined whether distant neighbours are more likely to produce novel, creative solutions relative to close neighbour combinations. Prior research has found that dissimilar combined concepts produce emergent properties that are uncharacteristic of either constituent; therefore, dissimilar constituents elicit creative attributes of the combined concept by abstract relational reasoning (Doboli, Umbarkar, Subramanian, & Doboli, 2014; Gielnik, Frese, Graf, & Kampschulte, 2011). Chan and Schunn (2015) found empirical support for the notion that with an appropriate amount of time for idea generation (i.e., iteration), distant semantic neighbours yield more creative interpretations.

In the present study, semantic relatedness was also conceptualized as the semantic distance between constituents. Semantic distance values were obtained from a lexical co-occurrence database (Durda & Buchanan, 2008). Lexical co-occurrence models (e.g., Buchanan, Westbury, & Burgess, 2001; Lund & Burgess, 1996) analyze large volumes of text and computationally generate large databases to quantify how frequently words co-occur in similar linguistic contexts. In these models, words are represented as vectors in a high-dimensional semantic space; word vectors with smaller distances apart are considered more alike in meaning relative to word vectors located more distally. Thus, the semantic distance between words is quantified and captured in these vectors. These models propose that the meaning of a target word is defined by its relation to other associated words in similar linguistic contexts. For example, the word *poison* is related to other words such as *venom, lethal, and deadly*. The associated words are considered semantic neighbours of the target word *poison*. The metrics from Durda and Buchanan's (2008) Windsor Improved Norms of Distance and Similarity of Representations of Semantic (WINDSORS) were used to obtain values of the semantic distance between adjectives and nouns, as this database controls for word frequency, a common confounding variable found in other similar databases (e.g., Lund & Burgess, 1996). Close, distant, and unrelated A-Ns pairs were used. Semantic distance was used as an objective measure of semantic relatedness in this study, and one of the aims of this study is to determine whether semantic distance captures plausibility. It is hypothesized that these two variables are highly similar; for example, unrelated A-N pairs would have low plausibility ratings and close A-N pairs would have high plausibility ratings.

In terms of interactions between semantic variables, other research on language comprehension provides insight into the synergistic effects of semantic distance and concreteness, whereas plausibility and AoA are less well studied. For example, Malhi and Buchanan (2018) used a semantic relatedness task with concrete and abstract word pairs. The word pairs were also manipulated in terms of their semantic relatedness; that is, the word pairs were either objectively close or distant neighbours based on the metrics from WINDSORS (Durda & Buchanan, 2008). Participants were asked to determine whether the word pairs were related in meaning. They found that reaction times were significantly faster when word pairs were closely related (Malhi & Buchanan, 2018). Moreover, results from their study contradict the typical concreteness phenomenon; instead, abstract word pairs demonstrated a reaction time advantage (i.e., an abstractness effect). They reasoned that the typical concreteness effect observed in visual word processing is likely due to the concretizing of abstract stimuli, whereas the presentation of abstract word pairs evokes the abstract relationship between words and circumvents concretization (Malhi & Buchanan, 2018). Thus, rather than relying on a visualization-based approach applied to concrete word pairs, abstract word pairs benefitted from an emotional valence approach by relying on the affective associations between abstract stimuli (Kousta et al., 2011; Malhi & Buchanan, 2018).

Relatedly, concreteness has interactive effects with other similar semantic variables. One semantic variable, called semantic richness, is a measure pertaining to the abundance and variability of information contained within a word's meaning (Pexman et al., 2008; Yap, Tan, Pexman, & Hargreaves, 2011). Semantic neighbourhood density (SND) is a variable of semantic richness represented by the variability in the distribution of neighbouring words surrounding a target word's semantic neighbourhood (Buchanan, Westbury, & Burgess 2001; Danguecan & Buchanan, 2016; Durda & Buchanan, 2008). Words can have dense or sparse semantic neighbours, depending on how a target word's semantic neighbours are distributed in its semantic space. For example, *fabric* has a dense semantic neighbourhood because it has many closely related neighbours whereas *ego* has a sparse semantic neighbourhood with a few loosely associated neighbours.

Research on visual word processing and figurative language comprehension has examined the interaction between SND and concreteness. In a series of visual word processing tasks recruiting varying explicit semantic engagement, Danguecan and Buchanan (2016) consistently observed the typical concreteness effect in single word processing, but for abstract stimuli, there was an interaction of SND. To elaborate, abstract words with dense semantic neighbourhoods (i.e., high SND) were processed slower than abstract words with sparse semantic neighbourhoods (i.e., low SND). Their findings were attributed to the greater linguistic complexity of abstract words, especially those with dense semantic neighbourhoods, relative to concrete words (Danguecan & Buchanan, 2016). The inhibitory effects found for SND in visual word processing also carry over to findings in figurative language comprehension. Al-Azary and

Buchanan (2017) examined the online comprehension of metaphor processing using stimuli that varied in concreteness and SND and found that low SND metaphors were more easily comprehensible. Further, metaphors that were concrete and high SND (e.g., *Embroidery is Ink)* were rated as more difficult to comprehend than abstract-high SND metaphors (e.g., *Language is a Bridge)*. These findings once again highlight that dense semantic neighbourhoods and concrete features can hinder processing by having too many competing associations and that SND interacts differentially with concrete and abstract stimuli (Al-Azary & Buchanan, 2017). The above findings also illustrate the interaction between semantic variables in both single word and phrase processing.

Overall, the goal of this study is to characterize the comprehension of complex A-N pairs by manipulating similar semantic variables. On the one hand, two of the semantic variables (i.e., concreteness and plausibility) are derived through subjective ratings. In contrast, AoA and semantic distant are objectively obtained. The subjective and objective models were compared to determine which model best predicts the comprehensibility (i.e., reaction time and accuracy) of A-Ns using tasks with differential levels of semantic engagement. Typically, researchers have relied on explicit tasks such as sense-nonsense judgments to compare the comprehensibility of diverse combinations. Implicit tasks have been largely overlooked in conceptual combination research despite prior research revealing neural correlate differences dependent on task demands. For example, Graves, Binder, Desai, Conant, and Seidenberg (2010) found a dissociation in the brain regions recruited for an implicit (i.e., 1-back) and explicit (i.e., meaningful judgment) conceptual combination task. In the former task, brain areas associated with lexical semantic processing were recruited whereas in the latter task, brain areas related to combinatorial semantic processing were engaged (Graves et al., 2010).

In terms of implicit tasks, Gagné and Shoben (1997) used a double lexical decision task (i.e., word/nonword judgment of word pairs) to determine if constituent relation frequency impacted lexical decision times. The relation used to interpret the combination could vary according to the frequency of each constituent (Gagné & Shoben, 1997). Thus, their stimulus set consisted of words that were highly frequent relations for both constituents (HH; *heat iron*), frequent for the modifier only (HL; *pine dust*), or frequent for the head noun only (LH; *marital instincts*) along with non-word pairs (i.e., either the modifier or the head noun was presented as a non-word). Analysis of reaction times demonstrated no reliable differences between word pair types during the implicit task (Gagné & Shoben, 1997). However, using the same stimuli and an explicit sense-nonsense judgment task yielded significant differences between combinatory types; that is, the LH condition was significantly slower, suggesting that only the modifier relation frequency contributes to comprehensibility (Gagné & Shoben, 1997). It is of interest whether manipulating the semantic characteristics of A-Ns exhibit similar task-specific effects.

Study Objectives and Hypotheses

The present study aimed to provide clarity as to which semantic variables facilitate comprehension of complex A-N pairs using a unique approach. This investigation will inform current theories of conceptual combination. Two different models were used to predict comprehensibility (i.e., reaction time and accuracy) of A-N pairs. The first model is comprised of subjective semantic characteristics of the A-N pairs, which include concreteness of the head noun and plausibility of the pair. The second model used objective semantic counterparts to the first model; that is, AoA was used to capture concreteness and semantic distance was used to encompass plausibility. Having an objective measure that equally or better captures the comprehensibility of complex A-Ns would circumvent future cumbersome rating studies and highlight the utility of objective measures. These two models were compared across tasks that differentially engage semantic processing to determine whether the level of processing interacts with the two models uniformly or uniquely. Although this is an exploratory study by nature, there are a few hypotheses to outline based on prior literature (e.g., Al-Azary & Buchanan, 2017; Danguecan & Buchanan, 2016; Kennison, 2010; Malhi & Buchanan, 2018; Murphy, 1990; Potter & Falcouner, 1979; Smith et al., 1988). These hypotheses will be summarized in terms of concreteness and semantic distance, as these two variables are more thoroughly researched; however, AoA and plausibility are expected to mirror their effects, respectively. Hypotheses are (a) close semantic neighbours would have faster reactions times across all tasks; and (b) concrete head nouns would have faster reactions times across all tasks. In terms of an interaction between variables, differences are expected based on task demands. For explicit tasks, the hypotheses were that (c) semantic distance would interact with concreteness in that hypothesis (b) would be supported for close neighbours but not distant and unrelated ones; and (d) in distant neighbours, a reverse concreteness effect on the speed of meaningful judgments would be observed. No interactions were predicted for the implicit tasks.

The first hypothesis is based on the idea that closely related pairs would be processed faster because the modifier would represent typical features in the noun's schematic representation (Murphy, 1990; Smith et al., 1988), and the second hypothesis is expected due to the typical concreteness effect (Paivio, 1991; Schwanenflugel, 1991) observed in simple concepts. This is in contrast to the abstractness effect found in Malhi and Buchanan's (2018) study because it is believed that pairing a noun with an adjective will encourage concretizing of abstract stimuli, whereas in their study, they avoided the concretizing of abstract stimuli by evoking the relationship between the abstract word pairs. The latter two hypotheses for the explicit task require further elaboration. If an adjective and noun are closely situated in semantic space (i.e., they are semantically related), recruiting imagistic processing for concrete nouns (Lucas, Hubbard, & Federmeier, 2017) will likely produce an image rapidly and thus, facilitate a meaningful judgment. In contrast, if an adjective and noun are more distantly related, relying heavily on mental imagery may hinder processing and instead, give abstract nouns an advantage. Additionally, abstract nouns with less rich semantic connections have demonstrated to have a processing advantage in similar studies (Al-Azary & Buchanan, 2017; Danguecan & Buchanan, 2016). Thus, it was expected that adjectives paired with distant abstract nouns would produce a faster meaningful judgment than distant concrete pairs.

CHAPTER 2

DESIGN AND METHODOLOGY

Operational Definitions

Concreteness

Concreteness values were obtained from Brysbaert, Warriner, and Kuperman (2014), who collected concreteness ratings from 4,000 participants. Concrete head nouns were operationalized as items that refer to a physical entity and had ratings above 3. Abstract head nouns were operationalized as items that do not refer to a physical entity and had ratings below 3. Concreteness served as a subjective measure as a counterpart to age of acquisition (see below), as it is obtained through participant ratings on a Likert-type scale.

Age of Acquisition

Age of acquisition (AoA) values were obtained from Kuperman, Stadthagen-Gonzalez, & Brysbaert (2012). The head noun AoA value was used to represent the pair. AoA served as an objective measure, as it is an estimate of the age that participants acquired a word (i.e., not rated on a Likert-type scale).

To characterize the similarity between AoA and concreteness, a *t*-test was conducted to ensure that concrete head nouns were acquired earlier than abstract head nouns. A significant difference was found, with concrete nouns having a significantly earlier AoA (M=7.64, SD=2.17) than abstract nouns (M=11.30, SD=2.27), $t(297.43)=14.14$, $p<.001$. In addition, a linear model with concreteness predicting AoA values was conducted. Concreteness explained 40% of the variance in AoA. The correlation between the fitted and observed values in the linear model were used to estimate the correlation between a categorical (i.e., concreteness) and continuous (i.e., AoA) variable. The two variables moderately correlated (*r*=.63). AoA was then categorized by a median split (*Mdn*=9.17), with early acquisition words falling equal to and below the median and late acquisition words corresponding to AoA values above the median.

Close, Distant, and Unrelated Semantic Neighbours

Semantic neighbours were operationalized as the semantic distance between the adjective and noun in a pair. Semantic distance is an ordinal measure, and the values were obtained from WINDSORS, which is a database that analyzed over 30 million words across multiple text sources (Durda & Buchanan, 2008). For example, Figure 1 depicts a close A-N pair (i.e., *deadly poison*). The target words *deadly* and *poison* are each surrounded by four neighbours that were selected to represent various semantic distances. The proximity of the target word to its neighbor represents the semantic distance, and the value underneath each neighbor quantifies the distance on an ordinal measure by representing the number of neighbours the word is from the target word.

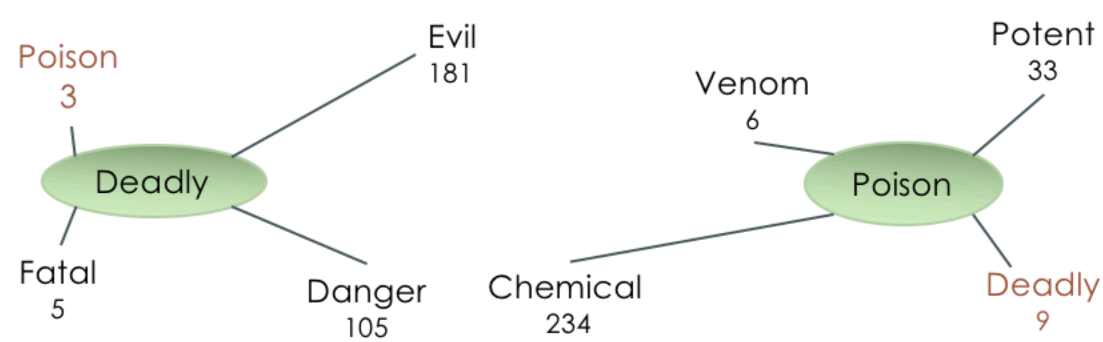

Figure 1. Example of a closely related A-N pair (*deadly poison*).

For each A-N pair, two numbers were examined: the number of neighbours from the adjective to the noun and the number of neighbours from the noun to the adjective. Close semantic neighbours were operationalized as those that were less than 50 neighbours away from the adjective and less than 100 neighbours away from the noun. Both conditions had to be satisfied in order to meet the criteria. This criterion is in place because nouns had densely packed neighbours whereas adjectives had more sparsely distributed neighbours. Similarly, distant semantic neighbours were operationalized as those that were greater than 100 neighbours away from the adjective and greater than 200 neighbours away from the noun. Unrelated adjectives were operationalized as those in which the noun and adjective were not semantic neighbours. Semantic distance served as an objective measure, as it is computed based on a co-occurrence model (Durda & Buchanan, 2008). See Table 1 for a summary of the operational definitions.

Table 1 *Operational Definitions of Key Semantic Variables*

Variable		**Definition**
Concreteness	Concrete	Refers to a physical entity, concreteness rating > 3
	Abstract	Does not refer to a physical entity, concreteness rating < 3
AoA	Early	AoA ≤ 9.17
	Late	AoA > 9.17
Semantic Distance	Close	< 50 neighbours from the A-N < 100 neighbours from the N-A
	Distant	> 100 neighbours from the A-N > 200 neighbours from the N-A
	Unrelated	Adjective and noun are not semantic neighbours

Note: Objective variables are highlighted in grey.

Method

Stimulus Development

The stimulus set consisted of 100 experimental nouns, 50 concrete and 50 abstract. Each noun was paired with a close, distant, and unrelated adjective (see Appendix A). Adjectives ranged from 3 to 13 letters in length and nouns ranged from 3 to 12 letters in length, and these words were combined to create A-Ns that ranged from 8 to 23 letters (M=14.16, SD=2.91).

Orthographic frequency (OF) values were obtained from WINDSORS (Durda & Buchanan, 2008), and the mean of the adjective and noun OFs were used to represent the pair. OF was kept below 13 per million occurrences for nouns and below 20 per million occurrences for adjectives. As frequency was kept low, adjectives and nouns should be relatively novel. Additionally, low frequency words were expected to form low frequency phrases and engage combinatorial processing instead of relying on simple retrieval (e.g., like for collocations such as *dog house*). *t*-tests were conducted to determine if there were differences in OF among semantic variables. OF values did not differ amongst semantic distance group ($p>.05$), but did differ between concrete and abstract nouns, as well as early and later acquired nouns (*p*'s<.05*,* See Table 2).

Table 2 *Summary of Means and Standard Deviations for OF*

OF	**Concreteness***		**AoA***		**Semantic Distance**		
	Concrete	Abstract	Early	Late	Close	Distant	Unrelated
M	4.52	1.87	4.04	2.33	5.61	4.95	5.16
SD	.37	.57	1.16	1.09	3.38	3.04	2.78

Additionally, for the implicit tasks (i.e., Experiments 2 and 3), 50 adjectives and 50 nouns (half concrete, half abstract) were collected (see Appendix B). These adjectives and nouns were compared to target adjectives and nouns on word length, AoA, and OF, using *t*-tests and found to have no differences (*p*s>.05; Table 3). For these tasks, 100 non-words were also created and matched for length.

Table 3 *Means and Standard Deviations of Word Length, AoA, and OF by Stimuli Type*

Stimuli Type		**Length**	**AoA**	**OF**
Target	Adjective	7.29 (1.99)	10.00 (2.48)	5.32 (4.91)
	Noun	6.87 (2.09)	9.45 (2.88)	5.16 (3.32)

Distractor	Adjective	6.58 (1.50)	10.38 (2.06)	5.32 (4.86)
	Noun	6.96 (1.54)	10.02 (2.05)	6.27 (5.64)

Participant Recruitment and Inclusion Criteria

Participants were undergraduate students at the University of Windsor. They signed up to complete the study through the Psychology Participant Pool. Inclusion criteria of this study required participants to report English as their first language and to have normal or corrected-normal vision.

Task Software and Display Detail

All tasks were administered on a Dell PC with Windows XP operating system using Direct RT (Pearson v2012; Empirisoft Corporation). A-N combinations were presented in capital letters in the center of the screen in turquoise colour and size 30 font.

List Generation

Prior to participation, three separate lists were quasi-randomly computed so that participants would only view each noun once (see Appendix C). For example, Participant A saw a noun paired with a close adjective, Participant B saw the same noun paired with a distant adjective, and Participant C saw the same noun paired with an unrelated adjective. Semantic relatedness varied within participants as well so that participants were exposed to nouns with close, distant, and unrelated adjectives. Three quasi-randomly generated lists were created with the 100 nouns (50 concrete, 50 abstract) paired with adjectives of assorted degree of relatedness. For the implicit tasks (i.e., Experiments 2 and 3), the additional 100 words (25 concrete nouns, 25 abstract nouns, and 50 adjectives) and 100 non-words were used.

CHAPTER 3

PRELIMINARY STUDY: PLAUSIBILITY JUDGMENTS

This preliminary study was conducted to obtain the plausibility of the A-N pairs, to eliminate items that were unknown to undergraduate students, and to determine if plausibility could be used as a subjective measure of semantic distance. Plausibility was defined as whether the A-Ns made conceptual sense when paired, regardless of the likelihood of encountering the pair (i.e., due to low frequency). It was hypothesized that plausibility would be highly related to semantic distance, in that close A-N pairs would have the highest plausibility values, distant A-N pairs would have plausibility ratings in between, and unrelated A-N pairs would have the lowest plausibility ratings (i.e., be implausible).

Method

Participants

Fifteen female undergraduate students from the University of Windsor Cognitive Neuroscience Laboratory were recruited. All were at least 18 years of age, had learned English as their first language, and had normal or corrected-to-normal vision.

Materials

The three lists with 100 experimental nouns paired with close, distant, and unrelated adjectives were used (see Appendix C).

Procedure

Each participant was given a list in an Excel™ file and asked to rate how plausible the pair is on a scale from 0 (completely implausible) to 4 (completely plausible). Plausible pairs were defined as those that make conceptual sense (i.e., *bright sky*) whereas implausible pairs were defined as those that do not make conceptual sense (i.e., *careful sky)*. Participants were instructed to use the number pad to rate the corresponding plausibility of the pair. If the participant did not know the definition of a word in a pair, they were instructed to mark the word with an asterisk (*). The three lists were distributed to the fifteen students, each separated by >4 weeks of time. Participants were instructed to **not** refer to previous lists.

Results

Plausibility judgments were combined to create a mean plausibility rating for each A-N pair. Judgments that were indicated with an asterisk were not included in the calculation of the mean rating. Items that were unknown by more than 4/15 (>25%) of the participants were removed from subsequent analyses, as these items were judged to be too infrequent for participants to appropriately judge in further tasks. This resulted in the removal of 5 items. Another item was removed for having the same adjective on the same list (i.e., *frail zombie* was removed because *frail symbolism* was found on the same list). See Table 4 for a summary of the mean plausibility judgments.

Plausibility judgements were identical for adjectives paired with concrete (M=2.19, SD=1.24) and abstract (M=2.19 SD=1.04) nouns, and nearly identical for adjectives paired with early acquired (M=2.27, SD=1.25) and later acquired (M=2.20, SD=1.03) nouns. A t-test was conducted to determine if there were any significant differences among these variables and none were found (ps>.05). An ANOVA was conducted to determine if plausibility judgments differed by the three levels of semantic distance (close, distant, and unrelated). A main effect of semantic distance was found, $F(2, 291)=228.80$, $p<.001$. Tukey pairwise contrasts were used to examine the differences. Close A-N pairs were rated as more plausible than distant [$t(291)=4.82$, $p<.001$] and unrelated [$t(291)=20.46$ $p<.001$] A-Ns. Distant A-N pairs were rated as more plausible than unrelated A-Ns, *t*(291)=15.64, *p*<.001 (refer to Figure 2).

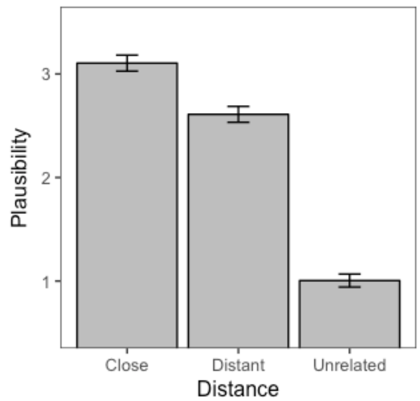

Figure 2. Mean plausibility judgments for each level of semantic distance.

To further characterize the relationship between plausibility and distance, a linear model was used to determine how much variance in semantic distance was explained by plausibility. The model was significant, F(2, 291)=228.80, *SE*=0.72, *p*<.05. Plausibility explained 60% of the variance in semantic distance. In addition, the correlation between the fitted and observed values in the linear model were used to estimate the correlation between a categorical (i.e., semantic distance) and continuous (i.e., plausibility) variable. Semantic distance and plausibility had a strong correlation, *r*=.78.

Discussion

Hypotheses were supported in that plausibility ratings were subjectively obtained and highly related to an objective measure of semantic distance. That is, close semantic neighbours were judged to be the most plausible and unrelated semantic neighbours were judged to be the least plausible, with distant semantic neighbours rated as in between. In further analyses, plausibility served as the subjective counterpart to semantic distance.

For subsequent analyses, plausibility was operationalized and categorized into three levels by splitting the values by percentiles. Implausible pairs were below the 30^{th} percentile, intermediate plausible pairs were between the 30^{th} and 70^{th} percentile, and plausible pairs were above the 70^{th} percentile. OF values did not differ for each level of plausibility (*p*s>.05) Refer to Table 4 for a summary of the operational definitions and OF comparison.

Table 4 *Operational Definition of Plausibility*

Variable		**Definition**	**OF *M*(*SD*)**
Plausibility	Plausible	Mean rating ≥ 3.13 (70^{th} percentile)	3.30 (1.37)
	Intermediate	Mean rating >1.44 and < 3.13	2.97 (1.42)
	Implausible	Mean rating ≤ 1.44 (30^{th} percentile)	3.43 (1.41)

CHAPTER 4

EXPERIMENTAL TASKS

The purpose of the experimental tasks was to explore how semantic variables interact to influence the processing of A-N pairs as measured by reaction time and accuracy and to determine which type of semantic variables were better at predicting comprehensibility of the pairs. The semantic effects were examined in three experimental tasks that engaged semantic processing at a shallow (i.e., implicit) to deep (i.e., explicit) level. These tasks include the non-pronounceable double lexical decision task, the pronounceable double lexical decision task, and the meaningfulness task, respectively. Semantic variables were divided into subjective and objective varieties. Subjective semantic variables include concreteness and plausibility, whereas objective semantic variables consisted of AoA and semantic distance. The hypotheses for each task were outlined above and are summarized in Table 5 for simplicity.

Table 5 Summary of Hypotheses for the Experimental Tasks

		Implicit ⟷ Explicit			
		Non-pronounceable DLDT	**Pronounceable DLDT**	**Meaningfulness Task***	
RT/Accuracy	*Main effects*	Plausible < Intermediate < Implausible Concrete < Abstract			
	Interaction	None		Concrete, plausible < all	Abstract, intermediate < concrete intermediate
RT/Accuracy	*Main*	Close < distant < unrelated			

effects	Early < Late		
Interaction	None	Early, close < all	Late, distant < early, distant

Note. The use of "<" denotes fewer errors and faster RTs. The hypotheses for the objective model mirror the subjective model and are highlighted in grey.
*For the Meaningfulness task, main effects are predicted for non-meaningful RTs with a typical concreteness/AoA effect and a reverse plausibility/distance effect.

Method

Participants

Two hundred and ninety-three University of Windsor undergraduate students (245 females, 95% between ages 17 and 25) participated for partial course credit. All participants had learned English as their first language and had normal or corrected-to-normal vision.

Materials

The three lists with 100 experimental nouns paired with close, distant, and unrelated adjectives were used (see Appendix C). In addition, 50 adjectives, 50 nouns (25 concrete, 25 abstract; See Appendix B), and 100 non-words were used for Experiments 1 and 2. Non-words were created by replacing a key vowel in a word to generate a non-pronounceable non-word (e.g., BGKE) for Experiment 1 and using a non-word generator to generate a pronounceable non-word (e.g., SHEP) for Experiment 2.

Procedure

Participants signed up to participate in the study through the Participant Pool. Upon arrival, participants were randomly assigned to complete one of the three experimental tasks. The entire task was completed on the computer in an individual testing room. They were asked to place their left index finger on the Z key and their right index figure on the / key and instructed to view A-Ns in the center of the screen. For Experiments 1 and 2, participants were randomly presented with one of three combinations (i.e., word/word, non-word/word, and word/non-word) and asked to judge whether both items in the pair were real words. If the combination was deemed to be comprised of real words or made up of one non-word, participants were instructed to press the Z or / key, respectively. For Experiment 3, they were asked to quickly judge whether the combinations are meaningful. Meaningful judgments were described as combinations that have meaning when paired together (*i.e., deadly poison*). Non-meaningful judgments were described as combinations that do not have meaning when paired together (i.e., *flirty poison*). If the combination was deemed meaningful or nonmeaningful, participants were instructed to press the Z or / key, respectively. Each experiment took approximately 15 minutes to complete. After completion of the study, participants received bonus points towards eligible courses.

Data Analysis

Data was analyzed using R (R Core Team, 2017) version 3.4.3. The lme4 (Bates, Maechler, Bolker, & Walker, 2015) and lmerTest (Kuznetsova, Brockhoff, & Christensen, 2017) packages were used. The optimizer bobyqa was used, which uses an iteratively derived quadratic approximation to deduce a solution. Probability values (*p* values) were obtained using the lmerTest package with Satterthwaite approximations to degrees of freedom (Kuznetsova et al., 2017).

For RT analyses, RTs of correct responses were analyzed in a linear mixed effects analysis. RTs were log transformed to ensure normality. For the subjective models, fixed effects included concreteness, plausibility, and their interaction. For the objective models, fixed effects included AoA, semantic distance, and their interaction. Subjects and items were included in the model as random intercepts for all models. Model trimming removed outliers with standardized residuals that were 2.5 standard deviations greater than 0, and it was only considered when standardized residuals were non-normal (i.e., by visual inspection of plotted residuals). Model trimming was only conducted if <5% of the data was removed.

For accuracy analyses, the binomial dependent variable (i.e., correct or incorrect) was analyzed using a mixed logit model (generalized linear mixed model; Jaeger, 2008). Fixed effects included independent and interaction variables. Subjects and items were entered into the model as random effects. For Experiment 1, subjects and items were analyzed separately because the model failed to converge with both random intercepts included. Accuracy analyses were not conducted for the Meaningfulness task (Experiment 3), as participants could not truly make an error on this task (i.e., it was participants' subjective opinion whether an A-N was meaningful or not).

Subjective and objective model comparisons were evaluated using Akaike Information Criterion (AIC), a likelihood ratio test that estimates model quality for non-nested models (Burnham & Anderson, 2004). Lower values indicate models that better fit the data (Burnham & Anderson, 2004).

In the following sections, the results are presented by task in the order of shallowest to deepest level of semantic processing (i.e., non-pronounceable lexical decision task, pronounceable lexical decision task, and meaningfulness task, respectively). Subjective models with concreteness and plausibility are presented first, followed by objective models with AoA and semantic distance, and then a comparison of the two models for all reaction time and error analyses per task.

Experiment 1: Non-pronounceable Double Lexical Decision Task (DLDT)

Results

Data Cleaning

Responses that were faster or slower than a pre-selected specified cut-off of 300ms or 4000ms, respectively, were removed (109 observations, 1.18% of the data). Participants with accuracy rates below 60% (0 participants) and items with accuracy rates below 60% (10 A-N pairs, 306 observations) were removed from analysis. This resulted in the removal of 3.36% of the remaining data. For the RT analysis, all incorrect responses were removed, resulting in the removal of 747 observations (9% of the remaining data).

Subjective Model – Concreteness and Plausibility

Upon visual inspection, the standardized residuals appeared normal, so the model was not trimmed further. Table 6 provides a summary of the mean RTs, standard deviations, and accuracy rates for the final models.

Table 6 *Mean RTs and Proportion Correct for the Subjective Model in the Non-pronounceable DLDT*

A-N Pair		***N***	***M* RT (ms) (*SD*)**	**% Correct (*SD*)**
Concrete				
	Plausible	94	1221.64 (272.80)	95.00 (.06)
	Intermediate	94	1317.43 (307.48)	91.34 (.01)
	Implausible	94	1399.47 (333.27)	88.05(.13)
Abstract				
	Plausible	94	1352.03 (330.08)	93.81 (.10)
	Intermediate	94	1442.72 (369.36)	90.94 (.11)
	Implausible	94	1366.08 (324.07)	90.13 (.01)

RT Analysis

Of the fixed effects entered in the model, there was an interaction between concreteness and plausibility, and main effects of concreteness and plausibility. See Table 7 for a summary of the model.

Table 7 *Summary of Fixed Effects in the Subjective RT Model for the Non-pronounceable DLDT*

Fixed effect	b	SE	t	p
Intercept[1]	3.06	.16	254.00	<.001
Abstract	.59	.16	3.77	<.001
Intermediate	.41	.15	2.66	.008
Implausible	.75	.15	4.94	<.001
Abstract*Intermediate	-.06	.21	-.01	.99
Abstract*Implausible	-.75	.23	-3.22	.001

[1] The intercept was set to concrete, plausible A-N pairs.
Note: These are the coefficients from the mixed model. *b* is the unweighted coefficient estimate, SE is the standard error.

The interaction and main effects were explored further with Tukey-adjusted pairwise comparisons. Concrete plausible A-N pairs had significantly faster RTs than concrete implausible and all abstract A-N pairs (i.e., plausible, intermediate, and implausible; *p*s<.05). Additionally, concrete intermediate pairs had faster RTs than abstract intermediate pairs (refer to Figure 3). For the main effect of concreteness, adjectives paired with concrete nouns had significantly faster RTs than adjectives paired with abstract nouns [b=-.03, SE=.006, t(274.67)=-3.83, p<.001]. For the main effect of plausibility, plausible A-N pairs yielded faster RTs compared to intermediate [b=-.03, SE=.008, t(273.68)=-3.77, p<.001] and implausible [b=-.03, SE=.008, t(274.67)=-3.34, p<.01] pairs. There was no difference in RT between intermediate and implausible pairs (p>.05).

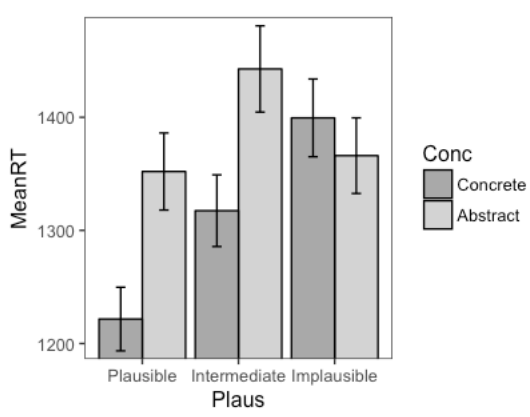

Figure 3. RTs for the subjective model in the Non-pronounceable DLDT. Error bars indicate standard error.

Accuracy Analysis by Participant

Of the fixed effects entered into the model, there was a significant interaction between concreteness and plausibility, *b*=-.51, *SE*=.21 *z*=-2.43, *p*<.05; see Figure 4. A main effect of plausibility for intermediate [*b*=.60, *SE*=.15 *z*=4.06, *p*<.001] and implausible [*b*=1.01, *SE*=.14, z=7.26, *p*<.001] A-N pairs was present. No main effect of concreteness was found (p>.05). Follow-up Tukey-adjusted multiple comparisons were conducted. For the interaction, participants made significantly fewer errors for concrete plausible A-N pairs than concrete and abstract intermediate and implausible pairs (*p*s<.001), and fewer errors for concrete intermediate than concrete implausible pairs (*p*<.05). Participants also made fewer errors for abstract plausible pairs relative to concrete and abstract implausible pairs (*p*s<.01). For the main effect of plausibility, all comparisons were significant, with plausible A-N pairs yielding significantly more correct responses from participants than intermediate [*b*=.48, *SE*=.10, z=4.60, *p*<.001] and implausible [*b*=.77, *SE*=.10, z=7.40, *p*<.001] A-N pairs, and intermediate pairs yielding more correct responses from participants than implausible A-N pairs, *b*=.29, *SE*=.09, z=3.12, *p*<.01.

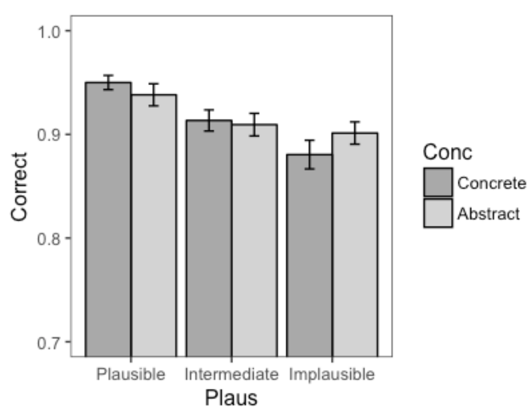

Figure 4. Participant accuracy rates for the subjective model in the Non-pronounceable DLDT. Error bars indicate standard error.

Accuracy Analysis by Item

Of the fixed effects entered into the model, there was a main effect of plausibility for implausible A-N pairs, *b*=-.10, *SE*=.27 *z*=-3.68, *p*<.001. No other interactions or main effects were found (*p*s>.05). Follow-up Tukey-adjusted multiple comparisons were conducted and determined that plausible A-N pairs (*M*=.94, *SD*=.08) yielded more correct responses than implausible pairs (*M*=.88 *SD*=.10), *b*=.83 *SE*=.20, z=4.08, *p*<.001. No differences were found for intermediate A-N pairs (*M*=.92, *SD*=.09).

Objective Model – AoA and Semantic Distance

Upon visual inspection, the standardized residuals appeared normal, so the model was not trimmed further. Table 6 provides a summary of the mean RTs, standard deviations, and accuracy rates for the final models.

Table 8 *Mean RTs and Proportion Correct for the Objective Model in the Non-pronounceable DLDT*

A-N Pair		***N***	***M* RT (ms) (*SD*)**	**% Correct (*SD*)**
Early				
	Close	94	1252.09 (291.77)	94.44(.07)
	Distant	94	1333.95 (302.62)	91.85 (.10)
	Unrelated	94	1331.78 (312.62)	91.40 (.09)
Late				
	Close	94	1400.15 (359.60)	90.78 (.12)
	Distant	94	1405.56 (343.34)	91.51 (.10)
	Unrelated	94	1393.06 (353.45)	89.85 (.10)

RT Analysis

Of the fixed effects entered in the model, there was a main effect of AoA [b=.05, SE=.01, t(275.05)=3.96, p<.001] and semantic distance [b=.03, SE=.01, t(275.39)=2.15, p<.05]. The main effects were explored further with Tukey-adjusted pairwise comparisons. For the main effect of AoA, adjectives paired with early acquired nouns (*M*=1307.08*,* SD=289.82) had significantly faster RTs than adjectives paired with late acquired nouns (*M*=1399.87*,* SD=289.82), *b*=-.03, *SE*=.007, *t*(274.67)=-4.35, *p*<.001. For the main effect of distance, follow-up contrasts were not significant (*p*s>.05).

Accuracy Analysis by Participant

Of the fixed effects entered into the model, all interactions and main effects were significant (see Table 7).

Table 9 *Summary of Fixed Effects in the Objective Accuracy Model in the Non-pronounceable DLDT*

Fixed effect	**b**	**SE**	***z***	***p***
Intercept[1]	3.24	.15	21.12	<.001
Late	-.62	.15	-4.21	<.001
Distant	-.49	.15	-3.30	<.001
Unrelated	-.59	.15	-4.03	<.001
Late*Distant	.57	.20	2.82	<.01
Late*Unrelated	.46	.20	2.28	<.05

[1] The intercept was set to early acquired, close A-N pairs.
Note: These are the coefficients from the mixed model. *b* is the unweighted coefficient estimate, SE is the standard error.

Follow-up Tukey-adjusted multiple comparisons were conducted. For the interaction, participants made significantly fewer errors for early acquired, close A-N pairs than all other A-Ns (*p*s<.001; see Figure 5). For the main effect of AoA, adjectives paired with early acquired nouns yielded more correct responses than adjectives paired with late acquired nouns, *b*=.28, *SE*=.08, z=3.55, *p*<.001. For the main effect of semantic distance, close A-N pairs yielded more correct lexical decisions than unrelated A-Ns pairs, *b*=.36, *SE*=.10, z=3.74, *p*<.001. No differences were observed for distant A-N pairs (*p*s>.05).

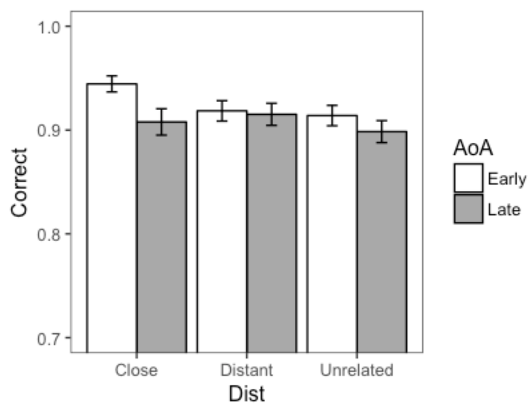

Figure 5. Participant accuracy rates for the objective model in the Non-pronounceable DLDT. Error bars indicate standard error.

Accuracy Analysis by Item

Of the fixed effects entered into the model, there was a main effect of semantic distance for distant [b=-.58, SE=.28 z=-2.03, p<.05] and unrelated [b=-.76, SE=.28 z=-2.66, p<.01] A-N pairs. There was also a main effect of AoA, b=-.76, SE=.29 z=-2.63 p<.01. Follow-up Tukey-adjusted multiple comparisons were conducted and were not significant (ps=.05).

Model Comparison

For all analyses, subjective models yielded lower AIC values compared to objective models (refer to Table 8).

Table 10 *Summary of AIC Values for Subjective and Objective Models for the Non-pronounceable DLDT*

	Subjective	**Objective**
RT	-11010.08	-10984.91
Participant Accuracy	4345.82	4719.53
Item Accuracy	4759.18	4765.24

Discussion

For the subjective model, the hypotheses were generally supported. The RT analyses were consistent with the hypotheses in that a concreteness effect was observed and plausible A-N pairs yielded faster reaction times than intermediate and implausible pairs, although no differences were observed between intermediate and implausible pairs. Unexpectedly, an interaction was observed, in which lexical decisions for concrete, plausible A-N pairs were faster than all adjectives paired with abstract nouns and concrete implausible pairs. A concreteness effect was not mirrored in accuracy analyses. Consistent with the RT analysis, plausibility had a clear linear trend in which plausible A-Ns pairs had fewer errors than intermediate and implausible A-N pairs, and intermediate pairs had fewer errors than implausible pairs. An interaction was observed as well, in which concrete plausible pairs were responded to more accurately than all other A-N pairs except for abstract plausible pairs. In addition, abstract plausible pairs were responded to more accurately than all implausible pairs, and concrete intermediate pairs had fewer errors observed than concrete implausible pairs. For the accuracy analysis by item, more errors were made for implausible pairs than plausible pairs.

For the objective model, hypotheses were partially supported. For the RT analysis, head nouns that were acquired early were responded to significantly faster than head nouns acquired late. This effect was mirrored in the participant accuracy analysis. The hypothesis of semantic distance was supported by the participant accuracy analysis in that closely related A-N pairs had fewer errors than unrelated A-N pairs, although no differences were observed for distant A-N pairs. In addition, AoA and semantic distance interacted in that early acquired close A-N pairs were responded to more accurately than all other A-N pairs.

Overall, the subjective model with concreteness and plausibility as predictors was a stronger model than the objective model with AoA and semantic distance as predictors for RT and accuracy analyses.

Experiment 2: Pronounceable Double Lexical Decision Task (DLDT)

Results

Data Cleaning

Responses that were faster or slower than a pre-selected specified cut-off of 300ms or 4000ms, respectively, were removed (324 observations, 3.39% of the data). Participants with accuracy rates below 60% (5 participants, 162 observations) and items with accuracy rates below 60% (27 A-N pairs, 972 observations) were removed from analysis. This resulted in the removal of 10.51% of the remaining data. For the RT analysis, all incorrect responses were removed, resulting in the removal of 922 observations (11% of the remaining data).

Subjective Model – Concreteness and Plausibility

Upon visual inspection, the standardized residuals appeared normal, so the model was not trimmed further. Table 9 provides a summary of the mean RTs, standard deviations, and accuracy rates for the final models.

Table 11 *Mean RTs and Proportion Correct for the Subjective Model in the Pronounceable DLDT*

A-N Pair		***N***	***M* RT (ms) (*SD*)**	**% Correct (*SD*)**
Concrete				
	Plausible	96	1399.77 (312.00)	93.91 (.09)
	Intermediate	96	1510.30 (342.58)	87.59 (.14)
	Implausible	96	1608.78 (357.82)	83.83 (.17)
Abstract				
	Plausible	96	1554.55 (357.25)	93.24 (.10)
	Intermediate	96	1635.99 (371.12)	88.75 (.12)
	Implausible	96	1621.38 (406.15)	84.47 (.17)

RT Analysis

Of the fixed effects entered in the model, there was an interaction between concreteness and plausibility, and main effects of concreteness and plausibility (see Table 10).

Table 12 *Summary of Fixed Effects in the Subjective RT Model in the Pronounceable DLDT*

Fixed effect	**b**	**SE**	***t***	**p**
Intercept[1]	3.12	.01	263.24	<.001
Abstract	.05	.01	4.05	<.001

Intermediate	.04	.01	3.20	<.01
Implausible	.06	.01	4.93	<.001
Abstract*Intermediate	-.01	.02	-.80	.42
Abstract*Implausible	-.04	.02	-2.41	<.05

[1] The intercept was set to concrete, plausible A-N pairs.
Note: These are the coefficients from the mixed model. *b* is the unweighted coefficient estimate, SE is the standard error.

The interaction and main effects were explored further with Tukey-adjusted pairwise comparisons. Concrete plausible A-N pairs had faster RTs than all other pairs. Additionally, concrete intermediate pairs had faster RTs than abstract intermediate pairs (refer to Figure 6). For the main effect of concreteness, adjectives paired with concrete nouns had faster RTs than adjectives paired with abstract nouns [b=-.03, SE=.007, t(258.56)=-4.16, p<.001]. For the main effect of plausibility, plausible A-N pairs yielded faster RTs compared to intermediate [b=-.03, SE=.008, t(255.87)=-3.75, p<.001] and implausible [b=-.04, SE=.009, t(258.91)=-4.25 p<.001] pairs. There was no difference in RT between intermediate and implausible pairs.

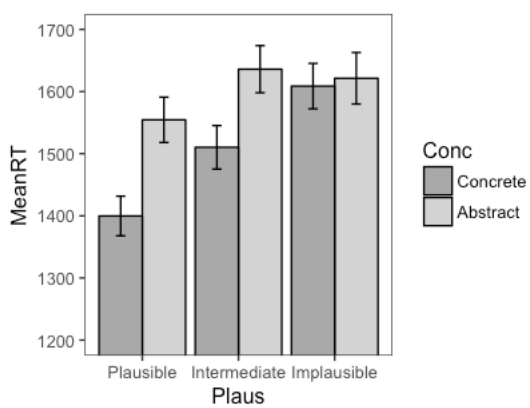

Figure 6. RTs for the subjective model in the Pronounceable DLDT. Error bars indicate standard error.

Accuracy Analysis

Of the fixed effects entered into the model, main effects of plausibility for intermediate [b=-.96, SE=.26 z=-3.75 p<.001] and implausible [b=-1.53, SE=.25, z=-6.00, p<.001] A-N pairs were found. There was neither a main effect of concreteness nor an interaction between concreteness and plausibility (p>.05). Follow-up Tukey-adjusted multiple comparisons were conducted the main effect of plausibility. All comparisons were significant, with plausible A-N pairs yielding more correct responses than intermediate [b=.83, SE=.18, z=4.54, p<.001] and implausible [b=1.37 SE=.19, z=7.31, p<.001] A-N pairs, and intermediate pairs yielding more correct responses than implausible A-N pairs, b=.55, SE=.18, z=3.09, p<.01 (refer to Figure 7).

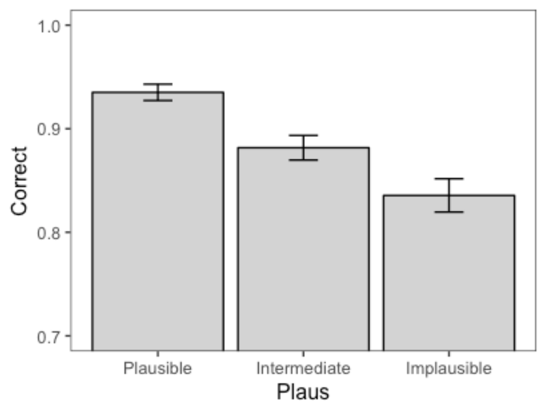

Figure 7. Accuracy rates by plausibility for the subjective model in the Pronounceable DLDT. Error bars indicate standard error.

Objective Model – AoA and Semantic Distance

Upon visual inspection, the standardized residuals appeared normal, so the model was not trimmed further. Table 11 provides a summary of the mean RTs, standard deviations, and accuracy rates for the final models.

Table 11 *Mean RTs and Proportion Correct for the Objective Model in the Pronounceable DLDT*

A-N Pair	***N***	***M* RT (*SD*)**	**% Correct (*SD*)**
Early			
Close	96	1439.39 (343.24)	94.37(.08)
Distant	96	1488.90 (308.18)	89.30 (.12)
Unrelated	96	1532.04 (356.18)	86.87 (.15)
Late			
Close	96	1615.76 (381.91)	90.44 (.12)
Distant	96	1584.77 (383.21)	88.19 (.12)
Unrelated	96	1667.43 (424.31)	84.34 (.16)

RT Analysis

Of the fixed effects entered in the model, there was a main effect of AoA [b=.05, SE=.01, t(255.03)=3.91, p<.001] and plausibility [b=.03, SE=.01, t(257.47)=2.32, p<.05]. The main effects were explored further with Tukey-adjusted pairwise comparisons. For the main effect of AoA, adjectives paired with earlier acquired nouns (*M*=1490.07, *SD*=309.59) had faster RTs than adjectives paired with later acquired nouns (*M*=1616.80, *SD*=348.07), *b*=-.03, *SE*=.007, *t*(257.15)=-4.73, *p*<.001. For the main effect of distance, follow-up contrasts were not significant (*p*s>.05), although there was a trend for close A-N pairs yielding faster RTs than unrelated A-N pairs (*p*=.09).

Accuracy Analysis

Of the fixed effects entered into the model, all interactions and main effects were significant at .05 (see Table 12).

Table 13 *Summary of Fixed Effects in the Objective Accuracy Model for the Pronounceable DLDT*

Fixed effect	**b**	**SE**	***z***	***p***
Intercept[1]	3.83	.24	16.04	<.001
Late	-.85	.28	-3.06	<.01
Distant	-.94	.27	-3.54	<.001
Unrelated	-1.40	.27	-5.26	<.001
Late*Distant	.75	.38	1.98	<.05
Late*Unrelated	.77	.38	2.03	<.05

[1] The intercept was set to early acquired, close A-N pairs.
Note: These are the coefficients from the mixed model. *b* is the unweighted coefficient estimate, SE is the standard error.

Follow-up Tukey-adjusted multiple comparisons were conducted. For the interaction, participants made significantly fewer errors for early acquired, close A-N pairs than all other pairs (*p*s<.01; see Figure 8). For the main effect of AoA, adjectives paired with earlier acquired nouns yielded more correct responses than adjectives paired with later acquired nouns, *b*=.33, *SE*=.15, z=2.24, *p*<.01. For the main effect of semantic distance, close A-N pairs yielded more correct lexical decisions than distant, *b*=.56, *SE*=.19, z=2.96, *p*<.01, and unrelated, *b*=1.01, *SE*=.19, z=5.46, *p*<.001 A-N pairs. Distant A-N pairs also had more correct responses than unrelated A-N pairs, *b*=.45, *SE*=.18, z=2.48, *p*<.05.

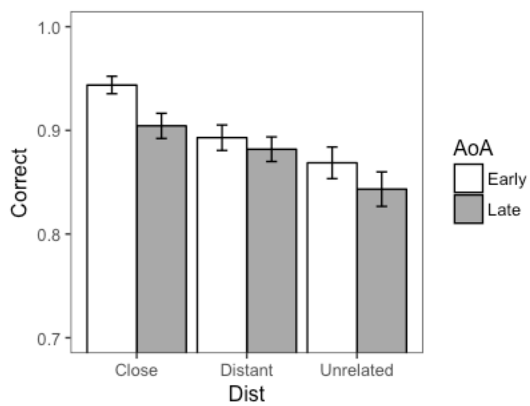

Figure 8. Accuracy rates for the objective model in the Pronounceable DLDT. Error bars indicate standard error.

Model Comparison

For all analyses, subjective models yielded lower AIC values compared to objective models (refer to Table 13).

Table 14 *Summary of AIC Values for Subjective and Objective Models for the Pronounceable DLDT*

	Subjective	**Objective**
RT	-8583.00	-8563.89
Accuracy	4924.71	4940.23

Discussion

Results for the pronounceable DLDT are similar to the non-pronounceable DLDT. For the subjective model, hypotheses were generally supported. The RT analysis were consistent with hypotheses in that a concreteness effect was observed and plausible A-N pairs yielded faster reaction times than intermediate and implausible pairs, although no differences were observed between intermediate and implausible pairs. Unexpectedly, an interaction was observed, in which lexical decisions for concrete, plausible A-N pairs were faster than all other A-N pairs.

Further, concrete intermediate pairs yielded faster RTs than abstract intermediate pairs. In contrast to the RT analysis, a concreteness effect was not mirrored in the accuracy analyses. Consistent with the RT analysis, plausibility had a clear linear trend in which plausible A-Ns pairs had fewer errors than intermediate and implausible A-N pairs, and intermediate pairs had fewer errors than implausible pairs.

For the objective model, the hypotheses were partially supported. For the RT analysis, head nouns that were acquired early were responded to significantly faster than head nouns acquired late. This effect was mirrored in the participant accuracy analysis. The hypothesis of a linear effect of semantic distance was supported by the accuracy analysis in that closely related A-N pairs had fewer errors than distant and unrelated A-N pairs, and distant pairs had fewer errors than unrelated pairs. In addition, AoA and semantic distance interacted in that early acquired close A-N pairs were responded to more accurately than all other A-N pairs.

Overall, the subjective model with concreteness and plausibility as predictors was a stronger model than the objective model with AoA and semantic distance as predictors for RT and accuracy analyses.

Experiment 3: Meaningfulness Task

Results

Data Cleaning

Responses that were faster or slower than a pre-selected specified cut-off of 300ms or 4000ms, respectively, were removed (557 observations, 5.89% of the data). Subjects and items were not removed from the analyses. During analysis, outliers with a standardized residual at a distance greater than 2.5 standard deviations from 0 were removed (see below). Responses were coded as meaningful and non-meaningful. Separate RT analyses were conducted for meaningful and nonmeaningful responses because response type was found to predict RT, b=.14, SE=.17, *t*(163.82)=3.09, *p*<.01. Meaningful responses consisted of 4880 observations and nonmeaningful responses consisted of 4006 observations.

Subjective Model – Concreteness and Plausibility

After the model was fitted, data was trimmed using the LMERConvenienceFunctions package as the standardized residuals appeared non-normal upon visual inspection. Outliers with a standardized residual at a distance greater than 2.5 SD from 0 were excluded. This resulted in the removal of <5% of the data. Table 14 provides a summary of the mean RTs and standard deviations for meaningful and nonmeaningful responses.

Table 15 *Mean RTs for Meaningful and Nonmeaningful Responses in the Subjective Model*

A-N Pair		***N***	**Meaningful *M* RT (ms) (*SD*)**	***N***	**Nonmeaningful *M* RT (ms) (*SD*)**
Concrete					
	Plausible	97	1542.16 (292.97)	73	1835.58 (647.56)
	Intermediate	97	1866.45 (376.63)	97	1942.03 (503.52)
	Implausible	79	1977.90 (562.22)	97	1876.77 (372.44)
Abstract					
	Plausible	97	1821.83 (342.00)	70	2033.62 (571.69)
	Intermediate	97	2044.36 (458.28)	97	2196.24 (485.21)
	Implausible	79	2048.12 (581.14)	97	1918.89 (419.40)

RT Analysis for Meaningful Responses

Of the fixed effects entered in the model, there was an interaction between concreteness and plausibility, and main effects of concreteness and plausibility (see Table 15).

Table 16 *Summary of Fixed Effects in the Subjective RT Model in the Meaningfulness Task*

Fixed effect	**b**	**SE**	***t***	***p***
Intercept[1]	3.17	.01	266.65	<.001
Abstract	.07	.01	5.69	<.001
Intermediate	.08	.01	6.66	<.01
Implausible	.10	.01	6.78	<.001
Abstract*Intermediate	-.04	.02	-2.04	<.05
Abstract*Implausible	-.06	.02	-2.86	<.01

[1] The intercept was set to concrete, plausible A-N pairs.

Note: These are the coefficients from the mixed model. *b* is the unweighted coefficient estimate, SE is the standard error.

The interaction and main effects were explored further with Tukey-adjusted pairwise comparisons. Meaningful judgements for concrete plausible A-N pairs were faster than all other A-N pairs (see Figure 10). In addition, abstract intermediate pairs yielded slower RTs than abstract plausible (p<.05) and trended for concrete intermediate (p=.05) pairs. For the main effect of concreteness, adjectives paired with concrete nouns had faster RTs than adjectives paired with abstract nouns [b=-.04, SE=.01, t(328.94)=-4.89, p<.001]. For the main effect of plausibility, plausible A-N pairs yielded faster RTs compared to intermediate [b=-.037, SE=.01, t(243.93)=-7.51, p<.001] and implausible [b=-.07, SE=.01, t(358.77)=-6.47 p<.001] pairs. There was no difference in RT between intermediate and implausible pairs.

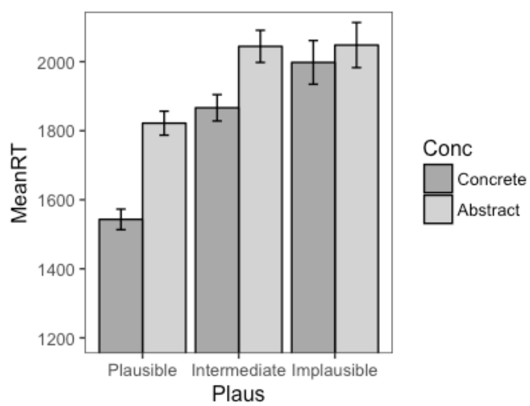

Figure 9. RTs for meaningful responses in the subjective model. Error bars indicate standard error.

RT Analysis for Nonmeaningful Responses

Of the fixed effects entered in the model, there was a main effect concreteness, b=.04, SE=.02, t(582.70)=-2.57, p<.05. Plausibility and the interaction between concreteness and plausibility had trends (p's=.06 and .05, respectively). A follow up Tukey-adjusted contrast showed that participants made faster nonmeaningful responses for adjectives paired with concrete nouns (M=1881.58, SD=382.48) compared to adjectives paired with abstract nouns (M=2030.11 SD=392.56), b=-.03, SE=.01, t(340.57)=-4.79 p<.001.

Objective Model – AoA and Semantic distance

After the model was fitted, data was trimmed using the LMERConvenienceFunctions package as the standardized residuals appeared non-normal upon visual inspection. Outliers with a standardized residual at a distance greater than 2.5 SD from 0 were excluded. This resulted in the removal of <5% of the data. Table 16 provides a summary of the mean RTs and standard deviations for meaningful and nonmeaningful responses for the final models.

Table 17 *Mean RTs for Meaningful and Nonmeaningful Responses for the Objective Model*

A-N Pair		***N***	**Meaningful *M* RT (*SD*)**	***N***	**Nonmeaningful *M* RT (*SD*)**
Early					
	Close	97	1570.47 (301.63)	90	1952.87 (610.36)
	Distant	97	1748.74 (375.20)	94	2024.95 (547.31)
	Unrelated	88	1908.79 (517.92)	97	1825.40 (386.83)
Late					
	Close	96	1865.85 (399.36)	96	2092.14 (497.78)
	Distant	97	2016.40 (479.79)	97	2126.92 (534.22)
	Unrelated	90	2079.50 (501.39)	97	1922.43 (371.45)

RT Analysis for Meaningful Responses

Of the fixed effects entered in the model, there was a main effect of AoA [b=.07, SE=.01, t(241.60)=5.00, p<.001]. There was also a main effect of semantic distance for distant, b=.04, SE=.01, t(240.40)=3.02, p<.01, and unrelated, b=.06, SE=.01, t(344.40)=34.18, p<.001, A-N pairs. The main effects were explored further with Tukey-adjusted pairwise comparisons. For the main effect of AoA, meaningful responses for early pairs (*M*=1682.70, *SD*=306.10) had significantly faster RTs than later pairs (*M*=1960.89, *SD*=387.12), *b*=-.05, *SE*=.01, *t*(303.24)=-6.69, *p*<.001. For the main effect of distance, close pairs (*M*=1709.89, *SD*=303.64) yielded faster RTs than distant (*M*=1858.09, *SD*=377.01), b=-.04, SE=.01, t(248.29)=-3.60, p<.0, and unrelated (*M*=2008.08, *SD*=450.74), b=-.05, SE=.01, t(328.94)=-4.79, p<.001, pairs. There were no differences in RT observed between distant and unrelated pairs (*p*>.05; See Figure 10).

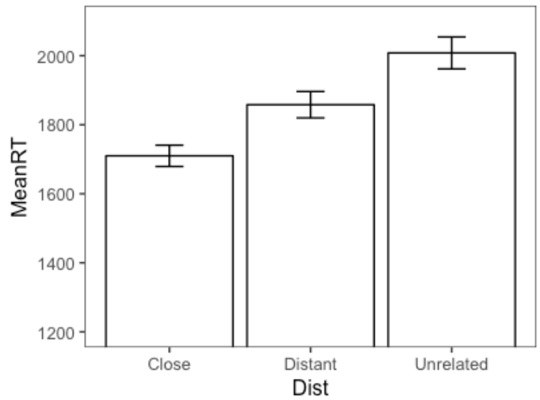

Figure 10. RTs by semantic distance for the objective model in the Meaningfulness task. Error bars indicate standard error.

RT Analysis for Nonmeaningful Responses

Of the fixed effects entered in the model, there was a main effect AoA, *b*=.03, *SE*=.01, *t*(374.50)=-2.11, *p*<.05. A follow up Tukey-adjusted contrast showed that participants were faster to make non-meaningful responses for early pairs (*M*=1897.83, *SD*=397.22) than late pairs (*M*=2004.94, *SD*=381.50), *b*=-.03, *SE*=.01, *t*(273.14)=-3.79 *p*<.001.

Model Comparison

For all analyses, subjective models yielded lower AIC values compared to objective models (refer to Table 17).

Table 18 *Summary of AIC Values for Subjective and Objective Models for the Meaningfulness Task*

	Subjective	**Objective**
Meaningful RT	-6235.11	-6199.54
Nonmeaningful RT	-4937.62	-4921.25

Discussion

For the subjective model, hypotheses were generally supported. The RTs for meaningful judgments were faster for adjectives paired with concrete head nouns and plausible pairs. In addition, concreteness and plausibility interacted in that concrete plausible A-N pairs yielded significantly faster meaningful responses than all other pairs. A concreteness effect was observed for distant A-N pairs, rather than a reverse concreteness effect that was predicted. For non-meaningful responses, adjectives paired with concrete head nouns yielded faster RTs than abstract pairs.

For the objective model, hypotheses were partially supported. The RT analysis for meaningful judgements were faster for early acquired nouns and semantically close pairs. However, no interaction was found. For non-meaningful responses, early acquired pairs yielded faster RTs than late acquired pairs.

Overall, the subjective model with concreteness and plausibility as predictors was a stronger model than the objective model with AoA and semantic distance as predictors for meaningful and non-meaningful RT analysis.

CHAPTER 5

GENERAL DISCUSSION

The purpose of this study was to explore the semantic effects that arise during the processing of complex A-N pairs with tasks that differentially elicit semantic engagement. A secondary purpose was to extend current theories of conceptual combination by incorporating these novel findings. This study took a unique approach to this challenge by comparing semantic variables that are obtained through subjective ratings on a Likert-type scale (see the preliminary study) to similar variables yielded through objective measures. This was to determine whether objective methods are equal to or better at predicting outcome variables than subjective models to avoid cumbersome data collection in the future. The discussion will proceed by integrating the findings from the subjective models, the objective models, then a comparison of the two models across tasks. This will be followed by a discussion of the limitations in this study and future directions for this topic.

Subjective Models – Concreteness and Plausibility

The subjective models included concreteness and plausibility as predictor variables. In general, hypotheses were supported. Across all tasks, a concreteness effect was observed in which adjectives paired with concrete nouns were responded to more quickly than adjectives paired with abstract nouns. However, the concreteness effect was not mirrored in the accuracy analyses for the DLDTs. Also consistent with hypotheses, plausible pairs were processed more quickly and more accurately across tasks compared to intermediate and implausible pairs. In addition, intermediate pairs were responded to more accurately than implausible pairs in the DLDTS. Findings diverge from hypotheses with no differences found for response times to intermediate and implausible pairs across tasks. In addition, the plausibility of the pairs did not affect non-meaningful judgments in the meaningfulness task.

In terms of an interaction between concreteness and plausibility, no specific predictions were made for the implicit DLDTs. However, in these tasks, concreteness interacted with plausibility in that concrete head nouns had faster processing times compared to abstract head nouns for plausible and intermediate pairs, but not implausible pairs. This pattern of differences with regards to head noun concreteness were not replicated for accuracy analyses, although concrete and abstract plausible pairs were processed more accurately than implausible pairs, and concrete plausible pairs more accurately than intermediate pairs for the non-pronounceable DLDT. For the explicit meaningfulness task, results supported hypotheses in that adjectives paired with plausible concrete nouns had faster meaningful responses than those paired with plausible abstract nouns. In contrast, a reverse concreteness was not observed in intermediate A-N pairs as predicted; rather, a typical concreteness effect was observed with faster meaningful judgments for concrete intermediate relative to abstract intermediate pairs.

Taken together, regardless of task demands, similar findings were observed. Plausibility of the pair had a positive effect on the processing of A-N combinations, and the amount that processing was facilitated was determined by head noun concreteness.

These results replicate and extend previous findings. Similar to the finding that head noun concreteness facilitates processing of A-N pairs, Lucas, Hubbard, and Federmeier (2017) reported that modifier noun concreteness promoted the creation of N-N definitions. Further, they recorded EEG waves, which indicated that the N400 was observed during the generation of N-N definitions. They concluded that mental imagery was being recruited when defining concrete-concrete noun pairs, but not abstract-concrete nouns pairs. The results from this study can be interpreted similarly. Pairing concrete nouns with adjectives may recruit mental imagery resources, as an adjective provides a more specific and descriptive quality to the noun, which ultimately would promote a rapid visualization of the pair. Further, based on single-word processing studies, abstract nouns may have a disadvantage according to the Dual Coding Theory, which proposes that concrete concepts are more elaborately encoded by both verbal and non-verbal (e.g., imagistic) processes, whereas abstract concepts do not benefit from non-verbal representations (Paivio, 1971). Relatedly, the Context Availability Theory (Schwanenflugel & Shoben, 1983) suggests that both concrete and abstract concepts are coded verbally, but concrete concepts benefit during processing by relying on a much richer and denser network of contextual knowledge. These explanations may extend to nouns that are paired with adjectives, which serve to describe a noun. Although Lucas, Hubbard, and Federmeier (2017) only tested concreteness in N-N combinations for an explicit task, these results broaden previous findings by demonstrating that the concreteness effect is present when processing complex A-N combinations, regardless of semantic processing demands.

In addition, the finding that plausibility facilitated processing of A-N pairs is consistent with Wisniewski and Murphy's (2005) , in which N-N combinations that were unfamiliar or implausible yielded slower reaction times for a sense-nonsense judgment task (Wisneiwski & Murphy, 2005). Interestingly, no differences in reaction time were observed for adjectives paired with intermediate and implausible nouns, although accuracy differed in that intermediate pairs yielded fewer errors. This suggests that plausibility is distributed over a continuum, but only the most plausible pairs gain a processing advantage. Pairs that are less plausible or implausible expend equal resources to process. The methodology referred to in Wisnewiski and Murphy's

(2005) study is similar to the explicit meaningfulness task used in this study. This finding extends further by replicating this effect in implicit tasks and for complex A-N combinations.

Although plausibility facilitated processing of A-N pairs, this effect was entirely dependent on head noun concreteness. That is, plausibility of the pair was an important determinant when an adjective was paired with a concrete head noun. In these instances, plausible concrete pairs were responded to the fastest, although no differences were observed between intermediate and implausible concrete pairs. In contrast, plausibility did not provide a similar advantage to adjectives paired with abstract nouns. In fact, abstract head nouns yielded slower reactions, regardless of whether they were paired with a plausible, intermediate, or implausible adjectives. This finding highlights the importance of considering concreteness simultaneously with the plausibility of the pair. Abstract head nouns have a significant disadvantage, likely due to their complexity and fewer representations as aforementioned (Paivio, 1971; Schwanenflugel & Shoben, 1983). In addition, this was a consistent finding regardless of the level of semantic engagement the task required.

Objective Models – AoA and Semantic Distance

The objective models included AoA and semantic distance as predictor variables. In general, hypotheses were partially supported. Across all tasks, adjectives paired with early acquired head nouns were responded to more quickly and accurately than adjectives paired with late acquired nouns. On the other hand, semantic distance had a larger role in accuracy analyses of the implicit tasks and in reaction times towards meaningful judgements of the most explicit task. That is, semantically close A-N pairs were responded to more quickly and accurately than distant and unrelated pairs. For the pronounceable DLDT accuracy analysis, distant pairs were also responded to more accurately than unrelated pairs. Hypotheses were not supported in implicit or non-meaningful RT analyses as no effects of semantic distance were observed.

Although no interactions were predicted for the implicit DLDTs, interactions between AoA and semantic distance were observed for accuracy analyses. For both implicit tasks, early acquired and semantically close A-N pairs were responded to more accurately than all other pairs. In contrast, interactions were predicted for the meaningfulness task, but none were observed.

Taken together, regardless of task demands, early AoA of the head noun facilitated processing of pairs consistently across tasks. In contrast, semantic distance differentially influenced processing based on the semantic demands of the task. That is, semantic distance facilitated the speed that A-N pairs were judged to be meaningful for the most explicit task, but not during lexical decision making for the implicit tasks. In addition, only close A-Ns pairs were facilitated, whereas distant and unrelated pairs had similar response times. Semantic distance did play a role in the implicit tasks in terms of how accurately participants responded to items. In these analyses, participants responded most accurately to close A-N pairs, but this was effect was dependent on an early acquired head noun.

Similar to single-word processing studies (Brysbaert, Wijnendaele, & De Deyne, 2000; Morrison & Ellis, 1995), AoA has a positive relationship with reaction time in that words acquired later are responded to more slowly than those acquired earlier. The findings of this study are consistent with this finding, and they demonstrate that irrespective of the AoA of the adjective, head noun AoA affects how rapidly and accurately the entire combination is processed, similar to head noun concreteness. This emphasizes how much semantic content is held in the second, or head, constituent of complex concepts (Wisniewski, 1997). We also expected that AoA would mirror the effects of concreteness. With this line of reasoning, adjectives paired with early AoA head nouns would likely benefit from imagistic processing, akin to adjectives paired with concrete nouns (see Lucas, Hubbard, & Federmeier, 2017).

As previously discussed, semantic distance has not been explored in the context of complex A-N pairs. However, results are consistent with those reported by Malhi and Buchanan (2018), in which they found that the semantic distance between N-N combinations facilitated processing on a task that emphasized semantic relatedness (i.e., asking participants to respond yes/no if a N-N pair is related). This is an explicit task that engages deep semantic processing, similar to the meaningfulness task in this study that would activate combinatorial processing. In line with Malhi and Buchanan's (2018) findings, this study observed a facilitation effect for adjectives paired with semantically close nouns. Malhi and Buchanan's (2018) stimuli did not consist of unrelated N-N pairs; however, an interesting finding in this study is that participants were not faster to make meaningful judgements towards distantly related compared to unrelated A-N pairs. Rather, these two types of A-N pairs were equally difficult to come to a meaningful judgement, suggesting that distant A-Ns do not contain enough related semantic content to gain an advantage over unrelated A-Ns. In addition, the effect of semantic distance did not translate to the speed of lexical decisions in the implicit tasks, similar to the task specific effects observed by Gagne and Shoben (1977) and their comparison of DLDTs and sense/nonsense judgments. However, for the implicit tasks, participants were more accurate in their lexical decisions for close pairs than for distant and unrelated pairs.

This latter finding in the implicit accuracy analyses was dependent on head noun AoA. Only close pairs with an early acquired head noun were processed more accurately than all other combinations. Thus, both AoA and semantic distance affected the ease with which A-N pairs were correctly responded to in the implicit tasks. In contrast, the interactions predicted for the explicit task were not found in these analyses. Predictions were based on findings from research on a similar semantic variable (i.e., SND; Al-Azary & Buchanan, 2017; Danguecan & Buchanan, 2016). In Danguecan and Buchanan's (2016) study, SND interacted with concreteness in that dense SNDs hindered processing only for abstract words. In Al-Azary and Buchanan's (2017) study, dense SNDs interacted with concrete metaphors and hindered processing. In contrast to these findings, the semantic distance between A-N pairs facilitated, rather than hindered, processing, and there were no differences observed in these pairs based on early or late AoA of the head noun. In this example, since the head noun captures the semantic content of the pair, semantic richness of the head noun may affect processing in the way these prior studies reported, although this was not tested. However, the semantic relationship between A-N combinations is not equivalent to the semantic richness of the pair, and instead, facilitates processing.

Subjective and Objective Model Comparison

Across all analyses, the subjective models with concreteness and plausibility were stronger at predicting processing outcomes than the objective models with AoA and semantic distance as predictors. Generally, AoA was able to mirror the effects of concreteness across all tasks. However, AoA differed from concreteness in accuracy analyses, in which AoA effects were found but concreteness effects were not. In contrast, despite the larger shared variance between semantic distance and plausibility, semantic distance did not mirror the effects of plausibility. Rather, in this sample of exclusively low frequency A-N pairs, plausibility may better capture how participants perceive relatedness of a pair relative to a variable that analyzes text sources. Additionally, eliciting participant ratings may in fact better map on to the way that semantic content is organized neuroanatomically, as participants make judgments based on the availability of semantic knowledge at their disposal.

Taken together, the semantic effects observed in the processing of A-N pairs can be used to inform and expand existing models of conceptual combination. According to Smith et al.'s (1988) SMM slot-filling model for simple-adjective noun pairs, the authors predicted that a noun phrase would be easier to comprehend if the modifier selected a clear, or more salient, slot in the noun's representation. This is akin to plausible or closely related A-N pairs. Although this prediction was supported by the objective model, the subjective model suggested that head noun concreteness interacted with how easily the A-N pair was comprehended. For example, for the most explicit task, which required comprehension and combinatorial processing of the pair to make a meaningful decision, plausibility of the pair did not facilitate processing of adjectives paired with abstract nouns. Therefore, the SMM may have better explanatory power for adjectives paired with concrete nouns, as concrete nouns have clearer attributes that can be modified by adjectives. However, abstract nouns do not have clear modifiable attributes. For example, consider the pair *stubby beak* from the stimulus set; *beak* is a concrete noun that has a *shape* attribute (i.e., slot) that can be filled with the value *stubby*. Now consider the pair *wry irony*; *irony* is an abstract noun, but the attribute that *wry* is modifying is unclear. In this case, it may be an attribute related to *type of*, but then the potential modifiers are infinite. Having a clear slot with a limited set of possible fillers allows for rapid comprehension of adjectives paired with concrete nouns. In contrast, having ambiguous slots with an infinite number of possibilities as fillers makes combinatorial processing of adjectives paired with abstract nouns onerous.

In addition, the SMM model would predict that intermediate plausible pairs would be processed faster than implausible pairs since the SMM predicts the occurrence of serial processing during comprehension of the pair (Smith et al., 1988). That is, once all possible slots have been exhausted and no appropriate filler is found, the pair is deemed to be non-sensical (Smith et al., 1988). This pattern was more clearly delineated in adjectives paired with concrete nouns during meaningful judgments; however, as mentioned, in abstract nouns, plausibility of the pair did not facilitate processing. In addition, this serial type of processing should be reflected during non-meaningful judgments, but this was not the case; rather, there was a trend for participants to make non-meaningful judgments faster for implausible pairs relative to intermediate and plausible pairs. This finding is supportive of a rapid integration of the semantic content of adjectives and nouns leading to a rapid rejection of implausible pairs, similar to models of spreading activation. Akin to previous studies (Medin & Shoben, 1988), this study addresses the shortfalls of the SMM model, most clearly the exclusion of abstract noun concepts and the predicted serial mode of retrieval.

SMM is one of many schema-based models. Despite its shortcomings, our findings generally support a schema-based model as opposed to a feature addition model. The latter model suggests that features of the adjective are combined with features of the noun (Clark & Clark, 1977). Again, this explanation may be applicable to simple and concrete A-N pairs, but it is insufficient to describe complex A-N pairs, especially those with abstract head nouns. Schema-based models propose that adjectives must be a part of the noun's schematic representation in order to be meaningful. For example, Murphy (1990) had participants provide interpretations and make meaningful judgments for adjectives that attributed a common feature to the noun and those that did not. He referred to this dimension as typicality. He found that adjectives that represent typical features of nouns were faster and easier to process (Murphy, 1990). Similarly, adjectives that are semantically related to or plausible when paired with a noun would likely be represented within a noun's schema. Thus, the processing of these A-N pairs was facilitated in this study.

In terms of the mode of retrieval, results are consistent with spreading activation, as opposed to serial processing. That is, processing of related A-N pairs was facilitated, although degree of relatedness did not influence processing in a linear fashion as no differences were observed for distantly related or unrelated pairs. These latter pairs may be considered unusual or novel according to Potter and Falcouner (1979); however, low frequency constituents were used to create novel pairs, regardless of semantic relatedness of the pair. Consistent with their proposal, closely related pairs facilitated speed and accuracy of responding across tasks, and unusual pairs required a more controlled type of processing to deduce the meaning of the pair.

In addition, results of this study also support context dependent retrieval consistent with Blank and Foss (1978) proposition; these authors assume that if participants respond faster to related A-Ns than unrelated A-N pairs, then this is evidence for context-dependent retrieval. This was a consistent finding across tasks when considering the plausibility of the pair in the subjective model, although it was only found for the most explicit task when considering semantic distance. Further, this study emphasized that although there are different degrees of relatedness or plausibility between A-N pairs, only the closely related or plausible pairs benefit during retrieval. In this case, it may be that distantly related or intermediate pairs do not provide enough context to aid retrieval.

Limitations and Future Directions

This exploratory study had some interesting findings to stimulate further research in the field of conceptual combination; however, there are some crucial limitations to highlight. Most importantly, plausibility ratings were compiled from 15 individuals of restricted demographics (i.e., all female). A larger database of plausibility ratings should be obtained to yield more stable values to guide further research in this area. In addition, although frequency was kept low, concreteness and AoA differed in frequency, and this may contribute to the findings from this study, as frequency is a common confound when investigating semantic effects (Durda & Buchanan, 2008). Future studies should control for all confounding lexical variables. Relatedly, low frequency stimuli were used to simulate novel A-N pairs and enhance semantic effects; however, this approach also jeopardized participants actually knowing what the stimuli referred to. Perhaps high frequency stimuli could be used in this case as long as the variable was tightly controlled across stimuli. In addition, certain characteristics of A-N pairs known to influence processing were not examined in this study (e.g., subjective and intersective A-N pairs; Kamp & Partee, 1995).

Furthermore, this study stimulates a further examination of semantic variables that facilitate abstract head noun processing. In many accounts (e.g., Theory of Embodied Abstract Semantics; Kousta, Vigliocco, Del Campo, Vinson, & Andrews, 2011; Vigliocco, Meteyard, Andrews, & Kousta, 2009), abstract concepts are considered to benefit from affective associations and concrete concepts from sensorimotor associations. Perhaps an approach that examines emotional attributes of abstract head nouns (e.g., valence) would be worthwhile to explore in the context of abstract A-N combinations.

Conclusion

In conclusion, the purpose of this study was to explore semantic effects in the processing of A-N pairs in both explicit and implicit tasks and address the shortcomings of existing theories in capturing the complexity of conceptual combination in A-N pairs. This study used a unique approach by examining and contrasting semantic variables that are obtained by subjective versus objective means. Overall, subjective models with plausibility and concreteness as predictor variables better captured the processing of A-N pairs across tasks, suggesting that large databases of participant rated variables are valuable. Idiosyncratic differences in language experiences allows individuals to evolve a unique mental lexicon, translating to differences in the storage of semantic knowledge and connections between words. Perhaps asking participants their perception of how a word pair is represented better captures how it is stored, and thereby, retrieved. The results of this study highlight the need for conceptual combination to be revisited in the context of complex A-N pairs, as current theories need to emphasize retrieval as a process that relies on spreading activation and integrate the finding that concreteness of the head noun may facilitate or hinder processing of the combination.

REFERENCES

Al-Azary, H., & Buchanan, L. (2017). Novel metaphor comprehension: Semantic neighbourhood density interacts with concreteness. *Memory & Cognition*, *45*(2), 296-307.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, *59*(4), 390-412.

Barsalou, L.W. (1982). Context-independent and context- dependent information in concepts. *Memory & Cognition, 10,* 82-93.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*(1), 1-48. doi:10.18637/jss.v067.i01.

Blank, M. A., & Foss, D. J. (1978). Semantic facilitation and lexical access during sentence processing. *Memory & Cognition*, *6*(6), 644-652.

Brysbaert, M., Warriner, A. B., & Kuperman, V. (2014). Concreteness ratings for 40 thousand generally known English word lemmas. *Behavior Research Methods*, *46*(3), 904-911.

Buchanan, L., Westbury, C., & Burgess, C. (2001). Characterizing semantic space: Neighborhood effects in word recognition. *Psychonomic Bulletin & Review*, *8*(3), 531-544.

Chan, J., & Schunn, C. D. (2015). The importance of iteration in creative conceptual combination. *Cognition*, *145*, 104-115.

Clark, H. H., & Clark, E. V. (1977). Psychology and language: An introduction to psycholinguistics. New York: Harcourt Brace Jovanovich.

Cohen, B., & Murphy, G. L. (1984). Models of concepts. *Cognitive Science*, *8*(1), 27-58.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological review*, *82*(6), 407.

Costello, F. J., & Keane, M. T. (2000). Efficient creativity: Constraint-guided conceptual combination. *Cognitive Science*, *24*(2), 299-349.

Danguecan, A. N., & Buchanan, L. (2016). Semantic neighborhood effects for abstract versus concrete words. *Frontiers in psychology*, *7*.

Doboli, A., Umbarkar, A., Subramanian, V., & Doboli, S. (2014). Two experimental studies on creative concept combinations in modular design of electronic embedded systems. *Design Studies*, *35*(1), 80-109.

Drašković, I., Pustejovsky, J., & Schreuder, R. (2013). Adjective-Noun Combinations and the Generative Lexicon. In *Advances in Generative Lexicon Theory* (pp. 181-202). Springer Netherlands

Durda, K., & Buchanan, L. (2008). WINDSORS: Windsor improved norms of distance and similarity of representations of semantics. *Behavior Research Methods, 40*(3), 705-712.

Estes, Z. (2003). Attributive and relational processes in nominal combination. *Journal of Memory and Language*, *48*(2), 304-319.

Gagné, C. L., & Shoben, E. J. (1997). Influence of thematic relations on the comprehension of modifier–noun combinations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *23*(1), 71.

Gagné, C. L., Spalding, T. L., & Ji, H. (2005). Re-examining evidence for the use of independent relational representations during conceptual combination. *Journal of Memory and Language*, *53*(3), 445-455.

Gielnik, M. M., Frese, M., Graf, J. M., & Kampschulte, A. (2012). Creativity in the opportunity identification process and the moderating effect of diversity of information. *Journal of Business Venturing*, *27*(5), 559-576.

Graves, W. W., Binder, J. R., Desai, R. H., Conant, L. L., & Seidenberg, M. S. (2010). Neural correlates of implicit and explicit combinatorial semantic processing. *Neuroimage*, *53*(2), 638-646.

Jaeger, T. F. (2008). Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models. *Journal of memory and language*, *59*(4), 434-446.

Kamp, H., & Partee, B. (1995). Prototype theory and compositionality. *Cognition*, *57*(2), 129-191.

Kennison, S. M. (2005). Different time courses of integrative semantic processing for plural and singular nouns: implications for theories of sentence processing. *Cognition*, *97*(3), 269-294.

Kennison, S. M. (2010). Processing prenominal adjectives during sentence comprehension. *Perceptual and motor skills*, *111*(1), 141-157.

Kousta, S. T., Vigliocco, G., Vinson, D. P., Andrews, M., & Del Campo, E. (2011). The representation of abstract words: why emotion matters. *Journal of Experimental Psychology: General*, *140*(1), 14.

Kuperman, V., Stadthagen-Gonzalez, H., & Brysbaert, M. (2012). Age-of-acquisition ratings for 30,000 English words. *Behavior Research Methods*, *44*(4), 978-990.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13), 1-26. doi: 10.18637/jss.v082.i13

Levi, J. N. (1978). *The syntax and semantics of complex nominals.* New York: Academic Press.

Lucas, H. D., Hubbard, R. J., & Federmeier, K. D. (2017). Flexible conceptual combination: Electrophysiological correlates and consequences for associative memory. *Psychophysiology*, *54*(6), 833-847.

Lund, K., & Burgess, C. (1996). Producing high-dimensional semantic spaces from lexical co-occurrence. *Behavior Research Methods*, *28*(2), 203-208.

Maguire, P., Devereux, B., Costello, F., & Cater, A. (2007). A reanalysis of the CARIN theory of conceptual combination. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(4), 811.

Maguire, P., & Maguire, R. (2011). Are word meanings atomic or complex? An investigation of conceptual knowledge activation in context. In B. Koknov, A. Karmiloff-Smith, & N. J. Nersessian (Eds.), *European perspectives on cognitive science.* Kildare, Ireland: New Bulgarian University Press.

Malhi, S. K., & Buchanan, L. (2018). A test of the symbol interdependency hypothesis with both concrete and abstract stimuli. *PLoS ONE, 13*(3), e0192719. doi: 10.1371/journal.pone.0192719

McElree, B., Murphy, G. L., & Ochoa, T. (2006). Time course of retrieving conceptual information: A speed-accuracy trade-off study. *Psychonomic Bulletin & Review*, *13*(5), 848-853.

Medin, D. L., & Shoben, E. J. (1988). Context and structure in conceptual combination. *Cognitive Psychology*, *20*(2), 158-190.

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology*, *90*(2), 227.

Murphy, G. L. (1988). Comprehending complex concepts. *Cognitive Science*, *12*(4), 529-562.

Murphy, G. L. (1990). Noun phrase interpretation and conceptual combination. *Journal of Memory and Language*, *29*(3), 259-288.

Osherson, D. N., & Smith, E. E. (1981). On the adequacy of prototype theory as a theory of concepts. *Cognition*, *9*(1), 35-58.

Paivio, A. (1971). *Imagery and verbal processes*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Paivio, A. (1991). Dual-coding theory: Retrospect and current status. *Canadian Journal of Psychology, 45*(3), 255-287.

Pexman, P. M., Hargreaves, I. S., Siakaluk, P. D., Bodner, G. E., & Pope, J. (2008). There are many ways to be rich: Effects of three measures of semantic richness on visual word recognition. *Psychonomic Bulletin & Review*, *15*(1), 161-167.

Potter, M. C., & Faulconer, B. A. (1979). Understanding noun phrases. *Journal of Verbal Learning and Verbal Behavior*, *18*(5), 509-521.

Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology*, *7*(4), 573-605.

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rumelhart, D. E. (1980). On evaluating story grammars. *Cognitive Science*, *4*(3), 313-316.

Schwanenflugel, P.J. (1991). Why are abstract concepts hard to understand? In P.J. Schwanenflugel (Ed.), *The psychology of word meanings* (pp. 223-250). Hillsdale, NJ: Erlbaum.

Schwanenflugel, P. J., & Shoben, E. J. (1983). Differential context effects in the comprehension of abstract and concrete verbal materials. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *9*(1), 82.

Smith, E. E., Osherson, D. N., Rips, L. J., & Keane, M. (1988). Combining prototypes: A selective modification model. *Cognitive science*, *12*(4), 485-527.

Springer, K., & Murphy, G. L. (1992). Feature availability in conceptual combination. *Psychological Science*, *3*(2), 111-117.

Swinney, D., Love, T., Walenski, M., & Smith, E. E. (2007). Conceptual combination during sentence comprehension. *Psychological Science*, *18*(5), 397-400.

Thagard, P. (1984, January). Conceptual combination and scientific discovery. In *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association* (Vol. 1984, No. 1, pp. 3-12). Philosophy of Science Association.

Vigliocco, G., Meteyard, L., Andrews, M., & Kousta, S. (2009). Toward a theory of semantic representation. *Language and Cognition*, *1*(2), 219-247.

West, W. C., & Holcomb, P. J. (2000). Imaginal, semantic, and surface-level processing of concrete and abstract words: An electrophysiological investigation. *Journal of Cognitive Neuroscience, 12*, 1024–1037.

Wisniewski, E. J. (1996). Construal and similarity in conceptual combination. *Journal of Memory and Language*, *35*(3), 434-453.

Wisniewski, E. J. (1997). When concepts combine. *Psychonomic Bulletin & Review*, *4*(2), 167-183.

Wisniewski, E. J., & Murphy, G. L. (2005). Frequency of relation type as a determinant of conceptual combination: A reanalysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *31*(1), 169.

Yap, M. J., Tan, S. E., Pexman, P. M., & Hargreaves, I. S. (2011). Is more always better? Effects of semantic richness on lexical decision, speeded pronunciation, and semantic classification. *Psychonomic Bulletin & Review*, *18*(4), 742-750.

APPENDICES

Appendix A. Stimulus set of nouns paired with close, distant, and unrelated adjectives.

Noun	Close Adjective	Distant Adjective	Unrelated Adjective
ACNE	ITCHY	HERBAL	KNOTTY
ANIMATION	VISUAL	COMIC	POROUS
ARENA	CIVIC	SUPER	FLEXIBLE
ASPHALT	CONCRETE	RUBBERY	LIKABLE
BEAK	STUBBY	GLOSSY	SELFISH
BULB	RADIANT	TRANSLUCENT	CRUDE
BUNGALOW	QUAINT	LUXURY	GREEDY
CACTI	PRICKLY	HAIRY	FRANTIC
CANISTER	INERT	CORROSIVE	MELLOW
CARTON	DISPOSABLE	ASEPTIC	ALOOF
CEMETERY	HISTORIC	RECUMBENT	HECTIC
CIDER	FRUITY	TANGY	VIABLE
CLUMP	SUCCULENT	MOSSY	TACKY
DEMON	IMMORTAL	FACELESS	FLUFFY
DESSERT	DELICIOUS	FLAKY	SPARSE
FAUNA	EXTINCT	TEMPERATE	DEFENSIVE
FURNACE	MOLTEN	GASEOUS	RECURRENT
GENDER	MASCULINE	OVERT	PRISTINE
HEADACHE	SORE	CHRONIC	TIPSY
INSECT	VENOMOUS	AQUATIC	AMAZING
JEWEL	PRICELESS	WONDROUS	SHREWD
LAUNDRY	HYGENIC	COSY	CHUMMY
LAVA	EFFUSIVE	SHALLOW	WEIRD
LIAR	DISHONEST	RUTHLESS	STOCKY
LID	REMOVABLE	RECTANGULAR	STEALTHY
LIQUOR	ALCOHOLIC	GASSY	BORING
MATTRESS	WASHABLE	PLIABLE	INSATIABLE
MOUSTACHE	UNKEMPT	WISPY	VALID
OAT	STARCHY	INEDIBLE	ERRONEOUS
ORCHID	ENDEMIC	MOIST	GEOMETRIC
PANTS	BAGGY	DRAB	DEVIOUS
PASTRY	CRUNCHY	SALTY	APOLOGETIC
POSTER	GRAPHIC	FAKE	RASH
POSTURE	MUSCULAR	GRACEFUL	FICKLE
RAFT	INFLATABLE	PERILOUS	CARPICIOUS
RECIPIENT	PRESTIGIOUS	ELIGIBLE	FRUGAL
RESIN	SYNTHETIC	CERAMIC	CLINGY
RHYME	POETIC	ARCHAIC	DEMANDING
SAUCE	SOUR	TASTY	COURAGEOUS
SHRUB	THORNY	WAXY	BLAND
SODA	FIZZY	SUGARY	NOCTURNAL

STENCH	FOUL	GROTESQUE	ENERGETIC
STIMULANT	ADDICTIVE	ILLICIT	PESKY
SWAMP	MUDDY	STONY	CURSIVE
SWARM	GIGANTIC	IGNEOUS	TENSE
TELESCOPE	ASTRONOMOICAL	PHOTOGRAPHIC	NAIVE
TORTILLA	CRISPY	SPICY	GIFTED
TREMOR	SPASTIC	ABNORMAL	PREDATORY
YARN	STRETHCY	SILKY	THRIFTY
ZOMBIE	SCARY	RABID	FRAIL
ACCOLADE	HONORABLE	LUKEWARM	IMAGINARY
ALLEGIANCE	LOYAL	UNEASY	SASSY
ALLUSION	LITERAL	SUGGESTIVE	SPUNKY
APPREHENSION	MOMENTARY	JUSTIFIABLE	DODGY
APTITUDE	EXCEPTIONAL	ADEPT	MORBID
AUTHENTICITY	CREDIBLE	CANONICAL	GIDDY
BOREDOM	INCESSANT	DREARY	FRAGILE
COGNITION	NEURAL	ASSOCIATIVE	TARDY
CREATIVITY	ARTISITIC	ENVIABLE	FLOPPY
DECEIT	BLATANT	RECKLESS	SENTIENT
DIMENSION	METRIC	TELEPATHIC	HURTFUL
DISDAIN	SCORNFUL	SNIDE	SERIAL
DOGMA	INFALLIBLE	SCRIPTURAL	SWEATY
EGO	NEUROTIC	DYSFUNCTIONAL	GAWKY
EMPATHY	INSTINCTIVE	INTUITIVE	LOUSY
ENCHANTMENT	MAGICAL	DREAMY	NERVY
EUPHORIA	HYPNOTIC	PLEASURABLE	OBSCENE
EXCELLENCE	INNOVATIVE	SCHOLASTIC	SHADY
FALLACY	EPISTEMIC	UNANSWERABLE	GREASY
HASSLE	INCONVENIENT	TIRESOME	EPIC
HONESTY	SELFLESS	IMPECCABLE	LAZY
INFERENCE	DEDUCTIVE	PLAUSIBLE	COMPETENT
INNOVATOR	VISIONARY	ECLECTIC	BIZARRE
INTIMACY	MARITAL	SENSUOUS	STUPENDOUS
INTUITION	SUBCONCSCIOUS	CLAIRYVOYANT	TEDIOUS
IRONY	WRY	INANE	COMMENDABLE
IRRITABILITY	CLAMMY	TRANSIENT	STURDY
LIKELIHOOD	PREDICTIVE	ROBUST	SCANT
LUNACY	HYSTERICAL	IRRATIONAL	GRACIOUS
MALPRACTICE	WRONGFUL	AVOIDABLE	FROSTY
MORALS	ETHICAL	PROFANE	RUNNY
NIGHTMARE	CREEPY	SHOCKING	SCALY
NOSTALGIA	SENTIMENTAL	SURREAL	ROTTEN
OPTIMISM	YOUTHFUL	JOYFUL	RHETORICAL
PARADOX	LOGICAL	EMPIRICAL	DEVIANT
PARANOIA	OBSESSIVE	AFFECTIVE	FUNKY
PLOY	DECEPTIVE	INGENIOUS	SPATIAL

PRIVACY	CONFIDENTIAL	RESTRICTIVE	FORCIBLE
REVERENCE	SINCERE	BENEVOLENT	VULGAR
RIDDLE	CRYPTIC	OBSCURE	PREPATORY
RITUAL	CUSTOMARY	ESOTERIC	MUGGY
SARCASM	WITTY	CORNY	EVASIVE
SAVAGERY	BARBARIC	BEASTLY	BALD
STIGMA	PERVASIVE	TRAUMATIC	TRICKY
SYMBOLISM	MYSTICAL	ABSTRACT	FRAIL
SYNDROME	ACUTE	SPINAL	COMPACT
TACT	ADMIRABLE	BOUNDLESS	SALIENT
TIRADE	INDIGNANT	DEROGATORY	SPIKY
TYRANNY	OPPRESSIVE	CORRUPT	STINGY
VOLITION	SUBJECTIVE	CAUSAL	FREAKY

Note. Abstract nouns are highlighted in grey.

Appendix B. Distractor adjective and nouns used in the implicit tasks.

Distractor Adjectives	Distractor Nouns
ARACHNID	ANVIL
AVID	BANQUET
BOGUS	BARNACLE
BRAINY	BARREL
BRAZEN	CANTEEN
BRITTLE	CAROUSEL
BURLY	CHARCOAL
CELLULAR	COFFIN
CITRIC	CUTICLE
COHESIVE	JAVELIN
CONCURRENT	MAST
CREAKY	MEADOW
CULTURED	METEOR
DECISIVE	NOZZLE
DIGITAL	PODIUM
DUSTY	PONCHO
EERIE	PROPELLER
EXISTENT	PYRAMID
FEASIBLE	RECEIPT
FLASHY	ROACH
FLIMSY	SERPENT
FLUENT	SHACK
FROZEN	SPINDLE
GALLANT	STATUE
GHOSTLY	TORPEDO
GORGEOUS	ACCORD
GRUESOME	ADORANCE
HABITUAL	AMBIVALENCE
LAVISH	COERCION
MARINE	DEVIANCY
MEEK	DOOM
JUDICIAL	ELEGANCE
MINI	ESSENCE
MUSTY	ETERNITY
PETTY	FRAUD
PHOBIC	HESITANCE
PLACID	IMPRUDENCE
SALINE	INSIGHT
SAPPY	INTEGRITY
SECTIONAL	LEGACY
SHIFTY	MERIT
SOBER	MOTIVE
STOIC	OBLIVION

SUCCINCT	PRESTIGE
SWELL	PSYCHE
SYMMETRIC	RHETORIC
TACTFUL	RUSE
THEATRICAL	SPLENDOR
UNAWARE	SYNTHESIS
VIRTUAL	WILLPOWER

Note. Abstract nouns are highlighted in grey.

Appendix C. The three lists that were generated.

Noun	List 1 Adjective	List 2 Adjective	List 3 Adjective
ACCOLADE	HONORABLE	IMAGINARY	LUKEWARM
ACNE	ITCHY	KNOTTY	HERBAL
ALLEGIANCE	LOYAL	UNEASY	SASSY
ALLUSION	SUGGESTIVE	LITERAL	SPUNKY
ANIMATION	COMIC	POROUS	VISUAL
APPREHENSION	JUSTIFIABLE	MOMENTARY	DODGY
APTITUDE	EXCEPTIONAL	MORBID	ADEPT
ARENA	FLEXIBLE	CIVIC	SUPER
ASPHALT	CONCRETE	LIKABLE	RUBBERY
AUTHENTICITY	GIDDY	CANONICAL	CREDIBLE
BEAK	GLOSSY	STUBBY	SELFISH
BOREDOM	INCESSANT	FRAGILE	DREARY
BULB	RADIANT	CRUDE	TRANSLUCENT
BUNGALOW	GREEDY	LUXURY	QUAINT
CACTI	HAIRY	FRANTIC	PRICKLY
CANISTER	INERT	MELLOW	CORROSIVE
CARTON	DISPOSABLE	ALOOF	ASEPTIC
CEMETERY	RECUMBENT	HECTIC	HISTORIC
CIDER	VIABLE	TANGY	FRUITY
CLUMP	MOSSY	SUCCULENT	TACKY
COGNITION	ASSOCIATIVE	NEURAL	TARDY
CREATIVITY	ARTISTIC	FLOPPY	ENVIABLE
DECEIT	SENTIENT	RECKLESS	BLATANT
DEMON	IMMORTAL	FLUFFY	FACELESS
DESSERT	DELICIOUS	SPARSE	FLAKY
DIMENSION	HURTFUL	TELEPATHIC	METRIC
DISDAIN	SNIDE	SCORNFUL	SERIAL
DOGMA	SWEATY	INFALLIBLE	SCRIPTURAL
EGO	GAWKY	DYSFUNCTIONAL	NEUROTIC
EMPATHY	LOUSY	INSTINCTIVE	INTUITIVE
ENCHANTMENT	MAGICAL	NERVY	DREAMY
EUPHORIA	PLEASURABLE	OBSCENE	HYPNOTIC
EXCELLENCE	INNOVATIVE	SCHOLASTIC	SHADY
FALLACY	UNANSWERABLE	EPISTEMIC	GREASY
FAUNA	EXTINCT	TEMPERATE	DEFENSIVE
FURNACE	MOLTEN	GASEOUS	RECURRENT
GENDER	OVERT	MASCULINE	PRISTINE
HASSLE	INCONVENIENT	EPIC	TIRESOME
HEADACHE	TIPSY	CHRONIC	SORE
HONESTY	SELFLESS	IMPECCABLE	LAZY
INFERENCE	COMPETENT	PLAUSIBLE	DEDUCTIVE
INNOVATOR	ELECTIC	BIZARRE	VISIONARY
INSECT	VENOMOUS	AQUATIC	AMAZING

INTIMACY	STUPENDOUS	MARITAL	SENSUOUS
INTUITION	SUBCONSCIOUS	CLAIRYVOYANT	TEDIOUS
IRONY	COMMENDABLE	INANE	WRY
IRRITABILITY	STURDY	TRANSIENT	CLAMMY
JEWEL	WONDROUS	PRICELESS	SHREWD
LAUNDRY	COSY	HYGENIC	CHUMMY
LAVA	WEIRD	SHALLOW	EFFUSIVE
LIAR	RUTHLESS	DISHONEST	STOCKY
LID	RECTANGULAR	STEALTHY	REMOVABLE
LIKELIHOOD	SCANT	ROBUST	PREDICTIVE
LIQUOR	BORING	ALCOHOLIC	GASSY
LUNACY	IRRATIONAL	HYSTERICAL	GRACIOUS
MALPRACTICE	FROSTY	AVOIDABLE	WRONGFUL
MATTRESS	WASHABLE	INSATIABLE	PLIABLE
MORALS	ETHICAL	PROFANE	RUNNY
MOUSTACHE	UNKEMPT	VALID	WISPY
NIGHTMARE	SHOCKING	CREEPY	SCALY
NOSTALGIA	ROTTEN	SENTIMENTAL	SURREAL
OAT	INEDIBLE	ERRONEOUS	STARCHY
OPTIMISM	RHETORICAL	JOYFUL	YOUTHFUL
ORCHID	GEOMETRIC	MOIST	ENDEMIC
PANTS	BAGGY	DEVIOUS	DRAB
PARADOX	EMPIRICAL	DEVIANT	LOGICAL
PARANOIA	AFFECTIVE	FUNKY	OBSESSIVE
PASTRY	SALTY	APOLOGETIC	CRUNCHY
PLOY	SPATIAL	DECEPTIVE	INGENIOUS
POSTER	RASH	FAKE	GRAPHIC
POSTURE	MUSCULAR	FICKLE	GRACEFUL
PRIVACY	CONFIDENTIAL	RESTRICTIVE	FORCIBLE
RAFT	CAPRICIOUS	PERILOUS	INFLATABLE
RECIPIENT	PRESTIGIOUS	ELIGIBLE	FRUGAL
RESIN	CLINGY	SYNTHETIC	CERAMIC
REVERENCE	BENEVOLENT	SINCERE	VULGAR
RHYME	ARCHAIC	POETIC	DEMANDING
RIDDLE	CRYPTIC	OBSCURE	PREPATORY
RITUAL	MUGGY	CUSTOMARY	ESOTERIC
SARCASM	CORNY	EVASIVE	WITTY
SAUCE	SOUR	COURAGEOUS	TASTY
SAVAGERY	BEASTLY	BARBARIC	BALD
SHRUB	WAXY	BLAND	THORNY
SODA	SUGARY	FIZZY	NOCTURNAL
STENCH	GROTESQUE	ENERGETIC	FOUL
STIGMA	TRICKY	TRAUMATIC	PERVASIVE
STIMULANT	PESKY	ADDICTIVE	ILLICIT
SWAMP	MUDDY	STONY	CURSIVE
SWARM	TENSE	IGNEOUS	GIGANTIC

SYMBOLISM	MYSTICAL	ABSTRACT	FRAIL
SYNDROME	COMPACT	ACUTE	SPINAL
TACT	ADMIRABLE	BOUNDLESS	SALIENT
TELESCOPE	NAÏVE	ASTRONOMICAL	PHOTOGAPHIC
TIRADE	DEROGATORY	INDIGNANT	SPIKY
TORTILLA	SPICY	GIFTED	CRISPY
TREMOR	PREDATORY	SPASTIC	ABNORMAL
TYRANNY	STINGY	OPPRESSIVE	CORRUPT
VOLITION	SUBJECTIVE	FREAKY	CAUSAL
YARN	STRETCHY	SILKY	THRIFTY
ZOMBIE	RABID	SCARY	FRAIL

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