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THE ABSTRACT LANGUAGE: SYMBOLIC COGNITON AND ITS RELATIONSHIP TO EMBODIEMENT

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THE ABSTRACT LANGUAGE: SYMBOLIC COGNITON AND ITS RELATIONSHIP TO EMBODIEMENT

STEVEN A. LENARDUZZI

ABSTRACT

Embodied theories presume that concepts are modality specific while symbolic theories suggest that all modalities for a given concept are integrated. Symbolic and embodied theories do fairly well with explaining and describing concrete concepts. Specifically, embodied theories seem well suited to describing the actual content of a concept while symbolic theories provide insight into how concepts operate. Conversely, neither symbolic nor embodied theories have been fully sufficient when attempting to describe and explain abstract concepts. Several pluralistic accounts have been put forth to describe how the semantic/lexical system interacts with the conceptual system. In this respect, they attempt to "embody" abstract concepts to the same extent as concrete concepts. Nevertheless, a concise and comprehensive theory for explaining how we learn/understand abstract concepts to the extent that we learn/understand concrete concepts remains elusive. One goal of the present review paper is to consider if abstract concepts can be defined by a unified theory or if subsets of abstract concepts will be defined by separate theories. Of particular focus will be Symbolic Interdependency Theory (SIT). It will be argued that SIT is suitable for grounding abstract concepts, as this theory infers that symbols bootstrap meaning from other symbols, highlighting the importance of abstract-to-abstract mapping in the same way that concrete-to-abstract mappings are created. Research will be considered to help outline a cohesive strategy for describing and understanding abstract concepts. Finally, as research has demonstrated efficiencies with concrete concept processing, analogous efficiencies will be explored for developing an understanding of abstract concepts. Such efforts could have both theoretical and practical implications for bolstering our knowledge of concept learning.

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CHAPTER I

INTRODUCTION

A quote that resonates well with what we will discover in this paper comes from Anthony De Mello – “Thought can organize the world so well that you are no longer able to see it.” Concepts, which are the basic units of our thoughts, organize the very fabric of reality. Metaphorically, our concepts are like a net that is cast into the world, allowing us to capture meaning from our inner and outer environment. We often assume we are seeing the world exactly how it is when, in reality, we are seeing the world through the lens of our concepts and conceptual language. Sometimes our concepts become so abstract that we get lost in our own minds. However, most of the time, this abstractness allows us to function optimally against life’s obstacles. Without such concepts, we would not be able to make sense of the world around us.

From ancient Greece to today, critical thinkers have grappled with the nature of concepts. A very separate problem, but inextricably linked, is “What gives our words meaning?” In psychology, we have generally agreed that concepts are mental representations of categories and associated bodies of knowledge or information. Concepts have semantic content, as they refer to some category in the world. Concepts also have cognitive content, as they consist of essential information for mental processing

(Michel, 2020). Even though we have come a long way in identifying what gives words meaning, serious difficulties arise when trying to understand words/concepts within the abstract domain.

Some argue that abstraction is the most powerful tool of human cognition. Abstraction comes in many forms and influences the relationship between perception and conceptualization while consequently influencing broader modes of thought, including metaphor, analogy, reasoning, and imagination. Abstraction permits us to broaden our mental horizons. With symbolic tools, such as natural language and mathematics, abstraction has facilitated immense human ingenuity.

A host of terms have been used synonymously with abstraction (e.g., global, general, gist, holistic, relational). Abstraction is often described as the process of stripping away superficial content so that the most relevant and principal content is exclusively present. However, this stripping away does not connote simplicity; abstraction can be very complex. Obtaining details that are most important allows us space to build on those essential details to be more comprehensive and substantive.

Concrete and abstract concepts are often pitted against one another due to many quantitative and qualitative differences; yet concrete and abstract concepts really exist more on a continuum of abstraction. Abstraction, like concreteness, has its efficiencies and deficiencies. The empirical basis for most theories of conceptual knowledge has been largely based on experimentation with concrete concepts, given that such concepts are naturally convenient for generating tangible experimental stimuli. An additional reason for favoring concrete concepts is because there is a lack of proper theory regarding abstraction so as to best conduct and guide experimental inquiry.

The success of a theory assessing abstract knowledge will depend on its ability to explain and describe the cognition of concepts. A theory needs to explain and describe the employment as well as the acquisition of concepts. There continues to be ongoing debate as to the theory/theories that can cover the descriptive scope of abstract concepts and the conceptual mechanism at which abstract concepts operate. These theories can be categorized in many ways, but the most evident distinction is between embodied and amodal/symbolic theoretical frameworks. These two schools of thought often make what are seemingly contradicting assumptions. Most notably, embodied theories claim that the same brain regions involved in perception are active during concept retrieval from semantic memory, while symbolic theories claim that these separate systems do not share a common representational format. Each theory has its faults and advantages, and the debate does not need to be so polarized. In order for the scientific community to make progress, I believe the best option is to bridge symbolic and embodied theories. The nature of abstract concepts remains mysterious, and better understanding on how we come to acquire and work with abstract concepts could be the missing link for reconciling symbolic and embodied theories. To that end, this paper will narrow in on the problem of abstraction within the purview of embodied versus symbolic theoretical descriptions. This paper will attempt to uncover how to address the best way for understanding the acquisition and use of abstract knowledge through better dissection of the language of conceptual systems.

CHAPTER II

CONCRETE CONCEPTS

One way of defining something as "concrete" is treating it as the antithesis of abstract. Concreteness is the degree to which a concept is perceived by the five senses. Concrete words have a reference to space and time in the real world (Lupyan, 2018). These referable words come in two all-encompassing categories: natural things and artifacts. Natural things refer to entities that are self-formed by nature without any intervention. Natural things can be living or non-living and include such words as sun, mountains, clouds, animals, plants, birds, water, fruits, vegetables, etc. Artifacts are objects that are created within the natural world, showing workmanship or modification and are thus distinguishable from natural objects. Artifacts include such words as tool, ornament, furniture, clothes, building, etc. Concrete words are categorical, meaning that they can come in formal, subordinate, basic, or superordinate classes. Subordinate is the most specific form, superordinate is the most general form, and basic is the intermediate form. Fitting within a superordinate category generally implies some form of abstractness given that such a concept could be used as an umbrella term for many things. In the case of artifacts, "recliner" would be an example of a subordinate category; "chair" would be a basic category; and "furniture" would be the superordinate category. Moving up or down in the hierarchy is referred to as "vertical generalization" while moving across individual exemplars is called a "horizontal generalization" (Dove, 2018). Here, horizontal alignments are mappings between representations at roughly the same level of abstraction while vertical alignments are mappings between representations at different levels of abstraction. For this reason, vertical alignment typically occurs faster than horizontal alignment, which involves a more complex negotiation between representations (Bowdle, 2005).

Some descriptions that are synonymous with "concrete" are specific, detailed, vivid, and imaginable (Burgoon, 2013). Imaginability is a separate, broader, but correlated category to concreteness. Imaginability refers to the subjective ease at which a mental image of a concept is produced, namely a sensorimotor mental image. Here, sensorimotor refers to bodily states and motor images, in most cases with a visual bias (Dove, 2011). Imaginability reflects more the ease with which an image is generated rather than defining the concept as more abstract or concrete (Borghi, 2017). Imaginability and concreteness overlap but are not identical since imaginability does not need to have a reference to time or space, allowing imaginability to support broader generalizations. Thus, abstract entities can be imagined in some limited cases (Malhli, 2018). For instance, the word "redness" can be brought to mind quite easily (i.e., visualizing the redness of an apple), but "redness" can be considered abstract given that it references a specific attribute rather than an entity in of itself (i.e., the color of the apple, not the apple itself). Concreteness ratings have a bimodal distribution, concrete at one end and abstract on the other. Conversely, imaginability ratings have a unimodal distribution, which means the entity in mind is considered "more or less imaginable."

The ease of identifying/processing concrete words is exemplified by the "concreteness effect," which highlights a superiority with processing concrete in comparison to abstract words. The concreteness effect is observed within a variety of tasks, including studies of learning, memory retrieval, comprehension, lexical decision-making, translation, EEG potentials, and semantic deficits. For example, Dohnd (2007) used EEG methods to demonstrate that concrete words have stronger N400 action potentials than abstract words. The N400 is an evoked related potential (ERP) component that peaks at around 400 milliseconds and indicates a typical cognitive response to meaningful stimuli such as words (Federmeier, 2009). Other studies show that individuals process abstract words less efficiently than their concrete counterparts in tasks of word recognition, recall, comprehension, and language production (Hoffman, 2016). For example, some studies have shown that individuals with dyslexia demonstrate an enhanced concreteness effect with greater impairment when reading abstract relative to concrete words (Katz & Goodglass, 1990; Coltheart, 1980). It is assumed that this effect is due to the readiness with which concrete words lend themselves to mental imagery since their physical referents are so palpable.

CHAPTER III

ABSTRACT CONCEPTS

According to Webster's Dictionary, the definition of abstraction is the quality of dealing with ideas while dissociating from events, people, objects, or places. Specifically, abstraction is a process by which more general concepts are derived from the usage and classification of specific examples or concrete signifiers. An even more precise scientific definition of abstraction refers to the process by which a multitude of incidental characteristics receive less weight. Therefore, the number of central invariant characteristics that are necessary to identify the concept gain attention (Trope, 2009). Conceptual abstraction is formed by filtering information within a concept or observable phenomena and selecting only the aspects that are relevant for a particular purpose. In other words, there is a stripping away of content to the very essence of the concept (Belenky, 2004). Abstraction can be thought of as the by-product of integration. During integration, one ignores properties that differ from instance to instance and accumulate the properties that are similar. Abstract words like "justice" could be conceived as an aggregate of properties while words like "goodness" refer to discrimination based on a single property (Reed, 2016). "Justice" highlights the mechanism of integration while "goodness" highlights the mechanism of discrimination. Though both integration and discrimination can occur simultaneously in the abstraction process, abstract words are often removed from space and time, making them psychologically distant (Burgoon, 2013). Being psychologically distant refers to concepts that usually exist as intangible ideas or ideal social constructs (Singh, 2019). To engage in abstraction is to broaden one's mental horizon so that one can navigate the psychologically distant. Since abstract words include fewer readily available characteristics, they capture thoughts that are less imaginable. As concrete words are tied to reality, an abstract word's existence depends on human minds and language given that no physical creation of an abstract term can occur, with the exception of interpretative art (Vigliocco, 2018).

When it comes to abstract words, the specific category denoted by a word's meaning does not exist apart from language. Rather than depending on sensorimotor information, abstraction is dependent on language. This is because an abstract word's meaning is defined by other words (e.g., through synonym associations; Lupyan, 2018). The arbitrariness of language specifically promotes abstraction. For example, a stop sign in the US is an abstract symbol in that it is arbitrarily related to its meaning because its form has no resemblance to its reference. For a stop sign in the US, we learn that the color red, the shape of an octagon, and the word "stop" are associated with slowing down to a halt while driving. A person who had no exposure to such a symbol would not be able to identify the concept of a stop sign in the US without first having knowledge of US cultural norms and representations. Conversely, iconic signs, such as hieroglyphs, are inimical to abstraction because they are too connected to specific contexts or sensory depictions. In other words, iconic signs do have a characteristic resemblance to their referent, which can be deciphered from analysis. Form-to-meaning arbitrariness promotes abstraction because of its freedom from obligation to any specific meaning. This allows one to form categories where none exists while allowing meaning to adapt to new contexts. By adapting to new contexts, language allows otherwise dissimilar entities to be grouped together while allowing similar entities to be categorically distinguished. For example, some symbols are polysemes, which is when the same word evolves to have different derivations. For instance, the word "good" can have coexisting meanings. If someone shoots a loved one, you may say they are a "good" shot but not a "good" person. This occurs because words are arbitrary and applying pre-existing words to new situations is a natural process of language change.

The principal organization of being embedded into categories hierarchically does not apply to abstract words as well as concrete words (Crutch, 2005). Although abstract words include closed class—as well as open class—nouns, concrete nouns are strictly open class. If you take away abstract words, like "democracy" and "justice," it can be argued that our language changes minimally. However, if you take away abstract words, like "kind," "that," "the," "think," "make," "easy," "other," and "again," then we drastically lose the ability to speak our everyday language (Lupyan, 2018). A corpus analysis showed that a majority of text is abstract, and the percentage rating as to the degree of word abstractness increases as you go from nouns to verbs to adjectives and adverbs. For instance, when doing a standard discourse analysis, research has shown that about 73% of written and spoken language is abstract with a less-than-median-level of concreteness (Burgoon, 2013). Particular subject matter has higher abstractness ratings than others. For instance, poetry, philosophy, law, and science are highest in terms of abstract material generated. In the case of science, it is important to realize how much of the jargon of scientific knowledge can be categorized as abstract (Meteyard, 2010). Subject matter can be either figurative or literal, the latter having the possibility of being abstract or concrete while the former is only abstract. While literal language is precise and lucid, figurative language is imprecise. It has been found that speakers use approximately one unique metaphor for every 25 words (Bowdle, 2005). This goes to show the ubiquity of abstractness in our everyday language.

Abstractness can be dichotomized in several ways, including abstract vs. literal, abstract vs. equivalent, abstract vs. particular, abstract vs. specific, abstract vs. imaginable, and abstract vs. external. "Equivalent" is more concrete than abstract, which does not treat all attributes equivalently but emphasizes those attributes that will be useful in performing a task. "Particular" is concrete because abstract entities apply to many particular instances of a category (Reed, 2016). It should be noted that human concept representations are more fluid than these dichotomous categories can capture; we are dealing with high-dimensional data, and one-dimensional explanations can only provide one side of the story (Hendrikx, 2020).

We know that the character of abstract concepts is harder for our minds to grasp than concrete concepts. Abstract concepts are very elusive in nature. Yet, we use these abstract concepts continuously without always realizing it. With an adequate idea of the character of both abstract and concrete concepts, it is now important to know how we learn abstract concepts in the first place.

CHAPTER IV

HOW ARE CONCEPTS LEARNED?

It is important to recognize how concepts are acquired. First, categorization is the mechanism by which concepts are formed. Categorization is broadly defined as a judgment of similarity for a particular object/entity in terms of whether it fits into an ingroup or outgroup. If there is a fit for the ingroup, then the concept is identified as such (Vergne, 2013). Under experimental settings, researchers use objects that have differing perceptual features—sometimes differing on just two dimensions (i.e., big or small, black or white) for participants to categorize. This is most effective for identifying concrete concepts, as similarity judgments are based on easy-to-recognize perceptual features. Another technique is to have objects in a sequence that follow a specific rule; if a participant extracts the pattern by finishing the sequence, then the concept has been sufficiently identified/understood (Reed, 2016). This feature of concept identification is important for learning abstract concepts given that individuals need to evaluate beyond perceptual features in order to understand such concepts. For example, a concrete concept could use a perceptual feature (e.g., "furry") to understand a word (e.g., "dog"). However, for abstract concepts, what features are being utilized to understand the word “patience” or “fear?” Here, all we know is that such concepts are understood outside of typical feature criteria.

Words are often acquired through a context; however, words can also be learned through decontextualization. Decontextualization is also known as a definitional technique where individuals are given a list of words and must match or recall an appropriate definition. Other methods include word-for-word learning such as synonym and antonym memorization (Pendidkan, 2018). These tasks are decontextualized in that they do not feature a given context to use for leverage. A contextualization method involves presenting individuals with unfamiliar words within a shared context, and the task is to guess the meaning of the word. Although the contextualization method is more suitable for a higher-level learner, contextualization is more effective for vocabulary acquisition. This is because vocabulary acquisition necessitates deeper processing (Nielsen, 1994). Decontextualization can occur when experiencing the same word in many different contextualized conditions. From viewing the same word in similar contexts, knowledge of syntagmatic relations may occur between words that co-occur together (e.g., the word “soft” evoking the word “pillow”), but as the viewer experiences more diverse contexts, then knowledge of paradigmatic relations can develop (e.g., “soft” can evoke the word “hard”) (Louwerse, 2011). Decontextualization and contextualization both have a unique relationship to abstract words, although decontextualization could be the more abstract form, and contextualization could be thought as the more concrete form. This is because contextualization refers to a more specific available context and is more rigid to its definition, much like a concrete word. However, a decontextualized word (much like an abstract word) is in a more general form and is subject to much change. This sets up a bit of a paradox in that abstract words inherit meaning from their context while, on the other hand, abstract words are often considered as being resistant to any specific context because their associations are sparsely distributed.

The age at which a concept is learned has much to do with a concept's mode of acquisition and whether the concept is abstract or concrete. Words are often divorced from their linguistic context or situational environment in everyday language. In other words, it is not often the case that a person gives a one-word response to something that is not a yes-or-no question. At a young age, typically around a child's first year, vocabulary consists of concrete words, mostly nouns (Colunga, 2003). These words are generally learned through ostension (i.e., pointing to an object and naming it). Since objects of attention are generally either artifacts or natural things, we incorporate them through their perceptual features. This resembles Piaget's earliest stage of cognitive development, which is the sensorimotor stage (and includes object permanence) and is accomplished through sensorimotor involvement with an object. Piaget helped establish the constructivist philosophy, which is embraced by the embodied movement. Constructivism is a theory in education that recognizes that learners construct new understandings and knowledge, integrating with what they already know (Sjoberg, 2010).

At around 24 to 30 months, a child begins to include abstract words into their vocabulary (Colunga, 2003). This is also around the same time a child begins to demonstrate a strong command of their native language. At this stage, a child will infer new words from sentences or longer discourse. It is no coincidence that a child's linguistic competence and acquisition of new words occur at the same age, as both are thought to reinforce one another. In contrast to concrete words, abstract words are typically not learned through ostension (Dove, 2020). To acquire abstract words, children need to first master a consistent amount of linguistic knowledge regarding syntax and initial semantics (Borghi, 2017). Thus, children with developmental language disorders have disproportionally more deficits with understanding abstract relative to concrete words, and this is thought to be the result of an inability to syntactically bootstrap (Vigliocco, 2018). Syntactic bootstrapping is the notion that children have innate knowledge of the links between syntactic and semantic categories and can use these observations to make inferences about word meaning. During early development, sensorimotor experiences shape the organization of concepts, but as a child grows and concepts develop, there is increasing reliance on language that centers the child's focus more and more on structural similarities or relational aspects (Pecher, 2018).

With insights into the development of abstract words and concepts, we may question what makes abstract concepts so different from concrete concepts. Are there calculable ways to know that there are differences between abstract and concrete concepts? Knowing these differences could inform researchers on how to formulate theories with certain corresponding constraints.

CHAPTER V

DELINEATING ABSTRACT AND CONCRETE CONCEPTS

Quantitative Differences

For researchers who pioneered the cognitive underpinnings of abstract concepts, most efforts went toward trying to explain an experimental quirk known as the concreteness effect. The concreteness effect refers to the more efficient processing of concrete words relative to abstract words. This efficiency can be reflected in faster recall times across a variety of tasks, including memory retrieval, comprehension and translation, along with faster discrimination times during lexical decision tasks (Hoffman, 2016). However, this concreteness effect is leveraged by keeping variables inherent to natural language unconstrained. Two competing theories have been proposed to account for the concreteness effect: dual code theory and context availability theory. Both theories describe quantitative differences between concrete and abstract concepts. The dual code theory holds that conceptual knowledge is mediated by two separate yet interactive semantic stores. This includes the verbal store, which codes linguistic relationships between words and the non-verbal store, which codes perceptual information gained through direct sensory experience (i.e., the visual code; Muraki, 2020). Knowledge of concrete words is obtained/demonstrated through both the verbal and visual codes, while abstract word meaning is exclusively verbally coded. The dual code theory's explanation for the concreteness effect is that the visual code is more memorable than the verbal code (Reed, 2016). Evidence for this comes from interference tasks where the verbal code can exert an online effect on the visual code by slowing down reaction times during a concurrent task (Unal, 2016). For example, when examining processing speed as a dependent variable, reaction times are slower when a decision task is concurrent with a rotation task compared to reactions times during two non-linguistic tasks (i.e., rotation and color discrimination; Winawer et al., 2007). However, one argument is that number—and not the quality—of a memory code explains the concreteness effect. The verbal code supports both concrete and abstract words, whereas concrete words have an additional memory code that supports recall when the verbal code is forgotten. There is evidence suggesting that abstract words elicit more left-lateralized brain activation, whereas concrete words are associated with relatively more symmetric hemisphere activation (Kiefer, 2012). One inference is that since the visual code can simultaneously activate both hemispheres, this extra neural furnishing provides precedence over the verbal code (Rodríguez-Ferreiro, 2014). This also makes sense since the language network is primarily left lateralized, and abstraction relies heavily on language constructs. Here, abstract concept processing may predominantly originate within the left hemisphere.

Instead of explaining effects in terms of greater availability of perceptually encoded information for concrete words, context availability theory posits only one representational system. The concreteness effect is explained in terms of greater contextual information stored in the semantic networks for concrete words (Dove, 2016).

There is evidence that concrete words have a higher degree of specificity in the lexicalization process, whereas abstract words appear in a wider variety of contexts (Hoffman et al., 2011; Shallice, 2013). Moreover, when abstract words are tested inside of a linguistic context, the concreteness effect disappears (Wang, 2016). This occurs because instead of having a multitude of contexts for fuzzy meanings that are left up in the air, the context is given and made definite. This led to the view that concrete words are context-independent because such words carry all their context with them while abstract words are context-dependent because they require additional information to disambiguate (Hoa, 2008). In other words, concrete words tend to have a constant set of words associated with them across contexts, whereas abstract words often have related but distinct meanings depending on the context for their present use (Crutch, 2005). For this reason, concrete words have a more consistent and consolidated repertoire of associated words available. For example, the concrete word "Christmas tree" has readily available contextual words such as "presents," "Santa Claus," and "decorations." Conversely, an abstract word "truth" could have very different meanings depending on the context (i.e., the term "truth" has different connotations in science versus law and criminal justice). While quantitative differences can be very helpful for illuminating how much abstract words differ from concrete words in number, an assessment of qualitative differences provides perhaps more specific insight in how to delineate the acquisition and use of these conceptual entities.

Qualitative Differences

There are differences between abstract and concrete concepts that make them not only quantitatively but qualitatively distinct. The first qualitative difference regards semantic richness. Here, concrete words have a higher semantic density, and abstract words have more semantic neighbors (Malhi, 2018). Semantic density refers to the features that are essential for defining a concept. Conversely, semantic neighbors refer to additional concepts related to the core concept in question (Muraki, 2020). This distinction is reminiscent of context availability versus context diversity given the sparseness aspect that is common to how we conceptualize semantic neighbors. The contents are sparse in that they are thinly dispersed or scattered unevenly. The term “sparse” can be visualized if one is to think of meanings being characterized in a semantic web or network.

Semantic richness is important to the notions of intrinsic and extrinsic relations. Concrete concepts are thought to have intrinsic relations while abstract concepts are thought to have extrinsic relations. Concrete concepts have intrinsic features because they are properties of the concept in and of itself, independent of other concepts (Granito, 2015). Abstract concepts are extrinsic because they are dependent on a relationship to another concept’s characteristics (Gentner, 2019). The terms intrinsic and extrinsic were developed by philosophers to help get a better idea as to the properties of objects. It may help to give a physics example to better understand the terms. For instance, weight is an extrinsic property of a physical object because it is a feature that helps us interact with that object in the world. This is because weight varies depending on the strength of the gravitational field in which the respective object is placed. Conversely, mass is an intrinsic property of any physical object since the object has this property purely based on its existence.

There is also a distinction between similarity and association. Concrete concepts are related via similarity to one another, and abstract concepts are more commonly related via associations to one another. This is what is known as the qualitatively different representations hypothesis (Crutch & Warrington, 2005). Concrete words are related by their similarity via an overlap in semantic features. This results in concrete words being categorical. Here, examples of words related by similarity (e.g., goose, crow, sparrow, pigeon) are under the superordinate category (e.g., birds). Conversely, abstract words are related by their associations, often via co-occurrences in language, which form familiar scenes or events (Schnur, 2008). Examples of words related by association (e.g., barn, tractor, cow, hay) are under the same theme (e.g., farm). Evidence for this comes from semantic refractory access dysphasia (SRAD). SRAD is an impairment of the neuromodulatory system leading to synaptic depression following activation of representations. This results in a refractory period during which subsequent neural firing is blocked or reduced. The closer the representations are to one another, the longer the refractory period. Previous research suggests that semantically associated abstract words reliably interfere with one another significantly more than semantic-synonymous abstract words. Concrete words show the reverse pattern (Crutch, 2005). This means that abstract words that are semantically associated are closer semantic neighbors than abstract words that are related by semantic similarity; the reverse is the case for concrete words (Zhang, 2013). This pattern has also been observed among healthy adults using an odd-one-out task wherein the speed of responses is an indicator of semantic relatedness. Here, a reverse concreteness effect for concrete words is revealed when words are related by association (Crutch, 2009). This indicates that response speed is impeded for concrete words within an "association" condition. This association feature may potentially demonstrate a powerful efficiency due to its dispersed but infinite associates.

Concrete words are represented by a set of intrinsic features; however, abstract words lack specific descriptive features. Instead, abstract words are represented by a situation or general theme, which makes abstract concepts relational. For instance, abstract words are relational because these thematic concepts label a set of items that all take part in a common event (Goldwater, 2011). For example, the concept "cause" has relational elements that involve an actor, an action, and an object/patient etc. (Dove, 2020). Relational concepts are properties of a situation, not properties of an object. In fact, one study found that pictures of situations facilitated the processing of abstract words that were related to those pictures and, additionally, those words facilitated processing of the depicted situations (McRae, 2018). Given that abstract words are relational, such words are often referred within role-governed categories. Roles are often filled with a feature-based category, and this is how the two representations become associated, particularly if the role is consistently filled with the same entity. For example, the role-governed concepts "guest" or "host" are often filled by specific people (Goldwater, 2011).

Abstract and concrete concepts differ in the format by which categorizations are made. Abstract concepts are usually in the "prototype" format while concrete concepts are usually in the "exemplar" format. Exemplar categorization often relies on a collection of all specific instances or episodes experienced with a category. Patterns are made by comparing category members so that the greater the similarity between the unknown item and an example from memory, the greater the possibility that item will be retrieved. This specificity makes an exemplar more concrete. On the other hand, a prototype is an instance of creation rather than experience. The prototype is created by generating a meta-average of instances based on family resemblance. It is this average mechanism and fuzzy characteristic that makes the prototype more abstract (Reed, 2016).

Another qualitative difference is that abstract words are inferential while concrete words are more commonly referential. Inferential knowledge can be conceived as a set of relations between items in the mental lexicon. Referential knowledge is self-explanatory and is simply the reference to an object. Inferential knowledge is a language-driven, internalized network while referential knowledge is in an imagistic or simulative code. Abstract words in semantic memory allow us to draw inferences from sentences containing words in other sentences while concrete words do not. The behavioral expression of inferential knowledge is the act of paraphrasing, producing, or retrieving a word from a definition, as well as finding synonyms. Referential and inferential knowledge can be partially dissociated neurologically and behaviorally while the two may reinforce one another (Blakemore, 2001).

All these qualitative differences offer unique components that differentiate abstract concepts from concrete concepts, showing a large diversity in what can be characterized as an abstract concept. Now, we turn our attention to specific theoretical accounts offered for assessing conceptual understanding.

CHAPTER VI

EMBODIED VS SYMBOLIC ACCOUNTS FOR CONCEPTUAL UNDERSTANDING

Assessing the Dispute

Now that we have adequate background information about abstract concepts, we can re-introduce and intimately examine the dispute between symbolic and embodied frameworks. It seems that if one is to understand abstract concepts, one must pick a side to stay on, but this is not necessarily the case. The main tenet of a strong embodied account is that conceptual mental states draw on the same mental states as those underlying perception, action, and emotion. This also suggests that there should be an isomorphism between the format of conceptual representations and conceptual content (Mahon, 2016). Therefore, embodied theorists argue that these same rules apply for both abstract and concrete concepts (Borghi, 2020). Since the perceptual system is evolutionarily older than the conceptual system, the idea is that the higher-level conceptual system was born from the same neural hardware as the lower-level perceptual system. In other words, there is neural reuse or representational re-instantiation from the perceptual to the conceptual system (Ostarek, 2019). Embodied theorists often talk about these representations as being "simulated," "situated," "grounded," or "enactive" to describe their dynamic and holistic nature (Winter, 2020). Conversely, the core of symbolic accounts is that sensorimotor information from the environment is transformed into symbolic representations, and these representations are distinct from those relevant for perception (Kiefer, 2012). In short, the argument here is that symbolic cognition can only be achieved if sensorimotor information is transformed into a qualitatively different format. This process of transforming a perceptual signal into a symbol is termed transduction (Meteyard, 2010). Transduction is said to occur over hierarchical stages of perceptual analysis. In order to proceed up to the level of an integrated three-dimensional description, the information signal becomes progressively more abstract after which no trace of any previous sensorimotor information persists (Gainotti, 2012). The resulting symbolic representations are abstract, arbitrary, and amodal so as to be readily manipulated (Zwann, 2014).

It may not be surprising then that for proponents of embodied theories only perception is relevant, and concepts are of no import. Such theorists would believe that percepts could be complex to the point of being full-on simulations. Symbolic theorists question the cognitive "tax" (i.e., resources and energy used) for these simulations and are concerned with cognitive economy, especially if the simulations are to be combined with each other in some systematic fashion (Machery, 2016). Rather, symbolic theorists believe that concepts and their subsequent propositions are more feasible. This is because propositional thinking can be independent of the particular thinking context. Here, it is possible to grasp a proposition without knowing its truth value or without any contact with the meaning of the proposition (Camp, 2009). This allows for representational flexibility and creativity. Additionally, concepts are the only way two different networks of association can be synonymous. For example, every instance of "selling" can also be an instance of "buying" (Dove, 2009). If these were simulations, there could be two separate and perceptually different simulations for buying and selling. Moreover, there is neuropsychological evidence, by use of perceptual classifications (i.e., matching perceptual viewpoints to objects) and semantic classifications (i.e., matching names to objects), where these cognitive functions can be hierarchically organized and differentially impaired. For instance, patients with semantic dementia can have intact abilities for matching pictures from different viewpoints of an object but cannot name or describe the same objects nor would they be able to match pictures to their descriptions (Leshinskaya, 2016). This gives symbolic theorists reason to believe that we cannot theoretically operate, and thus experiment, without the usage of the terms "concepts" and "percepts."

Strong proponents of embodied theories argue that semantic memory is modality-specific wherein modal systems respond to a specific class of input. Conversely, symbolic cognition is amodal in that such thinking responds uniformly to inputs from different modalities. As a result, symbolic cognition can tolerate slight variations in input (Haimovici, 2018). For this reason, the term "amodal" is sometimes interchangeable with the term "multimodal" because amodal reflects similar relationships across all modality-specific representations taken together (Patterson, 2007). In a modality-specific system, there is only concern with a modality specific region (i.e., primary sensory region). Here, if there is damage to the specific modal region, such as vision (i.e., primary visual cortex), one would have difficulty re-enacting the visual experiences of certain objects (e.g., dogs, apples, hammers, etc.) while still being able to re-enact these same objects within other (e.g., auditory, olfactory) modalities (Machery, 2016). Another example can be found when examining individuals displaying apraxia. An individual with apraxia will often experience a deficit with motor movement, and these individuals may demonstrate impairment with tool concepts given that such objects require motor movements for proper comprehension/production. It must be noted that there is additional convergent evidence for an amodal account whereby individuals with apraxia exhibit no such semantic impairment (Barsalou, 1999). Thus, the convenient distinction between modal and modality-specific may be too simple a dichotomy.

Some embodied theorists argue that concepts are experience-dependent wherein concepts are acquired through sensorimotor and affective interactions within the environment. This would mean that different people, inevitably having different experiences, would acquire different concepts. Some evidence for this comes from studies employing fMRI assessments. In one study, results suggested that musical experts use regions of the auditory cortex while listening to music in neurological activation patterns that are not observed among musical novices. These regions were not only recruited for musical experience but for conceptual recognition of musical instruments. This could be a demonstration of experience-driven neuroplasticity for highlighting conceptual representations of instruments that are "embodied" within the auditory cortex (Kiefer, 2012). This experience-dependency is coupled with the idea of a domain-general learning system. A domain-general learning system supports learning at a broad level, no matter the type of information, and is idealized to be malleable enough for individuals to learn just about anything. Evidence for this notion would be reflected in individuals learning skills in one domain that they then translate to skills not yet learned in another domain. Conversely, some symbolic theorists assume that semantics are domain-specific.

The idea that language, specifically syntax, is computed in a domain-specific manner was bolstered by the universal grammar (UG) movement. UG refers to the notion that there are a certain set of structural rules that are common to all human language abilities, independent of sensory experience. In this case, for semantics to be domain-specific, there need to be specialized, and presumably evolutionarily advantageous, learning modules that are only made for one specific task. Thus, if semantics were to be domain-specific and independent from sensory experience, then how would concepts be obtained in the first place? Symbolic theorists may answer this question by saying that some of our concepts are innate. For instance, there is evidence that infants have innate and fundamental "core-concepts" such as animacy, agency, causality, and magnitude (Lupyan, 2018). These core concepts constitute a set of concrete primitives from which we later expand on in order to learn abstract concepts (Reilly, 2017). Other evidence comes from category-specific conceptual deficits where some individuals suffering from neural damage exhibit a selective semantic knowledge impairment for some categories. This is said to be the result of an innate organization of neural pathways (Kiefer, 2012). There was even the case of an adult who only had permanent selective conceptual impairment for natural objects due to occipitotemporal cortex damage experienced at birth (Pulvermuller, 2018).

The embodied versus symbolic dichotomy has proven to be useful for distinguishing between theories in their early stages. However, new and revised initiatives have presented themselves, which are much different than the motive of distinguishing between theories. The dichotomy between "embodied" vs. "symbolic" may be more cumbersome than is beneficial, and we may need to combine the terms or devise an entirely new framework for refining our inquiry.

Neural Underpinnings of Abstract Cognition

Evidence from the field of neuroscience can help guide cognitive theories of concepts by determining which neural regions are assumed to be necessary/sufficient (or unrelated) to certain cognitive functions. Additionally, models that are deemed to reflect neurological configurations can give clues as to specific cognitive functions. There is evidence that certain neural regions may be more indicative of symbolic functions, embodied functions, or both. Abstract concepts present a puzzle in which they play a special role in defining neurological regions. This may be the result of such regions exhibiting an integration of both embodied and symbolic functions. Distinguishing the neurological makeup of abstract concepts may be the key to bridging the symbolic versus embodied debate.

Embodied and symbolic theorists are often at odds when it comes to the neurological make up of semantic memory. Embodied theorists believe semantic memory is a distributed network while symbolic theorists take a localist perspective (Kiefer, 2012). Things get even more tangled when we consider the neural underpinnings of abstract concepts from concrete. Symbolic theorists believe there is a unitary semantic system rather than multiple systems (Meteryard, 2010). A unitary system typically refers to a "modular" system. A modular system is defined by an encapsulated density of neurons connected to one another with few neurons connecting to outside neurons or other modules. Modules are usually designed to perform domain-specific functions. The notion of language centers being modular originated from the same UG movement mentioned earlier. For symbolic theorists, the sites of interest for semantic memory are the bilateral anterior temporal lobes (ATLs). Some symbolic theorists go so far as to say that a concept can be represented by a single cell, traditionally known as a "grandmother" cell (Barlow, 1995). Evidence for this was provided by stimulating single cells in the ATLs of rhesus monkeys that could distinguish between trees and non-trees (Roy, 2017). Single "number neurons" were found to encode numerosity, irrespective of the modality in which the number was presented. While it remains debatable whether single cell recordings are even possible due to a potential cascading effect that can trigger other neurons (Roy, 2017), it should be noted that one need not commit to the idea of single-cell representations when taking a localist perspective, nor does a modular system always imply single-cell representations of a concept.

In a distributed network, more than one neuron is required to represent a concept. Here, a pattern of activity across a collection of neurons is necessary. Importantly, in a distributed network, each neuron participates in the representation of more than one concept (Roy, 2017). There are no central points of convergence, only a dispersion across different cortices (Reilly, 2017). Embodied theorists believe that concepts are dispersed in the primary sensory regions depending on what modality the concept evokes. The primary sensory regions are of interest because these regions are highly involved in perception. Symbolic theorists that espouse a distributed account believe that semantic memory is dispersed through association cortices (Pexmann, 2007). Association cortices, sometimes interchangeable with heteromodal, supramodal, or even amodal, are where higher order associations between perceptual features are generated. Contrary to research supporting semantic memory in the ATLs, there is fMRI evidence suggesting that there is a particularly widespread pattern of cortical activation during the processing of abstract concepts (Muraki, 2020).

Researchers have generally agreed upon a model that conjoins distributed and localist accounts, which is called the hub and spoke model. The ATLs are thought to be the higher-order amodal hubs, and the lower-level modality-specific primary sensory regions are thought to be the spokes that radiate from the hub. The points at which these hubs meet are known as the multimodal convergence zones. Connectivity imaging support this model, revealing that the ATLs are strongly connected to almost every sensorimotor region of the human brain (Calzavarini, 2017). During normal object perception, activation will travel from the primary sensory regions through to the ATLs in a bottom-up fashion. However, during semantic retrieval, activation will begin in the ATLs and travel to the primary sensory regions in a top-down fashion (Reilly, 2017). Semantic information processed in the ATLs is thought to be underspecific and enriched by retroactivation to primary sensory regions that contain sensorimotor information (Reilly, 2016). Thus, the ATLs do not store the content but are thought to guide its retrieval (Kiefer, 2005). The convergence zones are the points at which high-fidelity sensorimotor information can be transformed into amodal, symbolic formats (Lohr, 2019). This model has implications for embodied theorists. Since the model maintains at least some sense of abstraction from sensorimotor information, this suggests secondary embodiment or weak embodiment at best.

When the focus is solely on the ATLs, the matter becomes more complicated. Some researchers have observed a semantic graded shift based on the degree of concreteness within the ATLs. For instance, the dorsolateral areas of the ATLs were found to be particularly active when processing abstract words while the ventromedial areas were preferentially activated when processing concrete words (Gainotti, 2017). Interestingly, additional research has shown that the right ATL is more active for pictorial tasks while the left ATL is more associated with abstract tasks. Since the left ATL has stronger connections to the left-lateralized language system, this could explain its more substantive role in abstract word processing (Gainotti, 2012). Thus, the ATLs may differ in function not only bilaterally but also within the territory of one hemisphere. Now, according to the fine vs. coarse hypothesis, some evidence suggests that the left hemisphere activates a narrow and more fine-grained semantic field while the right hemisphere activates a large and coarser semantic field covering distantly associated words (Gouldthrop, 2011). Given common associations between abstract words and context diversity and semantic richness, it could be inferred that the right hemisphere should be more involved in abstract word processing. Another layer of conflict is added when we consider language at the discourse level of processing within the left and right hemisphere. Contrary to the fine vs. coarse hypothesis, the left hemisphere is assumed to have a predictive capacity for the most relevant and dominant meaning based on context. Conversely, the right hemisphere is integrative in that it can maintain multiple meanings from a given context (Gouldthrop, 2015). Here, the ATLs may be antagonistic yet complementary in function when considering the entire brain in operation.

Even if indirectly, numerous additional brain regions are suspected to play a role in semantic processing. One region of key interest is the inferior frontal gyrus (IFG). Neuroimaging studies frequently report that the left IFG is prominently active during abstract word processing (Dove, 2014). The IFG includes Broca's area, which was first recognized for its involvement in syntactic computation and sentence production (Robinson, 2010). Damage to the IFG results in agrammatic speech. More recently, the IFG has also been associated with deduction, premise integration, and modal logic (Reilly, 2016). Since many abstract words, such as “desire” and “belief,” denote the occurrence of hypotheticals and predictions to be made, it is speculated that additional machinery provided by the IFG is needed to perform modal operations (i.e., recursive argument role filling; Shallice, 2013). Indeed, one recent study found that similar mental state verbs required additional recursive syntactic operations (Muraki, 2020). Another supplementary role for the IFG is with the executive function of semantic control. Given that an abstract word’s meaning depends on context, more effort is needed from the executive system to exert regulation when integrating within a diverse context (Della Rosa, 2018). Although they have proven to be crucial participants, it is clear that more than just the ATLs are involved in semantics, and it is also clear that more than just semantics is involved in the cognition of abstract concepts. Now, we can turn our attention to how knowledge from the field of neuroscience can be applied to cognitive theories of embodied and symbolic accounts.

Evidence for and Against Embodied and Symbolic Accounts

Both symbolic and embodied accounts have several arguments and counterarguments to support their view. We will find that they often incur different sides of the same argument and seem to antagonize each other when they may actually be in accord. I will show that the lines of argument for symbolic accounts are not only more overwhelming in number but seem to hold more weight relative to embodied accounts. Hence, I will argue for a pluralistic account that favors a symbolic bend.

Embodied theorists argue that sensorimotor information can influence semantic concepts but the one that readers might find most compelling is the action-sentence compatibility effect (ACE). ACE is thought to demonstrate a processing association between sensorimotor information and semantic memory. Some research suggests that when a sentence implies action in one direction (e.g., "give the cards to somebody," an action away from the self), participants are worse at judging whether the sentence makes sense if they are to respond while performing a movement in the opposite direction. Conversely, comprehension is facilitated when the sentence implies a congruent action (Borghi, 2017). Embodied theorists argue that the motor system is involved in language comprehension. Symbolic theorists argue that such congruency paradigms could be useful for establishing the informational content that is activated; however, they cannot fully determine the nature of the underlying process. (Ostarek, 2019).

Some symbolic theorists argue that abstract concepts are disembodied, meaning that such concepts are divorced from anything perceptually imaginable. Several researchers have conducted componential analyses and have found that an abstract concept's features can be as abstract as the concept itself (Wiemer-Hastings, 2005). Furthermore, additional evidence suggests a possible, but weak, correlation between abstract concept processing and modality-specific sensory-perceptual regions (Gao, 2019). Evidence from native sign-language shows that there are many signs that signify abstract concepts. Yet, these signs are not iconic, as icons are thought to be embodied in a metaphoric way (Borghi, 2014). Rather, these signs are symbolic in that they do not resemble their instantiations but are arbitrary representations. Evidence from social psychology examining abstract mindsets shows that parietal lobe areas responsible for somatosensory involvement are not required when engaging in abstract thought (Berkovich-Ohana, 2019). This all points to the possibility that symbols can rely on sensorimotor simulations without being associated with semantic content (Dove, 2011). This could be categorized as a "weak embodied" view or a symbolic view; however, it is unclear that simulations and semantic content are one in the same. One way to resolve the distinction between embodied and symbolic theories is to agree that sensorimotor representations could be considered a form of abstraction (Mahon, 2016).

Several researchers have rationalized that if the cognition of concepts is multimodal, this would be consistent with a symbolic account; however, if the cognition of concepts is modality-specific, this would be consistent with an embodied account. Some researchers value more direct evidence that provide clues for conditional statements about a particular stance. Evidence from fMRI assessments can be useful here. In order to make a case for modality-specific accounts, there is some evidence that primary motor cortex activation is observed during semantic memory for tools. Since primary motor regions are known to handle antecedent information isolated to rudimentary motor movement and perception, this is considered evidence for a modality-specific account (Dove, 2009). On the other hand, some studies observe more significant activation within the ATLs for tool concepts. For instance, behavioral motion capture experiments measure processing speed of kinematics for tools vs. non-tools, revealing predominant activation in the ATLs (Knights, 2020). As an example, when the word "hammer is presented on a screen without any context to influence imagery, activation predominantly within the ATLs is observed for both tool and non-tool concepts. Since the ATLs are considered to furnish all concepts, generally and inclusively, as an amodal site, researchers have concluded that semantic memory is for the majority handled in a multimodal fashion (Dove, 2011). Some researchers have come to an agreement that when introducing tool concepts, there is more activation in the premotor and parietal areas, located between primary motor and ATL regions. Such association regions, rather than having separate and independent functions, could be neurally integrated to serve both multimodal and modality-specific functions. Taken together, this evidence points neither to an exclusive multimodal or modality-specific account but is consistent with a convergence zone account (Gallese, 2005).

Hypothetically, if one were to suggest that the ATLs are the locus of semantic memory, then there would be the following implications. During semantic dementia, there is progressive deterioration of the ATL regions. Specifically, at initial stages of disease progression, deterioration in semantic concepts occurs in a domain-specific fashion (Gianotti, 2012). For instance, people with impairments exhibit disproportional deficits for categories such as animals, fruits/vegetables, conspecifics, and living/non-living things (Mahon, 2010). Some researchers reason that since semantic memory deteriorates in a category-specific way (subordinate, basic, and superordinate), and many of these categories share perceptual features with one another, then ATL processing must be modality specific (Lambon Ralph, 2008). Other researchers reason that since conceptual knowledge is organized by specified constraints on object knowledge, these impairments are due to a deficit in conceptual knowledge and not (only) to modality-specific input or output representations (Mahon, 2010). Moreover, during the later stages of disease progression, category deterioration occurs in what is actually known as a domain-general fashion. This could lead to the argument that ATL functioning is actually multimodal given that categories deteriorate beyond the limits of any specific domain (Gainotti, 2012). Here, the evidence seems to be more in line with a multimodal depiction, which favors a symbolic account. Lambon Ralph (2008) provided evidence for under-generalizations and over-generalizations in progressive semantic dementia during testing of category type, which indicates that the deterioration is indeed multimodal/amodal.

Another argument states that abstract words are associated with concrete words (or at least concrete features) due to a spreading of activation in semantic memory. For instance, when invoking an abstract word, a spreading will occur across neural nodes in a semantic web and evoke associated concrete words. What makes this possible is the finding that abstract words elicit associations with both abstract and concrete words, while concrete words mainly elicit associations with other concrete words (Hao, 2008). For example, one study assessing patients with aphasia observed that generative word-finding therapy with abstract words yields better improvements with vocabulary skill, as well as increased functional connectivity in language and semantic regions, than does training with concrete words (Nishijima, 2016). This spreading activation mechanism is said to have the property of linking semantic content but does not necessarily constitute semantic content.

Some researchers have provided a reason for why perceptual and motor information is attached to abstract concepts even though this sensorimotor information is not constitutive of content. The sensorimotor information is only contingent with content because of the need for cognitive efficiency. The computational offloading hypothesis states that there can be reduced cognitive effort by offering external information resources (Goldstone, 2005). These symbolic theorists reason that offloading may occur when the conceptual system does not encode the information needed for solving the task; rather, the perceptual system, which is stored in memory, does so. The conceptual system may then use perceptual cues as a heuristic to efficiently solve the task (Machery, 2016).

Additional evidence for a separation between perception and concepts comes from clinical double dissociations. The ATLs are thought to be responsible for semantic memory processes. In semantic dementia, the ATLs focally deteriorate. Despite the preservation of frontal motor areas, action word deficits still emerge (Dove, 2016). On the other hand, when traumatic brain injury occurs to primary motor areas, there are no deficits to action word comprehension, while the same phenomenon occurs for the other modalities. Another form of double dissociation occurs in semantic dementia. Depending on how the ATLs deteriorate, one individual may only exhibit deficits to abstract words while another may only exhibit deficits to concrete words. This suggests that at least at some level, abstract and concrete concepts are functionally independent and/or neurologically separate (Dove, 2011). This also indicates that abstract concepts can be represented without reference to embodied concrete concepts.

The "blind people argument" is another frame for interrogating embodied accounts. In the case of congenital blindness, in nearly all occasions, individuals utilize concepts in the same way as sighted people. However, there is likely to be more of a quantitative difference rather than a qualitative difference between how visually impaired and sighted individuals understand concepts. Despite drastic differences in sensory experiences, there are no drastic consequences for what the visually impaired know about objects and actions (Bedny, 2012). There is a relatively delayed development of social skills for the visually impaired, but this is quickly made up for in later years. Even for knowledge about color concepts, the visually impaired have strikingly similar concept usage when compared to the visually unimpaired (Lupyan, 2018). It is not only performance among the visually impaired but also their neural activation patterns for concepts that are similar to sighted individuals (Machery, 2016). This is thought to be a result of the visually impaired having approximately the same linguistic experience as sighted individuals. Research has shown that it is possible to gain a significant amount of information about color just from the distributional structure of color language (Dove, 2020). Distributional structure refers to distributional semantics, which attempt to quantify and categorize semantic similarities between linguistic items based on their distributional properties in large samples of language data. The distributional hypothesis states that words in similar contexts (distributional structure) will have similar meanings. Distributional semantics challenges embodied accounts, as research with individuals with congenital blindness have a stark decoupling between visual perception and concept knowledge; rather, there may be more of a coupling between conceptual knowledge and linguistic knowledge (Dove, 2020?).

It is generally agreed that language is symbolic, and there is extensive evidence that syntax is amodal (Dove, 2009; Louwerse, 2011). Syntax and semantics are known to be inextricably linked (Fedorenko, 2016). Much of what is learned semantically is done through syntactic bootstrapping (Borghi, 2018). Linguists have shown that semantics have a great deal of logical structure (Dove, 2011). This all seems to hint at the conclusion that semantics can be amodal. Evidence that semantics seem to be housed in the hubs of the ATLs gives credence to this argument. This seems to be especially true for abstract concepts given that abstract concepts have a larger syntactic component to their semantics (Calzavarini, 2017). Lastly, as will be discussed later, there is much reason to believe that language is responsible for abstract concepts and abstract thinking in general, making abstract concepts linguistic. More mouth activations (physical mouth movements, with such movements perhaps indicating that an individual is engaging inward rehearsal of these concepts via linguistic behaviors) are recorded with abstract concepts more so than concrete, suggesting a more "verbal" nature for abstract concepts. Conversely, the "spatial" nature of concrete concepts could be inferred through evidence suggesting that such concepts are associated with more motoric activations (i.e., with the hands and feet; Granito, 2015).

The generalization problem presents a major challenge for theories embracing modality-specific representations in semantic memory. First, patients with semantic dementia suffer from cross-modal deficits. For example, when a patient loses the concept "dog," the patient will lose all feature knowledge of dogs (visual, auditory, tactile, etc.). The patient will not just be unable to visually re-enact the experience of dogs; rather, they will be entirely unable to think about dogs and make proper inferences about dogs (Machery, 2016). Furthermore, individuals absent this disorder show little to no intermodal transfer costs in tasks that involve manipulating the modality of number representations (Barth et al., 2006). This is what should occur if semantic memory were amodal. This is because there is an integration of information across all modalities. Elementary conceptual attributes, such as shape and motion, are not straightforwardly mapped onto unimodal cortical areas. Thus, there is a need for multimodal cortices (Fernandino, 2016). Amodal theories argue for a computational architecture that has the ability to step away from surface similarities in order to generalize on the basis of conceptual similarity (Lambon Ralph, 2008). This is sometimes known as "transformational abstraction" whereby sensory-based representations of category exemplars are iteratively converted into new formats that are more tolerant of variation and noise (Dove, 2020). Another feature of an amodal semantic network is that it can make higher-order generalizations whereby inferences are made when we acquire new information. The new inferences are made based on a concept's abstract meaning rather than its visual featural characteristics. This is what is observed in semantic dementia: when patients are given new information, they undergeneralize (i.e., giving basic categories subordinate labels) and overgeneralize (i.e., giving basic categories superordinate labels) both verbally and nonverbally during receptive and expressive tasks (Lambon Ralph, 2008). Not only the generalization phenomenon, but semantic dementia progresses in a category specific, hierarchical fashion (Dove, 2016). For example, some patients lose the ability to identify specific bird species but are still able to identify a bird as being a bird/animal.

Building on the notion of generalization and inference, there is the problem of flexibility. Concepts are not stable entities; rather, concepts are constantly modulated by context. Technically speaking, you cannot use the same concept twice (Dove, 2016). What further complicates the matter is the problem that no set of entities can be characterized uniquely and precisely by any set of properties (Vigo, 2010). Given the context, the appropriate partition of properties will be utilized for a given concept. We are currently unable to account for how we flexibly produce concepts given the right environment, task, and goals, all while effectively and stably communicating our point to someone who has to comprehend (also in a flexible manner). Moreover, we cannot explain how our concepts combine in a non-linear fashion with characteristic emergent properties (Reilly, 2016). The embodied account that argues concepts are modality specific is drastically inflexible. Symbolic theorists believe that it is the multi-modal nature of amodal theories that allows for concepts to be context sensitive (Widomska, 2017). Some embodied theorists may rebuke this by saying that symbolic accounts have too much flexibility to even be context sensitive at all.

The most cited issue for symbolic theorists is what is known as the symbol grounding problem. The "Chinese room argument" is a thought experiment that can illustrate this problem. According to this argument, in a hypothetical world, an English speaker is isolated in a closed room in which they receive Chinese symbols and is tasked with translating these symbols according to strict rules. The catch is that the English speaker never knows what these symbols actually mean because they have no reference to the outside world (Meteyard, 2010). The lesson here is that experience with objects through our own sensorimotor apparatuses is what makes words grounded and, therefore, causally linked to something. Internal manipulation of symbols with other symbols is deemed to be insufficient for giving words their meaning (Louwerse, 2011). Embodied theorists use an analogy that, much like a computer, the imagined subject circularly receives input and generates output but is not conscious of what they are communicating (Louwerse, 2018). Some symbolic theorists respond by positing that there are basic core concepts that are innate. However, embodied theorists contend that there is still a missing link between these core concepts and any new concept (Pulvermuller, 2018). Symbolic theorists may ask the orthogonal question: how then is bodily experience ungrounded?

How do we acquire and understand concepts that are beyond our experience (Dove, 2018)? The discovery of mirror neurons seems to give embodied theorists validation regarding what is considered an embodied simulation. Mirror neurons are defined as motor neurons that discharge during motor movements and, more importantly, during the observation of motor movements (Mahon, 2008). Embodied theorists believe that mirror neurons are evidence of embodied simulations in conceptual analysis. Embodied simulations are referring to the process of understanding the meaning of language by simulating, in our minds, the experience that language describes through semantic memory of a related event (Gallese, 2005). As far as for embodied theorist, they have a major debating point that is a cornerstone to many of their arguments and this involves the mechanism of a metaphor.

Metaphor is such a debated topic when it comes to embodied and symbolic theories that the arguments regarding abstract concepts deserve its own section. Metaphor is an important feature to everyday abstraction in language, and the review of metaphor also gives fair accreditation to the embodied accounts of concepts. Conceptual metaphor theory (CMT) is an ever-popular embodied theory because it is thought to explain abstract concepts. Metaphor, in general, is useful for gaining an understanding as to the nature of abstract concepts. It should be noted that not all research on metaphor is supportive of CMT. Furthermore, not all of CMT's theoretical structure is solid. The following section will explain where CMT may be limiting and why it is not always a sufficient theory for describing abstract concepts or embodiment in general.

CMT stresses that metaphor is abundant in everyday language, not just in special cases (e.g., poetry). Many of our everyday metaphors are conventional, and we often do not realize when we are employing metaphor. For instance, when I state that "CMT's theoretical structure is not all that solid," I am using a metaphor that is treating the theory as having a foundation akin to a building. Here, CMT argues that metaphor takes a concrete subject (buildings) and maps the structural features onto an abstract subject (the term "theory") thereby grounding the abstract concept with perceptual features and making it less abstract and more understandable. This is (supposedly) how we exclusively understand abstract concepts. Strong embodied versions of CMT state that there is no independent representation of abstract concepts (Jamrozik, 2016). A corollary is that metaphors are built up from more simple, pre-conceptual image schemas that are learned from our sensorimotor experiences during the earliest stages of development. For example, whenever we bring any category to mind, we are utilizing an overarching image schema (e.g., "CONTAINER"). Here, containment refers to the reoccurring knowledge that objects have an in or out, hold content, and can be full or empty. For these reasons it can be thought that metaphor holds the strongest argument for an embodied account of abstract concepts. The question now is, is there a way to harmonize these arguments that is amendable to both embodied and symbolic accounts?

A Pluralistic Account for Abstraction

There are many conceptual models to account for how we acquire and understand abstract words. The most suitable conceptual models attempt to provide a pluralistic account that includes a reference to symbolic and embodied entities. When a theory is symbolic and embodied, it often means that the theory is accounting for linguistic and sensorimotor effects. For abstract words, the theories that emphasize a symbolic perspective are the most suitable. They are suitable because symbolic theories inherently are equipped to deal with language, and language is essential to understanding abstract concepts. I will go over specific theories that seem to have the most promise for solidifying strong arguments and offsetting counter arguments for representing abstract concepts. However, I will argue that the theory I review last, in particularly, is preferable for explaining our acquisition/understanding of abstraction.

The construction integration model (CIM) was originally a symbolic theory for describing the discourse processing of text (Kintsch, 1991). Discourse processing is how people integrate various parts of a text in order to create a coherent understanding. The model is dominated by propositional representations to create what is called a "propositional net." Propositions comprise concepts that include a predicate or relational concept and one or more arguments. For example, in the sentence "Socrates is a mortal," "Socrates" is the argument because he is the actor, and "mortal" is the predicate because it tells us something about the argument or subject. From this propositional net, a richer representation is formed, including perceptual representations (Louwerse, 2011). CIM views mental images as theoretically futile constructs for representations; instead, images can be expressed by propositions. Purely embodied theories usually work well for individual phrases but cannot account for global text integration, as is the case with CIM. CIM lends itself well to abstract concepts since CIM utilizes propositional representations. CIM contributes specifically to the decoding of sentences containing linguistically oriented abstract words while also improving the experiential embodiment of concrete words (Anderson, 2019). Including the comprehension of text, this model has led to other accomplishments such as the organization of propositions into semantic networks (Reed, 2016).

The dynamic multilevel reactivation framework (DMRF) is a pluralistic account that incorporates an association network. This association network is called abstract conceptual features (ACF) and is particularly important for the characterization and organization of abstract conceptual space (Primativo, 2017). Instead of the typical feature generation method, ACF does not ask individuals to list features but, rather, to rate the importance of particular types of information to the meaning of a given word. These theorists utilize control ratings of the contribution of different types of variables such as sensation, ease of teaching, ease of modifying, action, emotion, thought, social interaction, morality, time, space, quantity, and polarity. These ratings are then used to generate a high dimensional semantic space that represents the meaning of a word as a vector. This space allows for Euclidean distance measurements between individual concepts that are extracted as a metric of semantic relatedness (Crutch, 2013). As a result, the meaning of a given abstract concept can potentially be decomposed into a high-dimensional space factoring a range of these variables. These ratings were designed to measure the features of individual concepts instead of word co-occurrences, thus permitting examination of the similarity between two or more concepts. ACF was developed to examine the notion that domains of cognition, including (and beyond) the realm of sensorimotor and emotional processing, may play an important role in the acquisition and organization of conceptual knowledge. In ACF, many sources of modality-specific information about concepts converge and are bound into a single, coherent representation. This coarsely bound representation is then subjected to symbolic transformation. Therefore, the perceptual and linguistic systems ultimately converge upon a unitary semantic store (Reilly, 2017). The unitary nature of ACF allows us to dispense with the artificial dichotomy of abstract versus concrete concepts. In one study, it was demonstrated that ACF distance metrics outperformed other computational distance metrics analyses in predicting comprehension performance (accuracy) of a patient with global aphasia on a series of spoken word to written word matching tests of verbal comprehension (Crutch et al., 2013). DMRF is keen on current neuroscientific architecture, which provided by ACF also has impressive methodology. However, this is still an incomplete framework since it is missing the explanatory power that a full fledge theory should have.

The interactive grounding hypothesis (IGH) is more of a viewpoint than a theory. IGH supports a symbolic account of cognition, which in turn supports the idea that abstract concepts have a unique characterization (Mahon, 2008). IGH is a form of secondary embodiment, a grade weaker than weak embodiment. As a result of spreading activation, modality-specific activity is secondary to the essential amodal semantic information. The modality-specific information only has a functional role once an amodal concept has been instantiated (Meteyard, 2010). Within IGH, once the amodal concept is instantiated, sensorimotor information is tasked with enriching conceptual processing, grounding it, and providing it with relational context. For instance, the symbolic representation of the concept "beautiful" is given specificity by the sensorimotor information with which it interacts in a particular contextual instantiation such as in "a beautiful *song was composed by the orchestra.*" IGH theorists believe that the available evidence is consistent with the notion that there is a strict representational distinction between primary symbolic concepts and secondary sensorimotor information. Concepts are symbolic and abstract because conceptual processing must be packaged into a format that can be read by the neural system enervating throughout the body. To state their case, these theorists cite two analogies. The first analogy comes from Pavlov's classical behavioral conditioning experiment. In such an experiment, these theorists claim that motor system activation during conceptual processing is analogous to the role that activation of a dog's salivary system has in recognizing the bell. The second analogy comes from the study of lexical access in order to help us reconsider the assumptions that are made about the dynamics of activation flow within and between cognitive systems. During lexical access, speech production travels from a perceptual analysis, to conceptual selection, to lexical retrieval, and then to phonological encoding; each system is qualitatively different. Phonological activation of unproduced words could be analogous to the motor activation that accompanies conceptual processing. While motor activation has been used to constitute conceptual inference, the parallel inference that the phonology of a word is constitutive of a word's meaning would not be made. This highlights the fact that activation often travels between qualitatively distinct levels of processing. Although, this is not to say that sensorimotor activation is inconsequential to conceptual processing. To the contrary, removing sensorimotor information would result in a rather impoverished or isolated concept. As mentioned earlier, sensorimotor content has the role of enriching conceptual processing (Mahon, 2008). IGH gives us sharp insights, but it is more of a viewpoint than a testable and falsifiable theory.

The symbol interdependency theory (SIT) (Louwerse, 2011) may be the strongest of the pluralistic theories. SIT gives a principal role to linguistic rather than perceptual information and proposes that symbols do much of the labor across many cognitive tasks. This is due to the way symbols encode perceptual relations. Proponents of SIT believe it is an oversimplification to claim that words must be grounded to become meaningful since much of language is arbitrary, abstract, and amodal. Instead, language has evolved so as to map onto the perceptual system. Through language, speakers encode the world around them. Thus, the results attributed to embodied simulations can always be traced back to language itself (Louwerse, 2014). Perceptual inputs are transduced into symbols so that the process of understanding words does not necessitate perceptual experience. This is why complex capacities, such as language comprehension, are viewed as being different from lower-level perceptual processes (Malhli, 2018). Importantly, language production and comprehension are not vested in the brain, the computational process, or the embodied representations. Rather, production and comprehension are vested outside the user, in language itself, as a constructed and dynamic practice. Symbols can bootstrap meaning from other symbols because language encodes embodied simulations. To help our understanding, SIT introduces the notions of icons, indexes, and symbols that are hierarchically related. Symbols are hierarchical in that iconic relationships are necessary for indexical relations but not vice versa. An icon is like a portrait; it must have statistical regularity with its referent in order to become iconic. Icons are most often embodied representations. An index has less than a perfect statistical relationship with its referent. For example, determining that smoke could mean fire requires associative learning of smoke paired with fire. Lastly, the symbol has an arbitrary relation to its referent and, as a result, is the most abstract. In short, symbols get their meaning through indexical relationships, which in turn become meaningful through iconic relationships. Most importantly, symbols become meaningful through their relationship with other symbols. The contiguity of a symbol with another symbol offloads the necessity for grounding.

This is said to solve the symbol grounding problem because symbols bootstrap meaning from other symbols and their indexes (i.e., the reason for referring to "symbol interdependency"). This can be interpreted as stressing the importance of abstract-to-abstract mappings. For comparison, one could think about how the "grounding problem" between lexical concepts and phonology is solved. Here, a connection is drawn from the lexical concepts, to a lexical representation, to phonology. Yet, there is no concern as to whether we need a new theory of conceptual representations in order to understand how lexical concepts are "transduced" into phonological information (Widomska, 2017). Hence, just because abstract words themselves might not be grounded in perceptual experiences, abstract words can still indirectly acquire meaning through surrounding concrete words within a linguistic context. This is in accordance with context availability theory whereby the argument states that abstract words rely more on indexical relations than do concrete words (Louwerse, 2018). One of the many cases of this has been shown by the Concrete and Abstract Word Synonym Test (Warrington et al., 1998), a comprehension task in which the subject is asked to choose which of two options is semantically similar to the target item. Results have shown that concrete words, in relation to other concrete words, have not only more but stronger context availability than abstract words. The competence to interpret something symbolically depends upon already having the competence to interpret other subordinate relationships indexically and, ultimately, through icons.

Since embodied relations are encoded in language, SIT theorists believe that extracting meaning from language is computationally feasible. Thus, SIT theorists developed the computational model known as latent semantic analysis (LSA) (Louwerse, 2011). LSA adopts the motto that "one shall know the meaning of a word by the linguistic company it keeps" (Lupyan, 2018, p. 4) as opposed to the perceptual simulations it generates (Lupyan, 2018). LSA is based on the premise that words that have a similar meaning tend to be used in the same or similar linguistic contexts. Rather than looking at the relationship between words and their referents, LSA looks at the relationship between associated words (i.e., the relationship between symbols, indexes, and icons). However, to avoid circularity, there is an acknowledgment that a minimum number of concrete words do need to be grounded to their world referents (Borghi, 2017). LSA is not simply comparing one word to another; instead, LSA is examining the interrelations between words belonging to a semantic field (Louwerse, 2014). Via statistical co-occurrences of words, LSA has an algorithm that uses statistics from the surface structure of a large corpora of text to extract meaning from the latent structure of a global linguistic context (Wang, 2018). The statistical distribution of how words co-occur with one another offers a powerful medium of associative information that goes beyond the statistical distribution of how referent concepts co-occur in real word experience (Connell, 2018). Language, in principle, can capture qualitatively different aspects of the world when compared to embodied simulations. This is because for language, we can analyze the history of a word, question its validity, make inferences, and the effects on society can be interpreted. This is also true with other high-level topics of discussion whereas a simulation is unable to accomplish such cognitive feats. Importantly, it should be recognized that language is fundamentally different from a computer code due to contiguity of linguistic symbols with other symbols. The most important consequence of a theory like SIT is that it can be inferred that abstract words, in the context of other abstract words, can bolster meaning. Evidence for this comes from Malhi (2018) whereby symbolic word pairs (i.e., abstract) with high semantic neighbors were processed faster than iconic word pairs (i.e., concrete) with high semantic neighbors. A high semantic neighborhood is presumed to be the reason that word co-occurrences are so efficient for LSA, making LSA successful during text analysis tasks (i.e., coherence tests, metaphor comprehension, and genre classification of texts; Meteyard, 2010). The next theory piggybacks on SIT in that it envisions powerful implications SIT's concepts have on cognition consequentially.

Language as an embodied neuroenhancement scaffold (LENS) takes an attractive and valuable perspective on language. Language as a neuroenhancement and scaffold is particularly helpful for abstract words, underwriting our capacity for abstract thought. Language is thought to be the internalization of an external symbolic system that can program the user, much like a software program enhances a computer's computational capacity. Language is literally a technology that becomes an integrated part of our conceptual system (Borghi, 2020). Specifically, language enhances the combinatorial properties of non-linguistic cognition. Syntactic properties of language may translate to mentalizing abilities in social situations such as recursively thinking about what someone else is thinking (Borghi, 2018). LENS emphasizes the importance of labels, distributional patterns, and the compositionality of language for our cognitive ecosystem. This theory views language as an internalized symbolic system that is built on an embodied substrate (Dove, 2011). Language interacts with the embodied substrate but does not overlap with it. In this way, language acts as a cue for the brain to activate sensorimotor information and bring that information to the surface when deemed necessary. We learn to become fluent in manipulating grounded symbols in a systematic and productive fashion, which scaffolds cognition and abstract thinking by means of providing a distinctly effective medium of thought. This new medium of thought transforms cognition by offering a representational system that has all the favorable properties identified by supporters of amodal cognition (Dove, 2020).

Each of the presented contending theories fill a certain gap in our understanding of the cognition of abstract concepts. SIT highlights the importance of linguistic context, IGH redefines the line between percepts and concepts, DMRF introduces a new method for analyzing features, CIM finds a way to utilize propositions, and LENS sees language as a tool for cognitive enhancement. Thus, a new question arises about how we should aggregate these theories. Each theory is unique, and it is unlikely that the pieces will fit together uniformly to make one perfect picture. It is important to keep in mind what pieces we are attempting to solve while being careful not to just pick a theory simply because it is elegant or sounds nice. The simplicity in a seemingly uniform theory may not always be the best determining factor for whether a theory is adapted to reality or not.

CHAPTER VII

PROSPECTIVE THEORIES FOR BETTER UNDERSTANDING ABSTRACT CONCEPT KNOWLEDGE

Appraising various theories on how we best learn and understand abstract concepts brings up the question of unification. When studying the cognitive basis of concepts, there seems to be a divide between theories for abstract concepts and theories for concrete concepts. Theories for abstract concepts are more symbolic while theories for concrete concepts are more embodied. Symbolic theories are motivated by computation, and embodied theories are motivated by perceptual features. Moreover, there is also a divide between different kinds of abstract concepts given their heterogeneity (e.g., abstract number concepts, abstract emotion concepts, and abstract social concepts are all distinct subsets). Each category includes very different aspects of the world and seem to abide by different rules.

One key goal of scientific theories is to provide explanations for phenomena. One could argue that theoretical unification strengthens explanatory power. The sectioning of theories could cause a loss in explanatory power as each theory, alone, may not be sufficiently exhaustive. Treating all concepts the same may be useful for some purposes, but we may be missing important principles that only apply robustly for a certain subset of concepts. Thus, one option would be to first find the most general principles about all abstract concepts then become more specific and detailed about the subsets thereafter. Alternatively, we could first figure out all the details about the subsets of concepts and then work our way back to a unifying theory. I suggest that the second option is the better course of action. The first option gives the appearance of blindly devising a theory about abstract concepts wherein we are left with the distinct possibility that we are guiding ourselves by the wrong principles for working out details regarding concept subsets. The second option seems better because by first figuring out the details regarding subsets, we can better determine a vision for what a general theory should be. However, one limitation to this approach is that such a process is counterintuitive to the scientific method. The scientific method obligates that a hypothesis precedes the gathering of evidence; here, we would not be working from a theory that is guiding the process. Additionally, not only is there no means for finding details of the subsets, but there is no means for fitting all of the detailed pieces of the subsets together once identified. Nevertheless, there is a method to accomplish this theory-building goal, and that is through evidence itself. Therefore, it may be best if abstract concept subsets are worked out first.

There is a path toward amending debates between symbolic and embodied views. Embodied theories benefit from arguments stating that we know precisely the content of concepts, specifically sensorimotor information. By focusing on the content of cognitive representations, one can derive organizational principles. As an annotation, this is why SIT is so effective, because SIT benefits from having an explanation for how their symbolic content is grounded (e.g., via icons, symbols, indices, etc.). Thus, for embodied views, the external content from the environment has to be internalized somehow. However, instead of transducing a neuronal signal into a symbolic format, the signal is recreated. On the other hand, symbolic views benefit from knowing the mechanisms for that content. The idea of cognition as symbol manipulation provides a means to precisely define and distinguish psychological processes (Meteyard, 2010). Symbolic theorists believe it is the structure of the internal processor that is important and not the external content of the symbols being manipulated. There is internal consistency whereby the symbols do not change but the processor that creates, interprets, and manipulates symbols does change accordingly. Each view lacks from what the other benefits: a symbolic mechanism and embodied content. Each view, in their extreme forms, seems to collapse logically and evidentiarily. It seems imperative to find a happy medium. Some think that weak embodied and weak symbolic views are approaching that medium and that these views are actually more in agreement than what was once thought. For instance, some argue that it is not the mechanisms or the content that are different but the representational code or representational format (Machery, 2016). Much like a picture and its digitalized representation carry the same information despite being put in different codes, embodied and symbolic views are associates. For instance, a picture can be written in binary code, or it can be written in decimal code, but the picture still has the same content. Thus, it may not be up to theorists to decide what format is most appropriate, but there must be advancements in neurobiological, neurophysiological, and computational modeling for the true format of conceptual content to reveal itself. Thus, we may not really be in need of a new theory for abstract words but a new understanding of how information is exchanged between amodal representations of concepts and the sensorimotor system. Some refer to this as the biological/computational middle layer or the interface. In computer science, the middle layer often refers to the region of connections between the input and output layer, which is responsible for transformation. We need to know what format this interface licenses (Mahon, 2015).

The great majority of studies and theories on abstract words have considered abstract concepts' relationship with concrete concepts rather than studying abstract concept processing alone (Primativo, 2017). It would be fruitful for theories to study the relationship between abstract words and other abstract words as opposed to the typical comparison of abstract words to concrete words. Many characteristics of abstract concepts are just as abstract as the concepts themselves. To help get a better idea of why this is the case, we often understand words or explain words by using synonyms ("that meat tastes like chicken"). More often than not, an abstract word will be explained by using another abstract word in order to understand the prior word. For example, we may understand the concept "liberty" through the concept "emancipation," with both concepts being quite abstract (Wiemer-Hastings, 2005). Abstract-to-abstract generalizations seem to be the missing link for the unification of theories. I have some suggestions for experimental avenues that could lead to better understanding abstract concepts, which may ultimately help bridge this gap between theories. A qualified field to borrow from may be analogical reasoning. Some researchers have reasoned that computing the similarity of two concrete concepts results in an asymmetric feature comparison while computing the similarity between two abstract concepts requires more symmetric comparisons of relational predicates (Hill, 2014). This highlights the importance of abstract-o-abstract mappings and is important in hindsight of the systematicity principle.

This principle states that we often prefer deeper mappings over shallow mappings in which commonalities form a system connected by higher order relations (Gentner, 2017). Experiments using paradigms from analogical research can help us better understand abstract concepts by understanding how such concepts are analogically linked. It could be argued that the relational structure of concepts is stored in abstract domains, allowing processing of abstract domains without having to activate concrete domains (Santiago, 2011). Furthermore, it has been shown in stimulus and response binding experiments that concepts can be integrated even in the absence of perceptual repetition For example, binding theories assume that repeatedly encountering a stimulus can facilitate responding if the response is also repeated. If the stimulus or parts of its features are repeated within the time frame in which the binding is still intact, the previously integrated response is retrieved. This kind of binding is exactly what occurs during prime-probe experiments where abstract concepts bind during response-retrieval due to concept repetition (Singh, 2019). Another type of "generalization" or "binding" comes from the study of chunking. Chunking can be thought of as binding information from different contexts into a single concept (Pecher, 2018). According to (Miller, 1946) chunking is a recoding of where you are "to group the input events, apply a new name to the group, and then remember the new name rather than the original input event" [2] (Lupyan, 2019). Through the gradual alignment of linguistic contexts in which the word appears, a new chunk can be formed to segment the word into a new meaning (Cowen, 2015). Here, segmenting fewer, broader chunks of an experience is thought to indicate a higher level of abstraction (Burgoon, 2013). During discourse, information can be continuously added into the chunk so that it is encapsulated as a conceptual whole while enabling reference to the broader complex concept (Evans, 2016). Ultimately, we could use this kind of chunking between abstract concepts ubiquitously. Paradigms from chunking experiments can surely elucidate as to how abstract concepts generalize to other abstract concepts. I will go over what we currently do know about semantic generalization and make suggestions on where to go from there.

By examining patients with aphasia trained on word generalization, the strict directionality hypothesis was developed (SDH; Santiago, 1999). SDH implies an ontogenetic asymmetry in that more abstract concepts develop from more concrete concepts. SDH also implies a representational asymmetry in that more abstract concepts are represented in terms of more concrete concepts. This suggests that our conceptual apparatuses could look like a skyscraper (Chen, 2016). In this metaphorical building, the upper structures are abstract concepts, which are supported by the concrete bottom foundation; this creates a gradient of abstraction. Evidence for this hypothesis suggests that after training patients with aphasia to generalize abstract words to concrete words, there is increased functional connectivity within and between brain regions for abstract word processing and regions for concrete word processing. Though, it may be important to note that these connections are stronger in the abstract-to-concrete direction than they are in the concrete-to-abstract direction (Nishijima, 2016). In other words, training on an abstract word will spread activation so as to cause more robust processing for concrete words in the same context. Other evidence has been provided that shows an apparent contradiction to this view, indicating that congruent sentences—which have nouns and verbs of both concrete or abstract words—are processed faster than incongruent sentences (Dove, 2020). Moreover, compatible combinations of single words are processed faster than mixed ones. This suggests that there are two separate but parallel conceptual processors, one for abstract and one for concrete, that operate with the lowest costs when words are within the same processing assembly line (Scorolli, 2011).

To figure out the nature and direction of these connections, we must further assess generalization research. For one, it would be useful to manipulate analogies that go from abstract-to-abstract and see if these analogies prime other words or other analogies and the respective directionality of such priming. The specific subject field in which these generalizations or mappings are most efficient could also be addressed. For instance, maybe abstract-to-abstract generalizations work best within the subject of scientific concepts. Such analogies should be compared to see if they are grounded analogies that are directly linked or linking analogies that are indirectly linked. For example, a linking analogy in the field of mathematics could include a link between one branch of mathematics (i.e., the logic of classes) to another branch of (i.e., arithmetic) so as to better understand a mathematical problem (Winter, 2020). More basic and concrete mathematics (such as the number line) that scaffold more complex mathematical subjects are left behind at the expense of more abstract mathematical concepts. With linking analogies, the primary vehicle for abstract comprehension is abstract symbols, but such symbols may invoke grounded representations when the individual assumes it is better for comprehension (Zwaan, 2014). Additionally, common concrete concepts help stabilize the connection between two abstract concepts (Chen, 2016). There is evidence that when patients with aphasia are trained to better understand abstract words, there is increased functional connectivity within and between abstract and concrete word regions (Nishijima, 2016). There is superiority in learned generalizations when you start from abstract words that generalize to concrete words of the same type or context(Hoa, 2008). This is what is known as the Complexity Account of Treatment Efficacy, which is based on the idea that more complex structures are trained to facilitate generalization to less complex structures. Based on differences in imaginability and context-availability, the more complex structures are indeed the abstract words relative to the less complex concrete words. This shows that abstract concepts can actually have an efficiency when dealing with content that is more complex and can result in a greater quantity of generalized learning. Experimentation on the nature of these linking analogies and generalizations needs to be advanced.

Coming back to SIT, there are ways that that concepts learned from SIT can make sense of the phenomenon of generalization. There also are ways to improve on and further experimentally validate SIT. Bootstrapping is not only a way to ground symbols, but it is a way to learn from language by generalizing about the categories of your environment given a situational linguistic context. Generalizations can be seen as a kind of inference capacity about what words co-occur with what other words; each word and its complementary concept contain inferences about how your environment is cut into categories. The more abstract the word, the bigger the context diversity and the more variety of ways categories can be divided. We could expand on new methods of generalization other than how LSA's algorithms use word co-occurrences. There is a method of knowledge organization called Pathfinder Associative Networks (PAN). PAN uses algorithms from graph theory to map concepts into a network of associative strengths to one another. The advantage of this method is that it uses experimental evidence of associative strength rather than corpus information. With PAN, concepts correspond to nodes of a generated network, and the links of the network are determined by patterns of proximity (Schvaneveldt, 1989). Proximity is averaged from similarity judgments, which can be measured using priming experiments assessing reaction time. These strengths can be tested within a participant and between participants. Another interesting feature is that the networks will change within a participant going from novice to expert due to their experience within a field. The hope is that networks will converge to a normalized network state and can be used to generalize across a participant's knowledge organizations. If this kind of validated data can be integrated into an SIT framework, there could be great advantages. This could reveal the literal pathway of how abstract concepts grow from iconic, to indexical, to symbolic in experimental time within a network. More importantly, this could reveal the fluid pathway between abstract-to-abstract concepts. Moreover, this would be a step in the direction of going from a dictionary view of knowledge to an encyclopedic view of knowledge. As we have seen, full-fledged knowledge and concepts are far from just lexical entries and have background information that are filled with connotations related to the sensorimotor environment (Gallese, 2005). For instance, as is the case with aphasia, individuals often exhibit behavior that would suggest they have linguistic knowledge loss while also exhibiting behaviors of having a sense of conceptual knowledge. Thus, if knowledge were simply represented as co-occurrences, aphasics should lose conceptual knowledge as well as linguistic knowledge (Barsalou, 1999).

The efficiencies or advantages of abstract words are especially important. The efficiencies allow us to understand the deficiencies. The efficiencies tell us how to implement interventions or preventions for word leaners who struggle with abstract words. Examples of people who struggle with abstract word learning are those with developmental language disorders or autism spectrum disorder. Here, deficiencies can be determined so as to employ suitable experimental paradigms to help deliver more efficient abstract word learning and language skills. For instance, we could provide learners with the correct linguistic context during reading that is most conducive to efficient performance and subsequent learning. Parallel to the concreteness effect, an abstractness effect that hypothetically brandishes efficiencies with abstract words could shed light on ways to treat these disorders.

There are also ways to leverage advantages observed during abstract word processing. When controlling for age of acquisition, context availability, familiarity, imageability, and other variables, abstract words have reaction time advantages over concrete words (Dove, 2014). It may be interesting to consider why there is an advantage rather than equivalent processing efficiencies. Dove (2014) suggests that one possibility for this could be that abstract words require one less processing step relative to concrete words. With concrete word pairs, the first step is visualization, and the second step is mental manipulation. In contrast, with abstract word pairs, there is only one single step of mental manipulation (Malhi, 2018). An additional benefit may be from the fact that linguistic symbols are re-combinable in a way that non-linguistic embodied and grounded cognition is not. This independent structural flexibility may make it easier for abstract concepts to generate new thoughts and encode unexpected connections between thoughts (Dove, 2018). A third advantage may be an abstract symbol's multimodality. Abstract concepts can function as an interface between different sensory modalities, facilitating cross-modal associations. A cross-modal association occurs when there is an object and it's perceived visual features and auditory features overlap without having to switch modalities. This kind of multi-modal processing can help us be more efficient in virtually all everyday experiences where we have to make quick decisions based on different stimuli that is constantly incoming. There are reasons that symbol-to-symbol manipulations are more efficient, and this is where experimental evidence can be amended within the LENS framework. Within this theory, symbol-to-symbol manipulation is seen as an enhancement to cognition.

There are other ways to experiment on abstract concepts, as within the field of social psychology. Rather than just introducing language that is abstract, there are other ways to induce a general mindset of abstract thinking. An abstract mindset is an accessible set of cognitive operations that influence how subsequent information is organized and interpreted. For one, certain perceptual stimuli that will induce an abstract mindset can be provided with the instruction to focus on the perceptual whole of the stimulus (Gilead, 2014). Conversely, by focusing on the parts that make the whole, a concrete mindset would be induced. Another technique is to present objects and have participants focus on those objects' similarities; this can help facilitate an abstract mindset. When having participants focus on differences across objects, a concrete mindset typically emerges (Gilead, 2014). Lastly, if an action and the task is to focus on why that action happened, an abstract mindset is induced. Yet, if the focus is on "how" that action happened, a concrete mindset is typically induced (Burgoon, 2013). An abstract mindset has been shown to have considerable effects on many aspects of behavior. For instance, the abstract mindset can cause people to behave in a manner more consistent with their values (Kalkati, 2009). This may give reason for someone to make more efficient goal-oriented decisions. Moreover, a mindset may not be exploiting concepts singularly, but we can utilize this strategy to generate abstract concepts during experimentation.

There are other provisions that should be considered in order for research on abstract concepts to be conducted methodically. When conducting an experiment and focusing on a simulation, or any conceptual activity, we need to consider the depth of that simulation. The mechanics of perceiving something from retrieving/imagining something can be very different and should be made explicit in each analysis. However, some embodied theorists may reject the idea of treating perception and retrieval differently (as they may believe everything is a semblance of perception). The differences may be that the conceptual content is fully conscious, conscious but not attended, unconscious, or simply absent. Furthermore, imagining something from semantic memory may be very different from imagining something from episodic memory. There may be ways to experimentally isolate the neural substrates of unconscious, automatic, conceptual retrieval by minimizing conscious conceptual imagery. Conversely, there may be ways to employ tasks requiring deeper conceptual elaboration such as material at the sentence-level (Fernandino, 2016). Language comprehension (for the most part) uses symbolic representations while embodied representations for words do not necessarily need to be accessed or fully activated (Malhi, 2018). One could imagine tasks where symbolic stimuli may not always require deep conceptual simulations because the linguistic system may be sufficient for the task. Such a task might look like quick-scanned reading with the objective of getting fast representations that are just good enough to complete the task in an allotted time. Neurologically, when we use the terms unimodal, bimodal, and multimodal cortices, we may be considering gradients of depth. Similarly, if we consider the conceptual "building" of abstraction, as we climb the tower, the depth of the conceptual content may increase. Valid theory will give us a sound basis for practical action by knowing what information is important to collect and what information is important to predict.

Overall, it is clear that the specialized field of abstract concept cognition needs something of a paradigm shift to clear up inconsistencies between opposing schools of thought. This may even simply take the form of refining our definitions in some way that makes our theories logically flow more contingently between one another. This could require a process of precisely examining our language and cleaning up our terminology. It is important to know when it is necessary to introduce another mutually exclusive operational construct to the problem, when to eliminate constructs if cumbersome or irrelevant, and when to conjoin mutually inclusive constructs together if a synthesis is required. It is also important to make an effort toward bridging assumptions that can be equivocated in both embodied and symbolic accounts so as to create a more harmonious and coherent pluralistic account of abstract concepts.

CHAPTER VIII

CONCLUSION

This paper was written in the hopes of better elucidating our understanding of abstract concepts in comparison to our more refined understanding of concrete concepts. Yet, there is even much we do not know about concrete concepts, or for that matter, concepts in general. Furthermore, a goal toward "a better understanding of abstract concepts" may seem a bit oxymoronic. This is because we are seeking knowledge about something that by definition has a quality to it that could be argued as incomprehensible or inconceivable given that an abstract concept could have been invented due to an inability to describe such an entity solely with concrete language. Thus, it may not be fully possible for the human mind to understand abstract concepts through a reflection of itself with those very same abstract concepts. In other words, we are trying to understand something using concepts that we don't understand in the first place. This is good reason to study scientific concepts specifically, because in order conduct more wholesome science, we need to understand the very material we are using to describe our science: abstract language. In that respect, we can get a better grasp on what we actually mean and what we are actually referring to in our investigations, thus solidifying our theories. Nevertheless, as outlined in this review, we know that abstract words have psychological distance from their referents. Often, to shorten this distance, we apply metaphor to abstract words by using more tangible concrete words as an anchor. We know that abstractness arises from language and that language reinforces the comprehension of abstract words. One way language reinforces the comprehension of abstract words is through linguistic context, since we know that abstract words have sparse associations or context diversity. Additionally, given that language is symbolic, there is credence for a symbolic account(s) of abstract concepts. Finally, we went over some tactics that may be available to help us reconcile the symbolic versus embodied debate, especially with respect to abstract concepts.

Our use of abstract concepts is essential to being human. By continuing research on abstract concepts, we will hope to gain more insights in how individuals utilize such concepts, and we may then begin to implement intervention plans for those that are deficient with learning/using abstract concepts. If we are looking to get practical benefits form our science, we may hope to enhance the average individual's utilization of abstract concept knowledge. With a better understanding of abstract concepts, the utilization of these concepts will have a clearer and more concise meaning when utilized. As a result, this could give scientists better leverage in attaining more practical interventions with defects that may apply to people worldwide. The use of abstract concepts is universal, which means everyone may have the opportunity to improve their capacity to learn/acquire and more effectively use abstract knowledge. Scientists often ask for more and more concrete terms to better understand an operational construct. Given that 70% of our language is inherently abstract, hopefully, we may no longer fall into this trap.

Therefore, with this purpose in mind, may we continue to venture into the depths of the abstract mind.

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